BOOK OF ABSTRACTS

7th IBERIAN MEETING

AEROSOL SCIENCE AND TECHNOLOGY

TÉCNICO LISBOA

C²TN

9th to 11th July 2019 | Lisbon, Portugal

ORGANIZATION

TÉCNICO LISBOA

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In cooperation with LIFE Index-Air (LIFE15 ENV/PT/000674)

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THE LIFE INDEX-AIR TOOL, SPECIFICALLY DEVELOPED FOR DECISION MAKERS, WILL IDENTIFY ACTIONS TO IMPROVE AIR QUALITY AND QUANTITATIVELY EVALUATE THE IMPACT OF THESE ACTIONS, NOT ONLY ON AIR QUALITY, BUT ALSO ON HEALTH AND WELL-BEING OF THE POPULATION.

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- **QUANTIFY** THE INHALED DOSE OF ATMOSPHERIC PARTICLES
- **EVALUATE** THE EFFECTS OF THE PARTICLES IN HUMAN HEALTH
- **IDENTIFY** ACTIONS TO IMPROVE AIR QUALITY AND HEALTH
- **ENGAGE** THE POPULATION IN COLLECTIVE ACTIONS

IMPLEMENTATION OF THE TOOL IN 5 EUROPEAN CITIES
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TECHNICAL RECORD

TITLE

7th Iberian Meeting – Aerosol SCIENCE and Technology: Book of Abstracts

AUTHORS/EDITORS

Carolina Correia, Inês Cunha Lopes, Isabel Dionísio, Joana Coutinho, Joana Lage, Marta Almeida, Nuno Canha, Rosa Marques, Tiago Faria and Vânia Martins.

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Edited by: Carolina Correia, Inês Cunha Lopes, Isabel Dionísio, Joana Coutinho, Joana Lage, Marta Almeida, Nuno Canha, Rosa Marques, Tiago Faria and Vânia Martins.

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FOREWORD

The RICTA2019 Organizing Committee from the C2TN – Centro de Ciências e Tecnologias Nucleares (Instituto Superior Técnico, University of Lisbon, Portugal) will hold the 7th Iberian Meeting on Aerosol Science and Technology. The event will take place in the Pavilion of Knowledge – Ciência Viva (Lisbon) from 9th to 11th July 2019.

RICTA is an annually meeting that, since 2013, brings together Spanish and Portuguese groups active in aerosol research, as well as researchers from many other countries, combining multi-multidisciplinarity with the highest scientific quality. Portugal has the pleasure to be the host country of this international conference for the first time. During 3 days, experts will have the opportunity to network, find new and longstanding collaborations, exchange ideas, create novel ones, and be inspired by top-level keynote lectures, to further improve the field of aerosol research.

This meeting compromises oral and poster presentations, as well as invited renowned national and international speakers that will perform Plenary Lectures on topics of current significance nowadays in the Aerosol Science and Technology field. Furthermore, this year, the meeting will also benefit from a special session on Urban Air Pollution Mitigation Tools organized by the LIFE Index-Air project.

Therefore, the Organizing Committee is pleased to announce an exciting innovative congress, with scientific presentations covering a wide range of topics.

The Organizing Committee looks forward to your presence and participation to continue the Excellency of the previous RICTA editions.

Lisbon, 9th May 2019.

The National Organizing Committee

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INDEX

PROGRAMME

9 July 2019	
8:30 – 9:00	Reception
9:00 – 9:20	Opening session
9:20 – 10:05	Plenary Lecture: A global overview of hygroscopicity related aerosol light scattering enhancement factors ***Gloria Titos*** **, University of Granada | Spain**
10:05 – 10:30	Coffee Break
10:30 – 13:10	**Session 1 – Atmospheric Aerosols** **Chair: Gloria Titos, University of Granada | Spain**
10:30 – 10:50	Spatial and temporal variation of aerosol radiative forcing using Ceres data ***María Ángeles Obregón*** **, University of Évora | Portugal**
10:50 – 11:10	A statistical overview of the influence of Saharan dust in Sierra Nevada precipitation ***Alberto Cazorla*** **, University of Granada | Spain**
11:10 – 11:30	Closure of optical, chemical and microphysical properties of atmospheric aerosols at two contrasting environments using a Mie model ***Javier Villar*** **, University of Granada | Spain**
11:30 – 11:50	Seasonal variations of chemical composition of PM2.5 fraction in the urban area of Krakow, Poland: PMF source attribution and estimated sources ***Lucyna Samek*** **, AGH University of Science and Technology | Poland**
11:50 – 12:10	Pico Mountain Observatory on top of Pico Vulcano ***Paulo Fialho*** **, University of the Azores | Portugal**
12:10 – 12:30	Catalytic layers from electrosprays ***Jose L. Castillo*** **, National Distance Education University | Spain**
12:30 – 12:50	Synoptic patterns influencing aerosol properties in a South European suburban area ***Marcos Barreiro Romero*** **, CIEMAT | Spain**
12:50 - 13:10	Investigation of Raman and Fluorescence spectra of Bioaerosols for laser Remote Sensing Applications ***Luis Guerrero-Rascado*** **, University of Granada | Spain**
13:10 - 14:30	Lunch
14:30 – 16:10	**Session 2 – Aerosol Instrumentation** **Chair: Maria João Costa, University of Évora | Portugal**
14:30 – 14:50	CFD simulation for improving the tangential aerosol inlet reliability of a Vienna-type DMA ***Imara Ibarra Barajas*** **, CIEMAT | Spain**
14:50 – 15:10	Ceilometer calibration corrections in Icenet ***Pedro Luis Molina Molero*** **, University of Granada | Spain**
15:10 – 15:30	Effect of Nozzle Spacing in the formation of primary and secondary deposits in Multi-Nozzle Inertial Impactors ***Estíbaliz García Ruiz*** **, University of the Basque Country | Spain**
15:30 – 15:50	Improvements on lunar photometry: comparison with star photometer measurements ***Roberto Román*** **, University of Valladolid | Spain**
15:50 – 16:10	SentinAIR Aircam Imager: Satellite Imagery Techniques applied to ground based measurements for Air Quality Monitoring ***Javier Andrey Andrés*** **, SentinAir | France**
16:10 – 16:30	Coffee Break
16:30 – 17:30	**Poster Session**

10 July 2019	
9:00 – 9:45	Plenary Lecture: Where there's smoke, there's fire! ***Célia Alves*** **, University of Aveiro | Portugal**
9:45 – 11:05	**Session 3 – Combustion Aerosols** **Chair: Célia Alves, University of Aveiro | Portugal**
9:45 – 10:05	Polycyclic Aromatic Hydrocarbons in particulate, gaseous phases and tree barks near an industrial complex (Brazil) ***Guilherme Martins Pereira*** **, University of São Paulo | Brazil**
10:05 – 10:25	Aerosol impact on air quality during the 2017 Portugal wildfire season ***Maria João Costa*** **, University of Évora | Portugal**
10:25 – 10:45	PAHs in medium scale biomass burning emissions. Enrichment in ultrafine fly ash. Influence of operating conditions. ***David Sanz*** **, CIEMAT | Spain**
10:45 – 11:05	Intrusion of biomass-burning pollution during a Desert-dust episode at the Izaña Atmospheric Observatory ***Natalia Prats Porta*** **, Meteorological State Agency | Spain**
11:05 – 11:25	Coffee Break
11:25 – 13:05	**Session 4 – Exposure and Health I** **Chair: Mihalis Lazaridis, Technical University of Crete | Greece**
11:25 – 11:45	Modelling population exposure to PM2.5 in Lisbon ***Joana Ferreira*** **, University of Aveiro | Portugal**
11:45 – 12:05	Air quality assessment in schools from the European Sudoe region ***Joana Lage,*** **Instituto Superior Técnico | Portugal**
12:05 – 12:25	Particulate matter exposure during sleep ***Nuno Canha,*** **Instituto Superior Técnico | Portugal**
12:25 – 12:45	Impact of the new generation of cigarettes in the air quality ***Joseph Savdie*** **, Instituto Superior Técnico | Portugal**
12:45 – 13:05	The effect of variability in size distribution metrics of aerosol chemical components on the deposited dose for urban areas in Lisbon ***Konstantinos Eleftheriadis*** **, National Centre for Scientific Research "Demokritos" | Greece**
13:05 – 14:20	Lunch
14:20 – 16:20	**Session 5 – Exposure and Health II** **Chair: Heli Lehtomäki, National Institute for Health and Welfare | Finland**
14:20 – 14:40	Assessment of children's exposure to sized-fractioned particulate matter and black carbon in Lisbon Metropolitan Area ***Inês Lopes*** **, Instituto Superior Técnico | Portugal**
14:40 – 15:00	Air composition of a region near a petrochemical refinery in Brazil and the impacts in health ***Pérola de Castro Vasconcellos*** **, University of São Paulo | Portugal**
15:00 – 15:20	Exposure and inhaled dose of particulate matter by commuters in Lisbon ***Carolina Correia*** **, Instituto Superior Técnico | Portugal**
15:20 – 15:40	Relationship between Planatus A 1 allergen and airborne pollen in two cities of Northwestern Iberian Peninsula ***Ilda de Noronha*** **, University of Porto | Portugal**
15:40 – 16:00	Spread of antimicrobial resistant Staphylococcus aureus in office rooms ***Anna Lawniczek-Walczyk*** **, Central Institute for Labour Protection – National Research Institute | Poland**
16:00 – 16:20	Origin and physical-chemical properties of PM in the metro of Athens ***Luís Mendes,*** **National Centre for Scientific Research "Demokritos" | Greece**
16:20 – 16:40	Coffee Break
16:40 – 17:40	**Poster Session**
18:30 – 19:30	Walk in Lisbon
20:00 - 22:30	Conference Dinner

11 July 2019	
9:00 – 9:45	Plenary Lecture: Modelling PM in the air: current practices and challenges ***Ana Isabel Miranda*** **, University of Aveiro | Portugal**
9:45 – 10:45	**Session 6 - Air Quality Management I** **Chair: Ana Isabel Miranda, University of Aveiro | Portugal**
9:45 – 10:05	Urban aerosol assessment and forecast: Coimbra case study ***Oxana Tchepel*** **, University of Coimbra | Portugal**
10:05 – 10:25	Assessment of particulate matter levels in Central Portugal: What we learn from observations and models? ***Alexandra Monteiro,*** **University of Aveiro | Portugal**
10:25 – 10:45	AVIATOR - Assessing aViation emission Impact on local Air quality at airports: TOwards Regulation ***Victor Archilla*** **, INTA Turboject Test Centre | Spain**
10:45 – 11:10	Coffee Break
11:10 – 12:50	**Session 7 – Air Quality Management II** **Chair: Joana Ferreira, University of Aveiro | Portugal**
11:10 – 11:30	Spatial variability of personal exposure to particles in Lisbon ***Tiago Faria*** **, Instituto Superior Técnico | Portugal**
11:30 – 11:50	Relationship between indoor and outdoor size-fractionated particulate matter collected in urban homes and schools ***Vânia Martins,*** **Instituto Superior Técnico | Portugal**
11:50 – 12:10	Ambient particulate matter source apportionment using receptor modelling in 16 European and Asian urban areas ***Marta Almeida,*** **Instituto Superior Técnico | Portugal**
12:10 – 12:30	Evolution of an intervention to reduce atmospheric pollution: The case Taranto ***Cristina Mangia*** **, CNR Italian National Research Council Institute of Atmospheric Sciences and Climate | Italy**
12:30 – 12:50	Chemical variations in aerosols in an urban environment in the South of Spain: 12 years of study ***Sonia Castillo Fernández*** **, University of Granada | Spain**
12:50 – 14:15	Lunch
14:15 – 15:00	Plenary Lecture: Air Quality in Lisbon Metropolitan Area: plans, measures and an expected rapidly changing future ahead ***Hugo Tente,*** **NOVA University of Lisbon | Portugal**
15:00 – 16:00	**Session 8 – Urban Air Pollution Mitigation Tools I** **Chair: Marta Almeida, Instituto Superior Técnico| Portugal**
15:00 – 15:20	Sources of Children's Exposure to Particulate Matter ***Marta Almeida*** **, Instituto Superior Técnico | Portugal**
15:20 – 15:40	Artificial neural networks as a tool to control urban PM atmospheric levels ***Hélder Relvas*** **, University of Aveiro | Portugal**
15:40 – 16:00	Personal dose of PM10 for students in primary schools in Lisbon ***Mihalis Lazaridis*** **, Technical University of Crete | Greece**
16:00 – 16:20	Coffee Break
16:20 – 17:00	**Session 9 – Urban Air Pollution Mitigation Tools II** **Chair: Konstantinos Eleftheriadis, National Centre for Scientific Research "Demokritos" | Greece**
16:20 – 16:40	Burden of disease attributed to airborne particulate matter in five selected European cities ***Heli Lehtomäki*** **, National Institute for Health and Welfare | Finland**
16:40 – 17:00	LIFE Index-Air – Development of an integrated exposure-dose management tool for the reduction of particulate matter in air and the protection of public health ***Konstantinos Eleftheriadis*** **, National Centre for Scientific Research "Demokritos" | Greece**
17:00 – 17:30	**Final discussion about Urban Air Quality in Europe**
17:30 - 17:50	Awards Ceremony Oral presentation, Poster and PhD Thesis *SolMa* Awards
17:50 – 18:10	Closing session

ABSTRACTS

Plenary Lectures

A GLOBAL OVERVIEW OF HYGROSCOPICITY RELATED AEROSOL LIGHT SCATTERING ENHANCEMENT FACTORS

G. Titos

Andalusian Institute for Earth System Research, University of Granada, Granada, Spain
Keywords: aerosol hygroscopicity, scattering coefficient, relative humidity
Presenting author email: gtitos@ugr.es

Atmospheric aerosols are able to scatter and absorb solar radiation. The magnitude of the radiative impact of aerosol particles depends on their concentration, their size and composition as well as on relative humidity (RH) due to water uptake. Knowledge of the scattering enhancement factor, f(RH), is important for an accurate description of direct aerosol radiative forcing. This factor is defined as the ratio between the scattering coefficient at enhanced RH to a reference (dry) scattering coefficient. Aerosol light-scattering coefficients at humidified and dry conditions can be measured in situ e.g. with humidified tandem nephelometers (e.g., Titos et al., 2016).

In this work we present a global picture of f(RH) measurements. The work is based on a recently re-analysed and harmonized dataset of humidified nephelometer measurements which is openly available (Burgos et al., 2019, in review). The measurements were performed at 26 sites which were mainly part of the ACTRIS and NOAA network.

We investigate the temporal (seasonal and diurnal) and spatial variability of f(RH) measurements for PM_{10} and PM_1 size fractions depending on the measurement site. The measurement sites covered different aerosol types from Arctic, marine, rural to more polluted urban sites. Figure 1 shows the site to site variability of f(RH) exemplarily at RH=85% and λ = 550 nm for PM_{10}. The largest f(RH=85%) values are observed in Arctic sites, followed by marine sites, and the lowest is observed in a desert site. Concerning the diurnal evolution, f(RH) values do not show a clear diurnal pattern, except for urban sites where the variation is larger likely due to rapid changes in aerosol sources along the day. We also explore the relationship between f(RH) and optical variables such as single scattering albedo and Ångström exponent in order to look for possible proxies that could be used to estimate f(RH).

Finally, we present a comparison between our in-situ benchmark dataset of f(RH) and output from several models participating in the AeroCom initiative. The goal of AeroCom is to document and understand the differences apparent in current global aerosol models based on model intra-comparisons and evaluations with measurement data. We found that some models better capture observed measurement diversity while other models exhibit a narrow range of f(RH) regardless of aerosol type. Results at urban sites are particularly inconsistent likely due to greater variability in local sources. These results indicate that this approach shows potential for constraining simulations of aerosol/water interactions and improve model radiative forcing estimations.

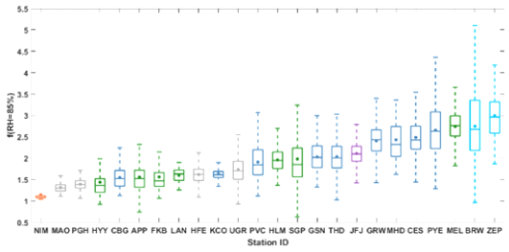

Fig. 1. Boxplots of light scattering enhancement factor by site type (orange = desert, grey = urban, green = rural, dark blue = marine, purple = mountain, light blue = Arctic).

Burgos, M.A. et al.: Data Descriptor: A global view on the effect of water uptake on aerosol particle light scattering, Scientific Data, 2019 (in review).

Titos, G. et al.: Effect of hygroscopic growth on the aerosol light-scattering coefficient: A review of measurements, techniques and error sources. Atmos. Environ., 141, 494 – 507, 2016.

This work was essentially supported by the Department of Energy (USA) under the project DE-SC0016541.

WHERE THERE'S SMOKE, THERE'S FIRE!

C. Alves

Centre for Environmental and Marine Studies, University of Aveiro, 3810-193 Aveiro, Portugal.
Keywords: wildfires, emission factors, organic speciation
Presenting author email: celia.alves@ua.pt

Wildfires are predicted to increase with global climate change, resulting in longer fire seasons and larger areas burned. On the other hand, the use of fire to reduce or dispose of vegetative debris is a worldwide and long-standing practice, since it is a quick and inexpensive way to manage the large amounts of residues. However, the smoke from both sources affects human health, worsens air quality, and can trigger severe regional haze events. At both national and international levels, there is an increasing focus on the establishment of emission inventories and regulations of regional carbon emissions to the atmosphere. From the standpoint of atmospherically-based carbon monitoring programs, fires are challenging because they tend to be extremely variable in both space and time, they are expected to increase in number and severity, and because emission estimates depend on biofuel characteristics and combustion phase. In addition to high spatial and temporal variations in fuel loadings and lack of observational data, one of the most influential and variable parameters is the emission factor. Emission factors (EFs) of selected species for major biomes have recently been reviewed and summarized by Akagi et al. (2011). However, due to the variability and complexity of the burning conditions and limited on-site experiments, EFs for many biofuels are still uncertain. In addition, EFs measured in the laboratory may substantially differ from those obtained in the field.

With the aim of quantifying and characterizing the emissions of trace gases and aerosol particles from representative wildfires and open agricultural burning events, the University of Aveiro has developed techniques to sample the smoke plumes under real conditions and to perform the detailed characterization of both the gas and particulate phases. The new datasets include carbon oxides, organic and inorganic volatile compounds, and a vast array of particulate constituents, including organic and elemental carbon (OC and EC), water soluble ions, metals and hundreds of individual organic compounds.

The comprehensive databases may be useful for numerical models to evaluate the impact of wildfires in the Mediterranean region, which is particularly uncover by this type of studies. This research may also contribute to improve source apportionment models allowing to estimate the input of wildfires to the atmospheric levels at specific monitoring sites. The results consolidate previous argumentations that smoldering emissions make a significant contribution to the total emissions, and therefore cannot be neglected. The smoke plume is mainly composed of fine particles containing carcinogenic (e.g. polycyclic aromatic hydrocarbons) and compounds that cause oxidative stress (e.g. phenolics). Thus, populations regularly exposed to fire smoke are at high health risk. Smoke particles are carbonaceous in nature with a clear dominance of OC and much higher OC/EC values than those reported in the literature for other sources. Since EC plays a key role in radiative forcing and considering the discrepancies between the various studies, the magnitude of the emission factor for EC remains uncertain and deserves further investigation.

The experimental work was performed within the project entitled “Contribution of biomass combustion to air pollutant emissions (BIOEMI)”, PTDC/AMB/65706/2006, funded by the Portuguese Science Foundation (FCT). The data treatment was partially carried out in the frame of the project “Chemical and toxicological SOurce PROfiling of particulate matter in urban air (SOPRO)”, POCI-01-0145-FEDER-029574, funded by FEDER, through COMPETE2020 - Programa Operacional Competitividade e Internacionalização (POCI), and by national funds (OE), through FCT/MCTES.

Akagi, S.K., Yokelson, R.J., Wiedinmyer. .C, Alvarado, M.J., Reid, J.S., Karl, T., Crounse, J.D., Wennberg, P.O. (2011) Emission factors for open and domestic biomass burning for use in atmospheric models. *Atmos. Chem. Phys*. 11, 4039-4072.

MODELLING PM IN THE AIR: CURRENT PRACTICES AND CHALLENGES

A.I. Miranda[1]

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Keywords: air quality model, study cases, approaches and scales
Presenting author email: miranda@ua.pt

Air quality models use mathematical and numerical techniques to simulate the physical and chemical processes that affect air pollutants, namely PM, as they disperse and react in the atmosphere. Based on meteorological and emission data inputs, these models are designed to characterise primary PM emitted directly into the atmosphere and, in some cases, secondary PM formed as a result of complex chemical reactions within the atmosphere.

They are important in air quality management systems because they are widely used to provide the identification of source contributions to PM air quality problems and to assist in the design of effective strategies to reduce this pollutant in the air. Moreover, air quality models can also be used to predict future PM concentrations from multiple sources after the implementation of a new regulatory program, in order to estimate the effectiveness of the program in reducing harmful exposures to humans and the environment. Aerosol air quality models are also used in the analysis of acute episodes like the 2003 heat wave (Hodzic et al., 2006) and in the assessment of the impacts of emission control strategies (Duque et al., 2016).

Air quality models can be classified with respect to the scale of the phenomena they are developed to simulate. In fact, scale separation has proven to be a quite successful approach for atmospheric modelling, because different approximations and parameterisations can be applied for the different phenomena occurring in the different scales. Hence, models can be classified into global, mesoscale (including regional and urban) and local.

As the name implies, global models consider the transport of pollutants throughout the atmosphere, with no artificial restriction of the domain. The large spatial extent of these models dictates that the spatial resolution (grid spacing) must be relatively coarse to keep the computational demands within reasonable bounds. Nowadays, several applications of chemistry climate models consider aerosols.

Mesoscale models, which include regional and urban models, consider spatial scales ranging from a few hundred to a few thousand kilometres, over which many of the most pressing PM concerns are important. Models on these scales are generally the most important for policy makers. For instance, Relvas et al. (2017) applied an integrated assessment model to identify the most cost-effective mix of urban policies for reducing human exposure to PM10, answering questions like “in which sector(s) will our investments be more effective?” or “how much will we benefit in terms of health (avoided costs) from our investments?”.

Local scale modelling is typically used to assess the impact of single sources, or small groups of sources, over distances ranging up to tens of kilometres. There are several studies applying Computational Fluid Dynamics (CFD) local models to estimate PM concentrations in build-up urban areas (e.g. Borrego et al., 2006 or Rafael et al., 2018).

The main purpose of this work is to overview current PM modelling activities and to discuss nowadays PM modelling challenges

Borrego C.; Tchepel O.; Costa A.M.; Martins H.; Ferreira J., Miranda, A.I. (2006) Traffic-related particulate air pollution exposure in urban areas. *Atmospheric Environment*, 40, 7205-7214.

Duque L., Relvas H., Silveira C., Ferreira J., Monteiro A., Gama C., Rafael S., Freitas S., Borrego C., Miranda A.I. (2016) Evaluating strategies to reduce urban air pollution. *Atmospheric Environment*, 127, 196-204.

Hodzic A., Vautard R., Chepfer H., Goloub P., et al. (2006) Evolution of aerosol optical thickness over Europe during the August 2003 heat wave as seen from POLDER data and CHIMERE model simulations. *Atmos. Chem. Phys.*, 6, 1853-1864.

Rafael S., Vicente B., Rodrigues V., Miranda A.I., Borrego C., Lopes M. (2018) Impacts of Green infrastructures on aerodynamic flow and airquality in Porto’s urban area. *Atmospheric Environment*, 190, 317-330.

Relvas H., Miranda A. I., Carnevale C., Maffeis G., Turrini E., Volta M. (2017) Optimal air quality policies and health: a multi-objective nonlinear approach. *Environmental Science and Pollution Research*, 24(15), 13687-13699.

AIR QUALITY IN LISBON METROPOLITAN AREA: PLANS, MEASURES AND AN EXPECTED RAPIDLY CHANGING FUTURE AHEAD

H.Tente

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Keywords: air quality plans, measures, mobility and transports, Lisboa
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Urbanization is a clear mark of human development in the last decades (UN, 2018), turning cities in an even more charismatic and atractive dynamic areas. Not surprisingly this growing attractiveness came with several burdens attached in which air pollution is one of the major examples.

To reverse this air quality degradation trend the European Commission established a framework in the late 90's introducing the figure of the Air Quality Plan, according to which Member States had to improve air quality where health and ecosystem protection based limit values were surpassed and maintaining good air quality elsewhere (EC,2008). Lisbon and its metropolitan area was one of the areas where this AQ plans were implemented in Portugal (Miranda *et al.*, 2015). PM_{10} and NO2 were the air pollutants focussed in two sets of AQ plans (published in 2006 and 2017 – Ferreira *et al.*, 2015). The idea is to draw up an idea of what were the adopted measures as well as it's results to date such as the evolution in PM_{10} measured levels

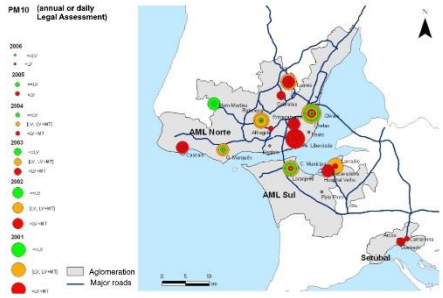

Figure 1. PM_{10} assessment overview in 2007 AQ plan.

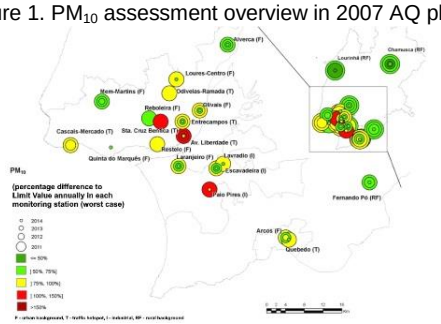

Figure 2. PM_{10} assessment overview in 2017 AQ plan

Meanwhile, we're in the era of sustainable smart cities and Lisbon embraced this challenge with enthusiasm so it is looking ahead to a wide set of modifications coming by, especially in what urban mobility is concerned.

Traffic management, a Low Emission Zone (LEZ), Integrated Transport Systems (ITS) technologies, sharing and integrated transport modes, promotion of walking, bulding an important cycle network, tackling the freight transport in more sensible areas, modifying urban structures and, last but not the least, adopting a people centric policy instead of a car centric one; are a significant part of the actual strategy for reducing emissions within the city. Some other measures, especially a part of those that need to tackle currently unaddressed sectors will be focussed as well as what are perceived near future challenges in this domain. Potential sinergies between air quality improvement measures and Climate Change related strategies will also be addressed.

The work that is going to be presented was partially supported by Comissão de Coordenação e Desenvolvimento Regional de Lisboa e Vale do Tejo and also by Câmara Municipal de Lisboa.

EC (European Commission), 2008. Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe, Official Journal of the European Union L 152

Ferreira F., Gomes, P., Tente, H., Carvalho, A.C., Pereira, P., Monjardino, J. (2015). Air quality improvements following implementation of Lisbon's Low Emission Zone. *Atmospheric Environment*. Volume 122, pp 373-381

Miranda, AI; Silveira, C; Ferreira, J; Monteiro, A; Lopes, D; Relvas, H; Borrego, C; Roebeling, P. (2015) Current air quality plans in Europe designed to support air quality management policies. *Atmospheric Pollution Research*, vol 6, pp 434-443

United Nations (2018). World Urbanization Prospects: The 2018 Revision: key facts. https://population.un.org/wup/Publications/Files/WUP2018-KeyFacts.pdf

Oral Presentations

Session 1 - Atmospheric Aerosols

SPATIAL AND TEMPORAL VARIATION OF AEROSOL RADIATIVE FORCING USING CERES DATA

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Keywords: global aerosol radiative forcing, CERES, aerosol optical thickness
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Atmospheric aerosol particles, of both natural and anthropogenic origin, interact directly with solar and terrestrial radiation through scattering and absorption as well as through emission processes, modifying the Earth's radiative balance. This effect is quantified by the aerosol radiative forcing (ARF), which is calculated as the change in the radiative balance at a given level due exclusively to the presence of aerosols. One of the main challenges of the climate community for climate projection is to reduce the uncertainty in estimating global ARF and to also quantify their local impact. For that purpose global coverage data is more useful, such as those provided by instruments on board satellite platforms.

The aim of this study is to analyse the spatial and temporal variation of ARF on a global scale. For this purpose, CERES (Clouds and the Earth's Radiant Energy System) SYN1deg products, version Ed4A, which provides radiation data at 1º (lat/lon) spatial resolution, have been used to calculate ARF. Shortwave ARF (SWARF) and longwave ARF (LWARF) at the Earth's surface (SURF) and at the top of the atmosphere (TOA) have been calculated using the CERES satellite-based 18-year database (Mar. 2000–Feb. 2018). The mean (and standard deviation) LWARF and SWARF values obtained at SURF are 1.4 (1.8) and −7.1 (7.8) W m $^{-2}$, respectively. The mean (and STD) ARF at SURF is –5.7 (7.1) W m $^{-2}$, indicating a global cooling of the SURF due to the reflection of the incoming solar radiation. At TOA, the mean (and STD) LWARF and SWARF values are 0.3 (0.6) and -3.9 (4.0) W m $^{-2}$, respectively and the mean (and STD) ARF is also negative, -3.6 (3.7) W m $^{-2}$.

A spatial analysis reveals that larger negative ARF at SURF occurs in India, Middle East, East Asia, West Africa and South America regions, which is consistent with the correspondent distribution of the aerosol optical thickness (AOT). A similar ARF distribution pattern is observed at TOA, although the values are less negative and even positive in the North Africa region. These spatial distributions vary throughout the year, as well as the ARF values. The most negative ARF values, in all mentioned regions, are obtained in summer, when AOT values are higher. The mean (and STD) seasonal ARF values at SURF are -5.8 (6.9), -7.1 (7.9), -5.2 (5.5) and -4.7 (5.3) W m^{-2} respectively for spring (MAM), summer (JJA), autumn (SON) and winter (DJF) seasons; while the corresponding ARF values at TOA are -3.5 (3.6), -4.1 (4.2), -3.3 (2.6), -3.4 (3.0) W m^{-2}.

This work was partially supported by FCT (Fundação para a Ciência e a Tecnologia) through the grant SFRH/BPD/86498/2012; by the European Union through the European Regional Development Fund included in the COMPETE 2020 (Operational Program Competitiveness and Internationalization) through the ICT project (UID/GEO/04683/2013) with the reference POCI-01-0145- FEDER-007690 and also through ALOP (ALT20-03-0145-FEDER- 000004) and DNI-A (ALT20-03-0145-FEDER-000011) projects, as well as by Spanish Ministerio de Economía y Competitividad through project CGL2014-56255-C2-1-R. Special thanks to the CERES Science

A STATISTICAL OVERVIEW OF THE INFLUENCE OF SAHARAN DUST IN SIERRA NEVADA PRECIPITATION

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Keywords: Saharan dust, precipitation, aerosol, Sierra Nevada, back-trajectories
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The study of precipitation on mountainous environments is of vital importance since they are very sensitive to climatic variations. Snow places a crucial role on water reservoirs, having special relevance on semiarid regions like the south of Spain. Sierra Nevada is one of the mountain ranges of higher altitude in Europe and represents a real-life laboratory for studies related to climate change and its impact on precipitation and water reservoirs.

On the process of formation and evolution of clouds, the atmospheric aerosol is pivotal, acting as cloud condensation or ice nuclei making possible the formation of cloud droplets and ice crystals respectively.

Air masses may transport particles from long distances, and it is particularly important the transport of mineral dust from the Sahara given its influence on precipitation and its high impact on the study area.

A total of 10 hydrological years (from September 2008 to September 2018) are analysed in order to assess the influence of mineral dust on cloud formation.

Precipitation, along with air temperature, relative humidity, wind speed and direction, solar and longwave radiation, and pressure, are monitored by the Fluvial Dynamics and Hydrology Research Group (DFH) at Refugio Poqueira (37.03N, 3.32W, 2510 m asl. Precipitation events (at least 5 mm of precipitation) are determined and a back-trajectory analysis using the HYSPLIT (HYbrid Single-Particle Lagrangian Integrated Trajectory) model with the ERA-Interim meteorological data sets (0.5º resolution and 37 isobaric levels up to 0.1 hPa) is used to classify the precipitation events according to the air mass origin. A total of 307 precipitation events are analysed.

In addition, during autumn-winter 2017-2018 chemical composition of wet deposition is used as indicator of the presence of mineral dust or other components at different air masses origins.

Results indicate that the years with more precipitation (2009, 2010 and 2012) present a larger occurrence of precipitation events with air masses of Atlantic with African influence (Fig. 1). An example of these air masses is shown in Fig. 2.

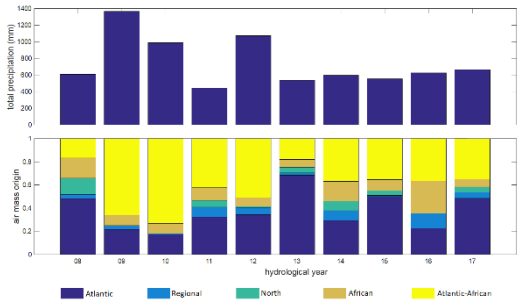

Fig. 1. Top panel shows the total precipitation per hydrological year. Bottom panel shows the air mass origin (fraction) per hydrological year.

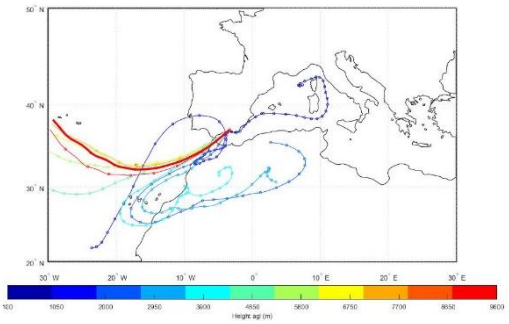

Fig. 2. Back-trajectories reaching the mountain site during a precipitation event where air masses come from the Atlantic with Saharan influence.

This work was supported by CGL2015-73250-JIN, CGL2016-81092-R, CGL2015-70741-R and ACTRIS-2 (Ref. 654109).

CLOSURE OF OPTICAL, CHEMICAL AND MICROPHYSICAL PROPERTIES OF ATMOSPHERIC AEROSOLS AT TWO CONTRASTING ENVIRONMENTS USING A MIE MODEL

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Keywords: Aerosol, scattering, closure, absorption.
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Atmospheric aerosols play an important role in climate and can affect human health. The Earth radiative balance is affected by the optical properties of aerosol since they may scatter and/or absorb light. Aerosol particles size distribution and chemical composition are the key factors controlling the aerosol optical characteristics. The main objective of this study is to perform a closure between aerosol optical, chemical and microphysical properties of atmospheric aerosols using the Mie model at two different environments.

Thus, to reach this objective, an Aerosol Chemical Speciation Monitor (ACSM) was deployed to measure submicron inorganic and organic aerosol concentrations. Black carbon (BC) concentrations were measured by a Multi-Angle Absorption Photometer (MAAP). The particle number size distribution was measured using a Scanning Mobility Particle Sizer (SMPS) in the diameter range 13.6-615.3 nm and an Aerodynamic Particle Size Spectrometer (APS) in the diameter range 0.54-19.81 µm. The aerosol light-scattering coefficient was measured with a nephelometer (TSI 3563) and the absorption coefficient with an aethalometer (Magee Sci. AE33). These measurements were performed in the high-altitude mountain station in Sierra Nevada, Spain (SNS, 37.09 N, 3.38º W, 2500 m a.s.l.) during June 2016 (SLOPE I campaign) and in the IISTA-CEAMA urban background station in Granada from December 2015 to February 2016 (AMICUS campaign). The atmospheric conditions in these two environments are quite different, being affected by varying aerosol sources, which offer additional insights in the results of the closure study.

The input of the Mie model is the particle number size distribution and the overall refractive index of the aerosol population. This bulk refractive index is obtained by volume-weighted averaging using the individual refractive indexes of the chemical components measured with the ACSM combined with the BC mass concentration from MAAP. Due to the available chemical composition measurements, we do not take into account the presence of dust. The outputs of the model are the aerosol light-scattering, backscattering and absorption coefficients, which allow us to calculate the single scattering albedo or extinction coefficient.

During SLOPE I campaign in Sierra Nevada, we obtained that the Mie model derived scattering coefficients agreed within 10% with measurements. Considering the previous results, what we did next was to assume a constant refractive index (i.e. a constant chemical composition) for the whole summer in Sierra Nevada. This refractive index was calculated as the average refractive index during SLOPE I. Fig. 1 shows the comparison of the scattering coefficient derived with the Mie model versus the measured one for the whole summer period (constant refractive index). The correlation between model-derived and measured coefficients is high (R^2=0.86). The model underestimates the measurements especially when coarse particles predominate (bluish colors) while it overestimates the measurements when fine particles predominate (reddish colors).

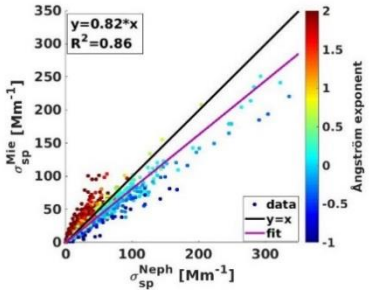

Fig. 1.Calculated aerosol light-scattering coefficient versus measured one.

This work was supported by Andalusia (P12-RNM-2409) and Madrid (Y2018/EMT-5177 Regional Governments by Spanish Government (CGL2015-73250-JIN, CGL2016-81092-R, GCL2017-90884-REDT, CGL2017-85344-R) and by EU H2020 (ACTRIS-2, 654109).

SEASONAL VARIATIONS OF CHEMICAL COMPOSITION OF PM2.5 FRACTION IN THE URBAN AREA OF KRAKOW, POLAND: PMF SOURCE ATTRIBUTION AND ESTIMATED SOURCES

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Keywords: Particulate matter, Elements, Ions, OC, EC, Positive matrix factorization
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Suspended particulate matter constitutes a large part of air pollution in urban centres. Exposure to PM2.5 fraction has adverse effects on human health. It may cause respiratory and cardiovascular diseases. This study is the part of an interdisciplinary research reporting a potential link between air pollution and atherosclerosis. Here we present characteristics of PM2.5 fraction collected during two seasons in Krakow (summer 2017 and winter 2018). The concentration of PM2.5 fraction and concentrations of 15 elements, 8 ions and EC, OC were determined.

Table 1. Seasonal changes in elemental and ionic composition of PM2.5 fraction.

Parameter	Winter (ng/m^3)	Summer (ng/m^3)
PM2.5	47000±24000	18000±4500
Cl	1392±890	<LLD
K	394±180	<LLD
Ti	15±5	17±3
Cr	6.1±0.9	8±3
Mn	13±5	10±5
Fe	203±140	88±45
Ni	3.6±1.0	2.8±0.6
Cu	8±4.6	5±2.4
Zn	107±70	46±30
Br	17±10	3±1
Sr	3.8±0.7	1±0.4
Pb	26±17	11±6
SO_4^{2-}	6300±630	2700±270
NO_3^-	5400±540	500±50
NH_4^+	5700±570	1600±160
OC	19100±10000	4210±900
EC	2100±1300	690±300

Based on chemical composition of PM2.5 fraction the sources of pollution were identified by PMF modelling.

Concentration of PM2.5 fraction was three times higher in winter than in summer. So strong seasonal variations are typical for Poland and representative for Eastern and Central Europe countries, where the energy production is on the base of combustion of fossil fuels (mainly coal). Chemical analyses presented below can give more information and explanation. Chlorine was observed mainly in winter. It may come from domestic boilers (combustion of low quality coal and domestic waste) and/or deicing of roads and pavements. Concentration of Fe, Zn, Br, Sr, Pb was also higher in winter. On the other hand, concentration of Ti and Cr was a little lower in winter when compared to summer. They are soil and/or industry derived elements. During winter, higher concentrations of SO_4^{2-}, NO_3^-, NH_4^+,OC and EC were observed (Table 1). Four source categories were identified from PMF modelling: (i) soil dust, industry and traffic, (ii) secondary aerosols (iii) combustion (iv) biomass burning. For combustion, biomass burning and secondary aerosols, higher concentrations in winter were observed. Traffic, soil and industry contributed to PM2.5 fraction on the same level in summer and winter.

This research has been partly supported by the National Science Center Project No DEC-2016/21/B/NZ7/01747 and by the AGH UST statutory tasks No. 11.11.220.01/1 and No. 11.11.220.01/3 within subsidy of the Ministry of Science and Higher Education.

PICO MOUNTAIN OBSERVATORY ON TOP OF PICO VOLCANO

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Keywords: Free Troposphere, North Atlantic, Aerosol
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Pico Mountain Observatory (OMP) is an established research facility integrated in an international effort aiming at monitoring climate and pollution within the North Atlantic region. OMP (Fig.1) is situated at 2225m above the mean sea level in the summit caldera of the Pico volcano on the Pico Island (Azores Is.). The site samples air masses transported over long distances from North America, the Arctic, Africa, Europe and the equatorial Atlantic above the Marine Boundary Layer (MBL) or the lower Free Troposphere (FT). This strategic location and the high elevation make OMP truly unique with respect to other observatories in the North Atlantic basin, besides providing an excellent base for volcano surveillance (Coen *et al*., 2018). Measurements at OMP are an important part of the international research carried out within an Atlantic chain of atmospheric observatories extending from Ascension Island, Cape Verde, the Azores, the Canaries and Ireland to Iceland, Summit, Greenland and Spitzbergen in Svalbard (Barrie and McGovern, 2018).

Fig. 1. View of OMP after a 2006 module extension (38^0 28'N; 28^0 24'W; 2225 m a.s.l.).

Some of the work, done at OMP, is presented together with a strategy for future activities at the Observatory. The importance of continued measurements at OMP is emphasized. Specifically, OMP could contribute to the international North Atlantic research network operating as a high profile Portuguese station within the World Meteorological Organization Global Atmospheric Watch (GAW) programme and as part of the European Aerosols, Clouds, and Trace gases Research InfraStructures (ACTRIS).

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Coen M., Andrews, E., Aliaga, D., Andrade, M., Angelov, H., Bukowiecki, N., Ealo, M., Fialho, P., Flentje, H., Hallar, A.G., Hooda, R., Kalapov, I., Krejci, R., Lin, N., Marinoni, A., Ming, J., Nguyen, N.A., Pandolfi, M., Pont, V., Ries, L., Rodríguez, S., Schauer, G., Sellegri, K., Sharma, S., Sun, J., Tunved, P., Velasquez, P., Ruffieux, D. (2018), Identification of topographic features influencing aerosol observations at high altitude stations, *Atmospheric Chemistry and Physics*, 18, 12289-12313.

Barrie, L. B. and McGovern, F., (2018), *Protecting the North Atlantic Atmosphere*, Report on the Outcome of an International Meeting on the Twentieth Anniversary of the Aerosol Characterisation Experiment (ACE2), 4-6 July 2017 Tenerife, Spain.

CATALYTIC LAYERS FROM ELECTROSPRAYS

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Keywords: Aerosol Technology, Electrospray, Aerosol deposits
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Aerosolized nanoparticles can be used to prepare catalytic layers with prime structure and morphology, Castillo *et al.* (2014, 2018). A catalytic ink is made dispersing Pt supported on carbon (Pt/C) nanoparticles in ethanol together with an ionomer and a dispersant. The ink is electrosprayed forming a cloud of charged droplets. The evaporation of the ethanol leaves a dry and charged residue with nanoparticle agglomerates, which are electrically driven towards a collecting plate.

Adjusting the electrospray control parameters (needle voltage, plate voltages and ink flow rate), a steady cone-jet electrospray can be maintained at the needle tip leading to well-structured and regular catalytic layers (Figure).

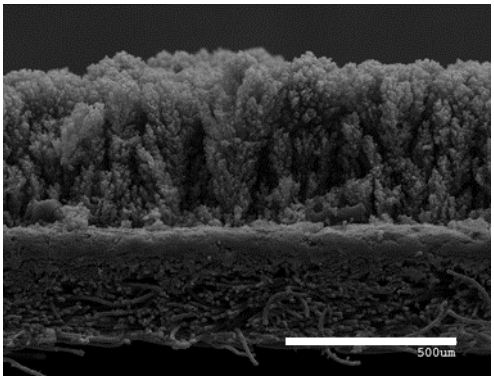

Fig. 1. Lateral SEM micrograph of a deposited catalytic layer, Castillo *et al.* (2018). Length scale 500 □m.

The large porosity and high dispersion of the Pt in the layer enhance the efficiency of the catalyst when used for preparation of ultra-low Pt-loading electrodes for Proton Exchange Membrane Fuel Cells (PEM-FC), Martin *et al.* (2017, 2018). Larger electrodes are prepared by changing the electrospraying settings (Martinez-Vazquez *et a*l., 2015). However, the low throughput of the electrospray remains as the main difficulty to overcome for bringing this technique to the required level for mass production of PEM-FC electrodes. Arrays of electrosprays have been proposed to increase the production rate although the interactions between near electrosprays in the array precludes the preparation of uniform layers. Changes in the electrospray configuration may lead to larger throughputs. Thus, a dielectric hemispherical cap inserted in the electrospray capillary needle promotes the capillary anchoring of the ink to the external cap and leads to the formation of a much larger Taylor cone (Morad *et al.,* 2016). The dielectric cap allows maintaining a steady cone-jet at flow rates even 15 times larger than the flow rates without the cap (*i.e.,* a single capped needle accounts for an array of 15 needles without the dielectric cap). For these larger flow rates, the collected nanoparticles spread on the plate forming larger substrates. Anyway, the efficiency of the PEM-FC electrodes formed with the cap remains almost unaltered.

Other electrospray modifications are under study to produce larger electrodes in a shorter time.

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Castillo, J. L., Martin, S., Rodriguez-Perez, D., Perea, A., Garcia-Ybarra, P. L. (2014) *KONA Powder and Particle Journal* 31, 214-233.

Castillo, J.L., Martin, S., Rodriguez-Perez, D. F.J. Higuera, F.J., Garcia-Ybarra, P.L. (2018) *J. Aerosol Sci.* 125, 148-163.

Martin, S., Perea, A., Garcia-Ybarra, P. L., Castillo, J. L. (2012) *J. Aerosol Sci* 46, 53-63.

Martin, S., Garcia-Ybarra, P. L., Castillo, J. L. (2017) *Applied Energy* 205, 1012-1020.

Martin, S., Garcia-Ybarra, P. L., Castillo, J. L. (2018) *Electrochemistry Comm.* 93, 57-61.

Martinez-Vazquez, B., Sanchez, D.G., Castillo, J.L., Friedrich, K.A., Garcia-Ybarra, P.L. (2015) *Int J. of Hydrogen Energy* 40, 5384-5389.

Morad, M.R., Rajabi, A., Razavi, M., Pejman Sereshkeh, S.R. (2016) *Scientific Reports* 6:38509.

SYNOPTIC PATTERNS INFLUENCING AEROSOL PROPERTIES IN A SOUTH EUROPEAN SUBURBAN AREA

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Keywords: urban aerosols, synoptic meteorology, aerosol number, atmospheric stability
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Air quality in urban areas, where most of the world's population lives, is one of the main concerns of the authorities due to the great impact of air pollution on human health and the environment. The main goal of this work is to perform an atmospheric circulation classification over the Iberian Peninsula (IP) centre with the aim to characterize the prevailing patterns that influence air pollution in this area, with a special emphasis on aerosol mass concentrations and size distributions.

The synoptic climatological approach used in this study groups the year 2015 daily sea level pressure (SLP) fields into a set of categories, using a non-hierarchical k-means cluster analysis. Six clusters were identified, each one representing a specific synoptic meteorological pattern (SMP), and subsequently characterized by meteorology and air quality parameters. Local meteorology was studied from an instrumented tower at different levels. Horizontal and vertical mixing gridded coefficients (K_h and K_z) from the HYSPLIT model characterised the atmospheric stability. Mixing layer height (MLH) was calculated by means of the "simple parcel method" by using vertical profiles from meteorological radiosoundings (Holzworth, 1964). Air pollution data were obtained from several monitoring sites with different features belonging to Madrid air quality networks. Particle number size distributions (PSD) were measured at CIEMAT, an urban background site.

Resulting SMP1 (intense high pressure centre over the western IP) and SMP6 (high pressure centre over the IP and the Mediterranean Sea) grouped most of the anticyclonic situations over the IP, whereas the other SMPs (SMP2 to SMP5) favoured the arrival of Atlantic or continental air mass flows. The variability analysis of stability and local meteorology data according to the different SMPs showed that the higher the SLP over the IP, the greater the atmospheric stability (derived from low MLH and mixing coefficient values) and the less the rainfall and the local wind flow. The impact of the SMPs on particle mass concentrations at the local scale showed higher mean PM10andPM2.5 concentrations for SMP1 and SMP6 at the urban monitoring site than for the other SMPs. At the suburban and rural monitoring sites SMP6 presented higher mean PM10 and PM2.5 levels than SMP1, exhibiting the influence of long-range transport episodes of PM in SMP6. Furthermore, averaged PSD showed number concentrations for ultrafine particles higher for SMP1 than for SMP6 which are in close agreement with the calculated MLH (Fig. 1). In summary, SMP1 and SMP6 represent different specific urban pollution episodes for this area. Local anthropogenic sources were the main factor contributing to reach elevated levels of PM10, PM2.5 and PSD in both situations, but at a higher rate in SMP1 than in SMP6. Besides, external contributions of mineral dust contributed to increase the levels of coarse PM in SMP6.

These results confirm the validity of this methodology for discriminating urban pollution episodes under stagnant meteorological conditions, which are not easily recognized analysing other synoptic pressure fields or air mass back-trajectories.

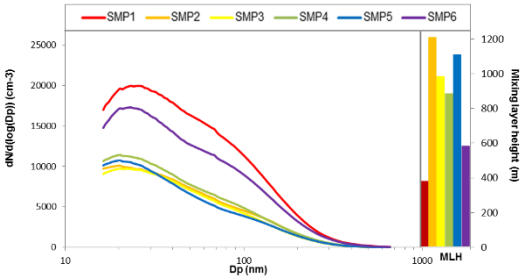

Fig. 1. Particle number size distributions (left) and MLH (right) averaged in each synoptic cluster.

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Holzworth C.G. (1964) Estimates of mean maximum mixing depths in the contiguous United States. *Monthly Weather Review*, 92, 235–242.

INVESTIGATION OF RAMAN AND FLUORESCENCE SPECTRA OF BIOAEROSOLS FOR LASER REMOTE SENSING APPLICATIONS

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Keywords: Bioaerosol, Remote sensing, In-situ, Raman scattering, Fluorescence
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For the proof-of-concept project, Mapping of Atmosphere-Reactive Bioaerosols with Laser Experiments (MARBLE), we are developing a prototype methodology and instrument for bioaerosol monitoring. The basis of our work is the detection of Raman and fluorescence signals that is used in laser remote sensing of atmospheric aerosol pollution. We plan for detecting bioaerosols at many kilometers distance (of height above ground) from the instrument. Detection at such distances provides us with the possibility to significantly extend the warning period before airborne bioaerosols if transported at high altitudes arrive at ground level, compared to ground-based in-situ monitor. Established in-*situ* monitoring of agricultural fields offers only limited spatial coverage, e.g. with regard to identifying pests (bioaerosols) such as fungi and spores. The core of our proof-of-concept study is a complex inelastic lidar spectrometer that has been developped at the University of Hertfordshire since 2013. The instrument consists of a seeded Nd:YAG laser combined with an Opto-Parametric Oscillator (OPO). This set-up allows for the emission of laser light at the core wavelengths 355, 532, and 1064 nm (Nd:YAG) and any other wavelength between 192 nm and 2750 nm (OPO).

In the first step, we investigate Raman and fluorescence spectra of a number of bioaerosol samples under laboratory conditions. We use a microscope and aerosol chambers in a controlled atmospheric environment. The setup includes an Olympus BX51TRF-6 microscope with several objective lenses that have magnification up to 100 times. The Raman spectra are obtained with a HORIBA 1250M Research Spectrometer that has four different gratings. A PI-MAX4 ICCD camera, photo multiplier tubes, and Si and InGaAs detectors are available for data acquisition.

Figure 1 presents examples of measurements of fluorescence spectra of different types of fresh (*Cupressus*, Poaceae, *Olea*) and aged (*Platanus, Cupressus, Parietaria, Olea*) pollen taken from different urban locations at the city of Granada (Spain, 680 m a.s.l.). The spectra were obtained by using the laser wavelenght 532 nm, a grating with 2400 grooves mm^{-1}, and 200 μm slit width. Gold-coated slides (up to approx. 50-nm thick coating) were used to improve signal intensity.

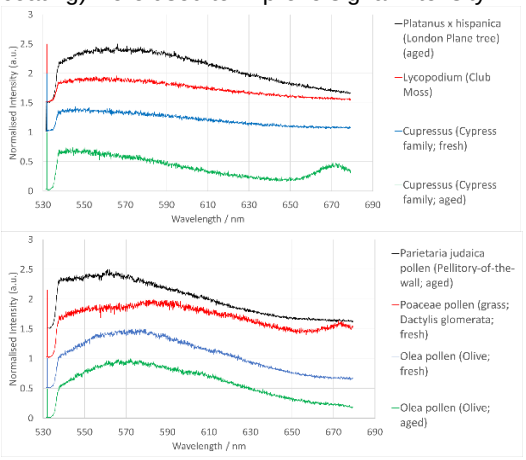

Fig. 1. Fluorescence spectra of fresh and aged pollen.

This work was supported by the University of Hertfordshire through capital investment and the proof-of-concept grant MARBLE. Boyan Tatarov is supported by a Marie-Skłodowska-Curie Action Fellowship of the European Commission (CAPABLE, H2020-MSCA-IF-2015). The authors also acknowledge the Spanish Ministry of Education, Culture and Sport through mobility subprogram José Castillejo 2018 (CAS18/00045).

Session 2 - Aerosol Instrumentation

CFD SIMULATION FOR IMPROVING THE TANGENTIAL AEROSOL INLET RELIABILITY OF A VIENNA-TYPE DMA

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Keywords: DMA, CFD, aerosol, tangential inlet
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The DMA have been studied for decades in order to classify a wide range of particle size. Its correct behavior is determined by the resolution, influenced by Brownian diffusion losses and distortions in the electric and flow field, produced by the configuration of inputs and outputs (Chen and Pui, 1997). One of these configurations is the tangential inlet for polydisperse aerosol, used in the Vienna-type DMA (Winklermeyer, 1991). The use of a tangential inlet reduces the residence time of the aerosol in the annular chamber, and therefore, diffusion losses decrease. In addition, the aerosol flow is distributed evenly before the particles penetrate in the classification region. However, non-uniform depositions of particles were observed in the internal electrode and swirl effects in this configuration (Chen and Pui, 1997). Fernández de la Mora (2017) studied the source of these distortions in the case of the Halfmini-DMA, as well as the development of several solutions to correct them.

In this work the 3D-Computational fluid-dynamics (CFD) was used to analyze the non-uniform particle distribution and the distortions expected in a Vienna-type DMA in previous studies. The procedure includes the geometry design using AutoCAD, the meshing by ICEM-CFD and the fluid-dynamic simulation by Ansys-Fluent (v15.0). The models of k-epsilon viscous, electric potential (MHD) and the injection of solid particles (DPM), considering diffusion or not, have been used (Ibarra, 2018). The calculation results have allowed design alternative geometries of the aerosol inlet, in this case, keeping the tangential inlet.

Fig. 1 shows a simulation example of the modified design. It shows the distribution and velocity of 50nm-particles from the polydisperse inlet to the monodisperse outlet slit, approximating to the optimum distribution requirements in the classification chamber. The penetration efficiency through the inlet slit (before the classification chamber) has been calculated for three particle sizes and both designs, original and modified (Table 1). The new design improves the distribution of the aerosol inside the annular chamber, especially at lower sizes. Even considering the diffusion losses the trend is kept.

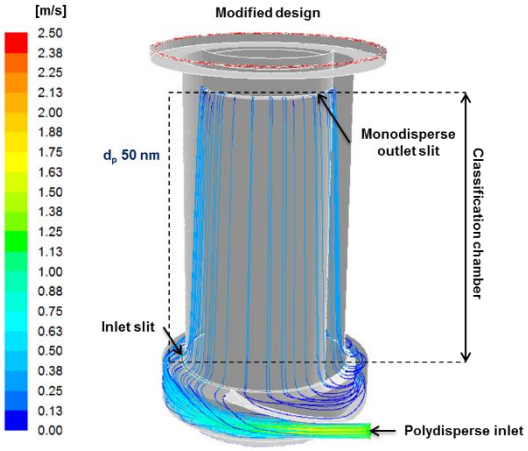

Fig. 1. Particle paths velocity from the tangential inlet to the monodisperse outlet slit.

Table 1. Penetration efficiency to the classification chamber for three size particle.

	Inlet Design	Dp [nm]		
		5	40	300
Diffusion OFF	Original	80.8%	82.9%	86.4%
	Modified	86.9%	86.7%	86.5%
Diffusion ON	Original	71.4%	80.8%	83.3%
	Modified	82.0%	86.0%	87.4%

Chen D. and Pui D.Y.H. (1997). Numerical modeling of the performance of Differential mobility analyzers for nanometer Aerosol measurements. *J. Aerosol Sci. 28-6, 985-1004.*

Winklmayr W. et al. (1991). A new electromobility spectrometer for the measurement of aerosol size distributions in the size range from 1 to 1000 nm. *J. Aerosol Sci. 22, 289 296.*

Fernandez de la Mora J. (2017). Expanded flow rate range of high-resolution nanoDMAs via improved sample flow injection at the aerosol inlet slit. *J. Aerosol Sci. 113, 265-275.*

Ibarra I. et al. (2018). Configuration and operation enhancement of a DMA by CDF simulation. *RICTA'18.*

CEILOMETER CALIBRATION CORRECTIONS IN ICENET

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The interest on vertically resolved aerosol characterization with ceilometers has increased in the last few years with the development of more sensitive ceilometers. The main advantage of the use of ceilometers for aerosol characterization is the automatic and much simpler and unattended operation compared to lidars. As a consequence, the number and spatial distribution of ceilometers providing backscatter profiles 24 hours has been rapidly increasing. The main disadvantage of ceilometers is the reduced signal to noise ratio compared to lidars, making difficult to retrieve aerosol information such as the aerosol backscatter coefficient.

ICENET (Iberian Ceilometer Network) is a collaborative network of Lufft CHM 15k Nimbus ceilometers in Spain. Cazorla *et al.* (2017) presented the network and a methodology for the automatic calibration in order to obtain comparable attenuated backscatter profiles. In this work, a correction of the calibration factor for four instruments from ICENET (Granada, Badajoz, Valladolid and Montsec) has been obtained using ceilometer metadata for four years.

A variation up to 60% of the calibration factor has been found, which was mainly linked to changes of the internal temperature of the ceilometer and the window transmissivity. Several tools have been developed in order to improve the calibration. First, an improved filter for the calibration factor data has been obtained using parameters as internal temperature, window transmissivity or sun position; second, an algorithm has been developed to obtain a polynomial parametrization of the calibration factor that depends on the internal temperature and window transmissivity. These tools allow ICENET to provide accurate calibration function (calibration factors are the polynomial coefficients). Figure 1 shows an example of the filtered mean calibration factor (blue line) and the corrected calibration factor applying the polynomial function (red line). In this example, a sudden change in the window transmissivity (cleaning the window) can be observed around 7:30 and the diurnal pattern due to temperature is also observed from 8:00 until midnight.

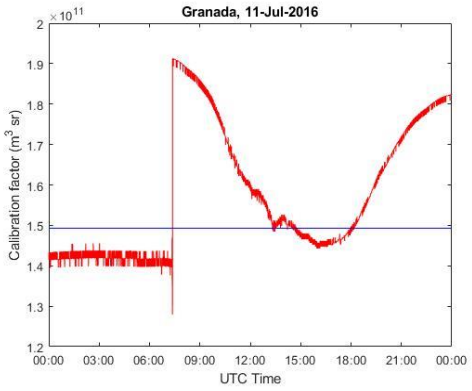

Fig. 1. Calibration factor during the day (red) and filtered mean calibration factor (blue).

Results show that these tools can be used to provide more accurate attenuated backscatter profiles in ceilometers.

This work was supported by CGL2015-73250-JIN, CGL2016-81092-R, CGL2014-56255-C2-1-R and ACTRIS-2 (Ref. 654109).

Cazorla, A., Casquero-Vera, J. A., Román, R., Guerrero-Rascado, J. L., Toledano, C., Cachorro, V. E., Orza, J. A. G., Cancillo, M. L., Serrano, A., Titos, G., Pandolfi, M., Alastuey, A., Hanrieder, N., and Alados-Arboledas, L. (2017) Near-real-time processing of a ceilometer network assisted with sun-photometer data: monitoring a dust outbreak over the Iberian Peninsula. *Atmos. Chem. Phys.*, 17, 11861-11876

EFFECT OF NOZZLE SPACING IN THE FORMATION OF PRIMARY AND SECONDARY DEPOSITS IN MULTI-NOZZLE INERTIAL IMPACTORS

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Keywords: Inertial impactor, Collection efficiency, Stokes number, jet-to-jet interaction.
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Particle deposits in an inertial impactor stage can be classified as primary or secondary. The primary deposits are directly downstream of each nozzle. Secondary deposits can be in the form of a halo around the primary deposit or of straight-lines between adjacent nozzles.

The jet-to-jet interaction in multi-nozzle inertial impactors and the formation of secondary deposits has been analyzed and quantified as a function of the distance between nozzles and the Reynolds number. This work has been studied experimentally and numerically, using CFD analysis to provide insight into the physical mechanisms for the formation of the secondary deposits and to support the experimental results.

To accomplish the objectives of this study an experimental impactor with interchangeable nozzle plates was designed. Each nozzle plate had three nozzles located on the vertices of an equilateral triangle. Four nozzle plates were made with nozzle-to-nozzle spacings of 2.5W, 4W, 6W and 8W, where W is the nozzle diameter. For each experimental condition, the impactor efficiency was measured with different particle sizes generated with a VOAG, to determine the collection efficiency curve.

From the experimental results it may be concluded that the jet-to-jet interactions can produce four non-ideal effects: premature primary deposits with a half-moon shape, straight-line deposits between nozzles, nozzle plate deposits between nozzle exits (losses), and dispersion of the halo deposits.

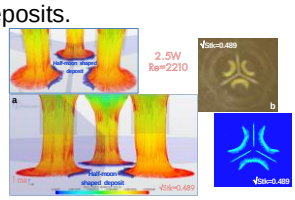

Fig. 1. Case Re=2210-2.5W-√Stk=0.489. (a) Tracks of particles and half-moon shaped deposit; (b) Experimental vs. simulated deposits.

The secondary deposits and premature primary deposits reduce the slope of the efficiency curve, and/or displace the $\sqrt{Stk}_{50}$ towards smaller values and/or generate tails at the low end. To avoid the formation of the additional deposits generated by jet-to-jet interactions (premature primary, straight-line and nozzle plate deposits), the nozzle-to-nozzle spacings have to be larger than 4W and/or the impactor should work at low Re (in this work Re≅465), even at 2.5W spacing.

In the study CFD models are introduced and validated to describe the flow field on the experimental impactor (3 impinging jets) and to determine the particle deposition mechanisms (primary and secondary deposits) for each experimental condition carried out. For the determination of particle trajectories, a steady state numerical analysis was carried out for laminar and turbulent flow continuum regimes. In addition to that, the effect of gravity and the so-called stochastic turbulent models on particle trajectories was also studied.

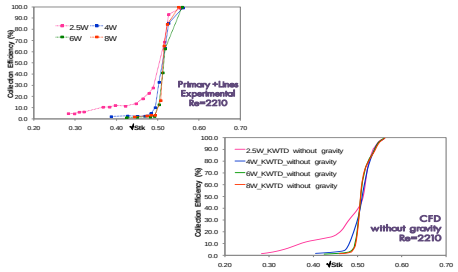

Fig. 2. Case Re=2210. Comparison between numerical and experimental efficiency curves.

The simulation results show that: (1) The half-moon shaped premature primary deposits are formed due to the deviation of the jet caused by the recirculation of the jet-to-jet interaction, (2) The straight lines deposits are formed by particles that are not able to follow the high velocities generated in the recirculation zone between pairs of jets and are separated inertially in the line of stagnation between them, (3) The nozzle plate backside deposits are formed with particles of the interaction region that ascend to the nozzle plate in the area in which the three jets converge, (4) with respect to the halo, the analysis of the formation of the halo must take into account both inertial and gravitational effects. Thus, it should be observed based on the combination of the Reynolds and the inverse Froude numbers, and (5) The halo has an unacceptable effect on the lower Reynolds number, Re≈500, and inverse Froude numbers of the order of 10^{-3}.

Rader (1985), Rocklage (2013), Arffman (2011).

IMPROVEMENTS ON LUNAR PHOTOMETRY: COMPARISON WITH STAR PHOTOMETER MEASUREMENTS

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Keywords: Aerosol optical depth, Moon photometry, Star photometry, RIMO
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Sun photometry has proven along decades to be a reliable technique to characterize aerosol columnar properties, mainly aerosol optical depth (AOD), at daytime. However, the AOD at night-time cannot be calculated by this technique, and this information is too relevant, especially in polar areas, where the polar night can last for months, appearing a large gap in the polar AOD data series.

One way to obtain accurate AOD measurements at night-time is by Star photometers (Pérez-Ramírez *et al.*, 2008), but these instruments are expensive and need supervision, hence, the number of them around the world is scarce.

Recently, the new photometer CE-318T, able to perform Sun and sky but also lunar measurements (Barreto *et al.*, 2016), allows automatic and unattended AOD calculations to be performed by lunar photometry. In contrast to Sun photometry, the extraterrestrial Moon irradiance needs to be known in lunar photometry since Moon irradiance is reflected (not emitted) and it constantly changes, especially with Moon Phase Angle (MPA). To solve that, a lunar irradiance model so called RIMO (Barreto *et al.*, 2019), which is an implementation of ROLO model (Kieffer and Stone, 2005), is used. However, some bias and uncertainties in the RIMO/ROLO irradiances has been reported in the literature, which they are propagated in the AOD calculations. Hence, the main objective of this work is to correct the RIMO values and to compare the AOD using this correction with independent AOD measurements taken with Star photometer at Granada (Spain).

Assuming that calibration at daytime of the sun/moon photometer can be translated to the night-time applying a well-known amplification factor, the AOD has been calculated using RIMO for 98 pristine nights at Izaña (Spain). A RIMO Correction Factor (RCF) is calculated thanks to the differences between these values and the theoretical AOD values assuming a smooth evolution of AOD along the night between two consecutive days. RCF has been parametrized as function of MPA for each wavelength.

The AOD at Granada (2016 and 2017) has been calculated applying the RCF to RIMO, and the obtained values have been compared against Star photometer values (Fig. 1). The differences are still significant but the RCF correction improves the accuracy of AOD at night-time.

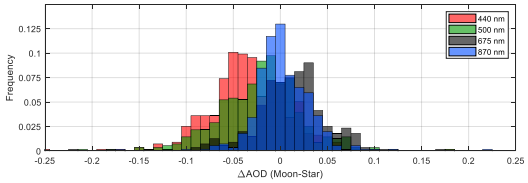

Fig. 1. Differences between AOD from Moon and Star photometers at Granada for four wavelengths.

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Barreto et al. (2016). *Atmos. Meas. Tech.,* 9, 631–654.
Barreto et al. (2019). *Atmos. Environ.*, 202, 190–211.
Kieffer C. and Stone T. (2005). *Astron. J.*, 129, 2887–2901.
Pérez-Ramírez et al. (2008). *Atmos. Environ.*, 42, 2733–2738.

SENTINAIR AIRCAM IMAGER: SATELLITE IMAGERY TECHNIQUES APPLIED TO GROUND BASED MEASUREMENTS FOR AIR QUALITY MONITORING

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In the cities, air quality measurements are taken by a limited number of stations managed by the city councils. These kind of measurements are related to the station and a few hundred meters around. Besides, these kind of stations are expensive to deploy and mantain. For a case where intra-city climate events like pollution events or urban heat islands (UHI) need to be studied, the measurements acquired by the city air-quality stations are not enough, being required urban models or drone measurements.

AirCam Imager fills the gap between good quality local measurements from cities air quality stations and urban models through teledetection techniques. This instrument uses 4 different cameras (1 red-green-blue, 2 or 3 monochrome CMOS detectors and, optionally, an additional 1 infrared detector) with a resolution between 5 and 20 megapixels for the current prototype considered. Coupled to the sensors, different objectives and filters, in the range from 280 to 1050 nm, allow to retrieve the average concentration of aerosols (PM1, PM2.5 and PM10) and chemistry pollutants like O3, H2O, O2, NO2, SO2, NO, CO2… in the path view of each image pixel. AirCam Imager is mounted on a tower permitting the cameras to move into two different axis (lateral and vertical) to cover several views of the city from the same point. Data will be acquired and sent into real time to SentinAir servers to provide air quality real time measurements to the cities. Tomography reconstruction techniques are applied to measurements from different AirCam Imagers to build a cartography of the pollutants in the city.

This work presents the so-called “proof of concept” (POC) of the instrument from a measurement campaign carried out at Toulouse in February-March 2018 as well as the characterization of of aerosol properties (Aerosol optical depth, Angström exponent, PM1, PM2.5) from the first AirCam Imager prototype carried out in 2019. Experiments with a similar approach can be found at Snik et al., (2014) or Igoe et al., (2014).

RGB images allow to exploit the pixels using different azimuth angles to retrieve the aerosol type present in the scenes by using the ratios of Red-To-Blue and and Green-to-Blue.

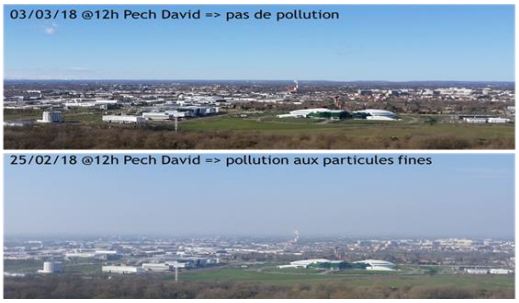

Fig. 1. Example of visibility reduction at Peach David colline (Toulouse) because of a peak of fine particules: PM2.5 concentration of 8.5 ug/m3 for the 03/03/18 and of 40 ug/m3 for the 25/02/18.

Details on how this algorithm works have been tested by radiative transfer simulations and validated from 2018 POC measurement campaign.
In summary, satellite imagery concepts can be exported to ground based measurement, allowing air-quality measurements. This new approach allows to produce pollutant cartographies for the cities to help in the application of city council environmental policies.

Igoe, D. P. et al.. (2014). Smartphone-Based Android app for Determining UVA Aerosol Optical Depth and Direct Solar Irradiances. *Photochemistry and photobiology*, *90*(1), 233-237.

Snik, F. et al., (2014). Mapping atmospheric aerosols with a citizen science network of smartphone spectropolarimeters. *Geophysical Research Letters*, *41*(20), 7351-7358.

Session 3 – Combustion Aerosols

POLYCYCLIC AROMATIC HIDROCARBONS IN PARTICULATE, GASEOUS PHASES AND TREE BARKS NEAR AN INDUSTRIAL COMPLEX (BRAZIL)

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Keywords: environmental chemistry, polycyclic aromatic hydrocarbons, tree bark
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The study objective is to assess the polycyclic aromatic hydrocarbons (PAHs) concentrations in total suspended particles (TSP), gaseous phase (PUF) and tree bark samples collected in the vicinity of the Capuava petrochemical complex. The site is located in an urban-industrial area near avenues and highways in the city of Santo André, São Paulo. The PAHs are very studied due to their carcinogenic properties and this is the first study performed with tree barks in the area.

The TSP and PUF samples were collected simultaneously (dry season – 2016), went through extraction with solvent, fractionation and analysis in a gas chromatograph coupled to a mass spectrometer (GC/MS). The tree bark samples of the species Tipuana and Sibipiruna were collected in the same year. The bark samples were cut and homogenized, then subjected to extraction in a Soxhlet apparatus (dichloromethane) and the PAHs were determined in a GC/MS.

The most abundant PAHs for Tipuana and Sibipiruna samples were fluoranthene, phenanthrene and benzo(b)fluoranthene (carcinogenic PAH) (Figures 1 and 2); benzo(b)fluoranthene is often found as the most abundant PAH in the particulate phase in São Paulo and is attributed to vehicular sources (Pereira et al., 2017). Benzo(b)fluoranthene was predominant in the TSP samples and phenanthrene, in the PUF samples; low weight PAHs in the gas phase samples and tree barks had relatively higher abundance than the observed for the PTS samples. Phenanthrene and fluoranthene are typically found in higher abundance in previous studies with plant materials (Pereira Netto et al., 2007).

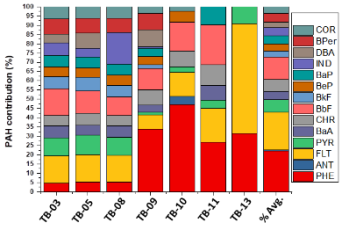

Fig. 1. PAHs abundances and average concentrations for Tipuana tree barks.

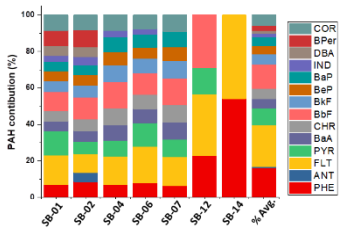

Fig. 2. PAHs abundances and average concentrations for Sibipiruna tree barks.

The sum of carcinogenic equivalents for benzo(a)pyrene, in gaseous and particulate samples, was above 20 ng m^{-3} (high cancer risk above 1 ng m^{-3}).

Good correlations were observed between coronene (vehicular exhaust marker) and fluoranthene in the tree bark samples. The diagnostic ratios fluoranthene/ (fluoranthene + pyrene) were around 0.6 (tree barks), similar to the observed for biomass burning (Tobiszewski and Namiesnik, 2012). The ratios indeno(1,2,3-cd)pyrene/(indeno(1,2,3-cd)pyrene+benzo(g,h,i)perylene) for the tree barks were similar to the observed for petroleum combustion (0.2-0.5). These ratios suggest diverse contributions, such as biomass burning and petroleum combustion, however they should be used with caution.

Conclusions: Tree barks in this area may adsorb pollutants emitted by anthropogenic sources.

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Pereira G.M., Teinilä K., Custódio D., Santos A. G., Xian H., Hillamo R., Alves C.A., Andrade J.B., da Rocha G.O., Kumar P., Balasubram-anian R., Andrade M.F., Vasconcellos P.C. (2017). Particulate pollutants in the Brazilian city of São Paulo: 1-year investigation for the chemical composition and source apportion-ment. *Atmos. Chem. and Phys.* 17, 11943–11969.

Pereira Netto A.D., Barreto R.P., Moreira J.C., Arbilla G. (2007). Spatial distribution of poly-cyclic aromatic hydrocarbons in Terminalia catappa L. (Combretaceae) bark from a sele-cted heavy road traffic area of Rio de Janeiro City, Brazil, *J. Hazard. Mater.*142,389–396.

Tobiszewski M. and Namiesnik J. (2012). PAH diagnostic ratios for the identification of pollution emission sources. *Environ. Pollut.* 162, 110-119.

AEROSOL IMPACT ON AIR QUALITY DURING THE 2017 PORTUGAL WILDFIRE SEASON

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Keywords: Wildfire aerosols, air quality, measurements, modelling
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Wildfire smoke emissions pose a serious problem for air quality. The health consequences of smoke inhalation can be immediate and acute, depending on the contamination levels and exposure time. Apart from these, long time exposure to smoke inhalation increase the risk of related illnesses, as the cumulative dose increases. In this sense it is important to understand the severity of the air contamination, because high levels may justify the evacuation of populated areas, even when the fire risk is not imminent at the site. Furthermore, it is known that wildfire aerosol emissions may be injected in upper layers of the atmosphere and transported for long distances, with climate implications.

The study aims at analyzing the aerosol air quality in the areas affected by the smoke plumes originated from the wildfires that raged across continental Portugal in several periods of 2017, burning more than 530000 ha (5.7% of the national territory). For this purpose, *in situ*, remote sensing and modelling data are combined to characterize the smoke aerosol plume over the affected areas. PM_{10} and $PM_{2.5}$ hourly concentrations are obtained from the Portuguese Environmental Agency (APA; https://www.apambiente.pt/) corresponding to the existing monitoring stations in continental Portugal. AERONET columnar aerosol quantities from existing sites in the areas overpassed by smoke are also considered, as well as vertically resolved aerosol properties from lidar measurements (ground-based or satellite). The Hybrid Single-Particle Lagrangian Integrated Trajectory model (HYSPLIT) is used to simulate the transport and dispersion of the particles, allowing for the identification of contaminated areas. Model estimations are assessed through comparisons with the available measurements.

Fig. 1 shows PM_{10} hourly concentrations measured at APA stations between June and October 2017, the period that mainly corresponds to the fire season in Portugal. The overlaid map illustrates the fire burned areas in Portugal during 2017 and particularly during the most burdensome episodes (June and October). Results show that several inhabited areas presented high aerosol concentrations and point to the development of a multi-tool early alert system aimed at the authorities and population.

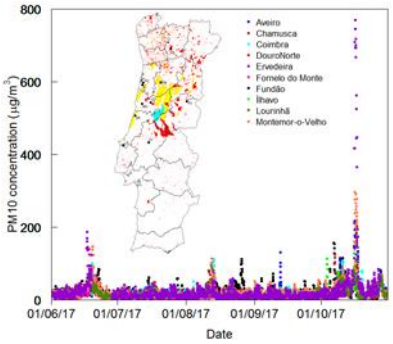

Fig. 1. PM_{10} hourly concentrations at several Portuguese sites between June and October 2017. The superimposed map of Portugal shows the sampling site locations, as well as the burned areas during: 2017 (red), 17-24 June 2017 (cyan), 13 -17 October 2017 (yellow) (https://www.icnf.pt/).

The work was supported by the EU through the European Regional Development Fund, included in COMPETE 2020 (Operational Program Competitiveness and Internationalization) through ICT project (UID/GEO/04683/2013) with reference POCI-01-0145-FEDER-007690 and also through TOMAQAPA (PTDC/CTAMET/ 29678/2017), NanoSen-AQM (SOE2/P1/E0569) and CILIFO (0753_CILIFO_5_E) projects and national funding though FCT grant SFRH/BSAB/143164/2019. The EU Horizon 2020 research and innovation program through project ACTRIS-2 (no. 654109) is also acknowledged. The authors are grateful to the APA for the data made available and to the NOAA Air Resources Laboratory (ARL) for the provision of the HYSPLIT transport and dispersion model and/or READY website (http://www.ready.noaa.gov).

PAHs IN MEDIUM SCALE BIOMASS BURNING EMISSIONS. ENRICHMENT IN ULTRAFINE FLY ASH. INFLUENCE OF OPERATING CONDITIONS

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Keywords: biomass, PAHs, combustion.
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Polycyclic Aromatic Hydrocarbons (PAHs) are produced during biomass combustion. Given their semi-volatile nature, PAHs condenses on fly ash particles present in the flue gas stream (Saez, 2007). Therefore, Emissions control devices are useful for controlling of PAHs emissions. Ultrafine particle's higher surface to volume ratio, together with size-dependent fractional efficiency of control devices may affect PAHs collection efficiency.

The flue gas from a 1 MW FBC (fluidized bed combustion) Plant was treated in a hybrid filter (HF) (Aragon, 2015). Olive tree and *Eucalyptus* wood and wheat straw biomass fuels in different preparations (chips and pellets) were tested, under different operating conditions (Sanz, 2018). Aerosol samples were taken in raw and treated gas on filters that were analysed for determining PAHs content (Garcia-Alonso, 2017).

Table 1. Operating conditions in FBC Plant

	Test EX1.1	Test EX1.4
Fuel	Olive tree wood chips (un-sieved)	
Sec. Air (%)	49	55
Comb. Air Temp (C)	46	89
Excess O_2 (%)	31	26

The fly ash in treated gas presented higher concentration of PAHs (ng/mass of fly ash) than fly ash in raw gas for all fuels and operating conditions. Total PAHs concentration per gas volume (ng/Nm^3) in treated gas was lower than in raw gas, due to much lower fly ash content.

Comparing experiments using the same fuel, it seems that lower secondary air ratio favors greater enrichment of PAHs in treated gas fly ash. This is illustrated in Table 1 and Figure 1 for a pair of selected experiments. Departure of points from the diagonal shows the difference between experiments.

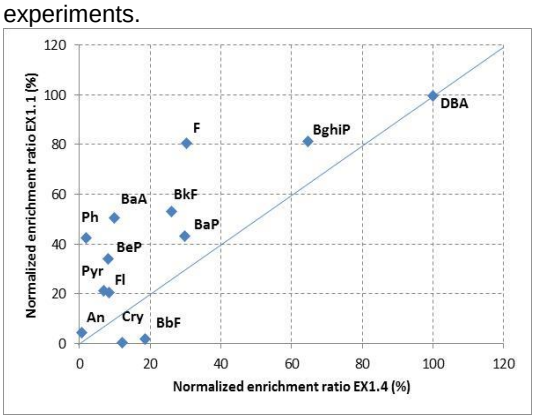

Fig. 1. Concentration enrichment factors (treated vs raw gas fly ash) by compound.

This work was supported by the Ministerio de Economía y Competitividad within the Programa Estatal de I+D+I Orientada a los Retos de la Sociedad (2013-2016) with reference CTM213-49121-C3-1,2,3-R

Aragon, G. et al. (2015), Enhanced Control of Fine Particle Emissions from Waste Biomass Combustion Using a Hybrid Filter *Energy & Fuels* **29**, 2358-2371

Garcia-Alonso S. et al (2017) PAH analysis in biomass combustion wastes: an approach to evaluate bias and precision of analytical results using routine samples *Accred Qual Assur* **22**, 153-159.

Saez F. et al (2007) PAH emissions in residential biomass combustion. In: *Proc. 15th European Biomass Conference & Exhibition.* May 7-11. Berlin. Germany

Sanz D. et al (2018) Influence of fuel and operating parameters on PAHs in biomass combustion fly ash. CLEANBIOM project. In: *Proceedings of Aerosol Technology, AT2018.* June 18-20. Bilbao. Spain

INTRUSION OF BIOMASS-BURNING POLLUTION DURING A DESERT-DUST EPISODE AT THE IZAÑA ATMOSPHERIC OBSERVATORY

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The Izaña Atmospheric Observatory (IZO, part of the Izaña Atmospheric Research Center, Spanish Meteorological State Agency) is located at 2367 m.a.s.l. in the free troposphere, close to the center of the island of Tenerife, at 28º 18' N, and 16º 29' E. During summer time, IZO is frequently immersed in the Saharan Air Layer (SAL), and it is very usual to observe mineral dust events with concentrations above 10 µg/m^3 (Rodríguez *et al*., 2015). For this reason, since 1987 extensive campaigns to characterize the SAL have been continuously carried out at IZO in the summer months. Thanks to the vast infrastructure that IZO offers as a WMO-GAW Station and also as a WMO-CIMO-Testbed for Aerosols and Water Vapor Remote Sensing, this characterization of the SAL can be performed by many different methods (Cuevas *et al*., 2017).

In summer 2018, during the first half of August, mineral dust from North Africa arrived to IZO, as expected and recorded by both in-situ and remote-sensing instruments for the study of aerosols. However, the measured microphysical, chemical, and optical aerosol properties showed features which did not completely correspond only to the presence of mineral dust. In particular, the black-carbon concentration measured by two Multiangle Absorption Photometers (MAAPs), and the scattering coefficients measured by a Nephelometer showed very high values, while at the same time the mass concentrations reported by a tapered element oscillating microbalance (TEOM) and a Beta air monitor remained at the usual levels of a dust outbreak (see e.g. Rodríguez *et al*. 2012 for a review of in-situ aerosols measurement methods). The behavior of these parameters, slightly different to the one expected, made us suspicious of the presence of another type of aerosol besides the mineral dust carried in the SAL.

Taking advantage of other GAW programs carried out at IZO, we also studied the behavior of the greenhouse and reactive gases, discovering an unexpected increase of CH_4 and CO in comparison to the background free-troposphere conditions normally present at the site. Furthermore, we also analyzed the data provided by the remote-sensing aerosol instruments operating at IZO, finding an increase of the aerosol optical depth and a decrease of the Ångstrom exponent.

Taking into account all these data, it would seem that pollution from a biomass burning event was mixed with the mineral dust. However, no forest fires were reported close to IZO. Air mass back trajectories and satellite data provided the final key to explain our observations, showing the connection between the aerosol present at IZO and the fires at Algarve (Portugal) in the first half of August 2018.

In this work, we present preliminary results of the measurements carried out during this unusual event by four programs operating at IZO: in-situ and remote-sensing aerosols, and greenhouse and reactive gases. Our analysis of all these parameters shows the effect produced on the atmospheric properties by the presence of a mixture of aerosols originating from a biomass burning event and a Saharan dust outbreak.

This work was supported by the project AEROATLAN (CGL2015-66299-P), funded by the Ministry of Economy and Competitiveness of Spain and the European Regional Development Fund (ERDF). The long-term records of the GAW programme are also funded by AEMET.

Cuevas, E. *et al*. (2017) Izaña Atmospheric Research Center Activity Report 2015-2016, AEMET, Madrid, Spain, and WMO, Geneva, Switzerland. Available from https://www.wmo.int/pages/prog/arep/gaw/gaw-reports.html

Rodríguez, S., Cuevas, E., Prospero, J. M., Alastuey, A., Querol, X., López-Solano, J., García, M. I. and Alonso-Pérez, S. (2015) Atmos. Chem. Phys., 15(13), 7471–7486

Rodríguez, S., Alastuey, A. and Querol, X. (2012) Aeolian Research 6, 55–74

Session 4 & 5 – Exposure and Health

MODELLING POPULATION EXPOSURE TO PM2.5 IN LISBON

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Keywords: Particulate matter, indoor-outdoor ratios, exposure, modelling
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Every day, a person breathing is exposed to different concentrations of atmospheric pollutants, as he/she moves from and to different outdoor and indoor places. Particulate matter (PM) is one of the pollutants of most concern in terms of adverse health effects [EEA, 2017], especially in urban areas, with high population density, and where industrial and traffic PM emissions are the major contributors to air pollution. Modelling approaches are adopted to characterize population exposure, which cannot be achieved by monitoring. This requires three types of input data: the population characterization, the spatial distribution of the environments visited by the population and the temporal variation of pollutant concentrations in each microenvironment.

In the scope of the LIFE Index-Air project, the population exposure to atmospheric PM was estimated for the year 2015, as the base year of the air quality modelling application, for the general population resident in the Lisbon region domain, and for the 5 to 9 years-old children population based on the data acquired at homes and schools in the Lisbon municipality. For the general population, a typical time-activity pattern was considered. For the 5 to 9 years-old subgroup, time-activity patterns based on performed questionnaires were used to characterize the daily routine of children.

The applied exposure model also calculates the indoor concentrations using the outdoor concentrations simulated by the WRF-CAMx modelling system and indoor/outdoor relations. Based on time-activity profiles, the most visited microenvironments can be grouped into three main types: home, outdoors, other indoors (school for children's group). Indoor and outdoor measurements at different homes and schools in Lisbon allowed computing indoor-outdoor relations for PM. The location of schools in the Lisbon municipality and the number of students per school permitted calculating the number of children at the school microenvironment by grid cell.

The exposure module delivers hourly population exposures by grid cell of the modelling domain. It also estimates the population exposure taking into account the number of people in each grid cell and the cumulative exposure for a certain period of time. Figure 1 presents the spatial distribution of the PM2.5 annual average exposure weighted by the number of people (general population and children) present in the Lisbon study case domain. The highest population exposures are obtained for the Lisbon urban area and for the areas with higher population density with non-zero concentration values. Regarding children's exposure, the highest values are modelled for the areas where more students spent most of their day time, at school. In fact, the indoor-outdoor ratios show that PM concentrations in schools have a great contribution from indoor sources, increasing the children's exposure to these pollutants.

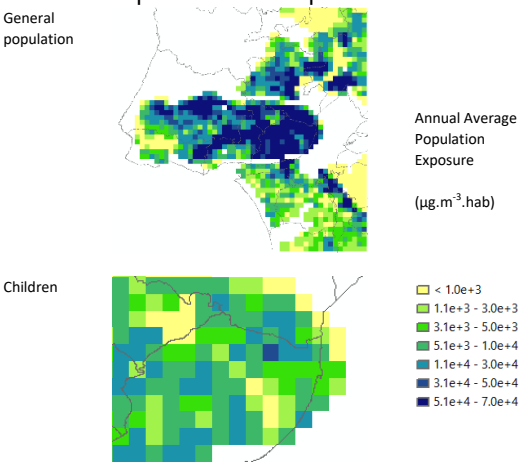

Fig. 1. Annual population averaged exposure to PM2.5 (µg.m^{-3}.hab) in the Lisbon modelling domain for the general population and the 5-9 years-old children.

This work was supported by EU LIFE Index-Air project (LIFE15 ENV/PT/000674) and CESAM (UID/AMB/50017/2019).

EEA (2017) *Air Quality in Europe – 2017 report*, EEA Report No 13/2017. ISBN 978-92-9213-921-6.

AIR QUALITY ASSESSMENT IN SCHOOLS FROM THE EUROPEAN SUDOE REGION

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Keywords: Indoor Air Quality, schools, particulate matter, volatile organic compounds, aldehydes
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Children spend most of their time indoors, and a great part of their daily-life is spent at the school. Beyond the fact that children are particularly vulnerable to indoor air pollution, scientific evidence shows that exposure to poor indoor air quality can cause or contribute towards short and long-term health problems including asthma, allergic reactions and respiratory tract infections and reduce the productivity.

The objective of this work was to assess the Indoor Air Quality in 38 schools located in the Sudoe region of Europe and was developed within the scope of the ClimACT project that aims to support the transition to a low carbon economy in schools.

Environmental and energy audits have been carried out in pilot schools from Portugal, Spain, France and Gibraltar. Indoor air quality and ventilation measurements were performed in 2 classrooms of all the schools. Levels of PM10, PM2.5, CO_2, CO and TVOC were measured with portable direct reading instruments. In addition, in the same classrooms, the concentrations of 9 aldehydes (formaldehyde, acetaldehyde, acrolein, propanal, butanal, pentanal, isopentanal, hexanal, benzal-dehyde) and 10 selected VOCs (benzene, toluene, styrene, tetrachloroethylene, trichloroeth-ylene, m-xylene, o-xylene, p-xylene, 1-4 dichlorobenzene, α-pinene) were measured with passive sampling - Radiello diffuse tubes. Measurements were performed during one week from Monday to Friday.

Results showed that contaminants as PM10, PM2.5, CO_2, TVOC and formaldehyde frequently exceed the guidelines (fig.1.).

This study demonstrated that to reduce students' exposure to pollutants in classrooms a proper ventilation strategy needs to be adopted. Such strategy is even more important in naturally ventilated schools where the air exchange rate is only based on the manual airing of classrooms.

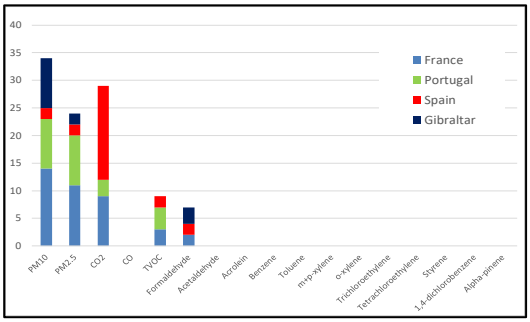

Fig. 1 - Number of measurements over the guidelines.

This work was supported by the European Regional Development Fund (ERDF) through the Interreg Sudoe project ClimACT– Acting for the transition to a low carbon economy in schools – development of support tools (SOE1/P3/P0429). C2TN/IST authors gratefully acknowledge the Fundação para a Ciência e Tecnologia support to the UID/Multi/04349/2013 project.

PARTICULATE MATTER EXPOSURE DURING SLEEP

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Keywords: indoor air quality, sleep, exposure, particulate matter
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Humans spend around one third of their life sleeping and it is well known that sleep plays a crucial role in human welfare and performance. However, assessment of the indoor air quality (IAQ) during sleep has been scarcely studied (Canha et al., 2017).

This study aimed to understand the human exposure to particulate matter (PM) while sleeping.

Ten volunteer couples participated in IAQ monitoring campaign during the 2017 cold season in the urban area of Lisbon, Portugal. IAQ monitoring was conducted during 3 nights (weeknights) and PM monitoring was done using a real time monitor, namely a DustTrak DRX monitor (8533 model, TSI, USA), to assess concentrations of $PM_{2.5}$ and PM_{10}. The monitoring was conducted during the sleep period of the volunteers and was done simultanelously both at the bedroom and at the outdoor.

Figure 1 shows $PM_{2.5}$ levels during sleep at the 10 studied bedrooms, where it is possible to highligh two bedrooms (B1 and B9) where mean $PM_{2.5}$ levels were above the Portuguese limit value of 25 $\mu g.m^{-3}$ (Ordinance no. 353-A/2013).

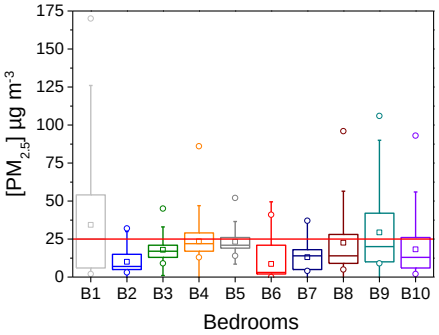

Figure 1. $PM_{2.5}$ levels during the sleep period

Figure 2 shows mean $PM_{2.5}$ levels at both indoor and outdoors of the selected bedrooms and monitoring days. It is possible to observe that 7 in 12 monitored nights, indoor $PM_{2.5}$ levels were higher than the ones found outdoors.

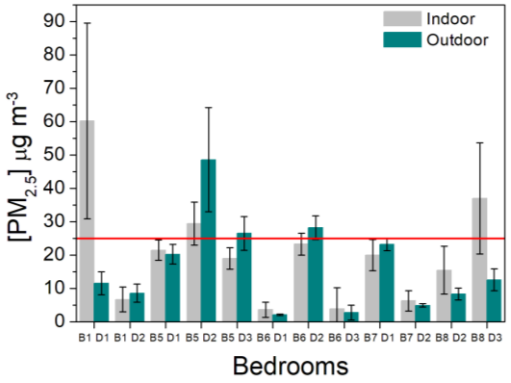

Figure 2. $PM_{2.5}$ levels indoors and outdoors during the sleep period

This study provided a PM characterisation during the sleep period and highlighted that PM exposure may be above the established limit values.

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Canha N., Lage J., Candeias S., Alves C., Almeida S.M. (2017) Indoor air quality during sleep under different ventilation patterns. Atmospheric Pollution Research, 8, 1132-1142.

Ordinance no. 353-A/2013 (2013) Ministério do Ambiente, Ordenamento do Território e Energia, da Saúde e da Solidariedade, Emprego e Segurança Social (Portugal).

Influence of new cigarette generations on indoor air quality

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Over the last decade, electronic cigarette (EC) and heat-not-burn tobacco cigarette (HNBT) popularity and use have increased among different adult demographic groups as popular nicotine delivery systems (NDS) (Grana, 2014; McMillen, 2014). These alternatives, although regarded as less polluting and a healthier alternative to traditional tobacco cigarettes are still a source of indoor air pollutants which may cause health impacts on humans.

This study aims to assess the effects on indoor air quality of traditional tobacco cigarettes and new generation cigarette alternatives (such as Vapes and HNBT) in both cars and homes, in order to determine which is the difference on their potential effects on human health.

Continuous measuring portable monitors were used to carry out secondhand smoke exposure assessment for particulate matter (PM10, PM2.5, PM1) - using a DustTrack DRX monitor (8533 model, TSI, USA), ultrafine particles (CPC TSI 3007) and black carbon (MicroAethalometer AE51, AethLabs). For both car and home scenarios measurements were conducted using nicotine content and non-nicotine charges on 2 different EC (Vapes and JUUL), a popular charge for the HNBT (IQOS) as well as 2 types of conventional tobacco cigarettes (regular and menthol).

The study on vehicles was carried out in a specific route of 4.95 km at Loures (Portugal) with low traffic intensity (mean speed of 34km/h) with the real time continuous monitors placed in the back seat of the car (in order to simulate the children exposure). The smoker was the driver, and, per type of cigarette, 3 rounds of the route were done (one with all windows opened (A), another with windows closed except the driver's (B) and the last with the same conditions as the previous but with the driver smoking (C)). Each cigarette was smoked with 10 puffs.

In homes, an initial non-smoking scenario was recorded for 2 hours. Afterwards, each NDS was continuously measured for 2 hours divided into eight 15-minute intervals. Each interval consisted of NDS being smoked with 10 puffs for 5 minutes leaving a 10-minute decay period between smokes.

In homes, regarding particulate matter, traditional cigarettes had significantly higher average concentrations, followed by vapes. IQOS had the lowest emissions with almost non-smoking level emissions. Ultrafine particles were highest in traditional cigarettes, followed by IQOS and vapes with similar concentrations (Fig. 1).

In Cars, both PM1 and ultrafine particle concentrations were higher for menthol and traditional cigarettes, followed by vapes. As was the case for homes, IQOS had the overall lowest emissions with similar levels to a non-smoking scenario (Fig 2).

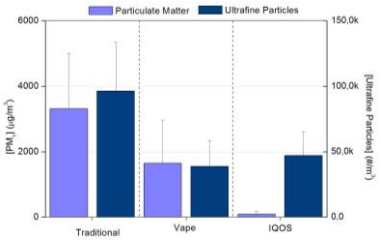

Fig 1. Average PM1 and ultrafine particle concentrations measured in homes.

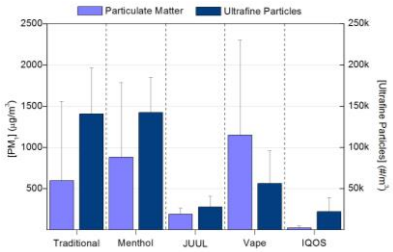

Fig 2. Average PM1 and ultrafine particle concentrations measured in cars.

This work was supported by LIFE Index-Air project (LIFE15 ENV/PT/000674) and by FCT – Fundação para a Ciência e a Tecnologia, I.P. (Portugal) through the UID/Multi/04349/2013 project. This work reflects only the authors' view.

Grana, R., Benowitz, N., & Glantz, S. A. (2014). E-Cigarettes, A Scientific Review. *Contemporary Reviews in Cardiovascular Medicine*.

McMillen, R. C., Gottlieb, M. A., Whitmore Shaefer, R. M., Winickoff, J. P., & Klein, J. D. (2014). Trends in Electronic Cigarette Use Among U.S. Adults: Use is Increasing in Both Smokers and Nonsmokers. *Nicotine & Tobacco Research*, 1-8.

THE EFFECT OF VARIABILITY IN SIZE DISTRIBUTION METRICS OF AEROSOL CHEMICAL COMPONENTS ON THE DEPOSITED DOSE FOR URBAN AREAS IN LISBON

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Keywords: size distributions, particle-bound metals, OC, EC, deposited dose
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Particulate matter (PM) is of major concern, due to its adverse impact on human health and climate. PM consists of a complex mixture of different chemical components including water soluble ions, trace metals and organic compounds. The modal structure of PM and its components size distributions is directly linked to the potential inhaled dose and adverse health effects caused by ambient PM exposure. However, highly-resolved size distributions typically require a lot of effort that could be avoided in some cases, when it comes to the dose estimates of specific chemical components (Zwozdziak et al., 2017). The present study aims at investigating the extent of the variability of the size distribution patterns of specific chemical components and its influence to the inhaled dose estimated from PM2.5 and PM10 mass concentration levels or/and PM mass size distribution measurements under certain assumptions.

In the framework of the Life Index-Air project, a measurement campaign was performed in schools and households in Lisbon, Portugal (October 2017 - January 2018). During these campaigns simultaneous indoor and outdoor sampling was performed at 4 households and 4 schools, by means of a 4-stage Personal Cascade Impactor Sampler (PCIS). Major and trace elements were determined by means of XRF (X-Ray Fluorescence) and AAS (Atomic Absorption Spectroscopy). The elemental (EC) and organic carbon (OC) concentrations were determined by thermal-optical method.

The initial size distributions (step function) were inverted into smoothed and corrected size distributions, taking into account the collection efficiency curves of each impaction stage. The inverted size distributions were fitted by a sum of log-normal distributions, described by a characteristic Mass Median Aerodynamic Diameter (MMAD), a Geometric Standard Deviation (GSD) and mass concentration (input parameters for dosimetry calculations). Then, the ExDoM2 (Chalvatzaki and Lazaridis, 2015) dosimetry model was applied for the quantification of deposited dose of particle mass and major components. The human experienced dose rate, through inhalation, was determined as the product of inhalation rate, concentration of exposure and deposited fraction in the respiratory tract.

The results are scaled with respect to the over or under predicted inhaled dose and associated risk when the overall mass size distribution structure is selected, instead of that of the individual major components.

This work was supported by the European Union's LIFE Programme in the framework of the LIFE Index-Air project (LIFE15 ENV/PT/000674). This work reflects only the authors' view and EASME is not responsible for any use that may be made of the information it contains.

Chalvatzaki E. and Lazaridis M. (2015). Development and application of a dosimetry model (ExDoM2) for calculating internal dose of specific particle-bound metals in the human body. Inhal. Toxicol. 27 (6), 308-320

Zwozdziak A., Gini M. I., Samek L., Rogula-Kozlowska W., Sowka I., Eleftheriadis K. (2017). Implications of the aerosol size distribution modal structure of trace and major elements on human exposure, inhaled dose and relevance to the PM2.5 and PM10 metrics in a European pollution hotspot urban area. Aerosol Sci., 103, 38-52

ASSESSMENT OF CHILDREN'S EXPOSURE TO SIZED-FRACTIONED PARTICULATE MATTER AND BLACK CARBON IN LISBON METROPOLITAN AREA

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Keywords: Children, Time-activity pattern, PM2.5, Black carbon, Personal exposure, Inhaled dose.
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Particulate matter (PM) is considered one of the most harmful air pollutants and one of the major environmental problems that influence people's health, ranging from respiratory and cardiovascular diseases to premature mortality (Burnett et al., 2018). Children are considered a susceptible group to the harmful effects of air pollution, since they breathe higher volumes of air relative to their body weights and their tissue and organs are growing (Faustman et al., 2000).

The main objective of this study was to quantify the children's daily exposure to sized-fractioned PM and black carbon (BC) in Lisbon. The personal integrated exposure assessed is the key determinant of the dose received by the children and thus directly influences the health impacts.

Methods: Children living in Lisbon metropolitan area carried out personal monitors for 72 hours each representing 27 days of sampling and their activities and microenvironments (MEs) frequented were recorded in a time-activity diary.

Results: The average $PM_{2.5}$ exposure (19 µg/m^3) was higher than those obtained in the nearest fixed urban background station (11 µg/m^3), indicating the importance of assessing the personal daily exposure since it depends on the ME frequented and activities performed. The average exposure to PM_1, $PM_{0.5}$ and $PM_{0.25}$ was 14 µg/m^3, 11 µg/m^3, and 7.7 µg/m^3, respectively. Children spent more than 80% of their time indoors, especially at home and in the classroom, indicating that risk assessment should focus mainly on indoor MEs in order to protect children from adverse health effects. Home was the microenvironment that mostly contributed to the daily BC exposure (39%) and inhaled dose (28%) thanks to the large amount of time spent there (55%). Although commuting only accounted for 5.0% of daily time, children inhaled 23% of their daily BC dose due to the high BC concentration (5.1 µg/m^3) in which the children were exposed (Figure 1).

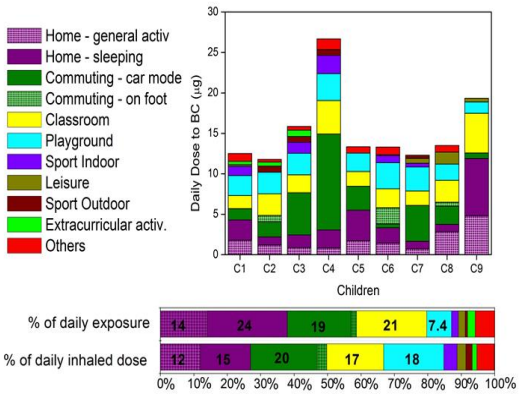

Fig. 1. Daily dose to BC of each child.

Time series analysis of the BC concentrations showed high peaks in underground parking lots, when candles are burning and during charcoal grills.

This study may be used to develop measures and policies focusing on the reduction of the exposure and, consequently, for the improvement of the children health and wellbeing.

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Burnett, R. et al., 2018. Global estimates of mortality associated with long- term exposure to outdoor fine particulate matter 115. https://doi.org/10.1073/pnas.1803222115

Faustman, E.M. et al., 2000. Mechanisms Underlying Children ' s Susceptibility to Environmental Toxicants Mechanisms of Susceptibility : 108.

AIR COMPOSITION OF A REGION NEAR A PETROCHEMICAL REFINERY IN BRAZIL AND THE IMPACTS IN HEALTH

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Keywords: air pollution, petrochemical emissions, health impacts
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The chronic exposure to fine particulate matter (PM) has been associated with many diseases, such as asthma, myocardial infarction and chronic obstructive pulmonary diseases (Atkinson et al. 2015). An industrial complex located in São Paulo Metropolitan Area which produces petroleum products has been investigated due to the high rate of thyroid diseases in the population living in this region. PM samples were collected between 2015 and 2017 and chemical characterization including organic carbon (OC), elemental carbon (EC), polycyclic aromatic hydrocarbons (PAH), *n*-alkanes and hopanes, was investigated. The samples collected in 2017 presented the highest concentrations of total PAHs (75 ng m^{-3}), Figure 1. Benzo(a)pyrene, classified as carcinogenic to humans was the major compound observed in 2017 (13 ng m^{-3}).

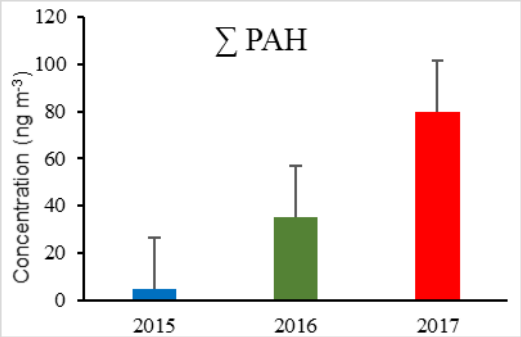

Fig. 1. PAH concentrations.

Benzo(a) pyrene equivalent values in all samples (2 ng m^{-3} for 2015; 13 ng m^{-3} for 2016 and 20 ng m^{-3} for 2017) were much higher than that recommended by World Health Organization (1 ng m^{-3}), indicating cancer risk.

High OC/EC ratios showed that different sources of organic aerosols were observed.

N-alkanes presented dominant emissions from compounds lower than C_{25}, coming mostly from anthropogenic sources (Simoneit et al. 1991). The stereochemical configurations of hopanes, helpful to determine the geological maturity of the petroleum (Alves et al. 2016), indicate emissions associated with completely mature petroleum.

Conclusions: the results show that this region is impacted by different emissions sources that affects the regional air quality. The industrial complex seems to contribute to local air pollution.

This work was funded by INCT-Energy and Environment and FAPESP (grant 2016/23339-1).

Alves, C. A., Oliveira C. C., Martins, N., 2016. Road tunnel, road side, and urban background measurements of aliphatic compounds in size segregated particulate matter. Atmos. Res. 168, 139–148.

Atkinson, R.W. et al. (2015). Fine particle components and health a systematic review and meta-analysis of epidemiological time series studies of daily mortality and hospital admissions. J. Expo. Sci. Environ. Epidemiol. 25 (2), 208-214.

Simoneit, B.R.T. et al. (1991). Molecular marker study of extractable organic matter in aerosols from urban areas of China. Atmos. Envir. 25, 2111-2129.

EXPOSURE AND INHALED DOSE OF PARTICULATE MATTER BY COMMUTERS IN LISBON

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Keywords: commuting; particulate matter; black carbon; exposure assessment; inhaled dose
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In urban areas and more specifically in the transport microenvironment the citizens are exposed to high concentrations of air pollutants namely particulate matter (PM) (Ramos et al. 2015, Diapouli et al. 2008). Exposure to PM in this microenvironment is particularly high due to the proximity of commuters to mobile sources (Kaur et al. 2007). This fact leads to a significant contribution to the overall daily exposure (Kaur et al. 2007), which may result in adverse effects on human health (WHO 2013). This study aims to assess commuters' exposure to particulate matter (PM) in car, bicycle, metro and bus mode in Lisbon.

Mass concentration of particles with aerodynamic diameter (AD) smaller than 2.5 µm ($PM_{2.5}$) and 10 µm (PM_{10}), black carbon (BC) and number concentration of particles with AD from 0.01 to 1 µm ($PN_{0.01-1}$) were measured in a selected route (6.7 km) that is representative of the daily commutes in Lisbon. Measurements were performed over 18 weekdays, five times per day (8h, 10h30, 13h, 18h and 20h). The inhaled dose was assessed to each mode of transport.

The highest $PM_{2.5}$ and PM_{10} average concentrations were observed in the metro. On the other hand, the highest BC and $PN_{0.01-1}$ average concentrations were found in car and bus mode, respectively. The outdoor concentrations and the type of ventilation appeared to affect the indoor concentrations. In cars, the use of ventilation led to a decrease of $PM_{2.5}$ and PM_{10} concentrations and to an increase of BC concentrations inside the vehicles. The highest inhaled dose was observed in bicycle journeys, due to the longest travel periods combined with enhanced physical activity and, consequently, highest inhalation rates (Figure 1).

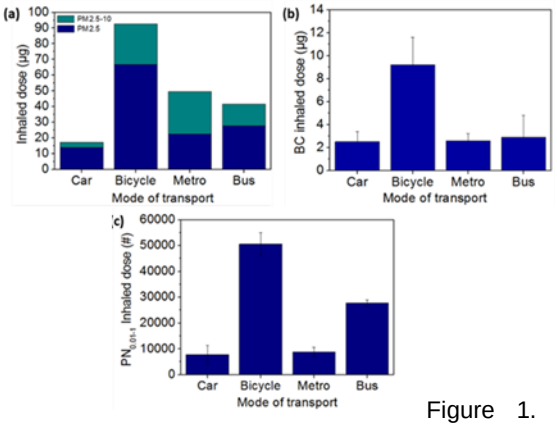

Figure 1. Inhaled doses per trip of $PM_{2.5}$ and $PM_{2.5-10}$ (a), BC (b), $PN_{0.01-1}$ (c).

This work was supported by LIFE Index-Air project (LIFE15 ENV/PT/000674). Authors gratefully acknowledge the FCT support through the UID/Multi/04349/2013 project and the PhD grant SFRH/BD/129149/2017. This work reflects only the authors' view and EASME is not responsible for any use that may be made of the information it contains.

Ramos MJ, Vasconcelos A, Faria M (2015) Comparison of particulate matter inhalation for users of different transport modes in Lisbon. Transp Res Procedia 10:433–442.

Diapouli E, Grivas G, Chaloulakou A, Spyrellis N (2008) PM10and ultrafine particles counts in-vehicle and On-road in the athens area. Water, Air, Soil Pollut Focus 8:89–97.

Kaur S, Nieuwenhuijsen MJ, Colvile RN (2007) Fine particulate matter and carbon monoxide exposure concentrations in urban street transport microenvironments. Atmos Environ 41:4781–4810.

WHO (2013) Health Effects of Particulate Matter: WHO Reg Off Eur 50:20. doi: 10.1097/00002030-200204120-00009

RELATIONSHIP BETWEEN PLATANUS PLA A 1 ALLERGEN AND AIRBORNE POLLEN IN TWO CITIES OF NORTHWESTERN IBERIAN PENINSULA

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Keywords: aeroallergens, bioaerosol, Plane tree, weather variables
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In Europe, allergic disorders related to pollen are an important public health problem (World Allergy Organization 2013). Plane trees are common plants in urbanized areas and release pollen that can induce allergenic reactions in the sensitized people (D´Amato et al. 2007). While airborne, pollen can hydrate and rupture thus releasing their allergen content, such as Pla a 1 allergen.

The objective of the present study was to quantify airborne *Platanus* pollen and Pla a 1 content in Porto (Portugal) and Ourense (Spain) cities, and to analyse how weather parameters can affect the patterns of pollen and allergen distribution.

Airborne pollen sampling was performed in 2018 using a Hirst volumetric sampler. Pla a 1 aeroallergen was collected using a Burkard multivial Cyclone sampler and quantified by ELISA method using a Pla a 1 specific antibody. A non-parametric Spearman´s correlation test was performed between daily pollen, allergens concentrations and meteorological parameters (maximum, minimum, average temperatures, rainfall and relative humidity).

Platanus main pollen season was shorter and earlier in Porto than in Ourense. The airborne annual pollen integral was seven times lower in Porto (750 pollen grains/m^3, with a maximum daily pollen content of 82 pollen grains/m^3) compared with Ourense (5382 pollen grains/m^3, with a maximum daily pollen content of 932 pollen grains/m^3). However, the Pla a 1 content was only 2 times higher in Ourense city than in Porto (respectively 5.4 ng/m^3, peak value of 0.53 ng/m^3 and 2.9 ng/m^3, peak value of 0.37 ng/m^3).

Airborne pollen and Pla a 1 aeroallergen were correlated with air temperature, rainfall and relative humidity.

In spite of difference in airborne pollen concentration of both locations, much higher in Ourense, the results suggest different allergenic activity in the atmosphere of both cities, and can be related to different allergen content of the pollen, influence of air pollutants in plants, meteorological factors or soil nutrient deficit.

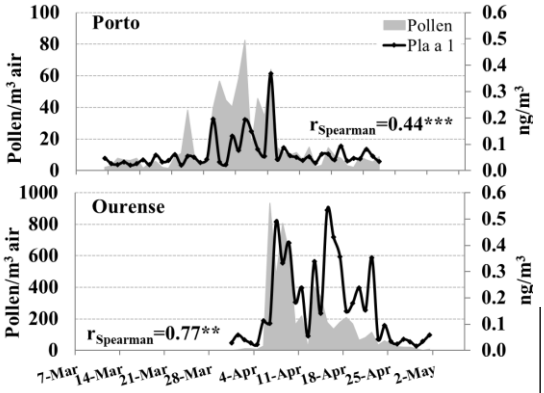

Fig. 1. Pollen grains, allergen concentration and its correlation in Porto and Ourense (***:p<0.01).

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D'Amato, G., Cecchi, L., Bonini, S., Nunes, C., et al. (2007). Allergenic pollen and pollen allergy in Europe. *Allergy*, 62(9), 976–990.

World Allergy Organization (2013). *The WAO white book on allergy*. In: Pawankar R., Canonica G.W., Holgate S.T., Lockey R.F., Blaiss M. (Eds.), World Allergy Organization, Wisconsin, United States of America, pp.20.

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SPREAD OF ANTIMICROBIAL RESISTANT *STAPHYLOCOCCUS AUREUS* IN OFFICE ROOMS

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Keywords: MRSA, antimicrobial resistance, microbial contamination, bioaerosol
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The air quality in office building has been receiving increasing attention as people spent more and more time in indoor environment (Gołofit-Szymczak and Górny, 2010). Office equipment surfaces in such places are often contaminated with different bacterial pathogens and may be responsible for the spread of antimicrobial resistant genes (Thapaliya et al., 2017). The objective of this study was to investigate the bacterial contamination of air and surfaces in office rooms and determine the potential health risk of workers exposed to antimicrobial resistant *Staphylococcus aureus*.
The study was carried out at one office building in Poland. The bioaerosol samples were taken using single-stage MAS 100Eco impactors. Swab samples from hands and different surfaces (desks, buttons and door knobs, handrails, telephones) were collected using nylon flocked QUANTISWABs. Microbial concentrations were assessed and the isolated microorganisms were taxonomically identified using biochemical tests. Disc diffusion method for antimicrobial susceptibility testing was carried out according to the Clinical Laboratory Standards Institute guideline.

Table 1. Prevalence of *S. aureus* and MRSA (meticillin-resistant *S. aureus*) in collected samples.

Samples (n)	*S. aureus* positive n (%)	MRSA positive n (%)
Bioaerosol (12)	4 (33.3)	1 (8.3)
Desks (6)	5 (83.3)	3 (50)
Telephones (5)	4 (80)	2 (40)
Main door (1)	0	0
Elevator bottoms (10)	4 (40)	1 (10)
Door knob (10)	5 (50)	1 (10)
Handrails (4)	3 (75)	0
Hands (10)	8 (80)	2 (20)

The concentrations of bacteria in the air at studied rooms were ranged from 1.1×10^2CFU/m^3 to 1.5×10^3CFU/m^3. The examined surfaces were significantly microbiologically contaminated. The highest concentrations of bacteria were recorded on the phone surfaces (4.1×10^3CFU/ml) and workers' desks (2.4×10^2CFU/ml). The overall percentage of surfaces contaminated with *S. aureus* was 57%. All isolates were tested for antibiotic susceptibility. The overall prevalence of meticillin-resistant *S. aureus* (MRSA) in collected samples was 17.2%. The highest prevalence of MRSA was observed in samples from desk, telephones and hands of office workers. One MRSA isolate was detected in the air from open space room. Among all MRSA isolates (n = 10), nine isolates were resistant to erythromycin, 8 to ciprofloxacin, and 7 to clindamycin, gentamicin and tetracycline.
The results of this study showed that multidrug-resistant MRSA strains are able to colonize different frequently touched office surfaces in public buildings posing a serious threat to workers. Therefore, it is necessary to elaborate the effective strategies to promote proper hygiene of hands and disinfection procedures for frequently touched office surfaces in this type premises.

This work was supported by a research task carried out within the scope of the fourth stage of the National Programme "Improvement of safety and working conditions" partly supported in 2017–2019 - within the scope of research and development - by the Ministry of Science and Higher Education/National Centre for Research and Development.

Gołofit-Szymczak M. and Górny R.L. (2010) Bacterial and fungal aerosols in air-conditioned office buildings in Warsaw, Poland-the winter season. Int. J. Occup. Saf. Ergon. 16, 465–476.
Thapaliya D., Taha M., Dalman M.R., et al. (2017). Environmental contamination with Staphylococcus aureus at a large, Midwestern university campus. The Sci. Total. Environ. 599:1363–8.

ORIGIN AND PHYSICAL-CHEMICAL PROPERTIES OF PM IN THE METRO OF ATHENS

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Keywords: Air Quality, Exposure, Metro, Particulate matter
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Human exposure to particulate matter (PM) has been an increasing concern, especially in urban areas, where pollutants are likely to reach concentrations above the recommended limits for human health protection.

Metro systems are a fundamental part of the modern city layout, providing time and energy efficient transport for millions of people in their daily commutes. While the metro reduces private vehicle usage and associated pollution, it has been shown that its intrinsic characteristics create a microenvironment prone to increased concentration of airborne pollutants, namely PM. Thus, it´s imperative to identify PM sources and factors influencing commuter's exposure, so that efficient air quality measures can be adopted on existing systems and embedded into future metro developments.

A 3-week measurement campaign was carried out at Nomismatokopio station (Line 2) of the metro of Athens, where measurements were taken at the train platform and outdoors, concurrently. Further information was obtained from a nearby urban background station. Real-time measurements of particle size distribution in the size range of 0.01 to 10µm were complemented by filter samples, subjected to gravimetric and chemical analysis for both $PM_{2.5}$ (ICP-AES/ICP-MS techniques) and PM_{10} (XRF technique). Additional measurements were carried out inside trains, in order to evaluate PM levels throughout the metro network and have a closer look into the real exposure of commuters and factors influencing it.

Figure 1 shows the average particle number, surface area and mass size distributions in the metro platform during the study period. It illustrates the need for different measuring techniques to characterize the wide aerosol size range.

On average, during metro working hours, particle number concentration was 1.33×10^4 # cm^{-3} and $PM_{2.5}$ and PM_{10} were 62 and 126 µg m^{-3}, respectively. While number concentration was within an expected range in urban environment, PM_{10} was manifestly high.

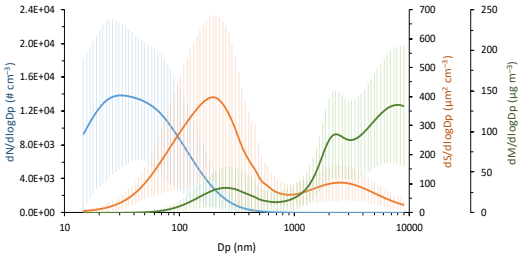

Fig. 1. Mean particle number (*N*), surface area (*S*) and mass (*M*) size distributions during the campaign.

This work strongly suggests that ultrafine particles originate mostly from outdoor urban air (Mendes et al. 2018), while fine and coarse particles measured as $PM_{2.5}$ and PM_{10} are mostly generated within the metro system, due to wear of rails, wheels, brakes and other moving parts of the trains. Chemical analysis showed that Fe was the predominant element of PM_{10} mass. These findings agree with previous studies in subway systems (Martins et al. 2016).

PM levels inside trains were found to be even higher than those on the platform. Train windows opened and pronounced curvature of the tracks were among the most influential factors contributing to increased exposure of commuters to PM levels inside the trains. There is a high potential for exposure reduction by means of simple and cost-effective measures.

This work was supported by the EC FP7 (grant: 315760 – HEXACOMM) and counted with the collaboration of the Urban Rail Transport S.A. Athens.

Martins, V., T. Moreno, L. Mendes, K. Eleftheriadis, E. Diapouli, C.A. Alves, M. Duarte, et al. 2016. "Factors Controlling Air Quality in Different European Subway Systems." *Environmental Research* 146.

Mendes, L., M. Gini, G. Biskos, I. Colbeck, and K. Eleftheriadis. 2018. "Airborne Ultrafine Particles in a Naturally Ventilated Metro Station: Dominant Sources and Mixing State Determined by Particle Size Distribution and Volatility Measurements." *Environmental Pollution* 239.

Session 6 & 7 – Air Quality Management

URBAN AEROSOL ASSESSMENT AND FORECAST: COIMBRA CASE STUDY

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Urban aerosol assessment is a complex issue that requires implementation of multiscale and integrative approaches able to provide consistent information on the pollutant sources and atmospheric processes involved. New operational air quality forecast services provide timely information on expected background concentrations at global and regional scales but challenging questions on urban air pollution forecast at street level are still remain.

The main objective of this work is to explore currently available regional scale services and to evaluate their applicability to urban scale air pollution assessment and forecast.

To address the defined objective, an integrated approach for urban scale air quality and forecast was implemented based on ADMS-Road and using two alternative approaches to characterize background pollution levels from regional scale modelling. For this purpose, the operational Copernicus Atmosphere Monitoring Service (CAMS) was explored. Additionally, the regional Chemical Transport Model CHIMERE, that makes part of the CAMS service and also of the operational air quality forecasting system for Portugal (Monteiro et al., 2005), was explored with different modelling set-up. Thus, different spatial resolutions and the specific parameterizations appropriated for high-resolution scale were investigated in order to obtain detailed input information for urban scale modelling.

The methodology was applied to Coimbra (Portugal) urban area considering local emission sources with high spatial and temporal resolution. Thus, road traffic emissions are quantified based on detailed transportation and emissions modelling (Dias *et al.*, 2016). Urban scale dispersion model is applied with 10m spatial resolution and the analysis is implemented for one year.

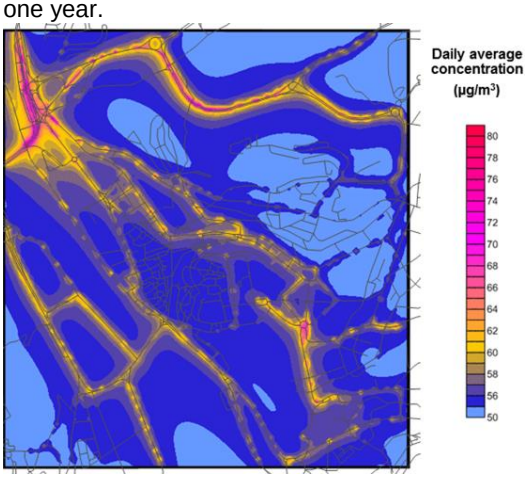

Fig.1. Spatial distribution of PM10 for a selected day.

The preliminary results of this study pointed out the influence of the regional input for the urban air quality forecast, reinforcing the importance of its accurate results.

This work is supported by TRAFFIC project (PTDC/ECM-URB/3329/2014, POCI-01-0145-FEDER-016729), ISY-AIR project (MITEXPL/IRA/0023/2017) and by FCT PhD grant of N. Pina (PD/BD/128048/2016).

Dias D., Tchepel O., Antunes A.P. (2016) Integrated modelling approach for the evaluation of low emission zones. *Journal of Environmental Management* 177, 253-263.

Monteiro A., Vautard R., Lopes M., Miranda A.I., Borrego C. (2005) Air pollution forecast in Portugal: a demand from the new air quality framework directive. *International Journal of Environmental and Pollution* 25, 4-15.

ASSESSMENT OF PARTICULATE MATTER LEVELS IN CENTRAL PORTUGAL: WHAT CAN WE LEARN FROM OBSERVATIONS AND MODELS?

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Keywords: air quality, PM10, atmospheric models, Central Portugal
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Despite a reduction, over the last decade, of particulate matter (PM) concentrations over Portugal (Gama *et al.*, 2018), PM10 and PM2.5 continue to be pollutants of particular concern, exceeding the limit values for the protection of human health every year in different monitoring sites. The main objective of this work is to provide an assessment of the aerosol background levels in Central Portugal for a one-year period, based on observations of PM10 and PM2.5 concentrations and results from a mesoscale chemical-transport model and back trajectories.

Air quality data, namely PM10 and PM2.5 concentrations observed within the national air quality monitoring network throughout 2018, is analysed in terms of temporal patterns (which include daily, weekly, and monthly cycles). WRF-CHIMERE (Menut *et al.*, 2013) simulations are used to complement observations. In addition, 4-day back trajectories are computed with the HYSPLIT model (Stein *et al.*, 2015) and a cluster analysis is performed to characterize regional flow patterns (as it is shown in Fig.1). Observations and model results are used to assess PM levels associated to the typical regional flow patterns.

Moreover, model performance and model uncertainty dependence on regional flow patterns is investigated. Preliminary results point out significant differences on model skills associated to the different clusters of back trajectories. More details will be presented and discussed during the conference.

This study contributes to the characterization of PM background levels in Central Portugal and to the ongoing discussion on sources and processes influencing those concentrations. Moreover, it provides new insights on model performance in simulating aerosol concentrations.

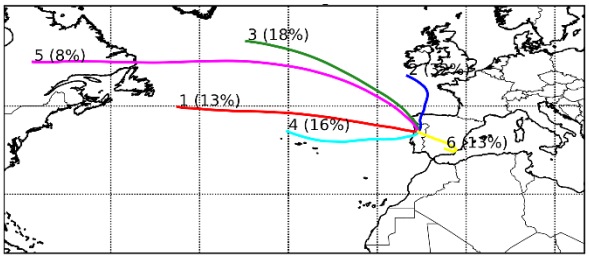

Fig. 1. Mean back trajectories of the six regional flow patterns simulated over Fornelo do Monte monitoring station.

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Gama C., Monteiro A., Pio C., Miranda A.I., Baldasano J.M., Tchepel O. (2018) Temporal patterns and trends of particulate matter over Portugal: a long-term analysis of background concentrations. *Air Qual Atmos Health* 11, 397-407.

Menut L, Bessagnet B., Khvorostyanov D., Beekmann M., Blond N., Colette A., Coll I., Curci G., Foret G., Hodzic A., Mailler S., Meleux F., Monge J.L., Pison I., Siour G., Turquety S., Valari M., Vautard R., Vivanco M.G. (2013) CHIMERE 2013: a model for regional atmospheric composition modelling. *Geosci Model Dev* 6, 981-1028.

Stein A.F., Draxler R.R, Rolph G.D., Stunder B.J.B., Cohen M.D., Ngan F. (2015) NOAA's HYSPLIT atmospheric transport and dispersion modeling system. *Bull Amer Meteor Soc* 96, 2059-2077.

AVIATOR - ASSESSING AVIATION EMISSION IMPACT ON LOCAL AIR QUALITY AT AIRPORTS: TOWARDS REGULATION

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Keywords: aviation, airports, emissions, LAQ, PM, VOCs
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Introduction

Emissions from aircraft have adverse effects on the air quality in and around airports, contributing to public health concerns within neighbouring communities. AVIATOR will adopt a multi-level measurement, modelling and assessment approach to develop an improved description and quantification of the relevant aircraft engine emissions, and their impact on air quality under different climatic conditions, specifically on non-volatile PM and volatile PM (down to <10 nm), and volatile PM gaseous precursors.

Engine generated particulate matter (PM) and gaseous emissions in test-cell and on-wing from an in-service aircraft will be measured to determine pollutant plume evolution from the engine and APU exhaust. This will provide an enhanced understanding of emitted pollutants, and the scalability between the regulatory test-cell and real-world environments.

AVIATOR will develop and deploy across multiple airports, a proof-of-concept low-cost sensor network for the monitoring of ultra-fine particles (UFP), total PM and gaseous species such as NOx, SOx and VOCs across airport.

Methods

WP2 TEST-CELL ENGINE EXIT AND IN-STACK PLUME MEASUREMENTS: The programme of experiments and measurements will be conducted on larges modern Rolls-Royce Trent family development engines in the INTA test-cell facility. Long term engine measurements within the test-cell will: i) ensure variability associated with ambient conditions (temperature, pressure, humidity), ii) limit the potential effect of solar radiation on plume evolution, iii) alleviate the impact of cross wind conditions on plume advection. These new insights will provide a better understanding of the potential for in-stack measurements to be used future regulatory purposes.

WP3 ON-WING ENGINE EXIT AND DOWNSTREAM PLUME WITH APU MEASUREMENTS: To establish a better understanding of the evolution of pollutants in the exhaust plume of an aircraft during the LTO cycle, and the impact of climatic conditions (and potentially solar radiance), two distinct test programmes will be conducted during different seasons (summer and winter). Testing will take place at: i) varying times (day and night), ii) different aircraft axial locations, iii) different engine power levels (LTO cycle) and APU modes. The influence of fuel composition on emissions will also be studied during an alternative drop-in fuel test.

WP4 AMBIENT MEASUREMENTS AND SENSOR NETWORK DEVELOPMENT: To characterize the pollution burden in and around the airports, transport and impact of emissions from aircraft engines and APU will be monitored in this more complex environment through: i) High-fidelity measurement of ambient air quality at Madrid Airport, ii) low-cost sensors nodes deployment at 3 airports (Madrid, Zurich and Copenhagen).

WP5 MATHEMATICAL AND NUMERICAL MODELLING OF PLUME MICROPHYSICS, CHEMISTRY AND DYNAMICS: A microphysics and chemical conversion of the plume evolution will be carried out in two phases: i) focus on examining the range of possible background parameter values and concentrations and ii) focus on the modelling on engine emissions. Physical dynamics of the hot and turbulent exhaust of aircraft main engines for different meteorological conditions will also be investigated.

WP6 NUMERICAL POLLUTANT MODELLING AND TRANSPORT IN AND AROUND AIRPORTS: Dispersion models will be initialized for Madrid and Zurich airports using the estimates and parameterizations developed in WP5 studies and the modelled concentrations of the key pollutants will be compared to those measured in the experimental campaigns at the airports.

WP7 REGULATIONS: Identification of potential gaps in aircraft engine emissions regulation, using technical evidence and the identification of pathways for bridging regulatory gaps.

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SPATIAL VARIABILITY OF PERSONAL EXPOSURE TO PARTICLES IN LISBON

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Keywords: Exposure, PM2.5, PM10, children
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Particulate matter (PM) is a concern due to the adverse effects it causes on human health. According to the World Health Organization (WHO, 2013), urban air pollution causes significant health problems throughout Europe, reducing the life expectancy of residents of more polluted areas for more than 1 year. The expansion of cities, due to an increase in population, has brought new challenges to combat air quality pollution, which is closely associated with traffic. Since people spend more than 80% of their time indoors, individual's exposure to PM is dominated by indoor air pollution, which is partly outdoor air pollution that penetrates indoors and partly pollution from indoor sources. This work was developed in the framework of the LIFE Index-Air project (www.lifeindexair.net) and aims to study the spatial variation of personal exposure to particles in the city of Lisbon.

PM was sampled in 40 houses, 5 schools and respective outdoor sites during 5 days each. Leckel MVS6 samplers operated at a flow rate of 2.3 m^3/h and were used to collect PM2.5 and PM2.5-10.

PM2.5 and PM10 levels were higher inside the schools, and above the limit values established by the national legislation on indoor air quality. This is caused by the typical movement of the children inside the classroom, which causes the resuspension of particles, and by the weak ventilation of the spaces. In Figure 1 the PM2.5 and PM10 concentrations measured in the indoor and outdoor of the 40 houses and 5 schools are scattered throughout the city. The construction characteristics of the houses, the distance to important traffic emissions, the existence of green spaces, among others, vary from parish to parish, affecting the indoor and outdoor PM concentrations. It was possible to observe a pattern along the city, and the measurements in the most recent parishes, presented PM concentrations lower than the oldest parishes and especially lower than the city center, where the traffic is heavier and the dispersion conditions are worse. In most of the houses, the indoor concentrations followed the outdoor concentrations.

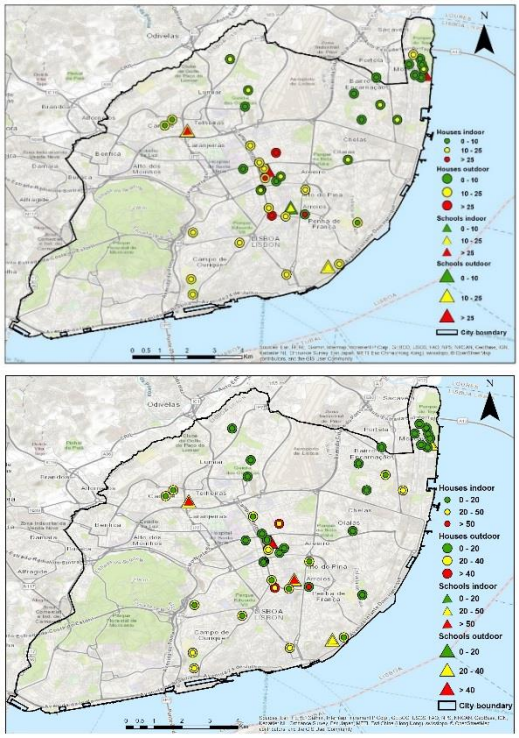

Figure 1 - PM2.5 and PM10 results in indoor and outdoor environments in houses and schools.

This work was supported by the EU LIFE Index-Air project (LIFE15 ENV/PT/000674). Tiago Faria acknowledges the PhD grant SFRH/BD/129149/2017 from the Portuguese Science Foundation (FCT, Portugal). This work reflects only the authors' view and EASME is not responsible for any use that may be made of the information it contains.

WHO (2013) Health effects of particulate matter: policy implications for countries in Eastern Europe, Caucasus and central Asia, Copenhagen, WHO Regional office for Europe.

RELATIONSHIP BETWEEN INDOOR AND OUTDOOR SIZE-FRACTIONATED PARTICULATE MATTER COLLECTED IN URBAN HOMES AND SCHOOLS

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Exposure to airborne particulate pollutants may pose potential public health problems [1], especially to children who represent a vulnerable group, with developing respiratory and immune systems. The health effects of particles depend strongly on their size, specific surface area, number and chemical composition [2]. The aim of this study was to evaluate the relationship between the indoor and outdoor size distribution of particles and its chemical constituents affecting the child exposure, which to the authors' knowledge is very scarce in the literature.

Methods: The study was conducted both in the indoor and outdoor of homes and schools located in the city of Lisbon (Portugal). Measurements were conducted in the living room and balcony of the homes and in a classroom and a playground location in the schools.

The size distribution of particles was obtained by using a Personal Cascade Impactor Sampler (PCIS), consisting of 4 impaction stages followed by an after-filter. Particles were separated in the following aerodynamic particle diameter ranges: <0.25; 0.25 to 0.5; 0.5 to 1.0; 1.0 to 2.5; and >2.5 µm. In order to ease interpretation of the data, a lower cut diameter of 0.03 µm was assumed for the stage of particles <0.25 µm. Moreover, the data for the coarser size fraction (2.5-10 µm) from the medium volume sampler (Leckel) operating concurrently was considered. The samples were representative of weekly (5-day) occupied-hours concentrations. The aerosol inlets were placed at roughly 1 m above the floor corresponding to the breathing level of the children.

Major and trace elements were analysed by X-Ray Fluorescence (XRF). The elemental (EC) and organic carbon (OC) concentrations were determined using the thermal-optical method.

Results: The pattern of the particles mass size distribution and its chemical constituents was very heterogeneous, not only among locations (home vs. school) but also between indoor and outdoor microenvironments. At homes, the indoor PM mass concentrations in the coarse mode were lower than outdoor, probably due to reduced penetration efficiency and faster settling times, as referred by Hussein et al. [3]. In schools the indoor concentrations tended to be higher than that in the corresponding outdoor for the size range between 2.5 and 10 µm, reflecting the contribution of indoor sources such as the resuspension and generation of particles associated with the students' activities.

In general, in the outdoor of both homes and schools the highest mass concentrations of PM were observed in the coarse fraction. This might be related to the high mineral and marine aerosol contributions in the study area. In the indoor, the highest contributions of mineral matter were observed for the coarser size fraction in the schools, associated to the outdoor infiltration and also to the presence of an indoor source (use of chalk on blackboards).

OC and EC were the main contributors of the mass of particles with aerodynamic diameter <0.25 in the indoors. Moreover, the EC contributions decreased with increasing particle size.

This work was supported by LIFE Index-Air project (LIFE15 ENV/PT/000674). Authors gratefully acknowledge the FCT support through the UID/Multi/04349/2013 project and the PhD grant SFRH/BD/129149/2017. This work reflects only the authors' view.

[1] Shaughnessy, W.J., et al (2015). Health effects of ambient levels of respirable PM on healthy, young-adult population. Atmos. Environ. 123, 102–111.
[2] Valavanidis, A., et al. (2008) Airborne PM and human health: toxicological assessment and importance of size and composition of particles for oxidative damage and carcinogenic mechanisms. J. Environ. Sci. Heal. Part C 26, 339–362.
[3] Hussein, T., et al. (2007) Evaluation and modeling of the size fractionated aerosol number concentration measurements near a major road in Helsinki. Atmos. Chem. Phys. 7, 4081–4094.

AMBIENT PARTICULATE MATTER SOURCE APPORTIONMENT USING RECEPTOR MODELLING IN 16 EUROPEAN AND ASIAN URBAN AREAS

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Keywords: PM2.5, source apportionment, EPA-PMF, Eastern Europe, Central Asia

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This work presents the results of a PM2.5 source apportionment study conducted in urban background sites from 16 European and Asian countries, within the International Atomic Energy Agency (IAEA) Technical Cooperation Project "Supporting Air Quality Management". For some Eastern European and Central Asian cities this was the first time that quantitative information on pollution source contributions to ambient particulate matter (PM) has been performed. More than 2200 filters were sampled and analyzed by Particle-Induced X-Ray Emission (PIXE), X-Ray Fluorescence (XRF), and Inductively Coupled Plasma Mass Spectrometry (ICP-MS) to determine the contents of chemical elements in PM2.5. Samples were also analyzed for the contents of black carbon, elemental carbon, organic carbon, and water soluble ions. The EPA Positive Matrix Factorization receptor model (version 5.0) was used to characterize similarities and heterogeneities in PM2.5 sources and respective contributions in the 16 cities. From the averages of sources contributions, considering all cities, 17% of PM2.5 was attributed to biomass burning, 14% to secondary sulfates, 13% to traffic, 13% to soil, 6.8% to fuel oil combustion, 4.0% to coal combustion, 2.3% to salt, 1.6% to industry emissions, 4.7% to "other sources" and 23% to unaccounted mass.

The results of this work indicate that biomass burning, traffic and industry are important contributors to air quality degradation in the 16 studied cities. The investment in clean energy in households, the development of sustainable transport solutions and the reduction of industrial emissions are the key targets towards healthy cities.

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EVALUATION OF AN INTERVENTION TO REDUCE ATMOSPHERIC POLLUTION: THE CASE TARANTO

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Keywords: Air quality intervention, Taranto, Dust dispersion, Wind day
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The present study focuses on the city of Taranto (Apulia Region, Italy). Taranto (Figure 1) is one of the most industrialized areas in southern Italy due to the massive presence of industrial sites with environmentally impacting activities that include: steel production (one of the largest plants in Europe), oil refining, cement production, harbour activities. The steel plant covers a surface of 15 million square meters and hosts a large open air mineral deposit, whose dust strongly impact the Tamburi neighborhood, downwind of the plant with respect to northwesterly winds. Several epidemiological studies conducted in this neighborhood and other areas of the town have revealed several critical situations in terms of mortality excess and short-term health effects of outdoor air pollution both for men and for women. (Gianicolo et al 2016)

In 2012 the Apulia Region enacted a law indicating some activity restrictions for the steel plant to be implemented during during particular meteorological situations characterised by northwesterly winds, called "wind-days" (wds).

The aim of the wds intervention is to reduce the dispersion of PM from the mineral deposit.

Aim of the work is to evaluate the overall effectiveness of the "wind days" intervention on air quality in the city of Taranto in view of an evaluation of the intervention on population health. Air quality data were analyzed at five urban/industrial monitoring stations (handled by Environmental Agency) located in different parts of the city (Figure 1), which continuously and simultaneously measured PM_{10}, SO_2, NO_2 from 2009 to 2016. Time-space statistical analysis before and after the intervention in the so-called "wind days" is carried out. The analysis is performed for different meteorological conditions, different wind days characterizations (strong/low wind persistence), time period, saharan dust intrusions. The results show that the effectiveness of the intervention depends on the different characteristics of the so-called "Wind days" concerns only some pollutants and some areas of the city (Figure 2)

Conclusions

Although the measures taken to limit the negative impacts of dust emissions during "windy days" are effective in some meteorological conditions and in some areas of the city, the results evidence the partiality of the intervention in the overall reduction of the impact of emissions on the air quality of the city. This calls for a more comprehensive intervention on the emissions to reduce their impact on air quality

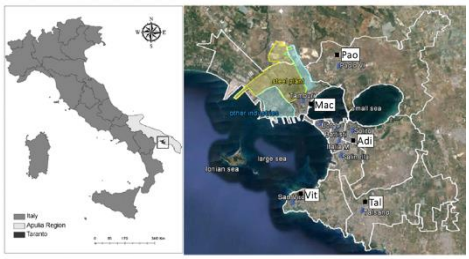

Figure 1 Area of study (left) and location of the measurement sites (right)

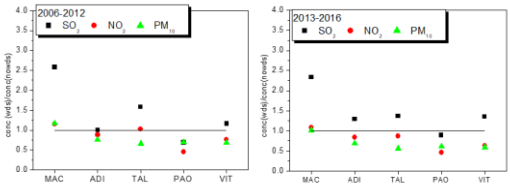

Figure 2 PM_{10}, NO_2 SO_2 ratios wds/nowds before and after the wind days intervention.

Gianicolo, E. A., Mangia, C., & Cervino, M. (2016). Investigating mortality heterogeneity among neighbourhoods of a highly industrialised Italian city: a meta-regression approach. *Int J Public Health*, 61(7), 777-785. doi:10.1007/s00038-016-0868-y.

Rich, D. Q. (2017). Accountability studies of air pollution and health effects: lessons learned and recommendations for future natural experiment opportunities. Environ Int, 100, 62-78. doi:10.1016/j.envint.2016.12.019

CHEMICAL VARIATIONS IN AEROSOLS IN AN URBAN ENVIRONMENT IN THE SOUTH OF SPAIN: 12 YEARS OF STUDY

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Keywords: urban aerosols, chemical profile, thermal inversion, Granada
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Atmospheric European legislation has been ruling for decades. Find the right strategies to reach the European targets is a difficult task, particularly the aerosol concentrations depend on large number of factors distintives from each specific location where targets are implemented.
Since 2006, a long time series of PM_{10} and PM_1 sampling of 12 years was performed in the city of Granada. Granada is a non-industrializated urban site in southeastern of Spain located in a valley surrounded by mountains with high elevations ranging from 1000 to 3500 m.a.s.l. The area is characterized by marked seasonal meteorological conditions due to its near continental conditions, with a winter period characterized by low temperatures and a summer period with elevated temperatures.
Along the 12 years, the PM_{10} levels in the city have registered an important reduction while this effect is not evident in PM_1 (Fig. 1). PM_{10} annual levels decrease from concentrations above the European target (48, 43 µg/m^3 in 2006 and 2007, respectively) to concentrations lower than 30 µg/m^3 in the last years. Related with PM_{10}, levels of nitrates, sulphates, mineral matter, non-mineral carbonaceous species and trace elements such as Cu, As, Cd, Sn, Sb, Ba and Pb present also parallel decrease along these years.

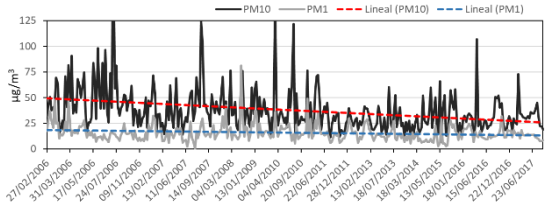

Fig. 1. Daily average concentrations of PM_{10} and PM_1 from 2006 to 2017.

Different meteorological conditions in the cold and warm periods also plays an important role in the chemical aspect of the aerosols in the city. In winter the development of thermal inversions favoured by the topography of Granada (Lyamani *et al*., 2010), added to the frequently stagnation episodes due to high pressure systems, favour the low dispersion of atmospheric pollutants, which lead in an increase of the aerosol concentrations near the surface (Lyamani *et al*., 2012). In summer, the increase of the boundary layer favours the transport of pollutants from the surface levels to high altitudes and in consequence a major dispersion of pollutants and the resuspension processes.
In the cold season, the PM present finer granulometry than in summer (PM_1/PM_{10}: 0.6 and 0.4 in cold and warm periods, respectively) especially in the carbonaceous compounds. The PM_{10} registered in the cold season show lower concentrations than in the warm season (34,2 and 37,5 µg/m^3 as average in the cold and warm season, respectively), and higher levels of PM_1 in the cold period (17,4 and 14,8 µg/m^3 as average in the cold and warm season, respectively). Also, chemical reactions are incremented in winter due to the thermal inversion situation. In this period, typical reactions involving NO_X/SO_2 (from traffic and domestic emissions principally) and crustal elements such as Ca and Mg (coming from the road dust resuspension, agricultural soils, construction activities and emissions from a Celestine Mine located in the south of the city) to generate $Ca/Mg(NO_3)_2$ and $Ca/MgSO_4$, develop large importance. These reactions are more frequent in summer in the south of Spain due to the large amount of Ca from the African dust episodes (Alastuey *et al*., 2005).

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Lyamani H., Olmo F.J., Alados-Arboledas L. (2010) Physical and optical properties of aerosols over an urban location in Spain. Atmos. Chem. Phys. 10, 239-254.
Lyamani H., Fernández-Gálvez J., Pérez-Ramírez et al. (2012) Aerosol properties over two urban sites in South Spain... Atmos. Env. 62, 424-432.
Alastuey A., Querol X., Castillo S. et al (2005) Characterisation of TSP and PM2.5 at Izaña and Sta. Cruz de Tenerife... Atmos. Env. 39 (26), 4715-4728.

Session 8 & 9 – Urban Air Pollution Mitigation Tools

SOURCES OF CHILDREN'S EXPOSURE TO PARTICULATE MATTER

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Keywords: Particles, homes, schools, receptor models
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Children living in Lisbon spend 87% of their time in indoor micro-environments (ME), such as homes (55%) and classrooms (27%). This indicates that risk assessment should focus on these ME where air particulate matter (PM) levels may differ from those outdoors due to specific indoor sources. Therefore, investigating the sources of PM in homes and schools and understanding to what degree indoor particles are affected by indoor activities or by outdoor pollution is a very relevant challenge. This work was developed in the framework of the LIFE Index-Air project (www.lifeindexair.net) and aims to identify the sources that affect the children exposure to PM in Lisbon.

This study was performed in the city of Lisbon at 40 houses, 5 schools and respective outdoor sites during the years 2017-2018 (Fig. 1). Leckel MVS6 samplers were used to collect PM2.5 and PM2.5-10 on Teflon filters, which were analysed by X-Ray Fluorescence for the measurement of major and trace elements, and on quartz filters, which were analysed by the Thermo-Optical Transmittance method for the determination of the organic and elemental carbon. A source apportionment analysis of the PM data was carried out by means of Positive Matrix Factorization to identify the main sources and their contribution.

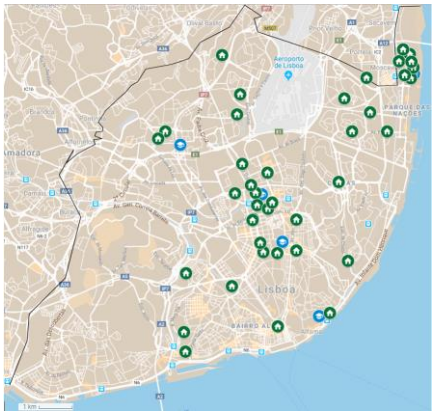

Figure 1. Localization of the homes and schools in Lisbon.

The PMF identified six source factors that contributed to PM: vehicles exhaust, secondary sulfates, mineral dust, a Pb source, sea salt and road dust.

The mineral factor was identified by crustal species such as Al, Si, Ca, Ti, Fe, Cr. In schools, the contribution of this source was significantly higher than in homes and outdoors, showing the important contribution of the high activity of primary schools students in the resuspension of deposited particles in classrooms.

Vehicles exhaust and road dust profiles comprise organic and elemental carbon from motor exhaust, metals form brake wear and mineral elements from the soil resuspension. Results showed a good correlation between the vehicles contribution to indoor (both in homes and schools) and the correspondent outdoor sites indicating significant children exposure to PM originating from outdoor urban sources, due to high aerosol infiltration rates.

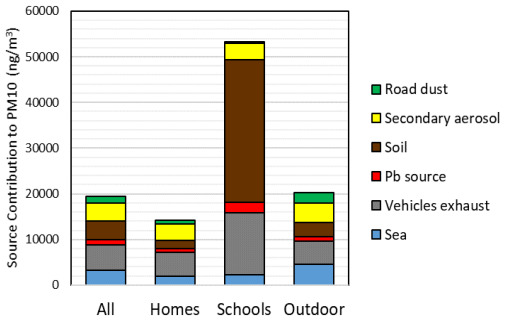

Figure 2. Source contribution to PM10 sampled in all ME, homes, schools and outdoors.

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ARTIFICIAL NEURAL NETWORKS AS A TOOL TO CONTROL URBAN PM ATMOSPHERIC LEVELS

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Keywords: artificial neural networks, emissions, air quality, improvement measures
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In order to reduce air pollution effects, particularly in cities where the majority of the population lives, it is urgent to define and support policy measures (Miranda et al., 2015). For this purpose, the ongoing project LIFE Index-Air develops an innovative and versatile decision support tool for policy makers, based on an integrated modelling approach, from emissions to health effects, which will help to test measures to improve air quality, reducing PM levels, and quantitatively assess their impact on the health and well-being of the populations.

The aim of this work is to simulate the link between precursor emissions and air pollution inside the tool, based on Artificial Neural Networks (ANN). The developed method will be used to identify PM10 emission control strategies. The methodology was applied over Lisbon (Portugal), a region frequently affected by high PM10 levels. Firstly, the WRF-CAMx air quality modelling system was run at a high spatial resolution (1×1 km^2), for the year 2015 and for a set of scenarios that reproduce possible precursor emissions variations. This procedure permits the training and validation of the ANN to be included in the tool, since the WRF-CAMx is too time consuming and cannot be directly used inside the operational tool. The trained ANN is able to estimate daily averaged PM10 concentration values with a correlation up to 75% (Fig. 1).

To operationally test the approach, two air quality improvement measures were simulated: introduction of electric cars (to control road traffic emissions), and fireplace improvement (to reduce residential combustion emissions). The results show that the fireplace replacement is more efficient to reduce PM10, and that ANN allows for a rapid exploration of potential air quality improvements resulting from different control measures, facilitating the decision making process. Face to the obtained results we conclude that this approach is suitable to be applied to the other four European urban areas of the LIFE Index-Air project: Porto (Portugal), Athens (Greece), Kuopio (Finland), and Treviso (Italy).

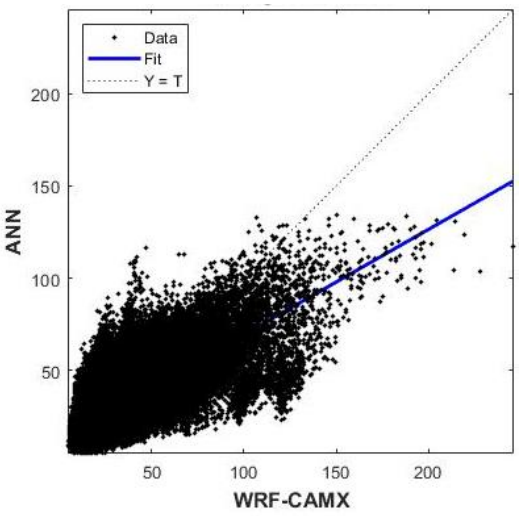

Fig. 1. Surrogate model validation scatter plot between WRF-CAM$_X$ (x-axis) and ANN (y-axis) for daily mean PM10 [µg/m^3].

This work was supported by the European Union's LIFE Programme in the framework of the LIFE Index-Air project (LIFE15 ENV/PT/000674). This work reflects only the authors' view and EASME is not responsible for any use that may be made of the information it contains.

Miranda, A., Silveira, C., Ferreira, J., Monteiro, A., Lopes, D., Relvas, H., Borrego, C., & Roebeling, P. (2015). Current air quality plans in Europe designed to support air quality management policies. Atmospheric Pollution Research, 6(3), 434-443.

PERSONAL DOSE OF PM_{10} FOR STUDENTS IN PRIMARY SCHOOLS IN LISBON

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Keywords: Particulate matter, dose, children,
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The personal dose of PM_{10} and PM_{10} -bound metals for students in five primary schools in Lisbon (Portugal) was calculated using a dosimetry model (ExDoM2; Chalvatzaki and Lazaridis, 2015). Three different environments (home (indoor), school (indoor /outdoor)) were considered but the same concentrations for home were adopted for all students. ExDoM2 has the capability to calculate the mass median aerodynamic diameter and geometric standard deviation for both coarse and fine particles. However, in the current work the diameter of each stage was considered monodisperse using the geometric midpoint. The deposition fraction DE_j was calculated by (ICRP, 1994):

$$DE_j = n_j \phi_j \prod_{jj=0}^{j-1} (1 - n_{jj}) \qquad (1)$$

where n_j is the deposition efficiency of j filter, ϕ_j is the fraction of tidal air that reaches the j filter and n_0 is the prefiltration efficiency.

In addition, the internal dose of Cr, Mn and Pb in the human body was calculated. The blood flow during no physical activity for children was based on Edginton et al. (2006) whilst the mass of organs was based on ICRP (2003).

Figure 1 shows that the higher weekly deposited dose was received by a student in school SD (2004 μg) while the lower weekly deposited dose was received by a student in school SE (1156 μg). The contribution of the type of environment for a student in school SD at the weekly deposited dose in the respiratory tract was found equal to 34.8 %, 59.6 % and 5.6 % for home (indoor), school (indoor) and school (outdoor) respectively, whilst, for a student in school SE it was 60.4 %, 31.0 % and 8.6 % for home (indoor), school (indoor) and school (outdoor) respectively. Higher deposited dose for Cr, Mn and Ni was received by a student at school SD while for Pb it was received by a student in school SC (no available data for school SE). Finally, it was found that Pb accumulated primarily in bones and blood, Cr in the GI-tract and lungs and Mn in lungs and other tissues.

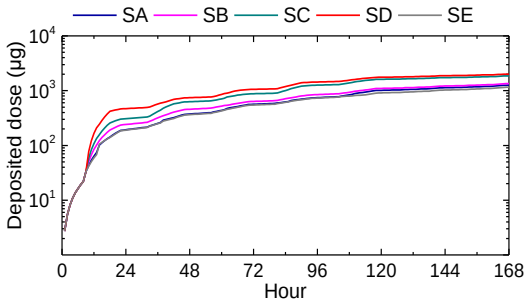

Fig. 1. Cumulative deposited dose of PM_{10} in the respiratory tract of students (10 years old children) in five schools (SA-SE) for one week.

This work was supported by the European Union's LIFE Programme in the framework of the Index-Air LIFE15 ENV/PT/000674 project. This work reflects only the authors' view and EASME is not responsible for any use that may be made of the information it contains.

Chalvatzaki E. and Lazaridis M. (2015). Development and application of a dosimetry model (ExDoM2) for calculating internal dose of specific particle-bound metals in the human body. Inhal. Toxicol. 27 (6), 308-320.

Edginton A.N., Schmitt W. and Willmann S. (2006). Development and evaluation of a generic physiologically based pharmacokinetic model for children. Clin Pharmacokinet. 45 (10), 1013-1034.

ICRP (1994). Human respiratory tract model for radiological protection. ICRP Publication 66. Ann. ICRP 24 (1-3). Pergamon Press, Oxford.

ICRP (2003). Basic anatomical and physiological data for use in radiological protection: reference values. ICRP Publication 89. Pergamon Press, Oxford.

BURDEN OF DISEASE ATTRIBUTED TO AIRBORNE PARTICULATE MATTER IN FIVE SELECTED EUROPEAN CITIES

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Keywords: fine particles, school absenteeism, health effects
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Introduction. Air pollution, especially particulate matter, is a leading environmental risk factor globally causing 6-7 million deaths annually (Landrigan et al., 2017). Therefore, it is essential to develop measures to reduce air pollution exposures.

Emission control strategies need to be evaluated in terms of the changes in actual exposures and accounting for specific particle compounds. Our objectives are to develop and describe a method, to be incorporated into the LIFE Index-Air Tool framework, for quantifying exposures and health impacts of air pollution. Specifically, we present burden of disease estimates for school children in Athens, Kuopio, Lisbon, Oporto and Treviso.

Methods. Geographical information on populations, pupils, and schools are combined with emission data, air quality models and meteorological data to estimate population exposures. Burden of disease methods are developed and used to estimate sick days due to upper respiratory infections and scaled for sick days at school, school absenteeism, and hospitalizations. Background population health data are from World Health Organization (WHO).

Results. Exposure levels of the general populations range from ca. 5 µg m^{-3} up to over 20 µg m^{-3} in the target cities. Preliminary results show that morbidity due to upper respiratory infections attributable to $PM_{2.5}$ exposure ranged from 10 YLD (Kuopio) to 290 YLD (Athens). The corresponding number of sick days ranged from 200 to 32,000 and respective days of absenteeism from 50 to 6000 per annum.

Sick days were chosen to assess the impacts of air pollution in school children, which generally have extremely low mortality rates. Fine resolution provided by sick days and absenteeism allow for efficient and concrete risk characterization also between air quality management measures, and meaningful communication with the public.

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Landrigan P, Fuller R, et al., 2017. The Lancet Commission on pollution and health. The Lancet 391:10119 https://doi.org/10.1016/S0140-6736(17)32345-0

LIFE INDEX-AIR - DEVELOPMENT OF AN INTEGRATED EXPOSURE - DOSE MANAGEMENT TOOL FOR THE REDUCTION OF PARTICULATE MATTER IN AIR AND THE PROTECTION OF PUBLIC HEALTH

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Keywords: policy tool, exposure to particulate pollution, dose assessment, burden of disease
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Exposure to airborne particulate matter (PM) has been associated with significant adverse health effects, mainly related to cardiovascular and respiratory diseases (Burnett et al., 2018). The relationships between exposure to PM and various health endpoints are focusing on the ambient atmosphere, even though urban populations spend the majority of theit time in indoor microenvirionments; thus, the impact of the air pollution mitigation policies to the real population exposure, and related health risks, has not been quantitatively assessed. On the other hand, developing effective control measures for PM pollution is still rather challenging, due to the complex nature of this pollutant and its multiple primary and secondary sources.

This work presents a novel policy support tool, based on an integrated exposure-dose-burden of disease assessment. The tool was developed in the framework of the LIFE Index-Air project (www.lifeindexair.net), and was initially applied for Lisbon and Porto (Portugal), Treviso (Italy), Athens (Greece) and Kuopio (Finland). Nevertheless, it has been designed in such a way as to allow in the future inclusion of other cities as well.

The tool focuses on the exposure of school children and uses data on PM concentrations outdoors and in selected indoor microenvironments (homes, schools, and transport modes), as well as time-activity information. The computational algorithms include the following Calculation Levels:

Level 1: Modelling of ambient concentrations based on PM emissions;
Level 2: Exposure model, for the assessment of individual and population exposure;
Level 3: Dosimetry models, for the assessment of respiratory deposition and internal doses;
Level 4: Methodology for calculating the burden of disease;
Level 5: Built-up of policy making scenarios, where the user may change selected input data (such as, strength of emission sources or children's time activity patterns) and repeat all the computations included in Calculations Levels 1 – 4.

Through this comprehensive exposure - health impact assessment, the Index-Air tool allows policy makers and other interested parties to: (i) quantify key parameters with respect to the exposure of citizens to PM pollution and the relevant health risks, and (ii) to assess exposure mitigation strategies, through a quantitative measure of their impact on PM concentration levels, exposures, doses to the human organism, and overall burden of disease.

Initial results suggest that, in baseline, exposure to $PM_{2.5}$ was related to 4-20 school absenteeism days per 1000 children in the five studied cities in 2015. The tool allows estimating the impacts of traffic and urban planning policies on this baseline burden.

This work was supported by the EU LIFE Index-Air project (LIFE15 ENV/PT/000674). This work reflects only the authors' view and EASME is not responsible for any use that may be made of the information it contains.

Burnett, R., et al. (2018) Global estimates of mortality associated with longterm exposure to outdoor fine particulate matter, *P. Natl. Acad. Sci. USA*, 115(38), 9592-9597.

Poster Presentations

Atmospheric Aerosols

STATISTICAL OVERVIEW OF VERTICAL RESOLVED CLOUDINESS IN GRANADA USING CEILOMETER

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Keywords: clouds, aerosol-cloud interaction, Sierra Nevada
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Granada is a non-industrialized medium-size city in the south-eastern part of Spain. The city is surrounded by mountains having the highest mountain range to the south-east (Sierra Nevada National Park). Cloud formation and development processes as well as precipitation events are crucial in such sensitive ecosystem. Additionally, its proximity to the Granada metropolitan area makes the study of aerosols and clouds of outmost importance due to the possible interaction of transported upslope aerosols in cloud formation and development in Sierra Nevada.

Ceilometers are instruments based on lidar principle. A laser pulse is sent vertically to the atmosphere and the backscatter signal is collected in a telescope. They can determine the cloud base height accurately (Martucci et al, 2009). However, cloud geometrical depth determination depends on the opacity of the cloud and the power of the ceilometer laser. In this study, a Lufft CHM15k Nimbus ceilometer has been used. Cloud base height and cloud depth can be determined in three layers. The ceilometer also provides an estimation of the sky condition (sky condition index, SCI) where rain cases can be identified.

In this study, a statistical overview of cloud conditions for the period December 2012 to December 2018 over Granada has been performed as a function of year and season. In order to get better results, we have developed an algorithm to determine the cases in which the ceilometer signal saturates or it is lost to find out when it is possible to obtain the cloud geometrical depth. Furthermore, the sky condition has been used to discriminate the cloud base during rain events.

As a result of this study, considering cases with no signal loss in the ceilometer, we observed that cloud heights are similar on the same season every year. In particular, during winter, the clouds are primarily detected between 3000 and 8000 m agl. In spring, the situation is similar to winter, but with more frequent cloudiness over 8000 m agl. In summer, there is a predominance of mid-height clouds (around 5000 m agl). Finally, in autumn, clouds are distributed over 4000 m agl and, beneath this level, are practically absent.

The seasons with more clouds are winter and spring, followed by autumn and finally by summer. In the latter case, the cloudiness is scarce and more concentrated in terms of height interval than in the rest of the cases.

If signal loss profiles are not eliminated from the statistics, we observe a cloud layer between 1500 and 2500 m agl. In these cases, it is difficult to determine the geometrical depth of these clouds. Finally, during rain evens, in all the cases studied, cloud bases are lower than 3000 meters, regardless of the season.

In conclusion, ceilometer data has been used in Granada to determine vertical resolved cloudiness. Low clouds always saturate the ceilometer signal and it is difficult to determine the cloud geometrical depth. However, for middle and high clouds, cloud base and depth can be determine accurately. According to ceilometer data, rain initiates on average at 3000 m agl. This height is close to the mountain top in Sierra Nevada. Future studies combining this statistical overview and aerosol measurements to investigate aerosol-cloud interactions are foreseen.

This work was supported by CGL2015-73250-JIN, CGL2016-81092-R and ACTRIS-2 (Ref. 654109).

Martucci G., Milroy C., O'dowd C.D. (2010) Detection of Cloud-Base Height Using Jenoptik CHM15K and Vaisala CL31 Ceilometers. Journal of Atmospheric and Oceanic Technology 27-2, 305.218.

SCAVENGING OF AEROSOL PARTICLES IN GRANADA URBAN AREA

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Keywords: aerosol, scavenging, optical properties, microphysical properties
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Below-cloud scavenging of aerosol particles by hydrometeors plays an important role in defining their atmospheric lifetimes. This mechanism is subject to large uncertainties in global models due to non-linear dependencies of scavenging efficiencies with hydrometeor diameter spectra and phase, precipitation intensity, atmospheric turbulence and particle diameter.

Granada is a medium size non-industrialized city located in the southeastern of Spain. The urban area is surrounded by mountains, with predominance of low wind speeds and frequent stagnant conditions, especially during winter. This situation limits the removal of particles due to ventilation. In this study we investigate whether scavenging of particles during rain events is an efficient mechanism of particle removal in the city of Granada.

In order to evaluate the scavenging of particles we have combined precipitation measurements with various in-situ aerosol measurements performed at the IISTA-CEAMA urban background station since November 2018. The hydrometeors size distribution was measured using an OTT Parsivel^2 disdrometer providing a diameter range of hydrometeors between 0.062 and 24.5 mm. The particle number size distribution was measured with a Scanning Mobility Particle Sizer (SMPS, TSI) in the diameter range 13.6-615.3 nm. Equivalent black carbon (eBC) concentrations were measured with an aethalometer AE33 (Aerosol d.o.o.). Additionally, an automatic weather station was used to measure temperature, relative humidity, wind speed and direction.

Rain events were identified and isolated using the following criteria:

a) a minimum of 0.4 mm of precipitation accumulated during the event
b) the precipitation intensity of the event exceeds 0.2 mm h^{-1}
c) a minimum of one hour without rain before and after the event
d) a maximum difference of 2 ms^{-1} in wind speed and 50º in wind direction during the event to minimize the influence of changing aerosol sources during the events.

Figure 1 shows an example of the precipitation events identification.

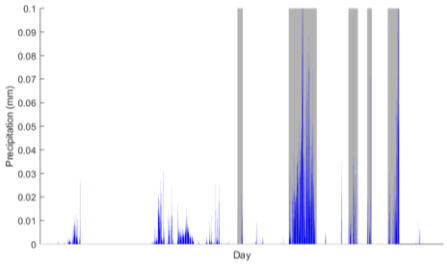

Fig. 1. Precipitation amount in mm (blue) and events identified (gray area).

The scavenging coefficient (λ) defined as

$$\lambda = \frac{1}{t_1 - t_0} ln \frac{C_1}{C_0}$$

where t_0 and t_1 are times before and after the rain event and C_0 and C_1 are the corresponding concentrations (Blanco-Alegre et al., 2019). In this study, λ has been calculated using eBC concentration and the particles number concentration in different size ranges (Aitken, accumulation, fine mode). For each rain event, the concentration change between times t_0 and t_1 was calculated as follows:

$$\Delta C = \frac{C_1 - C_0}{C_0} \times 100$$

The below-cloud scavenging efficiency for different particle size ranges and for eBC is evaluated as a function of rain drop size, precipitation intensity and weather type favoring precipitation.

This work was supported by CGL2015-73250-JIN, CGL2016-81092-R and ACTRIS-2 (Ref. 654109).

Blanco-Alegre C, Calvo A.I., Coz E., Castro A., Oduber F., Prévôt A.S.H., Mocnik G., Fraile R. (2019). Quantification of source specific black carbon scavenging using an aethalometer and a disdrometer. Environ. Poll., 246, 336-345

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A COMPARISON BETWEEN TWO CLASSIFICATION SCHEMES OF THE AEROSOL TYPE

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Keywords: Aerosols, classification, aerosol type
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This work deals with the analyses of aerosol optical and microphysical properties obtained by the Aerosol Robotic Network (AERONET) in two locations in South of Spain (Granada and Málaga), an urban site and a coastal site, respectively, with the objective of studying different aerosol typing approaches. In this analysis we used columnar aerosol properties measured during three coincident years (2010, 2011 and 2012). Columnar aerosol properties were measured by a CIMEL sun/sky photometer, which is the standard sun/sky photometer used in the AERONET network (Holben et al., 1998). The studied variables are: aerosol optical depth (AOD), Angström parameter ($\alpha_{440\text{-}870}$), fine mode fraction (FMF) and single scattering albedo (ω_o). Two schemes to characterize aerosol types have been used and compared, one based on AOD and $\alpha_{440\text{-}870}$ (Mateos et al., 2014), here nominated as classification 1, and another based on ω_o at 440 nm and FMF (Lee et al., 2010) (classification 2). Classification 1 refers to desert dust (DD), continental clean (CC), continental polluted (CP) and maritime (M). Classification 2 refers to absorbing fine mode (AF), non-absorbing fine mode (NAF), dust (D) and mixture (Mix). The results revealed that the second classification is more appropriate.

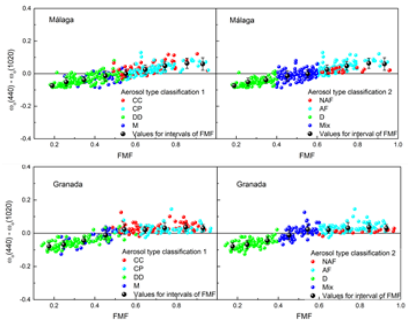

Fig. 1. Relationship between $\Delta\omega_o$ ($\omega_o(440)$- $\omega_o(1020)$) and Fine Mode Fraction (FMF)

This work was supported by the European Union's Horizon 2020 research and innovation programme through project ACTRIS-2 (grant agreement No 654109) by the Spanish Ministry of Economy and Competitiveness through projects CGL2013-45410-R, CGL2016-81092-R and CGL2017-90884-REDT, by the Andalusia Regional Government through projects P12-RNM-2409 and by the University of Granada through the contract "Plan Propio. Programa 9. Convocatoria 2013" The authors also thankfully acknowledge the FEDER program for the instrumentation used in this work and the University of Granada that supported this study through the Excellence Units Program "Plan Propio. Programa23 Convocatoria 2017".

Holben BN, Eck TF, Slutsker I, Tanre D, Buis JP, Setzer KA, Vermote E, Reagan JA, Kaufman YJ, Nakajima T, Lavenu F, Jankowiak I, Smirnov A. 1998. AERONET - A Federated Instrument Network and Data Archive for Aerosol Characterization. Rem. Sens. Environ. 66(1); 1–16.

Lee J., Kim J., Song CH., Kim SB., Chun Y., Sohn BJ. and Holben BN., 2010. Characteristics of aerosol types from AERONET sunphotometer measurements. Atmos. Environ., 44: 3110–3117, doi:10.1016/j.atmosenv.2010.05.035.

Mateos D., Sanchez-Lorenzo A., Antón M., Cachorro, VE., Calbó J., Costa, MJ., Torres B. and Wild M., 2014. Quantifying the respective roles of aerosols and clouds in the strong brightening since the early 2000s over the Iberian Peninsula, J. Geophys. Res. Atmos., 119,10382–1039.

A PRELIMINARY ANALYSIS TO EVALUATE THE EFFECTS OF AEROSOLS ON PHOTOSINTHETICALLY ACTIVE RADIATION AT GRANADA

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Keywords: Aerosols, radiative forcing, photosyntetically active radiation
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In this work we have performed a preliminary analysis to evaluate the radiative effect of atmospheric aerosols on photosynthetically active radiation (PAR). PAR plays a main role in plant growth, since PAR is utilized by plants in photosynthesis to convert light energy into biomass by biochemical processes. For this purpose and with data obtained at an urban site located in South of Spain (Granada), we have used columnar aerosol properties along with simultaneous measurements of PAR obtained during a full year (2016).

Columnar aerosol properties were measured by a CIMEL sun/sky photometer, which is the standard sun/sky photometer used in the AERONET network (Holben et al., 1998). This instrument is within RIMA (http://www.rima.uva.es/RIMA/) Iberian network of sunphotometers included in AERONET. We focus on aerosol optical depth (AOD) at 500 nm (around the mean of the solar spectrum in the visible region). In this study we use AERONET Level 2.0 data from the recent version 3, which is more reliable in terms of cloud screening and in detecting instrument anomalies (Giles et al., 2018). PAR has been measured using LICOR model 190 SA quantum sensors (Lincoln, NE).

PAR ranged from 121 to 2338 µmol m^{-2} s^{-1} with an average annual value of 1010 ± 540 µmol m^{-2} s^{-1}, while AOD at 500 nm varied from 0.02 to 1.04 with an average annual value of 0.14 ± 0.11. Aerosol forcing efficiency (AFE) on PAR was calculated using the direct method described by Satheesh and Ramanathan (2000) through the linear fit of photosynthetic photon net flux versus AOD for a fixed value of solar position (θ_0=15º ± 1º). The surface albedo was set to 0.15, corresponding to the average value given by AERONET at 675 nm during the year of study. Our results show an AFE of -280 ± 40 µmol $m^{-2}s^{-1}$ per unit of AOD at 500 nm (Figure1).

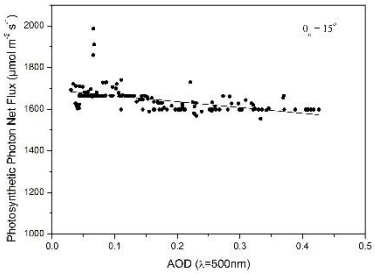

Fig. 1. Photosynthetic Photon Net Flux at θ_0=15º versus aerosol optical depth (AOD) at 500 nm.

This work was supported by European Union's Horizon 2020 research and innovation programme through project ACTRIS-2 (grant agreement No 654109) by the Spanish Ministry of Economy and Competitiveness through projects CGL2013-45410-R, CGL2016-81092-R, and CGL2017-90884-REDT, by the Andalusia Regional Government through projects P12-RNM-2409 and by the University of Granada through the contract "Plan Propio Programa 9. Convocatoria 2013".

Holben B.N., Eck T.F., Slutsker I., Tanre D., Buis J.P., Setzer A., Vermote E., Reagan J.A., Kaufman Y.J., Nakajima T., LAvenu F., Jankowiak I., Smirnov A. (1998) AERONET – Afederated instrument network and data archive for aerosol characterization. *Remote Sensing of Environment*, 66, 1-6.

Sathessh S.H. and Ramanathan V. (2000) Large differences in the tropical aerosol forcing at the top of the atmosphere and Eaarth's surface. *Nature*, 405, 60-63.

Giles, D.M., Sinyuk, A., Sorokin, M.S., Schafer, J.S., Smirnov, A., Slutsker, I., Eck, T.F., Holben, B.N., Lewis, J., Campbell, J., Welton, E.J., Korkin, S., Lyapustin, A., 2018. Advancements in the Aerosol Robotic Network (AERONET) Version 3 Database – Automated Near Real-Time Quality Control Algorithm with Improved Cloud Screening for Sun Photometer Aerosol Optical Depth (AOD) Measurements. Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2018-272.

HYGROSCOPIC PROPERTIES OF SUBMICROMETER ATMOSPHERIC AEROSOLS AT A SUBURBAN SITE IN THE IBERIAN PENINSULA

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Keywords: external mixing state, H-TDMA, particle hygroscopicity, urban aerosol
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Aerosol ability to absorb water can be highly variable and depends on its composition and the ambient relative humidity conditions, which can alters its properties. This is especially relevant concerning its impact on both climatic processes and human health.

An extensive database (December 2014-2015, 8424 data points) of H-TDMA measurements was obtained at a suburban site in Madrid. The aerosol hygroscopic growth distributions at 90% RH were measured for five particle dry sizes (50, 80, 110, 190 and 265 nm).

Additional observations such as particle number size distributions (15-660 nm), particulate matter (PM) and gases (SO_2, NO_x and O_3) concentrations and meteorological parameters supported this study. In this work we analyse, for the first time in this area, the seasonal, monthly and daily aerosol hygroscopicity variations in terms of known sources and meteorology.

The main results found in this study are depicted in Figure 1 and are summarized as follows:

(1) All aerosol particle sizes were more externally mixed in cold seasons (bimodal growth factor probability density functions (GF-PDFs)) than in warm ones (Fig. 1A). It is important to highlight that unimodal GF-PDFs dominated for particles of 50 and 80 nm during warm seasons, possibly associated with new particle formation (NPF) bursts.

(2) Average hygroscopic growth (GF_{mean}) was higher during warm seasons than during cold ones (Fig. 1B), in the same way that the number fraction of more-hygroscopic particle group (NF_{MH}), linked to photochemical aging promoted by the meteorological conditions during these seasons. However, the highest GF_{mean} peaks were found in cold seasons associated with nitrate formation during strong stagnation episodes.

(3) The larger the particle size, the greater the hygroscopic growth. Given that GF_{mean} values are well-represented by the hygroscopicity parameter κ, the hygroscopicity values by particle size depended highly on its chemical composition.

(4) The daily evolution of the aerosol hygroscopicity at this site was conditioned by the traffic emissions, finding the minimum GF_{mean} values during rush hours (Fig. 1C).

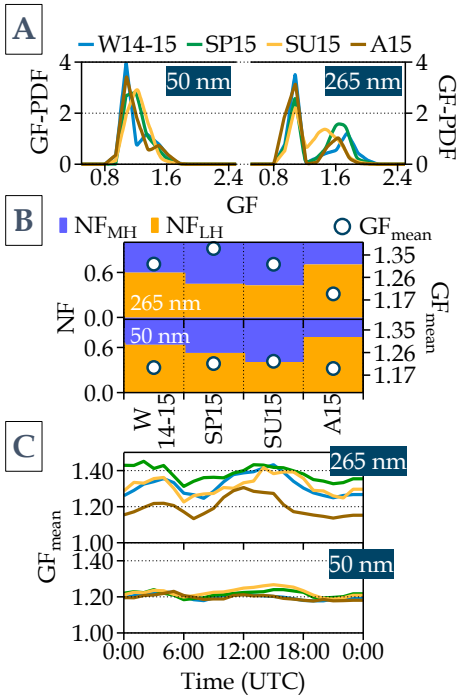

Fig. 1. Seasonal mean of (A) GF-PDFs, (B) the number fraction of less (NF_{LH}) and more (NF_{MH}) hygroscopic particle groups and GF_{mean} and (C) daily evolution of GF_{mean}. Here, only the parameters corresponding to 50 and 265 nm are shown. W14-15=winter 2014-2015, S15=spring 2015, SU15=summer 2015 and A15=autumn 2015.

The particle sources mainly traffic in cold seasons and NPF bursts in warm ones, and meteorology governed the hygroscopic behaviour of the aerosol particles in the Madrid suburban atmosphere.

This work was funded by the Spanish Ministry of the Environment (CGL2017-85344-R), Madrid Regional Government (P2018/EMT-4329 and Y2018/EMT-5177) and Red de Excelencia ACTRIS-ESPAÑA (CGL2017-90884-REDT). The authors wish to thank to Martin Gysel for the development of $TDMA_{inv}$ and Diego A. Alonso his help in the hygroscopic groups-fitting procedure.

CLOUD CONDENSATION NUCLEI VARIABILITY IN AN URBAN ENVIRONMENT

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Keywords: cloud condensation nuclei, supersaturation, activation fraction
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Cloud condensation nuclei (CCN) are atmospheric aerosol particles that can become cloud droplets. The two main characteristics that determine if a particle can become a cloud droplet are its size and chemical composition. CCN measurements are very important to understand aerosol-cloud interactions, which is one of the least understood processes in aerosol atmospheric science. CCN concentrations are affected by anthropogenic emissions, which can, in turn, modify cloud properties. Each CCN particle absorbs water vapour if the water vapour saturation is large than a threshold supersaturation (*ss*) value called critical supersaturation, S_c. In that case, the CCN particle is activated.

The objective of this study is to characterize CCN concentrations and activation properties in an urban environment. To this end, a single-column CCN counter (DMT) (Robert and Nenes, 2005) was deployed in the IISTA-CEAMA background station in Granada since October 2018. The CCN data are obtained for the following *ss* values: 0.1, 0.3, 0.5, 0.7, 0.9 and 1.1 %; and using two-operation procedures: 1) scanning the *ss* spectrum (a complete cycle covering the whole *ss* spectrum lasts one hour, taking five minutes in each *ss* value); 2) fixing the *ss* value (0.6 %) for a longer measurement period. In addition, a Scanning Mobility Particle Size spectrometer (SMPS) was used to measure the particle number size distribution in the diameter range 10.9-514.2 nm. The combined SMPS and CCN counter measurements allows the calculation of the activation fraction (fraction of particles that have been activated) and critical diameter (diameter at which particles activate). Also, we combine these results with black carbon (BC) measurements (Multi-Angle Absorption Photo-meter, MAAP) and chemical composition analysis (PM10 and PM1 high-vol samples).

Figure 1 shows the diurnal evolution of the activation fraction (0.9 % *ss* value), averaged for the first month of measurements. The diurnal evolution is characterized by two minima, coinciding with traffic rush hours. This diurnal pattern contrasts with the diurnal evolution of BC concentrations (Fig.1), characterized by two coincident maxima. In general, we observe that the activation fraction is very small for the supersaturation value considered. Two explanations could be: (i) the high contribution of ultrafine particles to the total fine aerosol concentration and (ii) the strong contribution of BC particles, with low activation capacity.

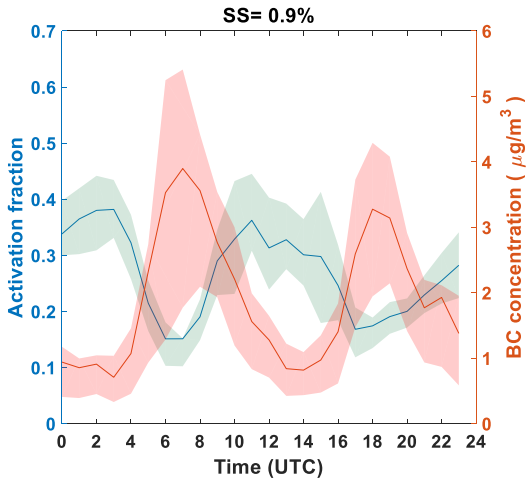

Fig. 1. Mean diurnal evolution of the activation fraction at 0.9% ss and black carbon concentration, during October 2018 in Granada. The shaded area is the interquartile range.

This work was supported by Spanish Government CGL2016-81092-R and GCL2017-90884-REDT, and by EU H2020 (ACTRIS-2, 654109) and by University of Granada Plan Propio (Visiting Scholars).

Roberts, G., and Nenes, A. (2005) "A continuous-Flow Streamwise Thermal-Gradient CCN Chamber for Atmospheric Measurements," *Aerosol Science and Technology*, 39, 206–221.

AEROSOL-CLOUD INTERACTIONS OBSERVED DURING GOAMAZON

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Keywords: aerosol-cloud interaction, GoAmazon, biomass burning, pollution
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The GoAmazon2014/15 experiment (Martin et al., 2016), conducted in the environs of Manaus (Brazil), was conceived to explain how human activities affect the climate in the Amazon Basin, particularly, the susceptibility to cloud aerosol precipitation interactions. It is well-known that aerosol particles may act as cloud condensation nuclei. When aerosol lading is relatively low, increases in aerosol lead to an increase in droplet concentration and a reduction in cloud effective radius. However, when aerosol optical depth is high, the droplet concentration usually saturates as aerosol loading increases. Moreover, if the aerosol is absorbing, there might be a reduction of droplet concentration (IPCC, 2013).

One of the aims of this work is to assess the impact of two different aerosol types on the cloud base height (CBH) for clouds inside the boundary layer: urban pollution from Manaus city and biomass burning particles. CBH under presence of high aerosol loads is evaluated and compared to when only background aerosol is present.

A 1 min-resolution database has been created. CBH is obtained from a ceilometer and a micro pulse lidar. In-situ data has been used to classify air masses in three possible scenarios, based on Thalman *et al.* (2017): background aerosol, Manaus plume and biomass burning. Only periods in which CBH temporal frequency were similar for two scenarios have been studied. These periods are January-May for Manaus plume and August-December for biomass burning (both with data of 2014-2015). CBH values were averaged in each month.

Both aerosol type scenarios showed an increase in CBH (Fig. 1). This effect could be due to an excess of cloud condensation nuclei in low levels, which could lead to an extreme competition between them for water vapour. Other explanation could be based on the absorption nature of the aerosol, cooling the surface and heating the atmosphere. Finally, maybe air masses carrying these aerosols have other external properties which lead to this effect. In order to assess the processes responsible for this effect, additional analyses will be conducted in the future, such as thermodynamic analysis on atmospheric stability.

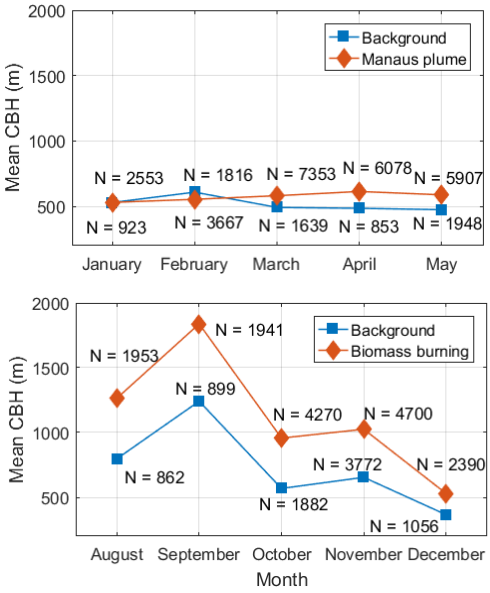

Fig. 1. CBH differences: (upper panel) Manaus plume vs background, (bottom panel) biomass burning vs background. Standard deviation is about 400-600 m for each month.

This work was supported by the Spanish projects CGL2013-45410-R, CGL2016-81092-R, CGL2017-83538-C3-1-R and CGL2017-90884-REDT, the European Union's Horizon 2020 research and innovation program through project ACTRIS-2 (grant agreement no. 654109), and by the visiting professor grants funded by FASPESP (2018/08934-6) and Carolina Foundation.

Thalman, R. et al. (2017): *Atmos. Chem. Phys.*, 17, 11779-11801.
Martin, S. T., et al. (2016): *Atmos. Chem. Phys*., 16, 4785-4797.

REMOTE SENSING TO STUDY AEROSOL HYGROSCOPIC GROWTH AT THE SIATA TOWER STATION IN MEDELLÍN (COLOMBIA)

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Keywords: Aerosol hygroscopic growth, ceillometer, microwave radiometer
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Atmospheric Aerosols

Water vapor plays a major role in the aerosol-radiation and aerosol cloud interaction because the capacity of some atmospheric aerosol particles to take up water from the environment, process known as hygroscopic growth. This process allows to particles increase their size under high relative humidity (RH) conditions. Aerosol hygroscopic growth have been widely studied using the enhancement factor $f_{\xi}^{\lambda}(\lambda, RH)$, defined as the ratio between some of the aerosol optical/microphysical properties ξ at wet atmospheric conditions and the corresponding reference value at dry conditions. Its magnitude depends on the aerosol chemical composition and size. These studies have been performed by using in-situ techniques, presenting some drawbacks mainly associated to the modification of the air sample. These issues have been overcome by using remote sensing techniques i.e., lidar, which allows to obtain high temporal and spatial resolved measures under ambient conditions (Bedoya-Velásquez, et al., 2018). In this work, we use the synergy between Vaisala CL 51 ceilometer and MP 3000 A, microwave radiometer (MWR), to study potential aerosol hygroscopic growth cases at the SIATA-tower station is located on the base of the Aburrá Valley, in Medellín, Antioquia, Colombia (6.26ºN, 75.59ºW, 1470 m asl).

The main goal is to take advantage of the continuous operation of those instruments measuring attenuated backscatter (β^{att}) and relative humidity (RH) co-located from ground level to 1 km, in order to search for aerosol hygroscopic growth potential cases in both, temporal and vertical coordinates.

Over a 3.5-year database, more than 50 cases were found in the vertical analysis and about 16 in the time evolution. The proposed methodology isolates cases where β^{att} and RH increase/decrease simultaneously (in time and in height), but also other atmospheric properties are considered. Fig. 1 shows an example of a case of temporal evaluation of hygroscopicity on 23/01/2018. The Hänel parameterization showed good correlation (R^2=0.95), with a γ=0.33 and ΔRH=33.5 %. The $f_{\beta^{att}}$(85 %) =1.5, allowing the possibility to have hygroscopic growth properties in this populated urban region.

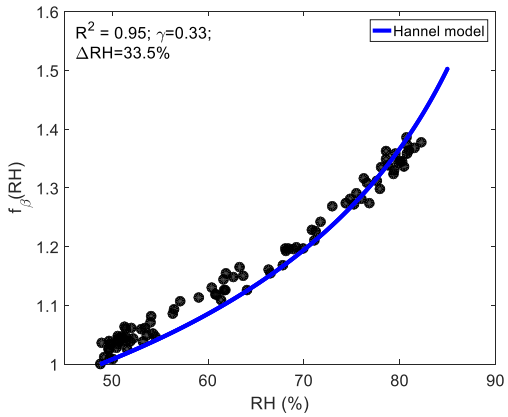

Fig. 1. Humidogram on 23/01/2018 from 06:63 to 09:36.

This work was supported by Colombian grant 'Beca de doctorado nacional Colciencias 647' and Sistema de Alerta Temprana de Medellín y el Valle de Aburrá (SIATA) for the data availability. The authors thankfully to the Spanish projects CGL2013-45410-R, CGL2016-81092-R, CGL2017-90884-REDT and CGL2017-83538-C3-1-R.

Bedoya-Velásquez, A. E. et al (2018): Hygroscopic growth study in the framework of EARLINET during the SLOPE I campaign: synergy of remote sensing and in situ instrumentation, *Atmos. Chem. Phys*., 18, 7001-7017, https://doi.org/10.5194/acp-18-7001-2018.

ANALYZING ATMOSPHERIC CONDITIONS THAT AFFECT EXTREME POLLEN EPISODES OVER SOUTHERN IBERIAN PENINSULA

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Keywords: extreme event, meteorology, pollen, remote sensing
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Extreme pollen episodes can be defined as an event when the pollen concentrations suspended in the near-surface atmosphere and the associated meteorological conditions cause an exceptional impact on health. Several studies have reported cases of asthma outbreaks and a significant increase in hospital admissions when high levels of atmospheric pollen and meteorological episodes of a certain intensity (i.e. heavy rains, strong winds) have occurred, with records much higher than the usual average pollen concentrations of each area, and even those recorded during the flowering peak.

The presence of high pollen concentrations in the atmosphere can be due to both the reproductive biology of plants and the meteorological conditions occurring before and during the flowering period. Numerous studies indicate surface temperature and precipitation as the main meteorological variables affecting the pollen production and their subsequent release. However, studies accounting for meteorological situations that influence the presence and permanence of high concentrations of pollen in the atmosphere, beyond the own species' phenology, are not frequent.

Our goal is to analyze meteorological variables that participate in atmospheric processes when pollen levels in the atmosphere can be considered as an extreme episode. The study is carried out in Granada (Spain), which due to its bioclimatic and biogeographical characteristics presents a very diverse aerobiological spectrum. A statistical analysis over an almost 30-year dataset (1992-2018) of accumulated daily pollen concentration has been used to investigate the extreme pollen episodes. Meteorological data at surface level from the Spanish Meteorological Agency (AEMET) station at Armilla (Granada) are used to characterize the surface meteorological conditions. Finally, the state-of-the-art automatic remote sensing instruments routinely operating at the IISTA-CEAMA station, such as a microwave radiometer (MWR), a Doppler lidar and ceilometer, are used to fully investigate the vertical distribution of atmospheric variables that potentially impact of the pollen concentration.

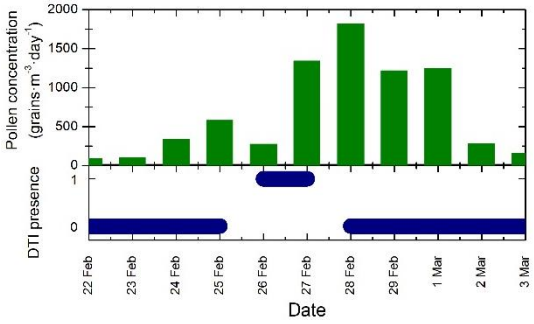

Fig. 1. Pollen levels and diurnal thermal inversion (DTI) presence during an intense pollen episode at Granada.

Figure 1 shows an episode (26 Feb. – 2 Mar. 2012) with values of total pollen concentration above the percentile P97. The peak concentration was 1817 grains·m^{-3}·day^{-1} on 28 Feb. partitioned in 96.8% *Cupresaceae*, 2.1% *Ulmus* and <1.1% other species. The microwave radiometer detected the presence of thermal inversions during daytime (11-15 UTC), which might contribute to prevent the vertical dispersion of pollen grains, increasing the surface pollen level during the subsequent days.

This work was supported by the Spanish projects CGL2013-45410-R, CGL2016-81092-R, CGL2017-83538-C3-1-R and CGL2017-90884-REDT, through the mobility subprogram José Castillejo 2018 (CAS18/00045) and H2020 program through project ACTRIS-2 (grant agreement No 654109). The authors acknowledge the FEDER program for the remote sensing instrumentation, AEMET for the historical surface data used in this work and the Aerobiological Sampling Unit of the University of Granada for the aerobiological data.

AEROSOL SCATTERING PROPERTIES AT A MOUNTAIN SITE INFLUENCED BY DUST IMPACTS

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Keywords: Light scattering, Mountain site, Saharan events, PBL
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Site and methods

Aerosol scattering properties (ASP) were obtained from November 2015 to October 2016 at a mountain station located at the Aitana peak (38° 39´N; 0° 16´W; 1558 m a.s.l). The mountain is located in the province of Alicante in the southeast of Spain. Sampling point is characterized by receiving air masses loaded with mineral dust from North Africa. A Nephelometer (model Aurora 3000, ECOTECH Pty Ltd, Knoxfield, Australia) was used to obtain ASP: σ_{sp} and σ_{bsp} at three wavelengths (450, 525 and 635 nm) along with SAE and backscatter ratio (b). The identification of episodes of air masses loaded with mineral dust from Sahara desert (SDE) has been achieved by means two forecast models: BSC/DREAM8b and NAAPS.

General features

Table 1 presents the statistics of ASP throughout the study period. The values of σ_{sp}, σ_{bsp} and b are referred to λ = 525 nm.

Table 1. Statistics of ASP obtained at Mt. Aitana from November 2015 to October 2016.

	σ_{sp} (Mm^{-1})	σ_{bsp} (Mm^{-1})	SAE	b
Mean	26.2	3.5	1.42	0.139
Median	20.2	2.8	1.47	0.138
SD	25.2	3.3	0.67	0.026
P95	60.9	8.3	2.51	0.182
P5	4.2	0.7	0.25	0.100

σ_{sp} mean value is located in the upper zone of the range of values recorded in most European mountain stations. σ_{sp} median value is lower than the mean value, which indicates the impact of the extreme events (mainly SDE) on σ_{sp}. SAE value suggests a certain relevance of coarse particles in the scattering process, in fact it can be pointed to that approximately between 30% to 40% of the light is scattered by particles larger than 1 μm. This value (1.42) is one of the lowest found in the European high altitude stations except for the Izaña station.

SDE impact on ASP

Fig. 1 shows the comparison of ASP statistical parameters between days influenced by SDE (N = 66) and days characterized by not registering air masses from North Africa (N = 175).

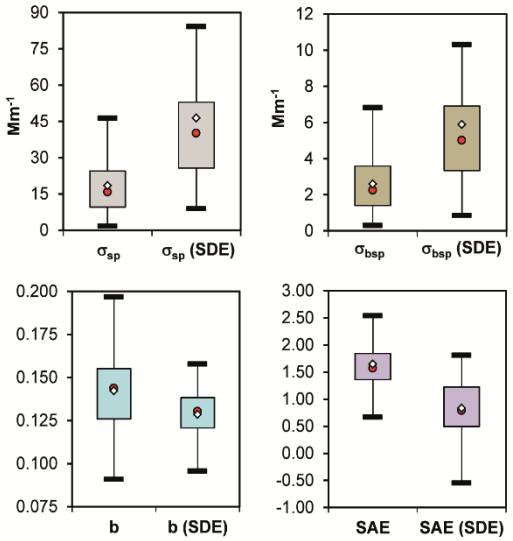

Fig. 1. Impact of SDE on ASP. (Mean: white diamond; Median: red point; P25 and P75: whiskers; Maximum and minimum: dashes).

σ_{sp} and σ_{bsp} undergo remarkable increases under the influence of SDE. The increase factor in σ_{sp} mean (~2.6) is slightly higher than that obtained by σ_{bsp} (~2.3). This difference explains the lower b value obtained during SDE since a large forward scattering is expected for mineral dust particles. SAE statistical parameters have an important decrease during SDE declining the SAE mean value from 1.65 to 0.83.

This work was supported by the Valencian regional Government under the GV/2017/199 (FAME) and AICO/2018/085 research projects. We would like to thank the military base (EVA nº. 5) for allowing access to its facilities.

OCCURRENCE OF POLYCYCLIC AROMATIC HYDROCARBONS IN AIR SAMPLES COLLECTED IN SÃO PAULO DURING WINTERTIME (FROM 2015 TO 2017)

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São Paulo (SPA) is the largest city in South America and has presented events of air pollution. Among the pollutants studied, polycyclic aromatic hydrocarbons (PAH) are the most investigated due to their mutagenic and carcinogenic properties (Pereira *et al.*, 2017). Aerosols samples were collected at SPA site, inside the university, for 3 years (2015, 2016, 2017) during pollution periods. PAH composition and cancer risk were investigated. Over 40 samples were submitted to extraction, fractionation and analysed by GC/MS. PM concentrations averaged 36 $\mu g.m^{-3}$ (for 2015, PM_{10}), 32 $\mu g.m^{-3}$ (for 2016, PM_{10}) and 22 $\mu g.m^{-3}$ (for 2017, $PM_{2.5}$). World Health Organization (WHO) recommends concentrations below 25 $\mu g.m^{-3}$ for $PM_{2.5}$ and 50 $\mu g.m^{-3}$ for PM_{10}. Fifteen PAH were determined and the most abundant compounds were phenathrene: 7 $ng.m^{-3}$ (2015), pyrene: 10 $ng.m^{-3}$ (2016) and fluoranthene: 15 $ng.m^{-3}$ (2017). These values are higher than those found previously at same site, indicating increasing contamination. These compounds are emitted by several sources and commonly found in urban areas impacted by vehicles (Alves *et al.*, 2015). Figure 1. presents the diagnostic ratios to indicate the emission sources.

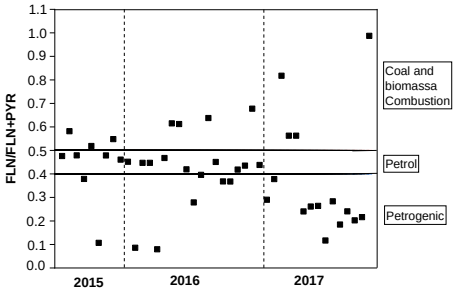

Figure1. Diagnostic ratios for SPA samples.

The results show that different emissions sources impact the air quality; in 2015 and 2016, biomass burning, petrol combustion and petrogenic are important sources; in 2017, oil combustion seems to have minor impact. Benzo(a)pyrene equivalent (BaPE) shows the cancer risk of the samples. Over 50% of the samples presented BaPE higher than 1 $ng.m^{-3}$, maximum value recommended by WHO. Besides local sources, back trajectories indicated air masses coming from biomass burning areas. Over 50% of the trajectories come from sugarcane plantation areas. Despite this activity is decreasing due to local laws, some events are still observed.

Conclusions: PM concentration are below recommended by WHO; low molecular weight PAH were the most abundant compounds indicating different emission sources. Over 50% of the samples presented cancer risk. Sugarcane burning seems to be an important source of pollutants at SPA site.

This work was supported by CNPq (152601/2013-9 and 870031/2013-1), and Public Ministry of São Paulo State and INCT Energy and Environment.

Alves et al. (2015). Size-segregated particulate matter and gaseous emissions from motor vehicles in a road tunnel. *Atmospheric Research*, 153, 134-144.

Pereira et al. (2017). Particulate pollutants in the Brazilian city of São Paulo: 1-year investigation for the chemical composition and source apportionment. *Atmospheric Chemistry and Physics*, 17, 11943-11969.

ELEMENTAL SIZE- DISTRIBUTION OF AEROSOLS COLLECTED IN A MEDITERRANEAN HARBOUR AREA

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Keywords: aerosol size distributions, chemical characterisation, harbour emissions
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Chemical composition and size distribution are the main parameters influencing aerosol effects on both a local and global scale. Nevertheless, detailed information on the size of segregated aerosol composition is still lacking in the literature. This is due to the considerable manpower needed and the time consumption required to perform the sampling when it is carried out using traditional instrumentation (multistage cascade impactors and laboratory analysis of the collected samples).

The objective of this work is to evaluate the elemental size distributions of aerosol collected in a medium-sized harbour located in Alicante (Spain). This harbour is quite close to the city so an impact on the concentrations of aerosols measured in the city is expected. In addition to the traffic of shipping containers, the industrial harbour´s main activity is related with the loading and unloading of raw materials (limestone and clinker mainly). The materials emitted during these activities are transported into the city owing to the breeze regime established during the summer.

In order to measure the aerosol elemental mass-size distributions, a Dekati cascade small-deposit area low-pressure impactor (SDI) was used. This sampler classifies airborne particles, from 30 nm up to 10 µm, into 12 size-fraction small deposit area stages.

Seven particulate matter samplings (a total of 84 filters) were carried out with the cascade impactor during 24 h periods during summer 2018 on polycarbonate membranes. The impactor samples were chemically analysed by Energy-Dispersive X-Ray Fluorescence. The raw chemical concentration-size data (mass per stage and per m^3) was processed with an inversion procedure (code MICRON) to generate smooth modal mass-size distributions for more than 17 elements: Na, Mg, Al, Si, S, Cl, K, Ca, Ti, V, Cr, Mn, Fe, Cu, Zn,, Br, Ba, Pb, Ni, y Sr.

The modes retrieved for each element was compared daily to identify possible differences due to different sources or to changes in the meteorology. Different elements related to different sources (e.g. sea spray, oil combustion, traffic, secondary sulphate) were identified and the possible size distribution of the sources is discussed.

In the figure 1, Ca size distribution during one day with operations of loading and unloading of bulk materials is shown.

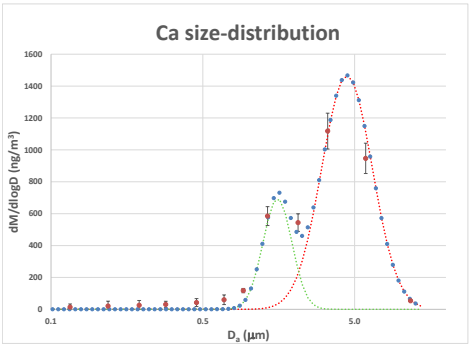

Fig. 1. Ca size distribution and mode retrieval. In red the experimental data, blue for the inverted distribution and green and light-red for the main modes of the distribution

This work was supported by the Generalitat Valenciana under the GV/2017/199 (FAME) project. We would like to thank the Harbour authorities for allowing access to its facilities

Maenhaut W., Hillamo R., T Màkelà T., Jaffrezo J. L., Bergin M. H., Davidson C. I. (1996) A new cascade impactor for aerosol sampling with subsequent PIXE analysis, Nucl.Instr. Meth.B, 109/110, 482.

INDIVIDUAL CHARACTERIZATION OF ATMOSPHERIC PARTICLES NEAR A MINING AREA: ALJUSTREL, PORTUGAL.

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Keywords: Mining areas, mine dust, atmospheric particles, Aljustrel, SEM-EDX, ICP-MS
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Mining activities produce several environmental polluting wastes, such as mine dust. This dust may mobilize dangerously high levels of metals and metalloids (Csavina *et al.*, 2012), which can have a substantial impact on the environment and human health. To comprehend their impact and dispersion is essential to do an individual characterization of these particles. This type of analysis will provide information about size, morphology and chemical composition on a single particle basis. Because the transport of the atmospheric particles depends on these properties, with this data it will be possible to estimate the concentration of chemical species, size and morphological distribution, and their source. And then define the impact of dust mine in the surrounding area.

The present work is about an individual characterization of PM10 particles and quantification of potentially toxic elements near the Aljustrel mine. Aljustrel is located in Beja district (SW Portugal) and belongs to the western sector of the Iberian Pyrite Belt (IPB). And this complex is one of the great IPB mining, of volcanogenic massive sulfide deposits (Candeias *et al.*, 2011). The exploitation of this deposits is one important source of heavy metals for the environment. The samples were collected in two points close to the processing of the ore (Fig. 1).

Atmospheric particles were collected in two periods of 2018: (1) from July 10 to 17 and (2) from November 1 to 9. The particles were captured from an inlet protected with a metal screen designed to exclude insects. The collection method consisted of a filter-based technique in which particles were continuously deposited onto filter at a controlled flow with a rotameter and a gas meter.

Figure *2* – Location of sampling points in the Aljustrel region.

The samples have been analyzed with SEM-EDX and ICP-MS techniques. SEM-EDX provides information about size, morphology and elemental chemical composition in a single particle basis (Fig. 2). For this analysis, samples collected in polycarbonate filters were coated with gold. For the subsequent analysis, a semi-automated routine was used, with a VP SEM Hitachi S - 3400N couple with EDX system and Esprit Feature software. ICP-MS was used to obtain, with more precision, the concentration of Ca, Na, Fe, Mn, As, Cd, Cu, Sb, Pb e Zn in the samples.

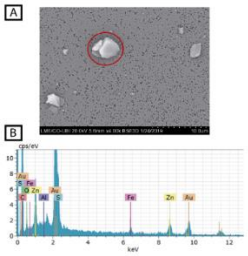

Figure *3* – Example of the individual analysis of the atmospheric particles collected in Aljustrel. (A - SEM image with identification the particle analyzed and B - Chemical composition of the particle)

Csavina J., Field J., Taylor M.P., Gao S., Landázuri A., Betterton A.E., Sáez A.E. (2012). A review on the importance of metals and metalloids in atmospheric dust and aerosol from mining operations. Sci. Total Environ., 433, pp. 58-73.

Candeias C., Ferreira da Silva E., Salgueiro A.R., Pereira H.G., Reis A.P., Patinha C., Matos J.X., Ávila P.H. (2011). Assessment of the soil contamination by potentially toxic elements in Aljustrel mining area in order to implement soil reclamation strategies. Land Degrad. Dev., 22, pp. 565-585.

AEROSOL RADIATIVE PROPERTIES IN A PRISTINE SUBARCTIC AREA USING LONG-TERM COLUMNAR RECORDS

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Keywords: Artic aerosols, aerosol properties, sun photometer, aerosol radiative effect.
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Atmospheric aerosols are an important forcing agent in the estimation of the Earth's changing energy budget, being the Arctic an area of special weakness. Studies of aerosols are, therefore, necessary in climatic change studies dealing with surface and atmospheric temperatures, sea-level rise, precipitation changes, frequency and intensity of extreme weather events, among others. The purpose of this study is to establish comprehensive aerosol climatology by a long-term database (2002-2018 period) in the sub-Artic region. This study also presents a collection of the aerosol event days observed in this site.

The collection of the columnar aerosol properties was registered at Andenes site (Northern Norway, 69ºN,16ºE) in the AErosol RObotic NETwork (AERONET). This database includes spectral Aerosol Optical Depth (AOD) at several wavelengths, Ånsgtröm exponent (AE), fine and coarse AOD, and complex inversion products using CIMEL sun-photometer records. All the experimental info is used to feed a radiative transfer code to simulate net fluxes of shortwave radiation. The aerosol radiative effect can be inferred using these simulations.

An inspection of AE and AOD(500nm) daily values, see Fig. 1, can determine the different aerosol types presenting in the study area. Well known thresholds of these two quantities (see Rodríguez *et al.*, 2012) are used to discern between continental, marine, polluted, and mixture aerosols. Clean continental aerosol episodes are the most frequent type, about 63% occurrence. A total of 30 smoke/pollution event days are registered, being about 4% of the total.

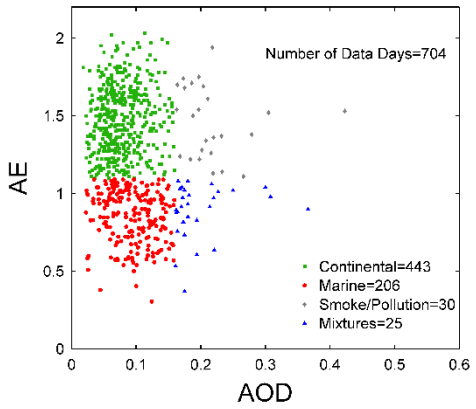

Fig. 1. AE-AOD scatterplot for all data days in Andenes site.

The most extreme aerosol event days with inversion products are also investigated. As expected, the larger AOD the larger radiative effects. For instance, on May 2nd, 2009 an aerosol episode with AOD(500nm) = 0.28 and single scattering albedo (SSA) at 675nm of 0.79 caused a loss of 35 Wm^{-2} of incoming solar radiation. The mean loss of shortwave flux during the aerosol event days is quantified about 15 ± 5 Wm^{-2}, with mean values of AOD(500nm) = 0.15 ± 0.04 and SSA(675nm) = 0.90 ± 0.06.

This work was supported by by EU under Grant Agreement Nr. 654109 [ACTRIS 2], POLARMOON project CTM2015-66742-R of Spanish Government (MINECO), and VA100U14 of Consejería de Educación of Junta de Castilla y León. Also thanks to AERONET-PHOTONS-RIMA staff and PI investigators and their staff for establishing and maintaining 'Andenes' site used in this study.

Rodríguez, E., et al. (2012). Aerosol characterization at the sub-Arctic site Andenes (69N,16E), by the analysis of columnar optical properties. Q.J.R. Meteorol. Soc., 138, 471–482.

CHARACTERIZATION OF A SETTLED DUST EVENT IN AN URBAN AREA AFFECTED BY INDUSTRIAL ACTIVITIES

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Keywords: Air pollution; industrial environments; pollution sources; settled dust; PIXE
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Due to a higher awareness of citizens towards air pollution, the population of the Seixal municipality (Portugal), noticed occasional settled dust events and questioned the local authorities in order to understand its sources and potential health hazards. Aiming to address the population's needs, the local council promoted a set of actions. Therefore, this study aimed to identify possible sources of a settled dust event that occurred in January 2019, in Seixal municipality, an urban area with 165 547 inhabitants, located nearby an industrial area, characterized by a steelwork, shipyard and other metallurgic activities.
The chemical characterization of the settled dust was determined by PIXE (Fig. 1), focusing on a total of 29 elements.

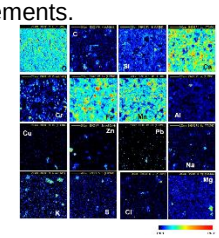

Fig. 1. Micro-PIXE elemental maps of a sample

Comparison with the chemical profiles of particulate matter from different types of environment was conducted (Fig. 2). For that purpose, a literature review was performed to gather mean values of the chemical composition of PM_{10} for different settings, in different countries ([1-5], among other references).

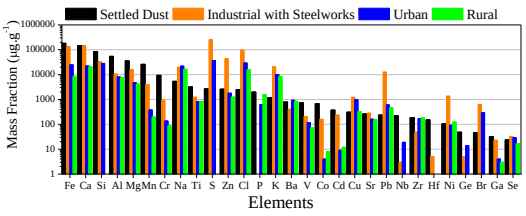

Fig. 2. Comparison of elemental mass fractions of the studied settled dust and in PM_{10} studies available in the literature

The assessment of crustal enrichment factors (EF) was also performed (Fig. 3). Several elements presented EF values above the threshold of 10, which indicates their non-crustal origin.

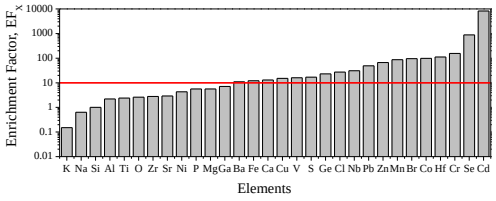

Fig. 3 Crustal enrichment factors for the studied settled dust

The above mentioned analysis, along with Spearman correlations between the assessed elements, allowed to understand which sources contributed to the settled dust event. The influence of a nearby industrial area was identified, due to the contents of Fe, Cr and Mn, which are typical tracers of iron and steel industries.

This work was supported by FCT – Fundação para a Ciência e a Tecnologia, I.P. (Portugal) through the UID/Multi/04349/2013 project.

[1] Amato F. et al. (2016) AIRUSE-LIFE+: A harmonized PM speciation and source apportionment in five southern European cities. *Atmos Chem Phys,* 16, 3289–3309.
[2] Aldabe J. et al. (2011) Chemical characterisation and source apportionment of PM2.5 and PM10 at rural, urban and traffic sites in Navarra (North of Spain). *Atmos Res,* 102, 191–205.
[3] Rodríguez S. et al. (2004) Comparative PM10-PM2.5 source contribution study at rural, urban and industrial sites during PM episodes in Eastern Spain. *Sci Total Environ,* 328, 95–113.
[4] Sylvestre A. et al. (2017) Comprehensive chemical characterization of industrial PM2.5 from steel industry activities. *Atmos Environ,* 152, 180–190.
[5] Querol X. et al. (2007) Source origin of trace elements in PM from regional background, urban and industrial sites of Spain. *Atmos Environ,* 41, 7219–7231.

Aerosol Instrumentation

EXPOLIS – AN AIR QUALITY EXPOSURE SENSING SYSTEM AIMING TO CHANGE THE WAY PEOPLE MOVE IN CITIES

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Keywords: sensing system; air quality; exposure; public transportation
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Monitoring airborne pollutants is of utmost importance since air quality is a major concern in many cities worldwide. In fact, pollutants have been demonstrated to have significant impacts on human health. Currently, air pollution is monitored by static stations which are high reliable, however they have high acquisition and maintenance costs, which limits the number of installations, and thus, the area coverage. Low spatial resolution is sufficient for ambient background monitoring but inadequate to assess personal exposure to air pollution and health risks. To obtain a high spatial resolution and improve the monitorization and knowledge about air pollutants concentations and exposure, a network of air quality sensors can be used. In fact, the usage of large quantities of low-cost sensors in wireless networks can lead to an increase of the coverage area and spatial distribution of the monitoring systems, especially if mounted on mobile platforms. Mobile air quality monitoring systems allow high spatial resolution across large areas and are a solution to derive fine-grained air pollution road maps.

ExpoLIS is developing an air quality exposure sensing system, composed by a network of sensor nodes, to be deploied on public transportation (buses) in order to obtain the real-time air pollution distribution in urban areas.

In table 1 are presented the sensors that are being used to assess the exposure of some pollutants such as: particulate matter (namely PM2.5 and PM10), carbon monoxide (CO) and Nitrogen dioxide (NO_2). Furthermore, temperature and relative humidity are also measured. The sensor nodes are designed for deployment on the top of buses, belonging to the main public transportation company in Lisbon (CARRIS). The implementation of ExpoLIS is being conducted in Lisbon to demonstrate its applicability to assess the exposure to air pollutants, to support urban planning policies, environment scientists and transport companies by generating massive air pollution data sets and to provide a health-optimal routing service to the population.

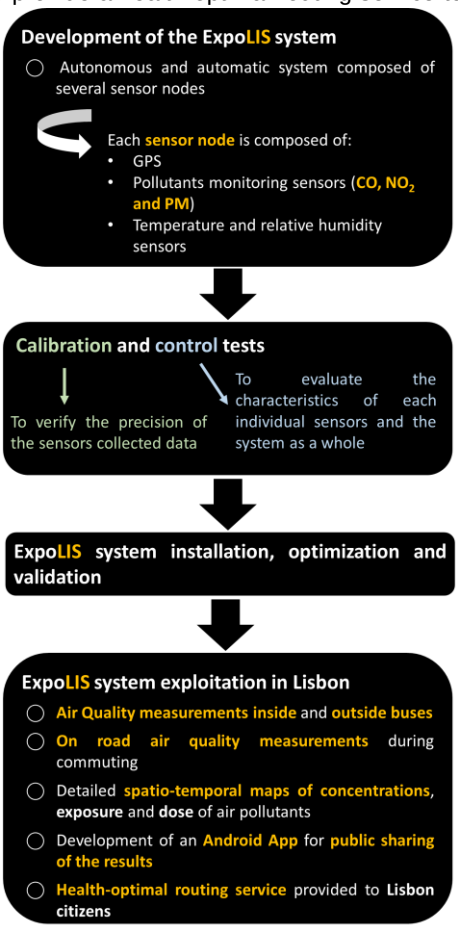

Fig. 1. Schematic representation of the project tasks.

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PM SENSORS – A VIABLE SOLUTION FOR MONITORING SPECIFIC MICRO-ENVIRONMENTS?

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Keywords: indoor air quality, sensors, exposure, particulate matter
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Characterisation of air quality is an important issue to understand human exposure levels and to define mitigation measures in order to improve the air that people breathe indoors and minimise their negative impacts, both on health and performance. European and national legislations define limit values for environmental parameters in indoor enviroments, along with which reference methods with standard equipments should be applied. However, some of these methods may have constraints when applied to a large number of sites (due to, for instance, their finantial costs or need of expertised personnel) or to specific micro-environments where, for example, noise from the use of pumps for air sampling may interfere with the activities developed in the micro-environment, such as, classes or sleeping (Canha et al., 2017). Sensor technologies have been developing fast in the last years where a range of sensors became available on the market, with an enormeous potential of applications due to their advantages. For instance, a cost of up to three orders of magnitude lower than standard/reference instruments, low noise levels, and a wide application for air pollution monitoring studies by researchers and general public, potentiating a citizen science among populations (Morawska L et al., 2018). One of the main challenges of this type of technology is the assessment of their performance with reference/standard equipments in order to promote its correct application in the field and to obtain a set of reliable and usable data for further analysis.The aim of the present study was to evaluate the performance of a monitoring box with a set of different sensors (in order to provide a multi-pollutant characterisation of IAQ) and, afterwards, its application in a specific micro-environment, which is sensible to noise, like the bedroom. A monitoring box (Figure 1) was assembled with several sensors: i) carbon dioxide (CO_2), sensor Sensirion SCD30 based on NDIR technology, with a measurement range between 400 and 10 000ppm; ii) volatile organic compounds (VOCs), sensor MiCS-VZ-89TE from Sensortech, with a measurement range from 0 to 1000 ppb isobutylene equivalent to total VOCs; iii) particulate matter ($PM_{2.5}$ and PM_{10}), Honeywell HPM series particle sensor bsaed on the light scattering method, with a measurement range between 0 and 1000 $\mu g.m^{-3}$; and iv) temperature (T) and relative humidity (RH), sensor Sensorion SHT31-DIS, with range from -40 to 90ºC (accuracy of 0.3ºC) and 0 to 100 % (accuracy of 2%) for T and RH, respectively.

Figure 1. Monitoring box used in this study.

The performance of the monitoring box was assessed by comparison with standard real time monitors for the selected parameters, namely, a Graywolf (IQ-610 probe, WolfSense Solutions, USA) to measure CO_2, VOCs, T and RH; and a DustTrak monitor (8530 model, TSI, USA) to measure PM_{10} and $PM_{2.5}$, in different types of micro-environments. The comparison studies were conducted following the European Direct 16450:2017 and Spinelle et al. (2013).The definition of correction factors regarding each parameter will allow the application of the monitoring box for a more accurate assessment of the pollutants' levels, PM among them.

This work is funded by national funds through FCT - Fundação para a Ciência e a Tecnologia, I.P. (Portugal). The FCT support is also acknowledged by C²TN/IST authors (UID/Multi/04349/2013 project) and by CESAM authors (UID/AMB/50017/2013).

Canha N., Lage J., Candeias S., Alves C., Almeida S.M. (2017) Indoor air quality during sleep under different ventilation patterns. *Atmospheric Pollution Research*, 8, 1132-1142.

EN 16450:2017 (2017) Ambient air - Automated measuring systems for the measurement of the concentration of particulate matter (PM_{10}; $PM_{2.5}$)

Morawska L et al. (2018) Applications of low-cost sensing technologies for air quality monitoring and exposure assessment: How far have they gone?. *Environment International*, 116, 286-299.

Spinelle L. et al. (2013) Protocol of evaluation and calibration of low-cost gas sensors for the monitoring of air pollution, EURAMET MACPoll project, Publications Office of the European Union.

UNCERTAINTY ON THE CEILOMETER RETRIEVALS OF AEROSOL EXTINCTION PROFILES USING SYNTHETIC DATA

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Keywords: GRASP, ceilometer, photometer, extinction, profiling
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The knowledge of vertically-resolved aerosol extinction profiles improves the understanding of the aerosol impact on Earth's climate. These profiles usually are obtained by lidar measurements, which are powerful instruments, but the number of these measurements is scarcy. Ceilometers are an alternative to multi-wavelength lidars with less accuracy and some limitation in the retrievals, but with the advantage of unnatended operation and larger data availability.

Recently, Román *et al.* (2018) proposed the retrieval of extinction vertical profiles from the combined use of ceilometer and photometric data using GRASP code (Duvobik *et al.* 2014). GRASP (Generalized Retrieval of Aerosol and Surface Properties) is a versatile algorithm for the inversion of atmospheric aerosol optical and microphysical properties. However, this is a new technique and its performance needs to be study under real and synthetic measurements.

In this framework, the aim of the presented work is to study the sensitivity of the mentioned technique for the retrieval of vertical extinction profiles using synthetic atmospheric scenarios. These scenarios are simulated using the forward ratiative trasnfer model included in GRASP code. In order to cover a wide range of representative atmospheric situations, three different vertical distributions have been designed: two dust and one smoke profiles. The analysis has been run for the corresponding optical and microphysical properties of these three profiles, but also for six different mixtures of them. Moreover, thirty different profiles of random noise have been added to each scenario in order to simulate the uncertainty in the real ceilometer measurements. These synthetic observations have been inverted by different methodologies, like GRASP inversion algorithm itself, and the standard Klett methodology used in Cazorla *et al.* (2017). As result, the uncertainty in the different methodologies has been characterized for further investigations.

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Cazorla A., Casquero-Vera J.A., Román R., Guerrero-Rascado J.L., Toledano, C., *et al.* (2017) Near-real-time processing of a ceilometer network assisted with sun-photometer data: monitoring a dust outbreak over the Iberian Peninsula. *Atmos. Chem. Phys.*, 17, 11861-11876

Dubovik O., Lapyonok, T., Litvinov M, Herman, Fuertes D, Ducos F, Lopatin A, Chaikovsky, *et al*. (2014) GRASP: a versatile algorithm for characterizing the atmosphere. *SPIE Newsroom*, 25.

Román, R, Benavent-Oltra J.A, Casquero-Vera J.A, Lopatin A., Cazorla A, *et al.* (2018) Retrieval of aerosol profiles combining sunphotometer and ceilometer measurements in grasp code. *Atmos. Res.*, 204:161-177.

PRELIMINARY VALIDATION OF CIMEL WATER VAPOR PRODUCT AGAINST GPS DATA IN SPAIN.

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Keywords: Cimel, Sun-photometer, Water Vapor, AERONET, GPS, Spain
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Water vapor is well aknowledged as a fundamental gas in the atmosphere. It has an important role in the greenhouse effect , and its hydrological cycle allows the redistribution of energy in the climate system.

Integrated water vapor (IWV) data provided by Global Positioning System (GPS) signal treatment allow hourly measurements with a quality similar to that of the radiosondes, which are traditionally regarded as a reference.

In this work, six stations in Spain with coincident GPS stations and Aerosol Robotic Network (AERONET) Cimel sun-photometer data are compared with the goal of validating the product from AERONET. The stations are: Cáceres, A Coruña, Huelva, Mallorca, Valencia, Valladolid. Data of both instruments were collocated in the following way: the Cimel measurements were averaged in a window of +-30 min. around the GPS measurement.

A regression line was obtained for every site. The results show a good agreement between both instruments. R^2 is higher than 0.90 in all stations. The y-intercept is always positive, ranging from 0.55 to 1.97 mm. The slopes are generally smaller than the unity, going from 0.84 to 1.02.

The distribution of differences (Cimel – GPS) is skewed towards negative values in Valladolid and Cáceres, while towards positive values in Valencia. The rest of stations show slight (A Coruña and Mallorca, towards positive values), and negligible (Huelva, towards negative values) skewness. However, the distribution of relative differences is skewed towards positive values in all stations.

The time series of the differences show several oscillations in the pattern that could be due to calibration issues (see Fig.1).

Dependences of relative differences on several variables were also studied: on IWV, solar zenith angle (SZA) and aerosol optical depth (AOD).

Low IWV values generally cause a higher relative difference, while high IWV values tend to negative relative differences.

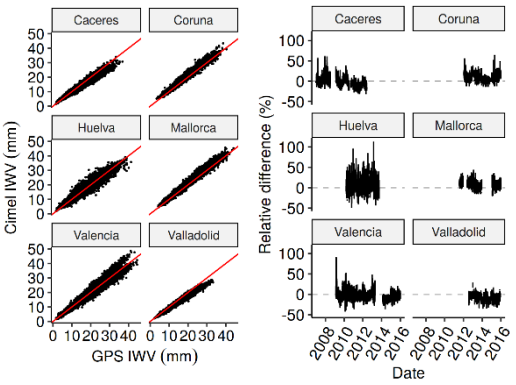

Fig. 1. Cimel IWV vs. GPS IWV scatterplot and regressions per site (left), and relative difference (Cimel – GPS) time-series (right).

The variation of SZA does not exhibit an important influence in the relative differences between Cimel and GPS IWV.

Despite the good agreement between Cimel and GPS, the Cimel water vapor product should be improved. The important dependence of relative differences on IWV values should be address, and the possible calibration issues that are observed in the time series of relative differences.

This work was partly supported by the Ministerio de Economía y Competitividad of the Spanish Government (CGL2017-87917-P), by the “Consejería de educación” of "Junta de Castilla y León" (project VA100U14) and the Spanish Ministry of Economy and Competitiveness under the project, CMT2015-66742-R. This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 654109

Aerosol Intstrumentation

EVALUATION OF THE PARTICLES TRANSPORT EFFICIENCY IN A MULTI-HOLE PROBE OF 14 METERS

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Keywords: Stack gas exhaust, inhomogenous, sampling, emissions, probe, particles.
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Aerosol sampling, from any emission source to the environment, must be representative, so that the measurement is properly evaluated. In the sampling sections, the emission flow is usually stable but not completely homogeneous, requiring sequential sampling in different points (UNE-EN 13284-1 and UNE-EN 15259). In rare cases, the emission flow can be heterogeneous and also transient; therefore, it makes necessary a simultaneous sampling in different points. A suitable solution is a multi-hole probe, in order to obtain close-to-representative samples under these conditions.

So as to obtain representative samples in the exhaust stack of the Turbojet Area test cell (INTA), a longitudinal probe (14760 mm) was designed and manufactured with six independent sampling points (PM1 to PM6) at different distances (Table 1) (Rodríguez Maroto et al, 2016).

Table 1. Holes position in Multi-hole probe.

Sampling points	PM1	PM2	PM3	PM4	PM5	PM6
In probe (mm)	11991	10491	7491	5991	3291	2091
Into stack (mm)	11091	9591	6591	5091	2391	1191

The stack sampling probe access, which is part of the multi-hole probe, has a difference of 900 mm.

This separation, between the different sampling points, requires an assessment of the deposition losses corresponding to the transport line of each one, for correction purposes.

The sample extracted from each sampling point is mixed in a homogenization chamber before being measured (Rojas-García et al, 2017 and 2018).

This work presents the experimental evaluation of particles efficiency transport through the multi-hole probe (Fig 1). Because of the particle size (10 to 600 nm), characteristic of turbofan engines throughout its power range, the deposition losses in the probe are only attributable to deposition and thermophoresis (Willeke and Baron, 1993).

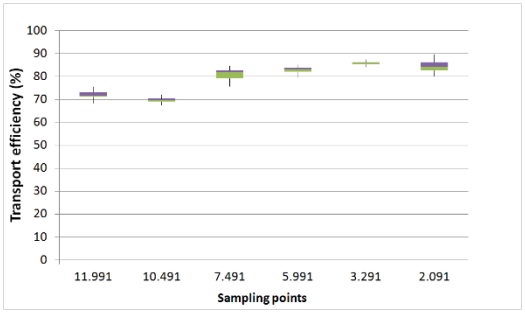

Fig. 1. Particles transport efficiency of each sampling point (measured with CPC).

Deposition of particles in each of the six lines of transportation, was determined by comparing measurements of particles of air, at the end of each line, and the point of suction (sampling nozzle). For the sample characterization, a CPC (Condensation Particle Counter), a particle size distribution, SMPS (Scanning Mobility Particle Sizer) and a NanoScan SMPS have been used. With the purpose of aiming tothe representativity of the results, several tests were performed at each sampling point.

Experimental results conclude that transport efficiency ranges from a minimum of 68% to a maximum value of 90%. This differences must be taken into account in the sampling results corrections.

This work was supported by collaboration agreement INTA-CIEMAT July 10, 2015

AENOR (2018), Normas UNE-EN 13284-1
AENOR (2008), Normas UNE-EN 15259:2008.
Rodríguez Maroto, J.J. et al (April, 2016), *Informes técnicos CIEMAT*. Madrid. ISSN: 1135-9420; NIPO: 721-16-070-6.
Rojas-García, E. et al (2017), *5th Iberian Meeting on Aerosol Science and Technology*. RICTA´17- Barcelona
Rojas-García, E. et al (2018), *6th Iberian Meeting on Aerosol Science and Technology*. RICTA´18- Bilbao
Willeke, K. and Baron, P.A. (1993) *Aerosol measurement: principles, techniques and applications*. New York (N.Y.) by Van Nostrand Reinhold.

CFD SIMULATION OF THE SAMPLING NOZZLES TO BE MOUNTED IN A MULTI-HOLE PROBE

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Keywords: thin-walled nozzle, CFD, inhomogenous, emissions, sampling, efficiency
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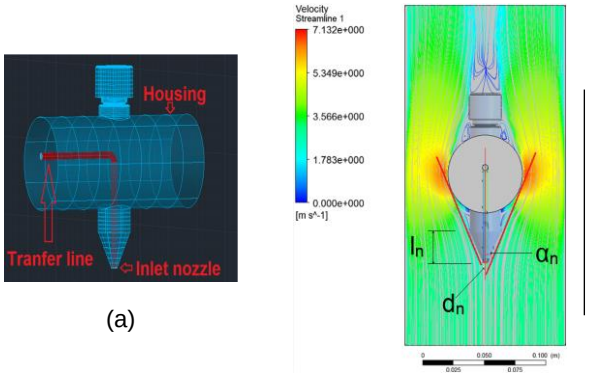
An aerosols sample is more representative when its physico-chemical characteristics do not change from the sampling point to the measuring equipment. Due to the atypical dimensions of the exhaust gas emission stack, together with the variable operating conditions in the turbofan engine tests at AT/INTA, the output flow is not homogeneous nor stationary. This prevent the application of conventional sampling standards for industrial stack (EPA, 1991). An alternative to sampling, involves using the CIEMAT model multi-hole probe (Rodríguez Maroto, 2016) designed to extract six simultaneous samples, from the stack to a mixing chamber and obtain a representative single sample (Rojas-García, 2018).

One of the fundamental aspects in the development of this probe has been the optimization of particle entry efficiency, η_{inlet}, through the appropriate design of sampling nozzles. The η_{inlet} for sampling with a thin-walled nozzle depends on both the number of Stokes ($Stk=U_o \cdot \tau/d_n$) being U_o the velocity of the gas stream, d_n, the diameter of the nozzle, and τ, the relaxation time; and the relationship between the velocities of the gas stream, and the sampling velocity, U and the sampling angle, θ (Willeke and Baron, 1993).

In this study, a series of simulations using CFD to determine the η_{inlet}, have been carried out. ANSYS Workbench Inc.® v15.0 software was used using the k-epsilon viscosity model (2eqn-realizable), Figure 1a. The design of this probe makes it necessary to consider, not only the already known parameters that influence η_{inlet}, with the exception of θ (since it is an isoaxial sampling), but also that they could be associated with the profile of the housing: nozzle length, l_n, and profile, α_n, Figure 1b. Table 1 shows the input data used in the CFD calculation, which includes the geometry of the probe, sampling conditions and particle sizes, d_p, characteristic of the emission of turbofan engines.



(a) (b)

Fig. 1. Simulación CFD software.

Table 1. Simulation input data.

	Nozzle			U_o/ U	d_p (nm)
	d_n (mm)	l_n (mm)	α_n (º)		
Min	4.75	15	0	1/2	20
Max	12.7	28.19	24	2	300

CFD calculations have determined the need to incorporate sampling nozzles to the multi-orifice probe. It has also allowed the design of a nozzle that minimizes losses at the suction point caused by flow disturbances due to the body of the probe, as well as considering the η_{inlet}.

This work was supported by collaboration agreement INTA-CIEMAT July 10, 2015

U.S. EPA (July 1, 1991) Reference Methods for Emission Testing. EPA 40 CFR PART 60, Appendix A to Part 60. Reference Methods Listing.

Rodríguez Maroto, J.J. *et al* (2016), Informes técnicos CIEMAT, Madrid. ISSN: 1135-9420; NIPO: 721-16-070-6.

Rojas-García, E et al (2018), 6th Iberian Meeting on Aerosol Science and Technogy. RICTA´18- Bilbao.

Willeke, K. and Baron, P.A. (1993) *Aerosol measurement: principles, techniques and applications*. New York by Van Nostrand Reinhold.

EULERIAN ANALYSIS OF THE SPACE CHARGE FLOW EMITTED FROM AN INFINITELY SHARP ELECTRIFIED CONE

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Keywords: Eulerian model, ion dispersion, space charge
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In the present theoretical work we analyze the ion cloud emitted from a semi-infinite electrified filament in vacuum. The main objective is to attain a statistical description of the emitted charge cloud near the electrified filament tip.

The mathematical model used is an application to the case of an infinitely sharp electrified cone, i.e., an electrified filament, of the general mathematical model shown in C. Hernández-San José *et al.* (2018) for the description of charge dispersion in vacuum. The mathematical model is based on the general assumptions of axial symmetry, steady state and monodisperse charge population. As in the aforementioned publication we also assume that the electric charge is emitted from a perfect conductor with zero initial velocity, and as a consequence the emitted charge velocity field is irrotational. However, in the present model the anode is assumed to be a solid surface, and as a consequence the boundary condition related to the mechanical equilibrium condition between electric forces and surface tension at the emission surface does not apply.

The general Eulerian mathematical model used is defined in terms of the ion number density, the electric potential and the emitted charge velocity field potential, as a function of the polar angle and distance to the filament tip. Assuming a semi-infinite filament, the high symmetry of the problem allows for a general solution in terms of self-similar functions. Thus, the dependence on the polar angle is factorized from the dependence on the radius, which is given by power laws, with exponents that must be determined as part of the solution.

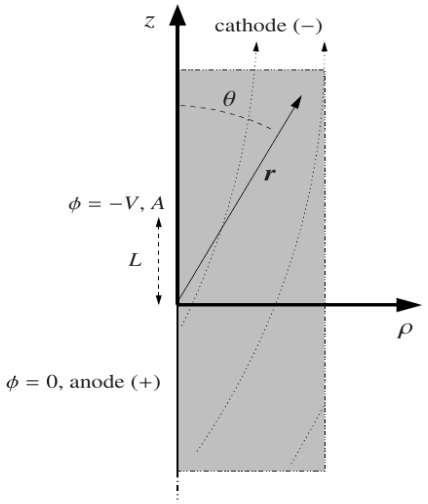

Fig. 1. Sketch of the problem geometry and notation (ρ ≡ distance to symmetry axis). The system under consideration may be seen an ideal diode in which the anode is a electrified straight wire or filament along the semi-axis θ = π and the opposite electrode or cathode is a plane z = const carried to the infinity..

This work was supported by Ministerio de Economía y Competitividad, Ref.: ENE2015-67635-R.

Hernández-san José C, Arias-Zugasti M. (2018) Analysis of the space charge singularity near the Taylor cone apex via simplified Eulerian model for electrospray beams in vacuum. *Journal of Aerosol Science*, 118, 82-99.

Aerosols and Climate

SEASONAL BEHAVIOR OF RADIATIVE FORCING EFFICIENCY AT Mt. AITANA IN SOUTHEAST SPAIN

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Keywords: radiative forcing efficiency, single scattering albedo, mineral dust.
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In this study the seasonal behavior of aerosol radiative forcing efficiency was analyzed from January 2014 to December 2015 at Mt. Aitana (38º39´ N; 0º16´ W; 1558 m a.s.l) on the top of a mountain range located inland in the province of Alicante, in southeastern Spain.

Scattering and backscattering coefficients at three wavelengths (450, 525 and 635 nm) were measured with an integrating Nephelometer (Aurora 3000, ECOTECH Pty Ltd, Knoxfield, Australia). Absorption coefficients were obtained at seven different wavelengths (370, 470, 520, 590, 660, 880 and 950 nm) using an Aethalometer (model AE31, Magee Scientific, USA).

The aerosol radiative forcing efficiency (RFE) from an optically thin aerosol layer can be calculated using the following equation (Haywood and Shine, 1995):

$$\mathrm{RFE} = S_0 D(1-A_c)T_{at}^2(1-R_s)^2\left[2R_s\frac{1-\mathrm{SSA}}{(1-R_s)^2} - \beta(b)\mathrm{SSA}\right]$$

where S_0 is the solar constant (1370 W/m²), D is the fractional day length (0.5), T_{at} is the atmospheric transmission (0.76), A_c is the fractional cloud cover (0.6), R_s is the surface reflectance (0.15) and $\beta(b)$ is the upscatter fraction. The single scattering albedo (SSA) and the backscatter ratio (b) were obtained from nephelometer and Aethalometer measurements.

The upscatter fraction $\beta(b)$ is parameterised as a function of the backscatter ratio using the equation (Sheridan and Ogren, 1999):

$$\beta(b) = 0.0817 + 1.8495b - 2.9682b^2$$

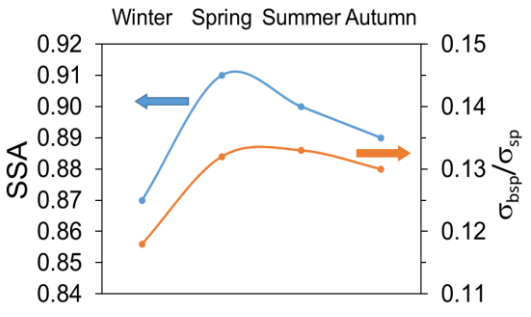

Fig. 1 SSA and backscatter ratio mean values

In Fig. 1 the mean SSA and backscatter values are plotted as function of the season. The greatest SSA values and backscatter ratios are obtained in the warmer months. In these months there are more Saharan dust intrusions composed of coarser particles but the boundary layer is higher than in winter. That means smaller particles can arrive at the sampling point. Scattering properties increases faster than absorption properties giving higher SSA values.

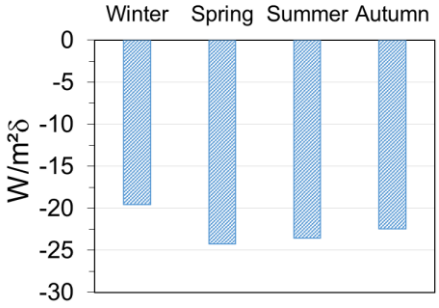

Fig. 2 RFE as a function of the season

The highest negative RFE values (cooling) are also obtained in the warmer months (Fig. 2) in accordance with the great scattering properties of mineral dust at these months.

This work was supported by the Spanish Ministry MINECO under the CGL2012-39623-C02-2 PRISMA-AITANA project. We would like to thank the Spanish Defense Ministry (EVA n. 5) for allowing access to its facilities.

Haywood, J.M., Shine, K.P. (1995). The effect of anthropogenic sulfate and soot aerosol on clear sky planetary radiation budget. Geophys. Res. Let. 22 (5), 603–606.

Sheridan, P.J.; Ogren, J.A. (1999). Observations of the vertical and regional variability of aerosol optical properties over central and eastern North America. J. Geophys. Res. 104, 16793–16805.

ANALYSIS OF DIURNAL OLIVE POLLEN CYCLE IN SOUTHEASTERN SPAIN

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Keywords: Olea pollen, daily cycles, Mediterranean, Transport, HYSPLIT
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The impact of regional and local weather on diurnal variations in airborne pollen levels was assessed by analysing bi-hourly Olea pollen counts in southeastern Spain (Alicante city) during 2010. A Hirst-type volumetric spore trap was used to obtain airborne pollen counts following the methodology indicated by the Spanish Aerobiology Network (Galan C. et al., 2007). The diurnal variation pattern was established using days on which the daily pollen concentration was equal or higher than the daily average of the main pollen season (≥P95); rainy days were eliminated. The HYSPLIT model was used to study the air mass movements that ocurred on days with the highest pollen count, simulating 36-h backward trajectories with 2-h intervals at an altitude of 500 m above ground level (Draxler et al., 2014).

The diurnal variation of airborne Olive pollen in Alicante showed average levels of pollen of 160 grains/m^3 with a maximum of 263 grains/m^3 at sunrise, falling outside the period of maximum efflorescence. The peak pollen counts coincided with maximum humidity levels and lower temperatures (Fig. 1).

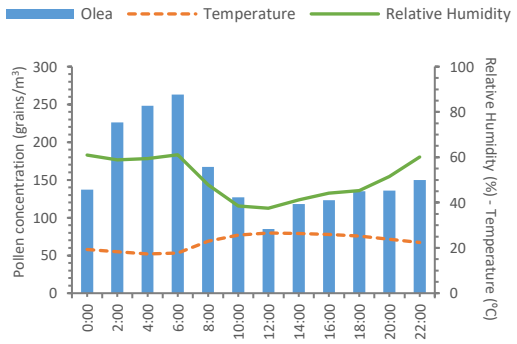

Figure 1. Variations in mean diurnal pollen counts and weather patterns at Alicante city over the days with the highest olive pollen counts.

Analysis of daily variations in surface winds revealed the arrival of westerly flows predominated in the morning (0:00-8:00 UTC), with speed ≤ 0.5 m/s, coincided with the maximum counts. Later in the day, the arrival of easterly flows coincided with a decline and subsequent levelling-off of pollen counts. Cluster analysis of diurnal olive pollen cycle revealed the existence of five different types of air mass movements (Fig. 2), indicating the main advection of flows from the west with a small variations in both origin and pathway.

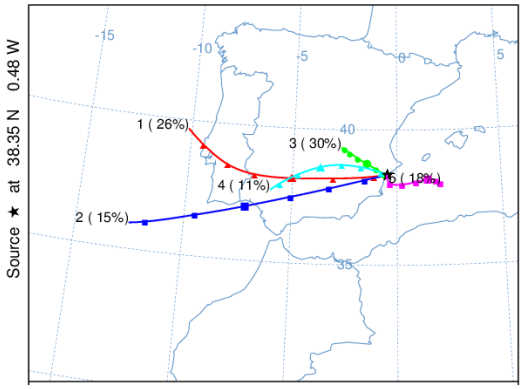

Figure 2. Average air masses obtained for the days with the highest olive pollen counts.

The Olive pollen counts in Alicante are generally very low, with the exception of punctual peaks strongly influenced by large sources of pollen mainly located in the south as well as the west and centre of Spain.

Galán C, Cariñanos P, Alcázar P, Dominguez E (2007) Management and quality manual. Spanish aerobiology network (REA). ISBN 978-84-690-6353-8.

Draxler RR, Stunder B, Rolph G, Stein A, Taylor A (2014) HYSPLIT4 user's guide. NOAA Tech. Memo. ERL ARL-230, NOAA Air Resources Laboratory, Silver Spring

RETRIEVAL OF ICE NUCLEI PROFILES BY 2-STEP POLIPHON METHOD DURING THE EXTREME SAHARAN DUST OUTBREAK OVER THE IBERIAN PENINSULA IN FEBRUARY 2017

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Keywords: dust, ice nuclei, lidar
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Desertification is one of the most important risks in our planet from a human and climatic point of view. Due to its current and dramatic spread, the interest on the study of the effect of mineral dust particles in many processes, has substantially increased in the last decades. Dust mineral particles interact with solar and thermal radiation, modulating the Earth's radiative balance, and act as condensation nuclei and ice-forming nuclei, contributing to radiative forcing due to aerosol-cloud interactions. However, the estimates for the adjustment of the clouds due to the presence of aerosol particles still present great uncertainties.

In order to contribute to the knowledge on the effect of mineral dust particles, this work is devoted to derive ice nuclei concentration (INC) profiles by the 2-step POLIPHON method reported by Mamouri and Ansmann (2015), which combines: (i) vertically-resolved optical dust properties derived from lidar, (ii) column-integrated dust optical and microphysical quantities retrieved from Sun-photometer, (iii) vertically-resolved thermodynamic properties of the atmosphere (in our work obtained from NCEP/NCAR R1 Reanalysis model), and (iv) parameterizations of ice nuclei from previous laboratory studies. As an example, Figure 1 shows the results comparing the INC profile retrieved on 20th February 2017 over Évora using two different laboratory parameterizations, the first one developed for a mixture of aerosol particles and the second one especifically for mineral dust particles.

The ability of dust particles to act as active ice nuclei strongly depends on the ambient temperature, among other factors. In order to simulate the impact of the climate change on the INC estimations, these profiles were also retrieved considering the optical properties of the dust particles monitored during this event combined with different temperature and pressure scenarios.

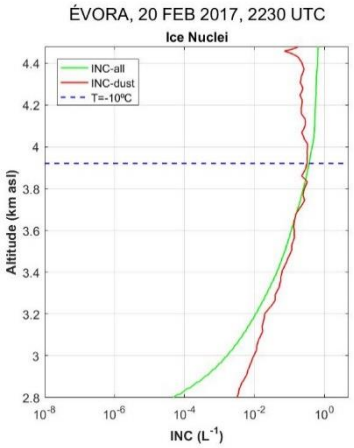

Fig. 1. Ice nuclei concentration profiles using two different parameterizations.

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Mamouri, R. E. and Ansmann, A. (2015) Estimated desert-dust ice nuclei profiles from polarization lidar: methodology and case studies. *Atmos. Chem. Phys*., 15, 3463–3477.

PRECIPITATION CHEMISTRY IN NW SPAIN: THE FINGERPRINT OF SUMMER WILDFIRES

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Keywords: aerosols, precipitation, wildfires.
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The summer of 2016 was a very hot and dry season. These meteorological conditions favored the occurrence of wildfires in the north and west of the Iberian Peninsula. Although the precipitation is scarce during summer, between 14 and 15 August (period P1) and 13 and 15 September (period P2) 2016, two short but intense rain events took place, coinciding with wildfire events. Because wet deposition acts directly on the removal and transport of different pollutants from the atmosphere to the Earth's surface (Seinfeld and Pandis, 2016), it could help mitigate the negative effects of air pollutants emitted by these type of events. Thus, the aim of this study is to determine the impact of forest fire emissions that occurred in the northwest of the peninsula during summer 2016 on the precipitation chemistry in León, Spain.

The sampling campaign was carried out in the Campus of the University of León, at León city, Spain (42º 36′ N, 05º 35′ W and 838 m a.s.l) at 24 hour intervals. The 24-h PM_{10} sampling was performed using a high volume sampler (CAV-Mb, 150 mm diameter quartz filters) and a low volume sampler (TECORA, ECHOPM, 47 mm diameter teflon filters). PM_{10} samples were analyzed: organic (OC) and elemental (EC) carbon, levoglucosan, water soluble inorganic ions and major trace elements. Rainwater samples were collected with a wet-only precipitation sampler (Eigenbrodt UNS 130/E), and were used for determination of conductivity and pH, dissolved organic carbon (DOC), water soluble ions, water insoluble organic (WIOC) and elemental carbon (WIEC).

On 14 August and 14 September 2016, NAAP modelling forecast images showed a high smoke concentration at the northwest of the Iberian Peninsula, and the air mass trajectories confirmed that the smoke from wildfires reached León city. The air chemical composition showed a significant increase of the main biomass burning tracers, K^+ and levoglucosan, and of EC concentrations during both events, confirming the contribution from wildfire emissions to the airborne aerosol in León on these days. The mean precipitation intensity was 1.6 mm h^{-1} and 0.85 mm h^{-1} for P1 and P2, respectively, and the accumulated precipitation was 3.72 mm in P1 and 4.63 mm in P2. The P1 rain sample was collected in one fraction of 0.03 L, while P2 was sampled in two fractions of 0.04 L and 0.11 L, respectively.

The chemical composition of P1 and P2 showed high concentrations of K^+, NH_4^+, Ca^{2+}, SO_4^{2-} and NO_3^-. These ions are commonly related to smoke particles. P1 sample had a pH of 4.8 and a concentration of DOC and WIOC of 14.7 and 1.7 mg L^{-1}, respectively, indicating an excess of acidic species, probably organic compounds. Regarding P2, the pH was 5.5, and the neutralization capacity was 0.8, showing that the alkaline constituents prevented the acidification of rainwater in this event. The highest conductivity value was obtained in P1, which had the highest concentration of ions of both studied events.

The scavenging effect of the rain was also observed through a decrease in the air pollutant concentrations and a slight increase in the pH of rainwater samples, showing that the rainfall amount and intensity are key factors for cleaning up the atmosphere.

This study was partially supported by the Spanish Ministry of Economy and Competitiveness (Grant TEC2014-57821-R), the University of León (Programa Propio 2015/00054/001 and 2018/00203/001) and the AERORAIN project (Ministry of Economy and Competitiveness, Grant CGL2014-52556-R, co-financed with European FEDER funds). F. Oduber acknowledges the grant BES-2015-074473 from the Spanish Ministry of Economy and Competitiveness. C. Blanco-Alegre acknowledges the grant FPU16-05764 from the Spanish Ministry of Education, Culture and Sport.

Seinfeld, J.H., Pandis, S.N., (2016). *Atmospheric chemistry and physics: from air pollution to climate change*. John Wiley & Sons

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EFFECT OF THE AEROSOL SPHERICITY ON THE RADIATIVE FORCING EFFICIENCY

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Keywords: relative humidity, hysteresis, radiative forcing efficiency
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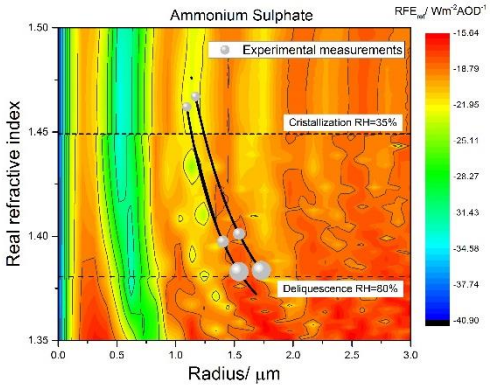
In this study, the effect of the hysteresis of the solid-aqueous particle phase transicion on the aerosol radiative forcing efficiency (RFE) has been analized focusing on ammonium sulphate (AS) aerosol. The phase transition affects the hygroscopic behavior and subsequently the size, the refractive index, and the radiative properties of a particle.

An AS particle exposed to increasing RH becomes aqueous at its deliquescence relative humidity point of 80% and as a result grows at higher RH by condensation of water vapor, but if this aqueous particle is later exposed to decreasing RH, it gradually shrinks but does not become solid until its crystallization relative humidity point of 35% (Wang, 2008). Therefore, it is expected to find in the atmosphere coexisting both solid (irregular) and aqueous (spherical) AS particles. Veghte *et al*. (2015) modelled the extinction cross sections using Mie theory and the discrete dipole approximation (DDA) to model more complex shapes. Mie theory had significant error with a 26.1% difference whereas roughened spheroids had a 11.2% difference from the experimental results. Using additional parameters that account for particle shape is necessary to model the optical properties and leads to improved extinction cross sections for modelling aerosol optical properties.

Advance refine parameterizations of the real refractive index as function of the relative humidity (RH) and the wavelength from elastic scattering of single levitated particles are considered in this analysis. These retrievals were used in previous studies to model optical parameters. This led to more accurate values on the estimated RFE (Valenzuela *et al*., 2018)

In this study, we consider two different models to calculate optical AS properties in order to account the shape of the particles.

We use Mie theory to model aqueous AS properties and a spheroid code (T-MATRIX) to model solid AS properties. We assume both phase state coexisting and their typical percent of presence in the atmosphere is taken from literature. Figure 1 shows RFE for AS particles as function of the size and the refractive index of particles until 3 μm and from 0 until 100 RH%.



The change of experimental radius with RH from two single levitated AS particles are also showed in the plot.

Fig. 1. RFE for AS particles as function of the size and the real refractive index. Black solid lines and circles indicated the change of the radius with the RH.

This work was supported by University of Granada and EU H2020 2020 through the MSC-COFUND Athenea 3i, ACTRIS-2 (GAn 654109) and Excellence Units Program; by the Spanish AEI projects CGL2016-81092-R and CGL2017-90884-REDT.

Valenzuela, A., Reid, J. P., Bzdek, B. R., & Orr-Ewing, A. J. (2018). Accuracy required in measurements of refractive index and hygroscopic response to reduce uncertainties in estimates of aerosol radiative forcing efficiency. J. Geophys Res. Atmos. 123. doi.org/ 10.1029/2018JD028365.

Veghte, D. P., J. E. Moore, L. Jensen, and M. A. Freedman (2015) Influence of shape on the optical properties of hematite aerosol. J. Geophys. Res. Atmos., 120, 7025–7039, doi:10.1002/2015JD023160.

Wang, J., D. J. Jacob, and S. T. Martin (2008) Sensitivity of sulfate direct climate forcing to the hysteresis of particle pase transitions, J. Geophys. Res., 113, D11207, doi:10.1029/2007JD009368

Combustion Aerosols

COAL COMBUSTION EMISSIONS: IMPACT ON AIR QUALITY IN NW SPAIN

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Keywords: aerosols, coal, arsenic, selenium.
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Emissions from coal combustion represent a serious environmental problem. In some megacities of China, an increase in the concentrations of NO_x, SO_2, CO_2 and toxic trace elements has been observed, which negatively impact human health and the ecosystem (Xie et al., 2006). For many years, León (Spain) has been the principal producer of primary energy from coal in Castilla y León (Antolín, 1996). According to the Junta de Castilla y León, in 2016, León produced 20.6 % of the total national coal-based energy. Furthermore, in 2014, 22% of the total energy consumption in the region came from coal combustion, increasing in 2015 to 24%. The emissions from coal burning increase during coldest months due to the use of domestic heating devices. Thus, the aim of this study was to carry out a deep study of a local event of coal combustion, through the evolution of gases and aerosol particles, highlighting the behavior of the main coal combustion markers (As, Se and S).

The sampling campaign was carried out in the Campus of the University of León, at León city, Spain (42º 36′ N, 05º 35′ W and 838 m a.s.l) between 01/12/2016 and 30/01/2017. The 24-h PM_{10} sampling was performed using a high volume sampler (CAV-Mb, 150 mm diameter quartz filters) and a low volume sampler (TECORA, ECHOPM, 47 mm diameter Teflon filters). PM_{10} samples were analyzed for: organic (OC) and elemental (EC) carbon, water soluble inorganic ions and major trace elements. Furthermore, the aerosol size distributions were determined by a high resolution nanoparticle sizer (SMPS Model 3938). Additional data provided by the regional air quality network (www.medioambiente.jcyl.es) related to SO_2 was also taken into account. An automatic weather station located in the sampling site recorded temperature, wind speed and direction and relative humidity. The evolution of the mixing-layer thickness was also analyzed, by using the data from NOAA database (https://www.ready.noaa.gov/READYamet.php).

As and Se concentrations showed a negative correlation with the temperature (r < -0.4, p< 0.01), and a positive correlation with the relative humidity (r > 0.2, p< 0.01). High concentrations of As and Se were obtained between 22 and 31 December, with a maximum of 0.004 ng/m^3 for As and 0.023 ng/m^3 for Se registered on 26 December 2016, coinciding with a slight decrease of the temperatures in León. An increase in the EC concentrations during the same period was also observed, going from 0.88 µg/m^3 to 2.70 µg/m^3. A simultaneous enhancement of the SO_2 values was recorded in the urban air quality station LE01 (urban station), from 8 µg/m^3 to 24 µg/m^3, indicating that León city is highly affected by coal combustion emissions during the coldest months.

This study was partially supported by the Spanish Ministry of Economy and Competitiveness (Grant TEC2014-57821-R), the University of León (Programa Propio 2015/00054/001 and 2018/00203/001) and the AERORAIN project (Ministry of Economy and Competitiveness, Grant CGL2014-52556-R, co-financed with European FEDER funds). F. Oduber acknowledges the grant BES-2015-074473 from the Spanish Ministry of Economy and Competitiveness. C. Blanco-Alegre acknowledges the grant FPU16-05764 from the Spanish Ministry of Education, Culture and Sport.

Antolín, G., Irusta, R., Velasco, E., Carrasco, J., González, E., Ortíz, L. (1996). Biomass as an energy resource in Castilla y León (Spain). *Energy* 21, 165–172.

Xie, R., Seip, H.M., Wibetoe, G., Nori, S., McLeod, C.W. (2006). Heavy coal combustion as the dominant source of particulate pollution in Taiyuan, China, corroborated by high concentrations of arsenic and selenium in PM_{10}. *Sci. Total Environ*. 370, 409–415.

EMISSIONS FROM PRESCRIBED FIRES OF TWO SHRUB SPECIES: GENISTA HISPÁNICA SUBSP OCCIDENTALIS AND CALLUNA VULGARIS

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In the Mediterranean area, forest fires have increased in number over the last 50 years, including bush fires. These produce large amounts of atmospheric carbonaceous material, particularly elemental carbon (EC) and organic carbon (OC), which play an important role in global warming (Boreddy et al., 2017). Prescribed fires have effects on the vegetation, soil, wildlife, water and air. So, the main aims of this study was to study the impact of prescribed burnings on air quality and to search the relation between the smoke generated in bush fires and the seed germination processes after the fire.

On October 2016, in La Cueta, León (NW Spain), six prescribed fires were conducted. Two species of shrubs were combusted: *Calluna vulgaris* (2 fires) and *Genista hispanica* subsp*. occidental* (4). During the sampling campaign various instruments were used: *i*) a Gent stacked filter unit sampler to collect PM_{10} onto polycarbonate filters; *ii*) a low volume ECHOPM of TECORA to collect $PM_{2.5}$ onto quartz filter; *iii*) a thermocouple network to register the temperature evolution of the fires; *iv*) TEDLAR bags for smoke sampling; *v*) CO and CO_2 Combo IAQ Meter. The quartz filters have been analyzed by a thermo-optical method for EC and OC determination. The ion concentration in the filters has been obtained by ion chromatography. Besides, the major organic components in the smoke samples have also been obtained.

The $PM_{2.5}$ concentrations registered were 31.1 and 12.0 $\mu g\ m^{-3}$ on average in *Calluna* and *Genista* burnings, respectively. For *Calluna*, the sum EC+OC represented 28.1% of $PM_{2.5}$, while for *Genista* it accounted for 32.9%. The sum of CO, CH_4, NO and C_2H_4 constituted more than 97.6 % of total mass gases concentration emitted in *Calluna* and *Genista* burnings. However, *Calluna* burnings presented higher gaseous concentration than *Genista* (81.3 vs 28.9 ppm, respectively). Regarding $PM_{2.5}$, the water soluble inorganic ions for *Calluna* presented higher concentrations than for *Genista* (except Cl^-). Furthermore, Cl^-, SO_4^{2-}, Na^+, Mg^{2+} and Ca^{2+} constituted more than 80% of the total ion emissions in the burning of both species. In terms of emission factors (EF) or mass of pollutant emitted per unit mass of fuel burned (Fig. 1), EF_{CO2} for *Calluna* were similar to those obtained during Amazonian forest clearing fires (Soares Neto et. al., 2009).

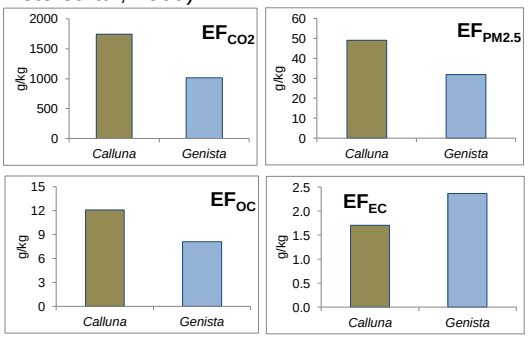

Fig. 1. Emission Factor (EF) of CO_2, $PM_{2.5}$, OC and EC during *Calluna* and *Genista* burnings.

This work was partially supported by the Grant TEC2014-57821-R, the University of León (Programa Propio 2015/00054/001) and the Grant CGL2014-52556-R. C. del Blanco Alegre acknowledges the grant FPU16/05764 from the Spanish Ministry of Education. Special thanks to the firefighters and the auxiliary people for their kindness and help during sampling.

Boreddy et al. 2017. Temporal and diurnal variations of carbonaceous aerosols and major ions in biomass burning influenced aerosols over Mt. Tai in the North China Plain during MTX2006. *Atmos. Environ*., 154, 106-117.

Soares Neto et al. 2009. Biomass consumption and CO_2, CO and main hydrocarbon gas emissions in an Amazonian forest clearing fire. *Atmos. Environ.* 43, 438-446.

CHARACTERISATION OF THE SMOKE PLUME FROM CHARCOAL GRILLING

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Charcoal-grilling is extensively used by households and restaurants in indoor and outdoor environments (Iqbal and Kim, 2016). Although charcoal is a popular cooking fuel worldwide, its burning is a source of numerous air pollutants (Vicente et al., 2018), which can pose significant health hazards due to the emission of mutagenic and/or carcinogenic compounds, such as PAHs (Kuo et al., 2006).

The aim of this study was to investigate particulate and gaseous compounds generated from starting a charcoal fire and then from cooking meat (pork and beef) and fish (sardine and salmon) on an outdoor stainless steel barbecue grill. The experiments were initiated by igniting two pine cones and by adding the charcoal on the top. The cooking procedure started when all flames had subsided. To characterise gaseous emissions, the generated smoke was sampled into Tedlar bags and determined in the laboratory using a Fourier transform infrared gas analyser. Simultaneously, a high volume sampler was used to collect PM_{10} on quartz filters. The equipment was positioned at about 5 m from the grill unit with the inlet at 1.2 m above ground to obtain samples from the core of the smoke plume. After gravimetric quantification, the organic and elemental carbon (OC and EC) in the particulate samples were determined by a thermo-optical technique. Particulate and gaseous background samples were collected, at the same location, prior to the tests. High levels of gaseous compounds, such as CO, CO_2 and total organic carbon (TOC), were registered during cooking on the charcoal grill. Due to the higher fat content, the highest gaseous concentrations were recorded during fish cooking. CO concentrations were 39 and 81 times higher than background levels during salmon and sardine grilling, respectively. During the grill fire up, charcoal combustion itself increased the PM_{10} levels by 28 to 104 times compared to the background levels. As observed for gaseous concentrations, PM_{10} levels increased by several dozens to over hundred times during fish cooking (79 and over 130-fold for salmon and sardine grilling, respectively). Due to lower fat content, meat grilling had less impact on the PM_{10} levels (9 to 21 times over background levels). Total carbon accounted for 6.2±0.01 (beef), 30 ± 8.9 (pork), 32 ± 1.5 (fish) and 37 ± 1.8 (charcoal) % wt. of the PM_{10} mass (Fig. 1).

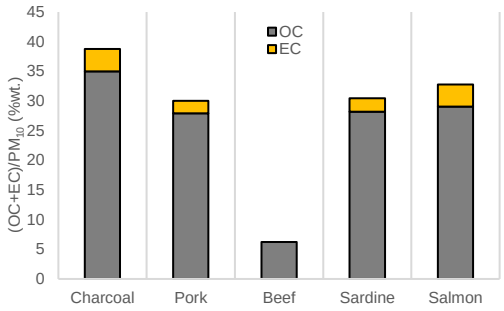

Fig.1 OC and EC particulate mass fractions.

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Iqbal, M.A., Kim, K.H., 2016. Sampling, pretreatment, and analysis of particulate matter and trace metals emitted through charcoal combustion in cooking activities. TrAC - Trends Anal. Chem. 76, 52–59.

Kuo, C.Y., Lee, H.S., Lai, J.H., 2006. Emission of polycyclic aromatic hydrocarbons and lead during Chinese mid-autumn festival. Sci. Total Environ. 366, 233–241.

Vicente, E.D., Vicente, A., Evtyugina, M., Carvalho, R., Tarelho, L.A.C., Oduber, F.I., Alves, C., 2018. Particulate and gaseous emissions from charcoal combustion in barbecue grills. Fuel Process. Technol. 176, 296–306.

Aerosols and air quality

Aerosols and Air Quality

SENSITIVITY OF ROADSIDE PLANT COMMUNITY TO PARTICLE-BOUND POLLUTANTS

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Keywords: particulate matter, phytotoxicity, roadside community, vegetative vigour test
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Roadside plant communities are especially exposed to air pollution. Higher plants have been widely used in bioindication studies, using a wide range of symptoms from biochemical end-points to community level changes. In our work, sensitivity of typical roadside plants have been assessed under controlled laboratory conditions, using the No. 227 OECD GUIDELINE FOR THE TESTING OF CHEMICALS: Terrestrial Plant Test: Vegetative Vigour Test. 10 plant species were selected for the study from different families (Table 1).

Table 1. Selected plant species.

Name of the plant	Family
Bellis perennis	Asteraceae
Sonchus oleraceus	Asteraceae
Taraxacum officinale	Asteraceae
Saponaria officinalis	Caryophyllaceae
Chenopodium album	Chenopodiaceae
Trifolium repens	Fabaceae
Salvia aethiopis	Lamiaceae
Rumex acetosa	Polygonaceae
Ranunculus acris	Ranunculaceae
Geum urbanum	Rosaceae

Plants were sprayed three times with one week interval with the aqueous extract of winter urban aerosol samples. The Guideline recommends the following end-points: shoot weight (alternatively fresh shoot weight), shoot height (where applicable), and visible symptoms on different parts of the plants. In our study additional end-points were used: photosynthetic pigments (chlorophyll a and b, carotenoid concentrations) total protein and peroxidase (APX).

Considering individual sensitivity, only one species, *S. officinalis* showed statistically significant response in four end-points: biomass and all photosynthetic pigments measured (chlorophyll a and b as well as carotenoid). It was followed by *T. repens* (significant response in biomass, carotenoid and APX). Two species (*B. perennis* and *C. album*) showed statistically significant response in two end-points, biomass and APX in case of *B. perennis* and APX and total protein in case of *C. album*. Finally, other two species, *S. oleraceus* and *R. acetosa* showed statistically significant response in one end-point. Out of 10 tested plant species, the following ones did not show statistically significant response to the treatment: *T. officinale*, *R. acris*, *R. acetosa*, and *G. urbanum*.

Assessing the sensitivity of different end-points, both biomass and APX showed significant response in four species. Peroxidase is an important enzyme for scavenging ROS (reactive oxygen species): PAHs influence plants through reactive oxygen species (ROS) production, oxidative damage to DNA, oxidative stress mechanisms, and impairment of the photosynthetic machinery (Risom et al. 2005). On the other hand, photosynthetic pigments proved more robust end-points than reported in other studies.

The final conclusion can be that as 4 species of the tested 10 did not show any response to the treatment, it might indicate the relative robustness of roadside communities.

This work was supported by the BIONANO_GINOP-2.3.2-15-2016-00017 and EFOP-3.6.1-16-2016-00015 projects.

Risom L., Moller P., Loft S. (2005). Oxidative stress-induced DNA damage by particulate air pollution. *Mutation Research*, 592, 119–137.

PM_{10} EPISODES AT A MEDITERRANEAN URBAN SITE

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PM_{10} samples collected at a site located in the city center of Elche (Southeastern Spain) during a three-year period were analysed to determine major and trace components. Saharan dust events and local pollution episodes caused by atmospheric stagnant conditions were identified using back-trajectory analysis, desert dust models, pressure level maps, and data on meteorological variables and pollutant concentrations of the regional surveillance network. The impact of such episodes on PM_{10} levels and composition was evaluated in order to distinguish between local emissions and long-range transport of aerosols.

Concentrations of PM_{10} and chemical components on event and non-event days are presented in Table 1.

Table 1. Average mass concentrations on non-event (NE), Saharan dust episodes (SDE) and local pollution events (LPE). Concentrations are given in µg/m^3, except for metals (ng/ m^3)

	NE	SDE	LPE
PM_{10}	22.2	45.8	41.3
EC	1.1	1.4	1.8
OC	5.3	6.8	10.1
[a]SOC	2.2	3.3	6.1
Cl^-	0.71	0.80	0.60
NO_3^-	2.04	3.43	5.22
SO_4^{2-}	2.31	4.38	2.72
$C_2O_4^{2-}$	0.18	0.29	0.26
Na^+	0.71	0.79	0.39
NH_4^+	0.50	0.72	1.01
K^+	0.15	0.23	0.41
Mg^{2+}	0.13	0.18	0.10
[b]Ca^{2+}	1.43	2.57	2.48
Ti	16	75	24
V	7	17	7
Cr	8	12	12
Mn	11	27	17
Fe	323	636	550
Ni	8	14	12
Cu	15	19	26
Zn	23	30	41
Sr	7	15	11

[a]Secondary Organic Carbon (SOC) concentrations were estimated using the EC tracer method.
[b]Ca concentrations measured by XRF are not shown since its variability has been proved to be analogous to that of Ca^{2+}

Average PM_{10} concentrations under both SDE and LPE were approximately double those measured on non-event days. SDE showed a clear impact on crustal components (Ca^{2+}, Ti, Mn, Fe and Sr). As previously reported (Galindo et al., 2018), Ti was the best tracer of this type of event. Ni and V also showed a marked increase, which may be due to the presence of these elements in mineral dust or to the transport by Saharan dust plumes of anthropogenic pollutants emitted in northern Africa and the Mediterranean basin. The increase in nitrate and especially sulfate concentrations is the result of the heterogeneous oxidation of nitrogen and sulfur oxides, respectively, on mineral dust particles (Hien et al., 2005).

Concentrations of SOC and nitrate increased more than double during LPE. The meteorological conditions characteristic of this type of event (low wind speeds and mixing heights, and clear skies) favor the accumulation of precursors near the emission sources and their transformation into secondary pollutants. Traffic-related components such as EC, Cu and Zn (emitted by vehicle exhaust, break wear and tyre abrasion, respectively) also showed significant increases. LPE had a notable impact on Ca concentrations as well, suggesting that calcium particles had a predominantly local origin (road dust resuspension) during these episodes.

This work was supported by the Valencian Regional Government under the AICO/2018/085 research project.

Galindo, N., Yubero, E., Nicolás J.F., Varea, M., Crespo, J. (2018) Characterization of metals in PM_1 and PM_{10} and health reisk evaluation at an urban site in the western Mediterranean. *Chemosphere*, 201, 243-250.

Hien, P.D., Bac, V.T., Thinh, N.T.H. (2005). Investigation of sulfate and nitrate formation on mineral dust particles by receptor modelling. *Atmospheric Environment*, 39, 7231-7239.

THE RAINFALL, THE BEST ALLY OF POLLEN ALLERGY SUFFERERS: BELOW CLOUD SCAVENGING OF NINE POLLEN TYPES

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Keywords: air quality, health, pollen, raindrop, scavenging
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The poor air quality produces a negative impact on human health and the environment. It is caused by several pollutants, among which are particulate matter (PM), which includes bioaerosols (pollen, fungal spore, bacteria) and non-biological particles or gases such as SO_2 or O_3 (Oduber et al., 2019). It has to be emphasized that pollen concentration causes a clear impact on human health: pollen allergy. So, the study of the pollen behavior during rain is vital, inasmuch as rain is one of the main aerosol sinks. Thus, the main aim of this study is to analyze the evolution of the concentration of nine types of pollen during rain events.

A sampling campaign was carried out between January 2015 and December 2018 in León (Spain). A Laser Precipitation Monitor (LPM) of Thies Clima was used to register raindrops between 0.125 and 8 mm in 22 channels, on one-minute basis. The hourly pollen concentration between 10 and 100 µm was measured with a volumetric Hirst type sampler. The below cloud scavenging during rain events has been analyzed through the scavenging efficiency (*ΔC%*) for nine types of pollen: *Betula*, *Castanea*, Cupressaceae, Oleaceae, *Pinus*, *Plantago*, Poaceae, *Quercus* and Urticaceae.

The *ΔC%* was estimated as Eq. 1 to evaluate the change in pollen concentration (a positive value is considered effective scavenging) between the times t_1 and t_2:

$$\Delta C\% = -\left(\frac{C_2 - C_1}{C_1}\right) \cdot 100 \qquad \text{Eq. 1}$$

The rain events should meet some selection criteria: i) hourly accumulated precipitation higher than 0.1 mm, ii) temperature and wind speed variations below ±3 °C and ±2 m s^{-1}, respectively, between 2 h before and after rain.

A global analysis of all events, 122 along sampling campaign, was carried out. A 71% of the total events presented effective scavenging.

The sum of pollen concentration showed a clear scavenging (*ΔC%*=35%). All types of pollen presented an effective scavenging between before and after rain (Figure 1), but there were differences between types. Thus, *Castanea* and Cupressaceae presented the higher *ΔC%* values and Urticaceae the lower one.

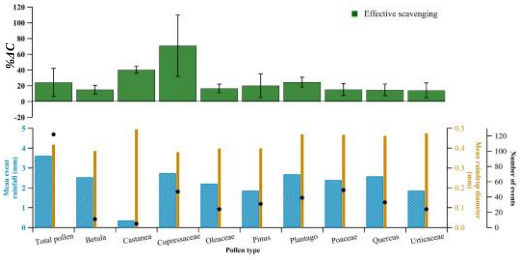

Fig. 1. *ΔC%* according to the different pollen types. Black dots indicate the number of rain events, striped boxes indicate the mean rainfall (mm) and vertical lines indicate the mean raindrop diameter (mm).

In conclusion, the rain causes a clear scavenging of pollen and this washing effect depends on the type of pollen. This kind of studies constitutes a valuable tool for the pollen forecast. Future studies will focus on the research of the root causes of the different scavenging efficiency values obtained for the different types of pollen.

This work was partially supported by the Spanish Ministry of Economy and Competitiveness (Grant TEC2014-57821-R), the University of León (Programa Propio 2015/00054/001) and the AERORAIN project (Ministry of Economy and Competitiveness, Grant CGL2014-52556-R, co-financed with FEDER funds). C. del Blanco Alegre acknowledges the grant FPU16/05764 from the Spanish Ministry of Education.

Oduber et al. (2019) Links between recent trends in airborne pollen concentration, meteorological parameters and air pollutants. *Agric. For. Meteorol.*, 264, 16–26.

SPATIAL AND TEMPORAL DISTRIBUTION CHARACTERISTICS AND SOURCE APPORTIONMENT OF FINE PARTICULATE MATTER IN ZHUZHOU CITY

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Keywords: Fine particulate matter, Urban environment, Source apportionment
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Zhuzhou, located in the south-central part of China, is a typical industrial city. The monitoring data in 7 state controlling air sampling sites in Zhuzhou Area have been statistically treated to analyze pollution situation and regularity of fine particles, 2014-2016. The PM2.5 filter samples were collected in the autumn and winter of 2016, and inorganic metal elements and water-soluble ion concentrations of fine particles were detected and analyzed by the equipment of ICP-MS and HPIC, respectively. Then, the principal component analysis and the positive matrix factor source apportionment method were used to determine the source and its contribution of fine particles. The study found that the annual average concentration from 2014 to 2016 of fine particles in Zhuzhou urban area were 63±32 , the quarter average concentration of fine particles in winter was the highest, while in summer was lowest. On the other hand, the serious area of fine particles pollution in the whole year was the northwestern part and the center, i.e. industrial and traffic intensive areas. The major elements with higher mass concentration of fine particles in residential area were Fe、Ba and Zn, and their level was above 1 . The high level of metal elements Ni、V、Pb、As、Mg … was related to the contribution from the major industrial sources such as local smelting, chemical industry and building materials. The level of As and Cd exceeded the limit, indicating the risk of carcinogenesis. The source apportionment in Zhuzhou urban showed that six important particulate sources were industrial dust, motor vehicle emission source, fossil fuel combustion sources, geology dust and biomass burning source and mixed source.

METHODOLOGY TO EVALUATE THE EFFECT ON AIR QUALITY AND HEALTH OF USING PHOTOCATALYTIC MATERIALS IN URBAN AREAS

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Keywords: urban air pollution, photocatalytic materials, health impact
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In Europe, emissions from road traffic represent the 39% and 10% of total nitrogen oxides (NO_x = $NO+NO_2$) and particulate matter (PM_{10}, $PM_{2.5}$) anthropogenic emissions, respectively (EEA, 2018). Directive 2008/50/EC imposes limit values for some related pollutants (NO_2 and PM_{10}) in order to protect public health. Despite the efforts dedicated to reduce pollution levels, these objectives are often not met in some urban areas. This situation is particularly worrisome in relation to the highlighted pollutants, taking into account that NO_2 is a species that has relevance, additionally, as a precursor of both ozone and secondary aerosol.

One of the emerging environmental control options that could complement conventional strategies aimed to reduce NO_x is the application of building materials that incorporate photocatalytic compounds such as titanium dioxide (TiO_2) which, activated by sunlight, allow the elimination of compounds such as NO_x from the air through heterogeneous photocatalysis.

In this work, the methodology implemented in the LIFE MINO$_x$-STREET project for evaluating the effectiveness of several photocatalytic materials applied in urban environments to remove ambient NO_x (LIFE MINO$_x$-STREET, 2019) and assessing their potential health benefit are presented. For that different steps were followed. Firstly, photocatalytic building materials were subjected to rigorous laboratory tests in order to study mechanical and physical properties, operation-induced changes, durability, air-purifying capacity, chemical and structural properties, changes induced by ageing and regeneration processes. Secondly, the sink effect on NO_x levels in presence of selected photocatalytic materials and NO_x deposition velocities were obtained and estimated under semi-controlled ambient conditions, far from direct emission sources, and in laboratory tests. Following, a real scale demonstration of the depolluting capabilities of these materials were implemented on different real urban scenarios. These results were used to evaluate a microscale numerical model capable to simulate the NO_x sink effect and the dispersion of pollutants at urban scale. Such model considered the photochemical reactions linked to the NO_x-O_3 chemistry and included the depolluting effect of the materials by means of the estimated deposition velocities. After that, the model was used to assess the individual and combined effect of different photocatalytic materials applied to different elements of the urban environment at different urban scales. To assess the effect of potential ambient NO_x reductions in PM concentrations at local scale a mesoscale dispersion model including heterogeneous chemistry should be used.

In order to evaluate the health benefit (i.e. short-term daily mortality attributed to both NO_2 and PM), of the use of these materials, two different scenarios were defined: a reference case with actual data and another with ideal lower NO_2 concentrations due to the presence of the photocatalytic products. Generalised linear models with a Poisson link, controlling for maximum and minimum daily temperature, trend of the series, seasonality and the autoregressive nature of the series and a meta-analysis with random effects was used to estimate relative risk and attributable risk of mortality for the studied area (Linares et al., 2018). Daily mean NO_2 and PM concentrations from data supplied by the local Air Quality Network and daily mortality data furnished by the National Statistics Institute were used for that. Finally the number of related deaths has been estimated.

This work was supported by LIFE financial instrument of the European Union (LIFE12/ENV/ES/000280).

EEA (2018) *Air quality in Europe 2018*. Office of the European Union, Luxembourg.

LIFE MINO$_x$-STREET (2019) Web page http://www.lifeminoxstreet.com/life

Linares C., Falcón I., Ortiza C., Díaz J. (2018) An approach estimating the short-term effect of NO_2 on daily mortality in Spanish cities. *Environment International* 116, 18–28.

A PLAGUE OF FIRES IN THE NW OF IBERIAN PENINSULA: THE SCAVENGING EFFECT OF RAIN ON AIR QUALITY

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Keywords: air quality, EC, levoglucosan, OC, particulate matter, rain.
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One of the major problems that concerns human health and climate in the Mediterranean area is air pollution. Forest fires present a great influence therein. An example is the set of fires that occurred in the North of Spain (Galicia, Asturias and León) and the North of Portugal in October 2017. Between 14 and 16 October, more than 100,000 ha were burned, and the plumes reached several cities of the northwestern Iberian Peninsula, including León. Thus, the aim of this study is to present the main results of the chemical analysis of air filters and rain collected during this period.

The sampling campaign was carried out at the campus of the University of León (Spain) between 16 and 18 October 2017. During this period, two rain events took place, on 16 and 17 October, with 0.84 and 4.84 mm of rain, respectively. Several sampling instruments were used: i) a High-Volume Air Collector, CAV-A/Mb model equipped with 150 mm diameter quartz filters; ii) a Low Volume Collector TECORA ECHOPM that operates with 47 mm diameter Teflon filters; iii) an automatic wet-only collector Eigenbrodt model UNS130/E.

The gravimetric quantification of PM_{10} quartz filters was made using an electronic microbalance (Mettler Toledo, XPE105DR). Filters were analyzed by different analytical techniques: i) a thermal–optical technique (Pio et al., 2011) for the determination of elemental and organic carbon; ii) ion chromatography for the quantification of water-soluble inorganic ions; iii) PIXE (Particle-Induced X-ray Emission), following the methodology described by Lucarelli et al. (2015), for the determination of the major trace elements; iv) gas chromatography–mass spectrometry (GC–MS) for organic speciation, including polycyclic aromatic hydrocarbons (PAH) and aliphatics. Furthermore, the mannosan and levoglucosan concentrations were also obtained. In rain samples, the dissolved organic carbon (DOC) content has been obtained by combustion and infrared detection in a Total Organic Carbon Analyzer from Shimadzu (TOC-VCPH).

The maximum hourly PM_{10} concentration registered during wildfires was 100.6 µg m^{-3}, whilst before the event the mean daily PM_{10} concentration was 13.9 µg m^{-3}. After rainfall, the rain scavenging caused a decrease of PM_{10} concentration of 42 %. The maximum total carbon concentration registered by thermal-optical technique was 4.9 µg m^{-3} with an OC/EC ratio of 5.6. Levoglucosan concentrations were 100 and 137 ng m^{-3}, before and after rainfall, respectively. This study complements a previous work already presented (Blanco-Alegre et al., 2018) on the physical properties of aerosols and precipitation in this sampling campaign.

This work was partially supported by the Grant TEC2014-57821-R, the University of León (Programa Propio 2015/00054/001) and the Grant CGL2014-52556-R. C. del Blanco Alegre acknowledges the grant FPU16/05764 from the Spanish Ministry of Education.

Blanco Alegre et al. 2018. Air pollution in León during a set of forest fires in the NW of the Iberian Peninsula: a post-fires rain event. *RICTA 2018*.

Lucarelli et al. 2015. The role of PIXE in the AIRUSE project “testing and development of air quality mitigation measures in Southern Europe.” *Nucl. Instruments Methods Phys. Res. Sect. B Beam Interact. with Mater. Atoms*, 363, 92–98. doi:10.1016/j.nimb.2015.08.023

Pio, et al. 2011. OC/EC ratio observations in Europe: Re-thinking the approach for apportionment between primary and secondary organic carbon. *Atmos. Environ.*, 45, 6121–6132. doi:10.1016/j.atmosenv.2011.08.045

INDOOR /OUTDOOR AIR QUALITY WITHIN A SCHOOL IN AN INDUSTRIALISED AREA OF SOUTHERN ITALY

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Children are more sensitive to air pollution than adults and they spend large amounts of their time in school buildings where they may be exposed to unknown levels of indoor pollutants (Rivas et al 2014).

The present study focuses on the city of Galatina (Apulia Region, Southern Italy) (Figure 1). The area hosts a large cementery and other small industries.

Since several decades, elevated male mortality rates (compared with the national values) for lung cancer in the Lecce province are reported, with an incidence cluster including the area of Galatina.

Another study (Idoli et al. 2018) showed that children aged 6–8 years living in such area had a higher frequency micronucleated cells in oral mucosa than children living in other areas of lecce Province not included in the cluster area.

Aim of the work is to assess indoor air quality in a school building located in Galatina (Lecce).

In this study simultaneous indoor and outdoor Volatile Organic Compounds (VOCs) monitoring has been carried out, both by Radiello cartridges and real time monitors (Corvus, Labservice Analytica, Italy).

In particular, VOCs and BTEX concentrations, obtained by using Radiello® diffusive samplers, were monitored in two classrooms, in two bathrooms, and outdoor of the school building for three weeks during the winter 2019. Simultaneously, Total VOCs (TVOCs) concentration was measured by means of real-time monitoring to individuate the activation of sources during the monitored days. Moreover indoor and outdoor monitoring of PM_{10}, $PM_{2.5}$, concentrations has been performed in the same environements. In addition, data from air quality monitoring station (ARPA Puglia) located close to the school was analysed.

Results evidence that indoor TVOCs concentration is bigger than outdoor ones (see figure 2): this suggests the presence of indoor pollutants sources. Moreover, when the site is upwind the industrial area, outdoor PM concentrations show low values contributing poorly to the indoor ones. Also in the bathrooms, high PM and VOCs levels highlighted the presence of indoor pollutants sources.

Figure. 1. Area of Study

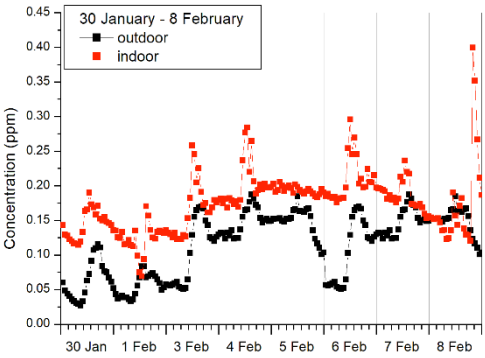

Figure. 2. Comparison between indoor (classroom) and outdoor (terrace next to the classroom) of TVOCs concentration during the first week of sampling.

Rivas, Ioar, et al. "Child exposure to indoor and outdoor air pollutants in schools in Barcelona, Spain." Environment international 69 (2014): 200-212.

Idolo, Adele, et al. "Micronuclei in Exfoliated Buccal Cells of Children Living in a Cluster Area of Salento (Southern Italy) with a High Incidence of Lung Cancer: The IMP. AIR Study." International journal of environmental research and public health 15.8 (2018): 1659.

AN INTEGRATED SYSTEM FOR THE SUSTAINABLE MANAGEMENT OF TRAFFIC, CONGESTED URBAN CORRIDORS AND BUSES FLEETS

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Keywords: Urban Air Quality, Exposure Assessment, Emission Testing, Modelling Tools
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Globally, exposure to air pollutants has been linked to harmful health effects all around the world (Lipfert and Wyzga 2008; Yang and Liu 2018). In urban areas, due to the increased traffic-related emissions, air quality problems have become a threat to the sustainable development of cities. Therefore, it is fundamental to better understand this problem in order to find alternatives and solutions aiming to improve air quality and human health.

Public transport, and in particular buses, are a key component of the transport system within cities. They run throughout the day and thus can lead to high concentrations of air pollutants in the urban environment. Considering their impacts on air quality and human health, this work aims to develop an integrated methodology for the sustainale management of congested urban corridors and buses fleets aiming to minimize the buses' air quality impacts.

The main research questions of this project are:

1) How do different factors, including vehicles characteristics, operation conditions, volume of traffic and street slope affect buses' emissions?

2) How do different factors, such as street morphology, building volumes, trees characteristics, existence of special corridors for buses or bicycles, distribution of the population and environmental conditions affect the impacts of buses on air quality and human health?

3) What are the most efficient strategies to reduce the impacts of buses on air quality and human health, in a cost-efficient way?

Figure 1 represents how this project will answer to the previous research questions. This work will enable the determination of accurate bus emission factors under heterogeneous traffic conditions (Task 2), the development of an integrated model system to estimate air pollutants concentrations, exposure and Burden of Disease and the determination of how buses emissions affect these three dimensions (Task 3) and, finally, the development of a systemic approach through an algorithm bringing together emissions, air quality, health and cost-benefit aspects to rank strategies based on the redefinition of buses' fleet, better allocation of vehicles and changes in street planning (Task 4).

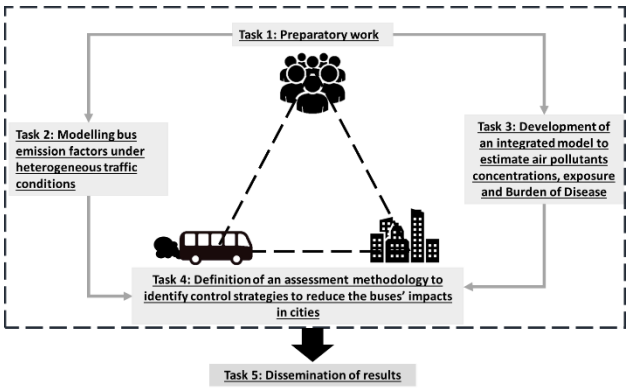

Figure. 1. Work plan.

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Lipfert FW, Wyzga RE (2008) On exposure and response relationships for health effects associated with exposure to vehicular traffic. 588–599. doi: 10.1038/jes.2008.4
doi: 10.1016/j.scitotenv.2018.06.281
Yang T, Liu W (2018) Does air pollution affect public health and health inequality: Empirical evidence from China. J Clean Prod 203:43–52. doi: 10.1016/j.jclepro.2018.08.242

CHARACTERIZATION OF BLACK CARBON CONCENTRATION IN AN URBAN AREA

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Keywords: Air pollution, Particulate matter, Black Carbon, Traffic pollution
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Black carbon (BC) is a constituent of fine particles emitted by the incomplete combustion of carbonaceous fuels (Moreno et al., 2015). It is considered a unique primary tracer for combustion as it has no non-combustion sources. BC represents a risk factor for human health (Guarieiro and Guarieiro, 2013) and has a significant impact on global warming due to the strong absorption of light in the visible and UV range (McConnell et al, 2007).

The main objective of this study was to characterize the black carbon concentration with urban-traffic during weekdays and weekends.

Methods: BC measurements were carried out at an urban monitoring station located near a high traffic road in Coimbra, Portugal. An Aethalometer model AE33 was used to collect and analyse aerosol carbonaceous particles continuously based on light absorption at different wavelengths and providing real-time data.

Results: Results show that there is a daily variation in BC concentration during weekdays and weekends (Figure 1) that seem to be linked with traffic emissions throughout the day. On weekdays, the highest BC concentrations were recorded at rush hours (8–10 a.m. and 6–8 p.m.) and the average BC concentrations were higher on weekdays (4.66 µg/m^3) than on weekends (3.91 µg/m^3), which can be attributed to high vehicular emissions on the working days.

This study shows that BC concentration at this sampling site was highly determined by vehicles emissions, so it can help to formulate air pollution mitigation policies.

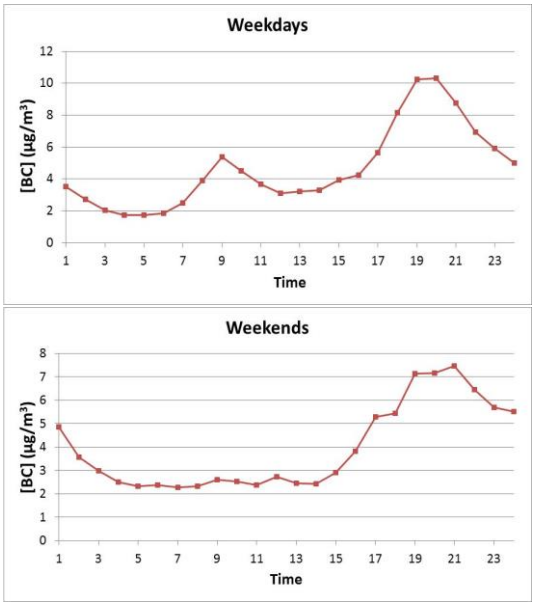

Fig. 1: Diurnal variation in atmospheric BC concentration during weekdays and weekends.

Authors gratefully acknowledge Colossal – Chemical on-line composition and source apportionment of fine aerosol (COST Action 16109) and ISY-AIR project (MIT- EXPL/IRA/0023/2017).

Moreno, T. et al., 2015. Urban air quality comparison for bus , tram , subway and pedestrian commutes in Barcelona 142, 495–510. https://doi.org/10.1016/j.envres.2015.07.022

Guarieiro, L.N.L., Guarieiro, A.N.L., 2013. Vehicle Emissions : What Will Change with Use of Biofuel ?, in: InTech (Ed.), Biofuels - Economy, Environment and Sustainability. Rijeka, Croatia, pp. 357–386. https://doi.org/10.5772/52513

McConnell, et al., 2007. 20th-century industrial black carbon emissions altered arctic climate forcing. Science 317 (no. 5843), 1381–1384.

MEASUREMENTS OF AMBIENT MICROBIAL LEVELS AND DEPOSITS INSIDE THE HISTORICAL MUSEUM OF CRETE

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Keywords: bioaerosols, microbial deposits, indoor air quality, museums
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The present study is focused on the determination of the cultivable airborne microbial load inside the Historical Museum of Crete as a key parameter for the evaluation of the suitability of the indoor air for the preservation of cultural heritage objects (Lazaridis *et al*. 2015 & 2018). Measurements of ambient viable microbial levels and deposits were performed in the Historical Museum of Crete for a period of two years (March 2014 – February 2016).

Air samples were collected using a MAS 100 one stage viable sampler for the determination of microbial concentrations. Measurements were performed indoors (*A. Kalokairinou* Room at the ground floor, *Z. Portalaki* Room *I* at the 1st floor, *Z. Portalaki* Room II at the 1st floor, and Ethnographic Collection Room at the 2nd floor) as well as outdoors. Monthly bioaerosol measurements (two replicates) were conducted before (1st year) and after the placement of photocatalyic Ionisers (one Daikin MC70L Ioniser per 65 m^3 of room space) (2nd year) to determine their efficiency to remove airborne microbes. Different microbiological growth media were used for the cultivation of viable airborne microbes (Lazaridis et al., 2015 & 2018).

The viable microbial concentration was influenced by the presence of visitors, the aeration rate and microbial emissions inside the museum, and showed a seasonal variability. An enrichment of heterotrophic bacteria, autotrophic chemolithotrophic bacteria, and acid producing bacteria was encountered indoors which may result to the deterioration of cultural heritage objects. In contrast, a relatively low concentration of viable fast-growing fungi was measured indoors.

In addition, the effectiveness of the use of ionizers in the museum for improving the air quality in respect to the concentration of viable microbes was examined. A considerable decrease of the measured viable microbes was measured after the deployment of the ionizers in the different indoor sites ranging from 5.5 % to 76 % (Figure 1).

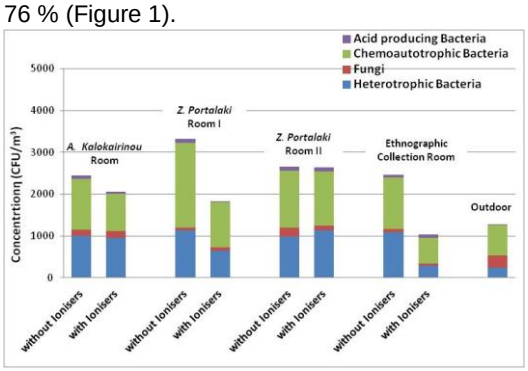

Fig. 1. Decrease of the ambient concentration of microbes (CFU/m^3) after the deployment of ionizers equipped with UV lamps.

Finally, the results from the microbial deposits on paintings after an exposure period of 18 months showed a clear correlation between the settlement and survival of viable heterotrophic bacteria on the exhibits surfaces and the chemical composition of the used painting materials of the model essays. However, no viable fungi deposits were encountered on the different materials placed, besides on tempera, charcoal and wax pastel.

This work was supported by the Operational Cross-Border Cooperation Programme «Greece-Cyprus 2007-2013» and was co-financed by the European Union (ERDF) (80%) and national funds of Greece and Cyprus (20 %)

Lazaridis M., Katsivela E., Kopanakis I., Raisi L. and Panagiaris G. (2015) Indoor/outdoor particulate matter concentrations and microbial load in cultural heritage collections. *Heritage Science* 3(1), 34-46. DOI 10.1186/s 40494-015-0063-0.

Lazaridis, M., Katsivela, E., Kopanakis, I., Raisi, L., Mihalopoulos, N. and Panagiaris, G. (2018). Characterization of airborne particulate matter and microbes inside cultural heritage collections. *Journal of Cultural Heritage* 30, 136-146. DOI: https://doi.org/10.1016/j.culher.2017.09.018.

THE STUDY OF THE STERILIZATION AND CLEANING OF THE INDOOR AIR IN HOSPITAL / CLINIC ROOMS BY USING THE ELECTRON WIND GENERATOR

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Exposure to aerosols may be especially hazardous in the clinics and hospitals. Therefore, it is very important to clean the air in such buildings, especially in the surgery rooms. There is a number of different portable cleaners, including electrostatic devices which seem to be especially promising (Huang et al., 2008).

The purpose of the reported study was to estimate the decrease in the concentration of particulate and biological aerosol in the selected rooms due to the work of the Electron Wind Generator (EWG). It is an air movement and air purification device using a sophisticated combination of electrode topology and specially designed high voltage power supply.

The best results were obtained in small rooms, e.g. in a 3-4 patient`s room in the hospital. In such rooms, with only sporadically opened windows, the concentration of bacterial aerosol after two hours of EWG operation dropped by almost half. The concentration of fungal aerosol after a few hours of the sterilization dropped to 30% of the previous level (see the Table 1).

Table 1. Example of the concentration level (CFU/m^3) of airborne respirable bacteria (B) and fungi (F) in the hospital room decreasing due to working the EWG cleaner.

Back-ground	After 2 hours	After 4 hours
(B) 70	42	21
(F) 258	208	84

However, in the hospital operating room (with a capacity of 150 cubic meters) using efficiently working ventilation system, the effect of the EWG device on microbiological air quality was low. The EWG purifier also reduces the concentration of airborne solid particles. For example, in a small rooms with a volume of 30-40 cubic meters the concentration of PM5 was reduced by half.

The studied sterilization process significantly changed the characteristic of species and genera of airborne bacteria. It was found that the contribution of Gram-positive cocci to the total viable bacteria increased from about 60-70% in the beginning to 75% (after 4 hours) and to almost 100% after 10 hours of sterilization.

Our work was also aimed to reduce both; the strong sparking occurring after a few hours of work of this device, and ozone emission. Therefore, the EWG sterilizer was equipped with a carbon filter and also a cloth filter to capture coarse particles.

This work was partially supported by the InnoEnergy Master School, Eindhoven, The Netherland (*Grant Smog-Health-For*) and partially by the grant No. 08/020/BK 18/0015 (*Studies of the quality of outdoor and indoor air*).

Huang R., Agranovski I., Pyankov O., Grinshpun S. (2008) Removal of viable bioaerosol particles with a low-efficiency HVAC filter enhanced by continuous emission of unipolar air ions. *Indoor Air,* 18, 106-112.

INTER ANNUAL VARIATION OF PM10 NEAR A PORT HANDLING BULK MATERIALS.

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Keywords: PM10, port emissions, source apportionment.
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The proximity of these ports to some cities in the Mediterranean region has increased the concerns of the population with regard to air pollution. The loading, unloading, transport and storage of bulk materials such as clinker, gypsum and different sizes of gravel from marble quarries are a potentially important contribution to particle concentrations in air close to ports.

The city of Alicante extends in parallel to its port in the bay of Alicante. The amount of bulk materials handled in the port of Alicante in 2016, 2017 and 2018 was respectively 1.9, 1.7 and 1.4 million tones, most of which has been for exports. The proximity of the city to the area of bulk charging has led to concerns regarding air quality amongst the population.

In 2017 the Port of Alicante started an air quality surveillance Project for PM10 to ensure the compliance of air quality standards in the boundary of the Port area and to discern the different sources contributing to PM10. Four stations measure PM10 on hourly and two samplers collect daily samples. Also several emission control strategies for bulk handling and a real time alert protocol have being implemented in august 2017. As such, annual average PM10 concentrations and the patterns scenarios occurring throughout the year could be compared in two years.

The annual PM10 average on the urban side of the Port ranges show a slight decrease in all stations: from 23-18 □g/m3 (in ISM station), 29-26 □g/m^3 (in TF station) and from 25-24□□g/m^3 in the PDM station, however are still above the average levels in the urban station of the city (fig. 1). This station also shows a decrease (PLA, 20.3-19.7□□g/m^3). The number of exceedances of the daily limit of 50□□g/m^3 has decreased in a larger extension pointing out the positive effect of the control emission program implementation.

At annual scale, the exceedances occur in autumn-winter during stagnant days and spring-summer with wind directions coming clearly from the zone where the materials are being handled.

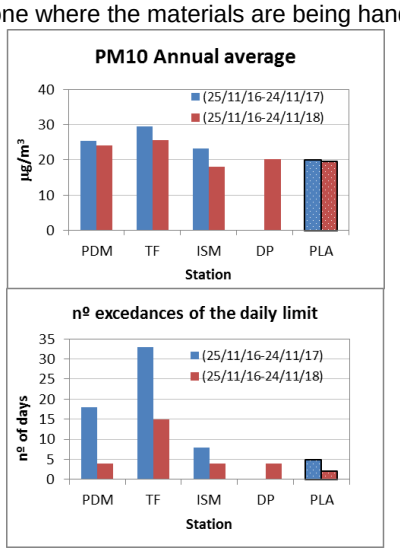

Fig. 1. Comparison of annual averages and number of exceedances.

Results from source apportionment (PMF) conducted in the chemical composition of two bunch of filters from TF station, one in the spring-summer period, where exceedances due to port handling dominate and other in winter period (stagnant period), showing the overlapping of traffic and Port activities sources in agreement with similar studies (Perez et al, 2016).

Aerosols and Air Quality

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APA (2016, 2017) Annual Report (https://www.puertoalicante.com/es)

*Pér*ez, N., Pey, J., Reche, C., Cortés, J., Alastuey, A. and Querol, X. (2016) Science of total environment 571, 237-250.

11-YEAR EVOLUTION OF EQUIVALENT BLACK CARBON CONCENTRATIONS IN A URBAN AREA

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Keywords: black carbon, transmissometer
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Black carbon (BC) is the fraction of carbonaceus particles that shows a strong absorption of visible light (Greilinger *et al.*, 2019). BC is strongly related to elemental carbon (considered a marker of primary emissions, from biomass burning and mainly from traffic), although this relationship depends on several parameters of the sample and also on the protocol used for analysis (Moosmüller *et al.*, 2009).

Routine monitoring of BC, despite its great interest, is difficult due to the cost of the required instrumentation for its on-line monitoring and the high time consumption for the alternative off-line determination of elemental carbon by thermal-optical methods. Nevertheless, as BC is a strongly absorbing component of PM, its concentration can be derived from optical absorption measurements in the sampled filters, using a transmissometer. Data of UV-absorbing particulate matter (UVPM), an indicator of aromatic organic compounds can be obtained as well. This method has many advantages, being fast and non-destructive and allowing to analyse filters that had been archived for a long time (Greilinger *et al.*, 2019).

In this work, a SootScan™ OT-21 transmissometer (Magee Scientific) has been used to analyse almost a thousand PM_{10} samples collected in an urban area for 11 years (2007-2018). The sampling site is located near a port, in the coast of La Coruña (North-western Spain).

The obtained data of estimated (or equivalent) BC and UVPM concentrations (derived from attenuation at 880 and 370 nm, respectively) have been explored to find temporal trends by using Openair package in R (Carslaw and Ropkins, 2012).

For both BC and UVPM concentrations a clear decrease is observed during the analysed years (Fig. 1). During this period, the PM_{10} concentrations have also decreased in the area. In addition, seasonal trends have been found, with lower levels during summer. Analysing the weekly variation, significant trends are observed too, with higher concentrations during weekdays, due to the reduction in port activity and road and maritime traffic in the weekends.

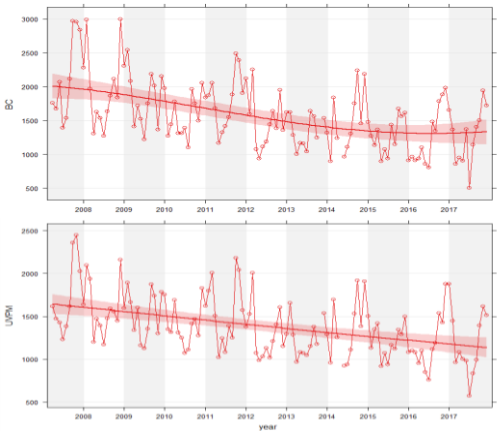

Fig. 1. Trend obtained for equivalent BC and UVPM concentrations in the sampling site from 2007 to 2018.

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Carslaw D.C., Ropkins K. (2012). *Environmental Modelling & Software*, 27-28, 52-61.

Greilinger M., Drinovec L., Močnik G., Kasper-Giebl A. (2019). *Atmospheric Environment*, 198, 1-11.

Moosmüller H., Chakrabarty R.K., Arnott W.P. (2009). *J. Quant. Spectrosc. Radiat. Transf.*, 110, 844-878.

DIFFERENCES IN AEROSOL CONCENTRATION AT TWO HEIGHTS (2500 AND 650 M ASL) IN SE SPAIN

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We present results from the 2018 measurement campaign of the FRESA project ("Impact of dust-laden African air masses and of stratospheric air masses in the Iberian Peninsula. Role of the Atlas Mountains") carried out simultaneously at El Albergue Universitario (2550 m asl) in Sierra Nevada and the Faculty of Sciences (650 m asl) in the city of Granada. The paired aerosol sampling at two heights in southern Spain provides long-term in-situ information on the vertical structure of the dust transport from North Africa to the Iberian Peninsula. The two sites were instrumented with low-volume samplers with PM10 inlet for daily sampling and mass and chemical composition characterization, high-volume samplers for weekly sampling of total suspended particles aimed to radionuclide activity determination, GRIMM 365 optical particle counters that provide continuously the aerosol diameter distribution, and automatic meteorological stations. The sampling period, from May to December, was longer than in the 2017 campaign and more instrumented than in a preliminary campaign held in 2016.

Both the local sources of suspended particulate matter and the atmospheric dispersion conditions are quite different at the two sites. In addition, large-scale air flows are found to be strongly decoupled at the two heights and therefore they influence differently the two sites.

PM10 concentrations higher than 50 μg m^{-3} are more frequent at the high-altitude site (4% of the days). These episodes are mostly associated to African dust outbreaks. Also concentrations lower than 20 μg m^{-3} are more frequently observed at Sierra Nevada. Rainfall/snowfall is found on 22% of the days (3% in 2017) with low PM10 levels at Sierra Nevada while in Granada they account for 12% of the days (13% in 2017) with low aerosol load. Moderately high values between 20 and 50 μg m^{-3} are most common in Granada.

Particle concentrations in the fine fraction are higher at Granada (except for a few smoke plumes from distant fires). In winter, fine particle levels increase at Granada and decrease at Sierra Nevada, while in summer levels at the two sites present some correlation. The altitude of the boundary layer is key in determining the impact in Sierra Nevada of the aerosols accumulated in the Granada basin. The coarse fraction is modulated by the African dust episodes in Sierra Nevada and Granada, although at Granada the impact is smaller and in occasions even not noticeable. Coarse particle concentrations at Granada present the typical urban two-peaks and therefore resuspension by traffic and other activities is also relevant.

During African dust outbreaks concentrations at Sierra Nevada are higher than in Granada as a consequence that air parcels reaching the area at heights between 2500 and 4250 m asl show on average a higher residence time over Africa, with a maximum at 3000 m asl. Therefore the high-altitude site receives more directly the dust plumes. In turn, under these episodes, parcels reaching Granada passed previously over the Mediterranean. However, downward dust entrainment and mixing processes lead to the presence of African dust at Granada in most episodes. Boundary layer height is also key here.

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INDOOR AND OUTDOOR CONCENTRATIONS OF POLYCYCLIC AROMATIC HYDROCARBONS (PAHS) AT RESIDENCES AND SCHOOLS, IN LISBON, PORTUGAL

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Polycyclic aromatic hydrocarbons (PAHs) constitute a small fraction of PM mass but have been given special attention since they belong to the group of Persisent Organic Pollutants (POP), and also display documented carcinogenic, mutagenic and toxic effects. PAHs consist of several hundreds organic compounds, with various structures and toxicity. They are formed during the incomplete combustion of biomass or fossil fuels, while they are also emitted during cigarette smoking and biological processes. There is a great number of works in the international literature reporting on PAHs concentrations in the ambient atmosphere. Much fewer, though, are the studies on indoor air quality. The present work reports of the PAHs indoor and outdoor concentration levels measured at residences and schools, in the city of Lisbon, Portugal. These two microenvironments have been selected as representative of children's exposure.

In total, 10 residences and 5 schools were studied, covering areas of the city with different characteristics of urbanization and traffic density. Indoor and outdoor PM2.5 and PM2.5-10 samples were simulteneously collected on Quartz filters, using low volume reference samples. Each home or school was monitored for five consecutive days, during hours occupied by children (9 am to 6 pm at schools; 6 pm to 9 am at homes on weekdays and during the whole day on weekends). The samples were analysed by Gas Chromatography – Mass Spectrometry (GC-MS) for the determination of 25 PAHs (Pateraki et al., 2019).

The observed ambient concentration levels were comparable to other Southern European urban background sites (Alves et al., 2017). Very low levels of benzo(a) pyrene (BaP) were recorded in the ambient atmosphere, being for several days below the detection limit (bdl) of the method. The concentrations were in the range bdl-0.87 ng/m3, with a mean value of 0.18 ng/m3 in PM10; thus, mean BaP levels were much lower than 1 ng/m3, which is the respective annual limit value set by EU (Directive 2004/107/EC). Similar levels have been reported for a suburban site in Athens and an urban background site in Florence (during the warm season) (Alves et al., 2017). BaP was mainly found in the fine size fraction. The relative concentrations of BaP and benzo(e)pyrene (BeP) may be an indication of the distance of the sampling site from emissions, since BaP is photodegraded faster than its isomer BeP. The BaP/(BaP+BeP) ratio was found on average equal to 0.52, suggesting impact from fresh emissions.

Indoor concentrations were lower than the respective outdoor levels, for all PAHs studied. The indoor-to-outdoor (I/O) ratios for the different PAHs were in the range 0.15 – 0.95 (mean value equal to 0.59 ±0.27). The I/O ratio for BaP was calculated equal to 0.90, demonstrating that a major fraction of ambient generated BaP is infiltrated in indoor microenvironments.

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Alves C.A., et al. (2017) Polycyclic aromatic hydrocarbons and their derivatives (nitro-PAHs, oxygenated PAHs, and azaarenes) in PM2.5 from Southern European cities, Sci. Total Environ., 595, 494-504.

Pateraki St., et al. (2019) The traffic signature on the vertical PM profile: Environmental and health risks within an urban roadside environment, Sci. Total Environ., 646, 448-459.

TREND AND CHARACTERIZATION OF DEPOSITION DUST OVER NINE YEARS IN THREE DIFFERENT ENVIRONMENTS OF THE SOUTHWEST OF THE IBERIAN PENINSULA

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Keywords: deposition dust, trend, chemical composition, North African wind
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The atmospheric deposition dust affects both human health and the Earth's climate. The deposition dust trend has been studied in the southwest of the Iberian Peninsula during 9 years (2008-2017). To this end, three sampling stations have been located in different environments. The first one is in an urban area, within the city of Huelva. The second one is in an industrial area situated about 10 km from Huelva. The third one is a rural station, very close to Doñana National Park, located ca. 50 km from Huelva. The samplings have been carried out with a frequency of two weeks continuously. A previous study has been carry out in this study area for a shoter period (2008-2011) than the present one (Castillo *et al*., 2013).

The results show a higher deposition rate in the industrial station followed by the urban one (Fig. 1).

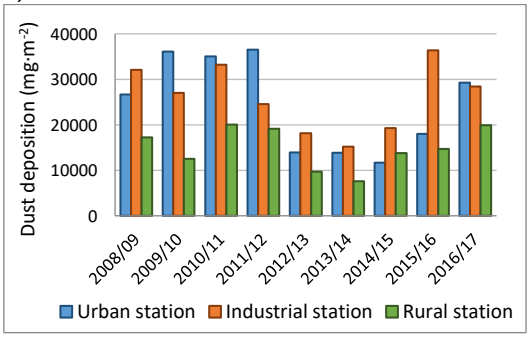

Fig. 1. Annual dust deposition in the study period (2008-2017) for the urban station, the industrial station and the rural station.

The average deposition values in the whole period are 25 $g \cdot m^{-2}$ for urban station, 26 $g \cdot m^{-2}$ for industrial station and 15 $g \cdot m^{-2}$ for the rural one. Overall, every year the highest deposition rates occur in the summer months. Deposition peaks usually coincide with large rainfall events or North African wind intrusion events. These intrusions have more effect on the deposition of urban and rural stations than on the industrial one. A general downward trend of deposition dust has been found, especially in the soluble fraction, although the trend changes depending on the season. Seasonally, the largest depositions have been found in spring, followed by summer, autumn and finally winter.

The chemical analysis shows variations among the stations. The urban and the rural have similar chemical compositions, while the industrial one varies significantly. Al, Fe, and Ca stand out as the main elements of the insoluble fraction; while on the insoluble fraction, Zn and Cl^- are the main ones. Moreover, it has been observed that the trend of some elements is very similar. Besides that, elements like Mg, Na and Cl^- are linked to rainfall events. There are also irregularities in the deposition of some elements, such as Zn, whose highest values are concentrated in 2010-2011.

Castillo S., de la Rosa J.D., Sánchez de la Campa A.M., González-Castanedo Y., Fernández-Camacho R. (2013) Heavy metal deposition fluxes affecting an Atlantic coastal area in the southwest of Spain. Atmospheric environment, 77, 509-517.

FINE PARTICULATE MATTER POLLUTION IN 16 EUROPEN CITIES IN 2014-15

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Fine particulate matter (PM2.5) pollution, i.e. aerosol particles with aerodynamic diameter less than 2.5 micrometer, is a key risk factor in densely populated urban areas around the world due to their adverse health effects.

In this work the first results obtained in the frame of the IAEA regional technical cooperation project "Supporting air quality management I-II" is presented. PM2.5 concentrations and elemental composition in 16 European and Eurasian cities were determined. PM2.5 sampling were carried in urban background sites in 16 countries all over Europe and Eurasia for a 1-year long period in 2014-15. The elemental composition of ~ 2200 filters were determined by PIXE, XRF, EDXR or ICP-MS.

The annual average PM2.5 concentrations were under 20 microg/m3 for most of the sites except in Banja Luka (BIH), Sofia (BUL), Skopje (FYROM), Krakow (POL), Ankara (TUR) and Dushanbe (TAJ). In the heating season the PM2.5 pollution levels were 2-3 times higher than in summer in the middle European cities and the urban areas in the Balkan. In Mediterranean countries like Portugal and Greece this ratio was around 1.

The effect of long range transport was also studied by observing emission episodes (e.g. Saharan dust intrusion) simultaneously in the distant sampling sites.

AVIATOR - ASSESSING AVIATION EMISSION IMPACT ON LOCAL AIR QUALITY AT AIRPORTS: TOWARDS REGULATION

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Keywords: aviation, airports, emissions, LAQ, PM, VOCs
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Introduction

Emissions from aircraft have adverse effects on the air quality in and around airports, contributing to public health concerns within neighbouring communities. AVIATOR will adopt a multi-level measurement, modelling and assessment approach to develop an improved description and quantification of the relevant aircraft engine emissions, and their impact on air quality under different climatic conditions, specifically on non-volatile PM and volatile PM (down to <10 nm), and volatile PM gaseous precursors.

Engine generated particulate matter (PM) and gaseous emissions in test-cell and on-wing from an in-service aircraft will be measured to determine pollutant plume evolution from the engine and APU exhaust. This will provide an enhanced understanding of emitted pollutants, and the scalability between the regulatory test-cell and real-world environments.

AVIATOR will develop and deploy across multiple airports, a proof-of-concept low-cost sensor network for the monitoring of ultra-fine particles (UFP), total PM and gaseous species such as NOx, SOx and VOCs across airport.

Methods

WP2 TEST-CELL ENGINE EXIT AND IN-STACK PLUME MEASUREMENTS: The programme of experiments and measurements will be conducted on larges modern Rolls-Royce Trent family development engines in the INTA test-cell facility. Long term engine measurements within the test-cell will: i) ensure variability associated with ambient conditions (temperature, pressure, humidity), ii) limit the potential effect of solar radiation on plume evolution, iii) alleviate the impact of cross wind conditions on plume advection. These new insights will provide a better understanding of the potential for in-stack measurements to be used future regulatory purposes.

WP3 ON-WING ENGINE EXIT AND DOWNSTREAM PLUME WITH APU MEASUREMENTS: To establish a better understanding of the evolution of pollutants in the exhaust plume of an aircraft during the LTO cycle, and the impact of climatic conditions (and potentially solar radiance), two distinct test programmes will be
conducted during different seasons (summer and winter). Testing will take place at: i) varying times (day and night), ii) different aircraft axial locations, iii) different engine power levels (LTO cycle) and APU modes. The influence of fuel composition on emissions will also be studied during an alternative drop-in fuel test.

WP4 AMBIENT MEASUREMENTS AND SENSOR NETWORK DEVELOPMENT: To characterize the pollution burden in and around the airports, transport and impact of emissions from aircraft engines and APU will be monitored in this more complex environment through: i) High-fidelity measurement of ambient air quality at Madrid Airport, ii) low-cost sensors nodes deployment at 3 airports (Madrid, Zurich and Copenhagen).

WP5 MATHEMATICAL AND NUMERICAL MODELLING OF PLUME MICROPHYSICS, CHEMISTRY AND DYNAMICS: A microphysics and chemical conversion of the plume evolution will be carried out in two phases: i) focus on examining the range of possible background parameter values and concentrations and ii) focus on the modelling on engine emissions. Physical dynamics of the hot and turbulent exhaust of aircraft main engines for different meteorological conditions will also be investigated.

WP6 NUMERICAL POLLUTANT MODELLING AND TRANSPORT IN AND AROUND AIRPORTS: Dispersion models will be initialized for Madrid and Zurich airports using the estimates and parameterizations developed in WP5 studies and the modelled concentrations of the key pollutants will be compared to those measured in the experimental campaigns at the airports.

WP7 REGULATIONS: Identification of potential gaps in aircraft engine emissions regulation, using technical evidence and the identification of pathways for bridging regulatory gaps.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 814801.

COMPOSITIONAL ANALYSES IN THE PM10 POTENTIALLY EMITTED FROM DIFFERENT TEXTURED SOILS OF ARGENTINA

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Keywords: Elements, PM10, Soils

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Less information is available on the elemental composition of the PM10 emitted by soils. Because of that we analyzed the contents of different elements in 9 different textured soils of Argentina and in the PM10 potentially emitted by them. PM10 of each soil was separated by means of an electrostatic precipitator coupled to a dust generator (Mendez et al., 2013). Elemental composition, excepting Si, was determined by plasma atomic emission spectrometry (ICP-OES Icap 6400 Thermo) after a $HCl/HNO_3/HF$ digestion. The composition variations of the studied soil samples and their respective PM10 were compared using perturbation vectors (Aitchison, 2005). Calculations were made using composition package in R software (van den Boogaart & Tolosa-Delgado, 2013). Compositional data are, by nature, difficult to handle straightforwardly. Each component does not vary independently from the others because the sum of all components, including those not measured, is equal to 100%. If this closure constraint is not taken into account, spurious correlations and biased conclusions are generally expected (Aitchison, 2005). Briefly, a transformation of the D variables (the elements) using log ratios of the concentrations built the suitable sample space of any compositional vector **x** with a D-1 dimension to get ride of the closure constraint**.** In this new space a compositional distance is defined and can be plotted as a classical distance (Aitchison 2005).

The biplot analysis is the two-dimensional projection of the compositional space using PCA. It shows that the chemical composition is systematically different between soils and aerosols. Aerosols are well separated from soils in the same direction (Zn or P on Sr or Ca ratios), except for PC (Pilcaniyeu) soil, and with about the same magnitude for LF (Los Frentones), AP (Abra Pampa), VM (Villa Mercedes), AN (Anguil), SR (Santa Rosa), AS (H. Ascasubi) and PA (Potrok Aike). Soils of these sites develop on aeolian Pleistocene or Holocene sediments, and differentiate from those of RM and PC, that develop on tertiary sediments. These last two parent soils do not exhibit a clear determinant contribution of any elemental ratio.

Compositional vector of a given soil can be compared to the compositional vector of its derived PM10 in a perturbation diagram (Fig. 1) showing the difference between PM10 and soil compositional vector for each element and without a PCA projection. The null perturbation (no difference between PM10 and soil) is represented as a blue dashed line.

According to this, Al, Ba, Ca, K and Sr appear to be depleted in the PM10 regarding soil, while Mn, P and Zn are enriched. Fe, Mg and Ti look similar between PM10 and soils.

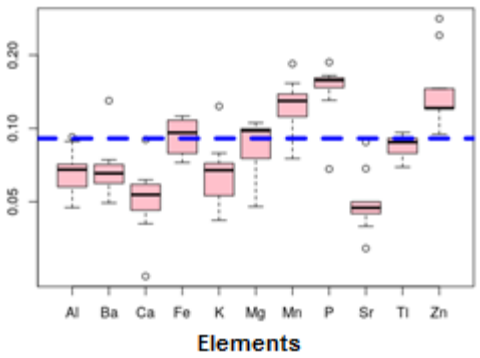

Fig. 1. Comparison of the contents of elements in the studied soils and PM10.

Aitchison, J. M. 2005. A Concise Guide to Compositional Data Analysis. 2nd Compositional Data Analysis Workshop, CoDaWork'05, Girona Universitat de Girona.

Mendez, M., Panebianco, J.E., Buschiazzo, D.E., 2013. A new dust generador for laboratory dust emission studies. Aeolian Res. 8, 59–64.

van den Boogaart K., G. and R. Tolosa-Delgado (2013), Analysing compositional data with R. Springer, ISBN 978-3.642-36808-0, 258 pp.

Exposure and Health

PM_{10} AND METAL CONTENT ASSOCIATED HEALTH RISKS IN THREE EUROPEAN CITIES

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Keywords: Particulate matter, metals, health risks, dose
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Air pollution can cause respiratory and cardiovascular diseases, thus, health impacts and the associated risk of the exposed subjects are necessary to investigate.

The objective of the current study is to estimate health risk indexes caused by the inhalation of PM by adult males and children using data sampled in three European cities (Athens, Kuopio, Lisbon). Accordingly, the cancer risk (CR) and the hazard quotient (HQ) were estimated from particle-bound metal concentrations whilst the epidemiology-based excess risk (ER), the attributable fraction (AF) and mortality cases were obtained due to exposure to PM_{10} and $PM_{2.5}$.

Cancer risks and hazard quotients were estimated using two methodologies: the first methodology (US EPA, 1989) incorporated the particle-bound metal concentration whereas the second methodology (Lyu et al., 2017) used the *deposited* dose *rate* of particle-bound metals in the human respiratory tract.

The cumulative HQ was lower than the limit of 1 in all examined cases except for Athens when the first methodology was used. Likewise, HQ for each metal was lower than the safe level ($HQ < 1$) for all cases involved and no significant toxic effect is expected. Additionally, using the first methodology to estimate the hazard quotient produced equal estimates for adults and children. On the contrary, using the second methodology higher estimates corresponded to children due to the higher deposition fraction.

Overall, the cumulative cancer risk for all under study (both methodologies) was lower than the acceptable level (10^{-4}), although individual CR for some metals exceeded the safe limit (10^{-6}). Using population data from the target cities we calculated the estimates of cancer cases, showing a total of approximately 74 cancers in a lifetime in Athens, 0.17 cancers in Kuopio and 217 cancers in Lisbon (Table 1). Cancer case estimates were dominated by Cr and Co.

Finally, excess risks for all-cause mortality estimated for each city showed that higher ER obtained for Lisbon (2.2%) (0.77 % Athens, 0.02 % Kuopio). Regarding the attributable fraction, the results indicated that 0.77 %, 0.02 % and 2.11 % of all-cause mortality could be avoided in Athens, Kuopio and Lisbon respectively if PM_{10} concentration was equal to the limit of 10 μg/m^3. Again, higher AF was obtained for Lisbon, a finding that was associated with higher PM concentrations measured in this city.

Table 1. Cancer cases per lifetime (70 years).

	Methodology 1 (US EPA)		
	Athens	Kuopio	Lisbon
As	12.2	0.020	1.5
Cd	-	0.003	-
Co	31.3	0.018	4.4
Cr	28.3	0.090	210.8
Ni	1.9	0.041	-
Cumulative	73.7	0.172	216.7

This work was supported by INDEX-AIR, Development of an Integrated Exposure-Dose Management Tool for the Reduction of Particulate Matter in Air. LIFE15 ENV/PT/000674. This work reflects only the authors' view and EASME is not responsible for any use that may be made of the information it contains.

Lyu Y., Zhang K., Chai F., Cheng T., Yang Q., Zheng Z., Li X. (2017). Atmospheric size-resolved trace elements in a city affected by non-ferrous metal smelting: Indications of respiratory deposition and health risk. Environ. Pollut. 224, 559-571.

US-EPA (1989). Risk Assessment Guidance for Superfund, Volume I: Human health evaluation manual (Part A). EPA/540/1-89/002. US Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, DC.

ASSESSMENT OF FOLIAR UPTAKE OF POLYAROMATIC HYDROCARBONS UNDER LABORATORY CONDITIONS

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Urban horticulture and community gardening have become more and more popular in the past years, as many people believe that homegrown vegetables may be more healthy and of controlled quality. Also, community building is a very important aspect.

However, it has been experimentally proven that the risk of bioaccumulation of atmospheric polycyclic aromatic hydrocarbons (PAHs) in vegetables grown in polluted areas cannot be neglected (e.g. Xiong et al., 2017). In our study, the No. 227 OECD GUIDELINE FOR THE TESTING OF CHEMICALS: Terrestrial Plant Test: Vegetative Vigour Test was followed to assess foliar uptake of PAHs from aqueous extract of urban aerosol.

Lettuce (*Lactuca sativa*) was selected as test organism, as it has been a very frequented test organism due to high foliar surface (e.g. Schreck et al., 2012) and also being a very popular vegetable in kitchen gardens.

Test plants were sprayed with the aqueous extract of winter urban aerosol sample. Plants received repeated treatments on Day1, Day8, and Day 15. The test was terminated on Day 22. A control was also set, where lettuce plants received foliar spraying with tap water on the same days.

PAH concentrations in the aerosol extract and in the leaves after harvest were measured by Agilent 6890GC 5973E MSD GC-MS. Alltogether 19 PAHs were found in the extract, including the 16 priority PAHs enlisted by US EPA. With the exception of dibenzo(a,h)anthracene, these PAHs were accumulated in the leaves. In the control, the concentration of all PAHs was under the detection limit.

In order to assess the bioaccumulation capacity of PAHs, bioconcentration factor (BCF) was calculated based on the equation: BCF = PAH concentration in the plant/PAH concentration in the sample (Kacálková and Tlustoš, 2011).

In general, significant accumulation was experienced. Highest bioconcentration factors BCFs were given for naphtalene (181.8) and for anthracene (186.4), pyrene and fluoranthene showed the lowest bioaccumulation potential (19.19 and 20.58, respectively).

Bioconcentration factor of each PAH showed strong correlation with molecular weight (Spearman's rank correlation: p= 0.0075, S= 1324.2, rho= -0.622852). In general, highly lipophilic PAH molecules (heavy PAHs) show lower accumulative potential than the less lipophilic ones (light PAHs).

The main conclusion can be that using the Guideline, accumulation studies can be carried out under laboratory conditions, clearly linking bioaccumulation with the composition of the sample. Also, bioaccumulation pattern of different PAHs can be assessed.

This work was supported by the BIONANO_GINOP-2.3.2-15-2016-00017.

Kacálková L. and Tlustoš P. (2011) The uptake of persistent organic pollutants by plants. *Cent. Eur. J. Biol.* 6(2), 223-235.

Schreck E., Bonnard R., Laplanche C., Leveque T., Foucault Y., Dumat C. (2012) DECA: A new model for assessing the foliar uptake of atmospheric lead by vegetation, using *Lactuca sativa* as an example. *J. Environ. Manage.* 112, 233-239.

Xiong G.N., Zhang, Y.H., Duan, Y.H., Cai, C.Y., Wang, X., Li, J.Y. et al. (2017) Uptake of PAHs by cabbage root and leaf in vegetable plots near a large coking manufacturer and associations with PAHs in cabbage core. *Environ. Sci. Pollut. Res.* 24,18953–18965.

IMPACT OF WOOD COMBUSTION IN FIREPLACES ON INDOOR AIR QUALITY

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In the last few decades, there has been a growing interest from international scientific community, policy makers, and environmental governances on indoor air quality (IAQ), particularly about the impact of the biomass burning in fireplaces. Especially in colder periods, this heating method is still widely used, and it is an important source air pollutant, both in outdoor and indoor environments [1]. Information is still very scarce about this subject, and since people spend 90 % of their time indoors [2], it makes sense to analyse what would be the impact of biomass burning in IAQ. There have been strong evidences that the exposure to emissions from biomass burning can lead to a wide range of health problems. Currently, 4.3 million people die annually from exposure to indoor air quality pollutants, most perish from stroke (34%), ischaemic heart disease (26%), pneumonia (12%) and lung cancer account for 6% of deaths, respectively. [3]

The purpose of this study is to assess the potential degradation of IAQ associated with biomass burning and the individuals' exposure to particulate matter (PM), namely PM10 and PM2.5, along with other parameters, such as particle number concentrations (PN0.01-1), black carbon (BC), carbon dioxide (CO_2) and carbon monoxide (CO). Levels of PM2.5 and PM10 were assessed also through filter sampling.

A series of experiments was performed to characterise the emissions from the combustion of four types of biofuel (*Eucalyptus globulus, Quercus ilex*, *Quercus suber* and *briquettes*) in a living room of a house, in a closed fireplace. The ignition phase was done with newspaper and pine cones, according to EPA's recommendations [4]. After analysis of the data collected, we can conclude that the particles are mostly concentrated in the fine fraction and the highest PM concentrations were recorded for *Quercus suber*. For the black carbon and for the carbon monoxide, the results were consistent with the PM, revealing peak values for *Quercus suber. Quercus suber* and *Quercus ilex* also stand out, with values exceeding the legal limit imposed by Ordinance 353-A/2013.

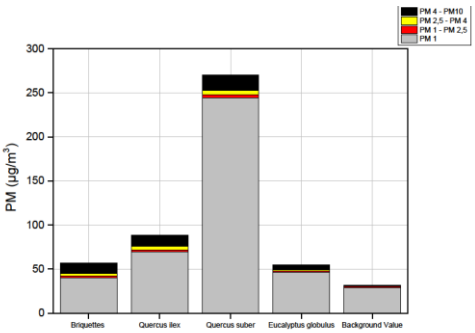

Figure 1 – PM concentrations measured during biomass burning in a closed fireplace

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[1] Environmental Protection Agency. Indoor Air Pollution and Health. (2007-2013).

[2] Klepeis, N. E., Nelson, W. C., Ott, W. R., Robinson, J. P., Tsang, A. M., Switzer, P. Engelmann, W. H. (2001). The National Human Activity Pattern Survey (NHAPS): A resource for assessing exposure to environmental pollutants. *Journal of Exposure Analysis and Environmental Epidemiology*.

[3] WHO, 2015. *Residential heating with wood and coal: health impacts and policy options in Europe, Word Health Organization.*

[4] U.S. EPA (2014) *Best wood burning practices* (http://www.epa.gov/burnwise/bestburn.html, 3/7/2019).

VEHICLE INTERIOR AIR QUALITY WHILE COMMUTING IN LISBON

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Keywords: airborne microbe, indoor, public transport, private cars
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Commuters spend about 5.5% of the daily time in-vehicle microenvironments (Xu, Chen, & Xiong, 2016). The vehicle cabin is susceptible to air contamination as outside pollutants can accumulate inside or the interior material can be a potential source of pollutants (Barnes, Ng, & Lai, 2018). Studies have concluded that short and long term exposure to air pollutants have a significant influence on respiratory infections, severe asthma and reduced lung function (Müller, Klingelhöfer, Uibel, & Groneberg, 2011). Drivers and passengers may be exposed to a variety of pollutants such as particulate matter (PM), black carbon (BC), volatile organic compounds (VOCs), carbon monoxide (CO), among others, than often do not meet air quality standards (Wong et al., 2018). Not only physicochemical pollutants are present, a few studies include the assessment of biological pollutants that may affect the health as well. This study aims to evaluate the interior air quality while commuting in cars, buses and trains in Lisbon to contribute to assess the effects that may cause on human health.

For each vehicle type a different route was selected. Three and 18 commutes were sampled in public transports and cars. A more detailed study was made in cars, evaluating three different ventilation conditions: Fan Off, Fan on and with Air conditioning (AC) allowing the entrance of fresh air. PM with diameter lower than 1, 2.5 and 10 µm and BC were measured at 10 seconds intervals from the start to the end of the journey. The Dusttrak DRX Aerosol Monitor 8533 and a MicroAeth® AE51 were used to measure PM and BC respectively. Total airborne bacteria and fungi were estimated at the beginning, middle and end of the journey via impaction of 250 L of air in Tryptic Soy Agar (bacteria) and Malt Extract Agar (fungi) petri dishes using the MAS-100® Microbial Air Monitoring (100 L/min).

In cars the ventilation mode affected the concentrations of bioaerosols (Fig 1). The bacterial and fungal loads were almost 8 and 2 times higher when the ventilation was off. Compared to the public transports, there was a higher airborne microbe load since the occupancy is much higher than cars.

It was possible to observe a prevalence of fine particles in all cases (PM < 1µm). However, when the ventilation in cars changed to Fan On or AC, coarser particles decrease almost 5 times, but the finest remained unchanged (Fig 2). There is higher portion of coarse particles in public transports due the opening and closing of doors. In terms of BC, there is a particular effect of the ventilation on the concentrations of this pollutant; it is 2 times higher when the ventilation is on than with the Fan Off. BC is higher in buses than trains.

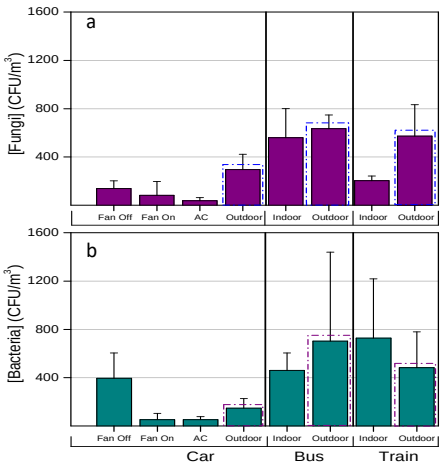

Fig 1. Fungal (a) and bacterial (b) loads (CFU/m³) in vehicles cabin and outdoors.

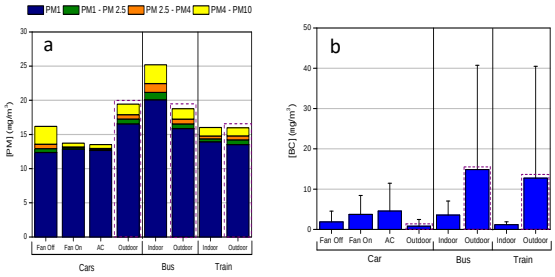

Fig 2. a) PM and b) BC concentrations in vehicles cabin

This work was supported by LIFE Index-Air project (LIFE15 ENV/PT/000674). This work reflects only the authors' view.

Barnes, N. M., Ng, T. W., & Lai, K. M. (2018). In-Cabin Air Quality during Driving and Engine Idling in Air-Conditioned Private Vehicles in Hong Kong. *International Journal of Environmental Research and Public Health*, *15*(4), 611. https://doi.org/10.3390/ijerph15040611

Müller, D., Klingelhöfer, D., Uibel, S., & Groneberg, D. A. (2011). Car indoor air pollution - Analysis of potential sources. *Journal of Occupational Medicine and Toxicology*, *6*(1), 33. https://doi.org/10.1186/1745-6673-6-33

Wong, L. P., Alias, H., Aghamohammadi, N., Sulaiman, N. M. N., Lin, H., & Zhao, J. (2018). Commuting on Public Transport: Health Risks and Responses. In J. Del Real Olvera (Ed.), *Air Pollution - Monitoring, Quantification and Removal of Gases and Particles* (pp. 35–53). IntechOpen. https://doi.org/http://dx.doi.org/10.5772/intechopen.79694

Xu, B., Chen, X., & Xiong, J. (2016). Air quality inside motor vehicles ' cabins : A review. *Indoor and Built Environment*, *27*(4), 452–465. https://doi.org/10.1177/1420326X16679217

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HEALTH RISK ASSESSMENT OF PARTICLE-BOUND POLYCYCLIC AROMATIC HYDROCARBONS AT AN URBAN BACKGROUND SITE IN LISBON, PORTUGAL

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Polycyclic aromatic hydrocarbons (PAHs) are a class of organic compounds containing two or more fused aromatic rings that are primarily formed and released to the atmosphere during the incomplete combustion of carbon-based fuels. Emitting sources are largely anthropogenic and include vehicle exhaust, domestic heating, power generation, oil refining, waste incineration, forest fires and agricultural waste burning.

The aim of this study was to characterize the levels of PM_{10}-bound PAHs and the associated health risks in an urban background atmosphere of Lisbon metropolitan area.

Sampling was performed at the air quality reference station of the Portuguese Environment Agency (38˚ 44' 21''N; 9˚ 12' 18'' W), which is located in Alfragide, at the outskirts of Amadora, an urbanized municipality in the northwest of Lisbon metropolitan area. Two to five 24 h aerosol samples were collected per month from early January 2012 to the end of December 2012. Aerosol particles were concentrated on pre-baked quartz fiber filters with a high volume sampler equipped with a PM_{10} size selective inlet and operated at a flow rate of 1.13 m^3/min. PAHs were extracted from filters, concentrated and then analyzed by high-performance liquid chromatography with coupled fluorescence and ultraviolet/diode array detection. 10 PAHs were determined in the 45 aerosol samples collected during the study period: fluoranthene (Flt), pyrene (Pyr), benzo(a)anthracene (BaA), chrysene (Chr), benzo(b)fluoranthene (BbF), benzo(k)fluoranthene (BkF), benzo(a)pyrene (BaP), dibenzo(a,h)anthracene (DBahA), benzo(g,h,i)perylene (BghiP) and indeno(1,2,3-c,d)pyrene (InP).

The carcinogenic potential of the PAHs mixed in the aerosol samples was assessed with the toxic equivalency factor (TEF) approach, a method that assigns relative toxicity values to each individual congener in a mixture of structurally similar compounds, sharing a common toxic mechanism, in comparison to the toxicity value of a reference chemical (usually BaP). The BaP toxic equivalent concentration (BaP_{TEQ}), which is a measure of the overall carcinogenic potential of the PAHs mixture, was calculated by multiplying the concentration of each individual congener by the respective TEF value and by summing the resulting concentrations.

The carcinogenic risk, which is defined as the probability of an individual developing any type of cancer from lifetime exposure to PAHs, was estimated according to the USEPA (2009) guidelines.

The annual average of the ΣPAHs was 1.64±1.85 ng/m^3. A marked seasonal variation was observed, with the highest concentrations in winter and the lowest in spring and summer.

The annual average BaP_{TEQ} was 0.185±0.232 ng/m^3, and the main contributor to the total carcinogenic activity of the PAHs mixture was BaP (57.8%), followed by BbF (13.0%), InP (8.6%) and BaA (7.2%). BaP_{TEQ} values calculated in this study were significantly lower than those reported before in densely populated regions.

Average carcinogenic risk estimates for the individually investigated PAHs were in the range of 1.5×10^{-10} to 6.2×10^{-8} (minimum and maximum obtained for Chr and BaP, respectively). An average value of 1.0×10^{-7} was calculated for the cumulative carcinogenic risk of the PAHs congeners. These values were lower than the health-based guideline of 1×10^{-6} set by the USEPA (2009), pointing to a negligible risk of developing cancer due to inhalation of particle-bound PAHs.

USEPA (2009) Risk Assessment Guidance for Superfund. Volume 1: Human Health Evaluation Manual (Part F). EPA-540-R-070-002. Office of Superfund Remediation and Technology Innovation. United States Environmental Protection Agency, Washington DC, USA.

DOMAINS OF AIR POLLUTION HEALTH IMPACT ASSESSMENT IN THE LIFE INDEX-AIR PROJECT

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Keywords: fine particles, health impact assessment, exposure
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Introduction. The aim of health impact assessment (HIA) is to quantify changes in health due to non-health sector policies (WHO, 2019). EU LIFE Index-Air project has developed a tool to quantify health effects of particulate matter air pollution and to evaluate a versatile set of policies at city level. The tool is demonstrated for five European cities with diverse climate conditions and affected by different emission sources. The tool covers multiple dimensions discussed in this paper.

Aerosol composition domain consists of particle-bound chemicals

Aerosol properties domain particle sizes affect both the behaviour of the particles in the atmosphere, and their penetration to indoor spaces as well as their uptake in the respiratory tract. Aerosol composition affects volatility, solubility and toxicity.

Exposure domain covers processes from emissions to concentrations in various environments including indoors. Individual time-activity and mobility lead to changes in the exposure concentrations and in the intake and uptake. Finally, the cumulative retained dose affects the health effects at different time scales.

Temporal domain covers variations in the air quality and population time activity from hourly, daily and weekly scales to seasonal and annual patterns.

Spatial domain describes variability of outdoor air concentrations. By locating individuals, schools and population groups on the spatial domain allows for estimating respective exposures.

Population domain characterizes people from individuals to school classes, schools, school and city districts, cities, and even provinces and nations. Exposures can be expressed in individual or group level.

Health domain covers the various endpoints affected by air pollution. In this work we also consider secondary effects of illness, such as school absenteeism, further potentially leading to tertiary effects like losses in academic performance.

Measures domain to consider different policies, actions or measures to reduce emissions and exposures.

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AIR POLLUTION EXPOSURE AND SCHOOL ABSENTEEISM

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Children are more vulnerable to air pollution exposure due to their developing respiratory system and, higher exposure per body mass. However, health impacts of air pollution on children are not well-captured by disease burden methods. Such burden does not cover less severe outcomes

We aim to develop a more sensitive method to quantify impacts of fine particle (PM2.5) exposures on school children in five European cities. Specifically, we look at attributable (i) sick days at school; (ii) school absenteeism, and (iii) doctor visits and hospitalizations; at a local level using refined exposures accounting for the school days and commuting.

Methods. Upper respiratory infections were chosen as a health endpoint. We divided sick days into three categories: days with mild, medium and severe symptoms based on WHO's reported disability weights (table 1). Duration of the condition was based on expert judgement. Sick days with medium and severe symptoms were assumed to lead to absenteeism on school days.

Table 1. Disability weights (DW) for infectious diseases (WHO, 2017) and an average duration of the condition in days per year (expert judgement).

Health state	DW (%)	Duration (d)
Mild	0.60	5
Moderate	5.1	6
Severe	13	0.05

We use national level WHO burden of disease data for 2015 scaled for cities with age adjustment (eq. 1)

$$DBcity = \frac{f_{city}^{age}}{f_{nat}^{age}} \times \frac{Ncity}{Nnat} \times DBnat \quad (1)$$

Sick days were divided into school days based on number of school days per year (OECD 2018). Fraction of school days from whole year varied from 48 % (Greece) to 55 % (Italy).

The fraction of sick days attributable to PM2.5 exposure were estimated using population attributable fraction (eq. 2):

$$\mathrm{PAF} = \frac{\mathrm{f} \times (\exp(\mathrm{E} \times \ln(\mathrm{RR}')) - 1)}{\mathrm{f} \times (\exp(\mathrm{E} \times \ln(\mathrm{RR}')) - 1) + 1} \quad (2)$$

in which f is the percentage of the exposed population in the whole target population, E is exposure and RR' is the relative risk per unit exposure (1.0038 per 10 µg/m3 PM2.5, Li et al., 2018).

Results. The developed model for sick days allows for efficient and concrete risk characterization also between air quality management measures and meaningful communication with the public. We developed a method which allows moving from burden of disease based estimates into sick days, and school absenteeism, which could be further connected with difficulties in learning, and academic performance.

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Li, Y., Xiao, C., Li, J., Tang, J., Geng, X., Cui, L., & Zhai, J. (2018). Association between air pollution and upper respiratory tract infection in hospital outpatients aged 0–14 years in Hefei, Chin. Public health, 156, 92-100.

OECD (2018), Education at a Glance 2018: OECD Indicators, OECD Publishing, Paris, https://doi.org/10.1787/eag-2018-en. (Accessed 25 February 2019).

WHO (2017) WHO methods and data sources for global burden of disease estimates 2000-2015. GHE Technical Paper WHO/HIS/IER/GHE/2017.1. https://www.who.int/healthinfo/global_burden_disease/GlobalDALYmethods_2000_2015.pdf (Accessed 28.2.2019)

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OUTDOOR PM2.5 LEVELS AT HOME AND SCHOOL LOCATIONS IN THE LIFE INDEX-AIR TARGET CITIES

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Keywords: fine particles, exposure, school, home
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Fine particle ($PM_{2.5}$) exposures at schools vary by location. Pupils at schools that are situated for example near to the busy roads are exposed to higher concentrations while in rural areas exposures can be considerably lower. Differences can also be found in exposures between homes and schools. The aim of this work is to characterize population weighted $PM_{2.5}$ outdoor concentration variability at home and school locations in the LIFE Index-Air target cities in 2015.

Materials. Annual population-weighted $PM_{2.5}$ outdoor concentrations (PWC) for home and school locations were calculated according to eq. (1.

(1) $$PWC = \frac{\sum_{i=1}^{N} C_{m,i} P_i}{\sum_{i=1}^{N} P_i}$$

where N is the number of population in each grid cell, $C_{m,i}$ is the modelled concentration in i^{th} cell and P_i is the population in i^{th} cell. Fine particle concentrations were modelled in the scope of the LIFE Index-Air project (LIFE Index-air 2017) at 0.01° longitudinal and latitudinal resolution. Geostat 2011 population grid data by subsection, disaggregated to 1x1 km^2 resolution (Eurostat 2019), was used as home locations as well as weights for the corresponding concentrations. The $PM_{2.5}$ grid concentrations corresponding to schools and the number of pupils were used to calculate population-weighted concentration of schools (Table 1).

Table 1. Population in modelling domains, and schools and pupils.

	Grid cells w/pop. (n)	Pop. ('000)	Schools (n)	Pupils ('000)
Athens	1 003	3 300	n/a	n/a
Kuopio	189	84	24	11
Lisbon	1 264	2 300	242	81
Porto	876	1 200	128	36
Treviso	1 329	880	n/a	n/a

Note: '000: numbers are in thousands.

Annual time spent at home and school was taken into account when calculating average concentrations.

Results. Population-weighted concentrations at schools were 20 % higher in Lisbon when compared to homes (Figure 4). In Porto weighted concentrations at schools were 10 % and in Kuopio only 2 % higher. Average concentrations were only slightly higher (0.2-3.4%) when compared to home locations. Population-weighted concentrations at homes were highest in Athens and Treviso.

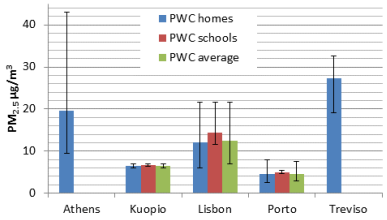

Figure 4. Population-weighted annual mean concentrations of $PM_{2.5}$ with min. and max. values at home and school locations in 2015. School locations yet missing for Athens and Treviso.

Values here presented were computed based on annual outdoor concentrations. School location concentrations were compared to total population averaged concentrations in the modelling domains. With combination of time-activity data of school children, concentration data with higher temporal resolution (1h), and population data with age distributions, $PM_{2.5}$ exposures of school children will be assessed more accurately.

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Eurostat. 2019. "GEOSTAT 2011 Population Grid." https://ec.europa.eu/eurostat/web/gisco/geodata/reference-data/population-distribution-demography/geostat (February 27, 2019).

LIFE Index-air. 2017. Technical Report on Setup of the Air Modelling System. Deliverable B3.1. http://www.lifeindexair.net/sitelifeindexair/wp-content/uploads/2018/03/Annex-B3-1-Technical-Report-on-Setup-of-the-Air-Modelling-System.pdf.

INHALATION BIOACCESSIBILITY ESTIMATION OF POLYCYCLIC AROMATIC HYDROCARBONS IN PARTICULATE MATTER (PM10)

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Keywords: inhalation bio-accessibility, risk assessment, toxicity prediction, polycyclic aromatic hydrocarbons
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Inhalation of pollutants in particulate matter (PM) represents a significant exposure pathway to humans. Target values of pollutants, pollution reduction policy and conclusions derived from the applications of these guidelines are currently based on the total pollutant content in PM. However, the knowledge of total pollutant content in PM provides an overestimation of the contaminants toxicity. A real evaluation of the risk to human health associated to pollutants in PM involves the knowledge of the harmful substances concentrations, which once inhaled are assimilated (bio-accessible/bioavailable fraction) by the people exposed. Bio-accessibility / bioavailability based approaches may more accurately quantify human health-risk exposure to contaminants in PM (Wei et al., 2018).

In this research an *in-vitro* testing to assess the inhalation bio-accessibility of polycyclic aromatic hydrocarbons (PAHs) in PM10 samples (collected at A Coruña city, northwest coast of Spain) was developed combining simulated pulmonary fluids (Gamble's solution) and physiologically based extraction conditions.

PAHs bio-accessibility average percentages were found in the range of 10 to 60%.

Several hazard indexes (average daily intake (EDI), hazard quotient (HQ) and hazard index (HI)) have been used to exposure assessment using bio-accessible concentrations.

Chemical composition (major constituents) of PM can alter the bio-accessibility of PAHs. The influence of chemical composition (major ions, metals, carboxylic acids and black carbon (BC)) on bio-accessibility ratios of PAHs was also assessed.

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Wei W., Bonvallot N., Gustafsson A., Raffy G., Glorennec P., Krais A., Ramalho O., Le Bot B., Mandin C, (2018) Bioaccessibility and bioavailability of environmental semi-volatile organic compounds via inhalation: A review of methods and models. Environment International, 113, 202–213.

BIOAVAILABILITY OF POLYCYCLIC AROMATIC HYDROCARBONS IN PM10 VIA GASTROINTESTINAL TRACT

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Keywords: oral bioavailability, risk assessment, polycyclic aromatic hydrocarbons, PM10
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After air inhalation during breathing, suspended particles in air are deposited in the lung throughout several mechanisms, which are depending on the particle sizes. Following deposition, clearance of particles deposited in the respiratory system may occur via absorption of the dissolved fraction via blood (inhalation bioavailability), transport to lymph nodes or transport to the gastrointestinal tract (oral bioavailability) (Kastury et al., 2017).

In the context of human health-risk assessment, oral bioavailability refers to the fraction of pollutant that diffuse across the gastrointestinal tract and reach the systemic circulation (blood). A first step in assessment of oral bioavailability is the study of the oral bio-accessibility, which indicates the maximum fraction of a substance that is theoretically released from particulate matter in the gastrointestinal tract (bio-accessible fraction), and thus becomes available (i.e. enters the blood stream) (Ruby et al., 1999).

The main aim of this research is the development of a novel *in-vitro* testing to assess the oral bioavailability of polycyclic aromatic hydrocarbons (PAHs) in PM10 samples, and the accurately toxicity prediction of PAHs in PM10 using bioavailable concentrations.

In-vitro oral bioavailability test involves the use of pepsin solution for simulated gastric digestion (37 ºC, 150 rpm, 120 min) and pancreatin / bile salts solution for simulated intestinal digestion (37 ºC, 150 rpm, 120 min). During simulated intestinal igestion, a dialysis membrane of 10 kDa MWCO filled PIPES (1,4-Piperazinediethanesulfonic acid sodium salt) solution (pH 7.5) was used to simulates cell walls of the intestine.

Low oral bioavailability ratios (< 5%) were found in several in PM10 samples collected at A Coruña city (northwest coast of Spain). Oral bioavailability concentrations of PAHs were used to exposure assessment.

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Kastury F. (2017) A critical review of approaches and limitations of inhalation bioavailability and bioaccessibility of metal(loid)s from ambient particulate matter or dust. Science of the Total Environment, 574, 1054-1074.

Ruby M.V. (1999) Advances in evaluating the oral bioavailability of inorganics in soil for use in human health risk assessment. Environmental Science and Technology, 33, 3697-3705