

# EuNetAir Newsletter

COST Action TD1105 Iss. 7/Dec 2015

## Editorial

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This seventh issue of **Newsletter** covers the Action grant period July-December 2015 to disseminate the networking activities and current research results in environmental science and technology from COST Action TD1105 ([www.cost.eunetair.it](http://www.cost.eunetair.it)) European Network on New Sensing Technologies for Air-Pollution Control and Environmental Sustainability - EuNetAir, edited half-yearly in the next four years (2012-2016) by an Editorial Board, chaired by Prof. Ralf Moos (University of Bayreuth, DE) with Editorial Board Manager by Dr. Daniela Schönauer-Kamin (University of Bayreuth, DE).

The excellent teams of over 200 involved international experts such as scientists, researchers, technologists, modelers, SMEs managers from 31 COST Countries, 4 International Partner Countries (IPCs) and 3 Near Neighbor Countries (NNC) are working hard to contribute to the objectives and workplan of COST Action TD1105 in the air quality monitoring including environmental technologies, nanomaterials, gas sensors, smart systems, air-pollution modelling, measurements, methods, standards and protocols.

The concerted COST Action TD1105 is very pleased to present the networking/dissemination results of the national/international research from Action partnership to various international conferences/workshops such as **EUROSENSORS 2015** (6-9 September 2015, Freiburg, Germany) with a COST Session focused on **New Sensing Technologies for Air Pollution Detection: Trends and Challenges**; and a Special Session devoted to European Sensor Systems Cluster (ESSC) with the participation of the Steering Committee and EC Officer as Observer of the ESSC to plan roadmapping activities in the sensor-systems.

Furthermore, Action has held a **WG1-WG4 Meeting on Air Quality Monitoring and Calibration: Horizons in Sensing Technologies, Methods and Modelling** (13-14 October 2015, Belgrade, Serbia) with a special

focus on 2nd EuNetAir Air-Quality Joint-Exercise Intercomparison Sensors-versus-Analyzers in the context of the smart cities and citizens observatories with large participation joined to WeBIOPATR 2015 conference.

Also, COST Action TD1105 managed the **Fifth Scientific Meeting** based on Working Groups and Management Committee Meeting focused on **New Sensing Technologies for Indoor Air-Pollution Monitoring and Environmental Measurements** at the Bulgarian Academy of Sciences in Sofia (16-18 December 2015, Sofia, Bulgaria). This EuNetAir event is expected to be attended by at least 50 world-class experts.

Currently, EuNetAir has planned to financially support at least 9 Short Term Scientific Missions (STSMs) in the period Year 4 (1 July 2015 - 30 April 2016) for visit and exchange of motivated Early Stage Researchers and experienced scientists from a laboratory to another one in order to start and consolidate new international research collaborations in the whole area of EuNetAir topics for fruitful networking in S&T cooperation. The Action MC invites ESRs to use this efficient tool for starting collaborations in the international networking.

The COST Association approved the **extension of the Action TD1105 (EuNetAir) until 15 NOVEMBER 2016**, as approved by COST Steering Committee in October 2015.

On behalf of Action Management Committee, I would like to thank ALL Action participants for their valuable scientific work, kind availability and great enthusiasm that will make our Action very successful as an excellent S&T platform to address in collaborative research teams the challenges of Horizon 2020!

Michele Penza, COST Action TD1105 Chair,  
ENEA, Brindisi, Italy,  
November 2015  
[michele.penza@enea.it](mailto:michele.penza@enea.it)



## Focus On

## Focus On

## EuNetAir selected as a COST Action Top-Story

M. Penza, Action Chair, ENEA, Italy

On behalf of the Management Committee, we are very proud to announce that our COST Action TD1105 EuNetAir - European Network on New Sensing Technologies for Air Pollution Control and Environmental Sustainability - has been selected in July 2015 by COST association as a TOP-STORY.

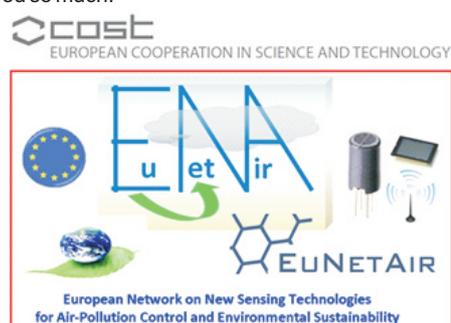
EuNetAir is considered a success-story of international networking by COST top-management with the involvement of a large number of SMEs, spin-offs, agencies and academia/research. On July 2015, EuNetAir involved more than 120 organizations and 200 experts from 31 COST countries and 7 Non-COST countries. Spin-out activities from COST networking as FP7 projects and H2020 proposals have been carried out successfully by joint-initiatives.

You can visit the official webpages of the COST Association at the link:

[http://www.cost.eu/media/cost\\_stories/EuNetAir](http://www.cost.eu/media/cost_stories/EuNetAir)

This is an excellent team work result and international cooperation of all of us!

Thank you so much!



## Special Sessions EuNetAir and ESSC at EUROSENSORS XXIX

A. Schütze, WG2 Leader &amp; ESSC WG IQ Leader, Saarland University, Germany

Many EuNetAir members participated at EUROSENSORS 2015, the XXIX edition of the conference series, held in Freiburg, Germany, from September 6 to 9, 2015. In addition to presentations in the general conference programme, EuNetAir also presented a special session with talks covering the wide spectrum of EuNetAir activities from sensor materials to integrated sensor systems for environmental monitoring. Michele Penza, EuNetAir chairman, first provided an overview and future plans of the Action. Then, Michel Gerboles from JRC Ispra presented the "Performance evaluation of amperometric sensors for the monitoring of O<sub>3</sub> and NO<sub>2</sub> in ambient air at ppb level" which proved that indeed low cost sensors can provide valuable insights and can complement existing high-cost measurement stations, but that further research especially concerning selectivity and long-term stability is needed. Albert Romano-Rodriguez, University of Barcelona, gave an inspiring overview on trends and challenges for low-cost fabrication of zero-power metal oxide nanowire gas sensors. Danick Briand, EPFL, presented their work towards disposable sensing platforms and analytical instruments for air quality monitoring. Both talks clearly showed that materials and novel sensor methods are still a very active and promising research field which promises to expand the range of sensor use as we know today. Anita Lloyd Spetz, vice-chair of EuNetAir, representing

both Linköping and Oulu University, gave a talk on a new packaging approach for toxic gas and particle detection based on LTCC, which extends the application spectrum to harsh environments and also might provide a basis for low cost particle sensors, an important aspect of air quality that is too often overlooked. Finally, Andreas Schütze, Saarland University, focussed on integrated sensor systems for indoor applications providing ubiquitous monitoring for improved health, comfort and safety. This talk, with results from EU projects VOC-IDS and SENSIndoor, stressed the fact that sensor systems require also sampling, optimized operation and data analysis to solve application requirements.

The picture shows Anita Lloyd Spetz and Alexey Vasiliev in intensive discussion during the EUROSENSORS poster session.



## Focus On

The steering committee of the European Sensor System Cluster (ESSC) also met during EUROSENSORS 2015 to discuss next steps and to present the cluster, its goals and activities to the conference participants. During the ESSC session on September 9, Dr. Hans-Hartmann Pedersen, EC Research Programme Officer in the field NMP, gave an overview on opportunities for sensor and sensor system R&D in the Horizon 2020 Research and Innovation Programme and also addressed clustering as a means to increase impact of R&D, with a special view towards the ESSC. He made clear that the European Commission expects concrete input and suggestions for future calls and that the sensor community can provide that input through the ESSC. However, he also emphasized the fact that H2020 projects have to be outcome oriented, i.e. they have to address societal needs and challenges. For the ESSC, Michele Penza, ENEA, Rudolf Frycek, Amires, and Andreas Schütze, Saarland University, presented vision and objectives, the governance and the roadmap

currently being prepared by the ESSC in an open process inviting participation by all interested members from the sensor community. The focus of the ESSC is in chemical sensor technologies to address the key areas of human health and comfort as well as environmental sustainability including monitoring of air (indoor and outdoor) and water as well as agricultural and industrial processes. All EuNetAir partners are invited to contribute to the ESSC and especially to the roadmap currently being prepared.



Andreas Schütze presents the roadmapping activity to address the key areas with impact on every human during the ESSC session at EUROSENSORS 2015.

## Selective Monitoring of Monoaromatic Hydrocarbons in Air: the challenge of ASTHMAA project

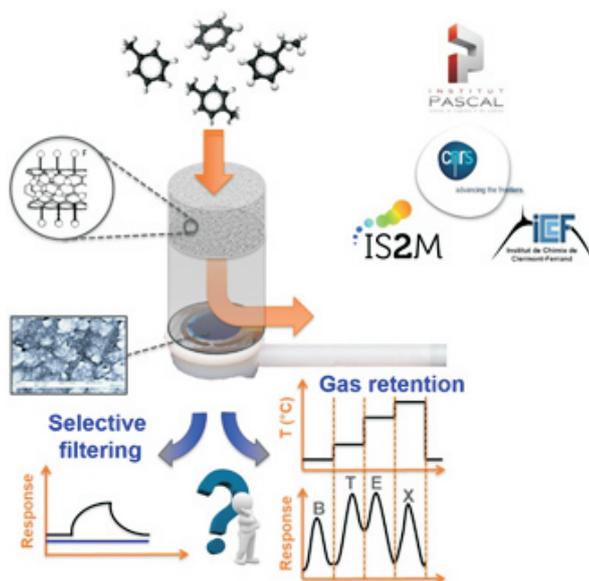
J. Brunet, MC Member; A.L. Ndiaye, A. Pauly, Blaise Pascal University, France

The hazardous impacts of atmospheric pollutants on human health are now well-established by many international health agencies. This is especially factual for benzene and ethylbenzene considered respectively as definitely and potentially carcinogenic by the International Agency for Research on Cancer (IARC).

Establishing a causal link between these pollutants and pathologies previously requires the accurate monitoring of the personal exposure of each individual. To address these issues, portable sensor-systems are highly relevant.

With the financial support of the French National Center for Scientific Research (CNRS), the ASTHMAA project that we coordinate aims to develop sensitive and selective sensor-systems for discriminated measurements of BTEX in air. The sensing element is a QCM coated with tetra-tert-butyl metallophthalocyanine. It exhibits high sensitivity, low detection thresholds (sub-ppm), high repeatability, and partial selectivity toward BTEX compounds. The discrimination of each aromatic hydrocarbon will be performed by air sample treatment through mesoporous nanocarbons implemented upstream the sensor. Their suitability as selective chemical filter or as gas retention matrix will be evaluated. In this second option, the release of each monoaromatic hydrocarbon can be sequentially performed by controlled thermal desorption before being quantified by the sensor. To benefit from low temperatures of desorption, fluorinated mesoporous carbons are investigated.

The results of this exploratory project coordinated by electronic researchers from the Institut Pascal of Clermont-Ferrand and in collaboration with chemists from Clermont-Ferrand (ICCF) and Mulhouse (IS2M) will be given soon during future meetings of the EuNetAir COST Action.



## Focus On

## Challenges of an air quality and noise sensor network on a maritime port

C. Borrego, A. M. Costa, J. Ginja, C. Ribeiro, M. Coutinho, IDAD, Portugal

Cargo movement, in particular of dry bulk, and also the movement of ships and road vehicles are the main port activities with possible impact on air quality through the emission of atmospheric pollutants. Air quality monitoring is therefore a decisive tool in the management process of air quality in ports, allowing direct intervention in the



functioning of the main sources operating at the port.

The impact of both air quality and noise are particularly relevant in ports situated adjacent to urban areas, being the most common cause of complaints from neighbouring residents.

Results of air quality and noise monitoring performed with a conventional monitoring approach show the importance to conduct a more detailed assessment within the port vicinity where sensible receptors are located, in order to capture the impacts of the whole ports activity. To achieve this goal, a new air quality monitoring strategy is being studied in Portuguese ports to include a wide network of air quality and noise sensors in the port area, allowing for real-time monitoring a large number of locations. This network will be integrated in the smart management interface of Port authorities, crossing information with the type of vessels and cargoes and enabling real-time alerts and the adoption of effective prevention and mitigation procedures.

The figure illustrates the atmospheric emissions from a ship on a maritime port.

## Air Quality Sensors Network developed by Italian national project RES-NOVAE

M. Penza, Action Chair, ENEA, Italy

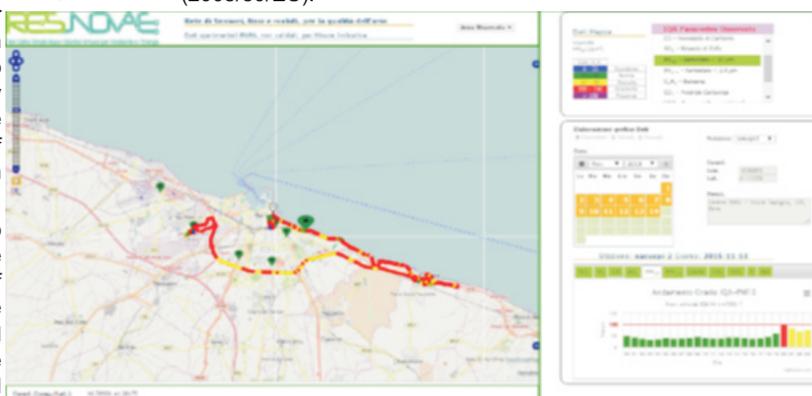
The Italian national project RES-NOVAE - Networks Buildings Streets: New Challenging Objectives for Environment and Energy - funded by Italian Ministry of University, Research and High Schools (MIUR) in the framework of PON Research & Competitiveness Smart Cities, developed and demonstrated an integrated system of new technologies for sustainable development in the green cities (Bari and Cosenza, Italy) to improve environmental sustainability and carbon footprint and to enhance energy efficiency at level of network of buildings, smart district and urban control center.

The final goal of RES-NOVAE is to implement a trust of best available technologies to improve the quality of life of citizens and support the decisions of the policy-makers and city managers in order to plan the urban development with reduced greenhouse gases emissions.

A sensors network, designed and operated by ENEA, based on 10 nodes (9 stationary and 1 mobile on public bus), for air quality monitoring has been deployed in the city of Bari for a long-term experimental campaign since June-2015. Each multiparametric sensor node is composed by at least 9 sensing elements ( $\text{NO}_2$ ,  $\text{O}_3$ ,  $\text{CO}$ ,  $\text{SO}_2$ ,  $\text{PM}_{10}$ ,  $\text{tVOCs}$ ,  $\text{CO}_2$ ,  $T$ ,  $\text{RH}$ ) including data acquisition system and mother board (Raspberry Pi), GPS, GSM modem with standard functionalities of wireless data transmission

towards a base station.

Mapping of the targeted air pollutants, expressed as individual Air Quality Index (AQI), has been automatically implemented using sensors data and compared to the referenced data of the city air monitoring stations in order to address the Indicative Measurements of the Ambient Air Quality EU Directive and Cleaner Air for Europe (2008/50/EC).



A typical map of AQI using the sensor network data from the stationary nodes (e.g., airport, port, city office, factories, university, etc.) and mobile node (mounted on city public bus) for air monitoring in the city of Bari (Italy) is shown in the Figure.

The RES-NOVAE Consortium has been led by ENEA with partners such as large companies (ENEL, project manager, IBM, GE), small companies (Asperience, Tera), academia (Technical University of Bari, University of Calabria) and research (CNR, ENEA). A strong support from Municipalities of Bari and Cosenza has been received as public end-user of the final output (products and services) of the national project.

News from  
Working  
Groups

## WG 2 - Sensors, Devices and Systems for AQC

A. Schütze, WG2 leader &amp; ESSC WG IQ Leader, Saarland University, Germany

During the last EuNetAir WG2 meeting during the project meeting at Linköping University, several interesting presentations were given regarding devices and systems. Most notably, probably, was the impressive presentation of Jean-Moïse Suisse, Université de Bourgogne, Dijon, France, on the importance of inter-laboratory reproducibility tests for chemical sensors and systems. He reported on large differences observed for the same sensor measured in two different facilities even though the test gas compositions were nominally the same. This proves the importance of checking the performance of the gas test equipment regularly, e.g. by reference sensors or by sampling and subsequent GC-MS analysis, which is, however, not universally applicable. Other presentations touched on functionalized carbon nanotube sensors (Eduard Llobet, Universitat Rovira i Virgili, Tarragona, Spain), additive technologies for ceramic MEMS gas sensors (Alexey Vasiliev, NRC Kurchatov Institute, Moscow, Russia), new theories for QCM and SAW devices in sensing (Marina Voinova, Chalmers University of Technology, Gothenburg, Sweden) and finally measurement of monoaromatic hydrocarbons by phthalocyanine-based QCM sensors. In the latter presentation, Jerome Brunet, Université Blaise

Pascal, Aubiere, France, also presented the new exploratory project ASTHMAA using selected filter with time programmed desorption to increase sensitivity and selectivity.

This latter aspect is also addressed within the SENSIndoor project, in which several EuNetAir members collaborate. The partners have recently presented a novel concept for a low-cost gas sensor system with integrated pre-concentration to boost sensitivity and selectivity of gas sensor systems (A. Schütze et al.: A novel low-cost pre-concentrator concept to boost sensitivity and selectivity of gas sensor systems, Proceedings IEEE Sensors 2015, Busan, South Korea, Nov. 1 - 4, 2015, ISBN: 978-1-4799-8202-8, pp. 735-738). At this conference, a second joint topic was presented by EuNetAir partners Saarland University and Université de Bourgogne, which is the direct result of two STSMs supported by EuNetAir: in a late news poster and short paper the optical excitation of MSDI sensors was presented for the first time. This approach allows an increase in selectivity to measure ammonia under changing relative humidity (M. Schüler et al.: Selective quantification of humidity and ammonia by optical excitation of molecular semiconductor - doped insulator (MSDI) sensors, Proceedings IEEE Sensors 2015, Busan, South Korea, Nov. 1 - 4, 2015, ISBN: 978-1-4799-8202-8, pp. 914-917).

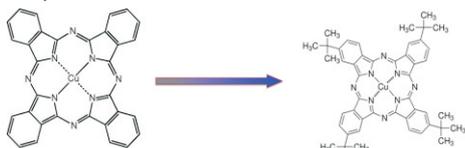
Novel sensor devices and systems as well as their testing also played a major role at the EuNetAir special session organized within the Eurosensors conference at Freiburg in September (see separate report in this issue). Thus, the step from sensor elements to integrated sensor systems is still a very active and important research topic for addressing different aspects of environmental monitoring.

News from  
Special Interest  
Groups

## SIG 3 - Guidelines for Best Coupling

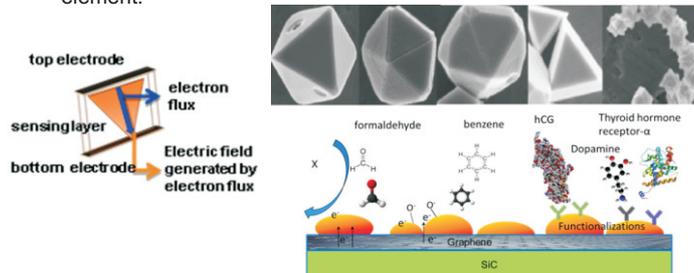
E. Llobet, MC Member &amp; SIG3 vice-leader, University Rovira i Virgili, Spain

During the recent EuNetAir Meeting in Linköping, SIG3 group had an interesting discussion and many presentations on the best coupling of air pollutants and transducers. In particular, the Group from Institut Pascal in Clermont-Ferrand, France, showed that metallophthalocyanines offered interesting, weak interactions with aromatic molecules, make them a promising material for an active coating in QCM transducers for the room-temperature detection of aromatic VOCs.



A group from the Institute of Materials in Cologne, Germany, showed how employing a three-dimensional electrode configuration could be devised for significantly increasing the sensitivity and lowering operating temperature of Cr-doped nano-tubular ZnO layers towards nitrogen dioxide. Gebze Technical University (Turkey) presented a five-fold increase in sensitivity towards VOCs of chemoresistors that employed hydrothermally-synthesized, titanium oxide nanorods by spin

coating them with suitable polymers. The URV group (Tarragona, Spain) presented a selective and highly sensitive benzene probe employing carbon nanotubes functionalized with cavitand molecules. Applied Sensor Science from Linköping, Sweden, showed that the Pulsed Plasma Hollow Cathode Sputtering method enables the synthesis of metal oxide nanoparticles with well-defined surface geometry, enhancing sensitivity and selectivity. This group presented also a sensing platform employing epitaxial graphene as transducer element.



The figures show from left to right: Substituted metallophthalocyanine to detect aromatic VOCs employing QCM transducers (Institut Pascal, France); Three-dimensional electrode configuration for increasing sensitivity of nano-tubular MOXs (Institute of Materials, Cologne, Germany); MOX NPs (top-right) and epitaxial graphene sensing platform (bottom-right) (Linköping University, Sweden).

## News from Ad-Hoc Groups

### Short Term Scientific Missions (STSMs)

J. Theunis, MC member & STSM coordinator, VITO, Belgium

In the third year of EuNetAir, a total of 13 Short Term Scientific Missions (STSMs) were carried out. Researchers from Italy, Germany, Turkey, United Kingdom, Croatia, Serbia, and Belgium visited to host institutions in Denmark, UK, France, Finland, Italy, Sweden, Norway, and Slovenia. Over the three years of the action, already 39 researchers, most of them Early Stage Researchers (ESR) benefited from a grant that allowed them to travel abroad, acquire new skills in a host laboratory in one of the participating COST countries and strengthen trans-European scientific collaboration and networking. In this newsletter, on six of these STSMs is shortly reported.

The fourth call for STSMs gives again the opportunity to young researchers, PhD-students and graduated early-scientists to apply for scientific missions in host laboratories of Action partners in MoU-signed COST countries. The call is open for the whole fourth period of the Action (1 July 2015 - 30 April 2016). Applicants are requested to apply as soon as possible. Details of the call for year 4 can be obtained from the EuNetAir website:

[http://www.eunetair.it/cost/documenti/COST\\_Action\\_TD1105\\_Call\\_STSM\\_Year4\\_V1.pdf](http://www.eunetair.it/cost/documenti/COST_Action_TD1105_Call_STSM_Year4_V1.pdf)

### Gender Balance

I. Steinberga, MC member & GB coordinator, University of Latvia, Latvia

During the period from 2012 to 2015, in the COST action meetings and in the leading positions, the percentage of female members substantially grew, from 20 % of female members at the beginning of the Action (2012) until now, where in some cases female members in meetings achieve 46 %. This

indicates a strong positive tendency.

Of course, the number of female members varies from topic to topic. While in some Special Interest Groups (e.g. SIG4: Expert Comments for the Revision of the Air Quality Directive (2008/50/EC)) even 60 % of the speakers in meetings are female, this number is rather low in other groups.

## Science & Tech Talk

### Science & Tech Talk

#### GERIA Project

A.S. Mendes, J.P. Teixeira, Environmental Health Unit,  
National Institute of Health, Portugal

The GERIA project work was conducted in the two main Portuguese cities, Lisbon and Porto. Within the 1st phase of this study, 53 Elderly Care Centers ECC (33 in Lisbon and 20 in Porto) were selected through proportional stratified random sampling (by parish) from the 151 included in the Portuguese Social Charter (95 in Lisbon and 56 in Porto). These 53 ECC were attended by 2,110 residents (1,442 in Lisbon and 668 in Porto). The 2nd phase completed a thorough analysis based on the 1st phase preliminary study. Eighteen ECC were further studied in detail.

The aim of GERIA project was to carry out a risk assessment, which is often difficult for older people, involving the identification of multiple factors that potentially affect health and quality of life, the quantification of human exposure to pollutants, and the evaluation of the individual's response to these stimuli. The results of this project contribute to the understanding of health effects

due to indoor environment variables and to provide health benefits to ECC residents with relatively simple measures. The final results will be released by the end of this year on December 11th in the final Seminar of this study. They will then be available on the project website: <http://geria.webnode.com/> in form of an e-book

This research project was supported by the Foundation for Science and Technology (Fundação para a Ciência e Tecnologia - FCT) - GERIA Project: PTDC/SAU-SAP/116563/2010.



Science &  
Tech Talk

## Study on marine aerosols

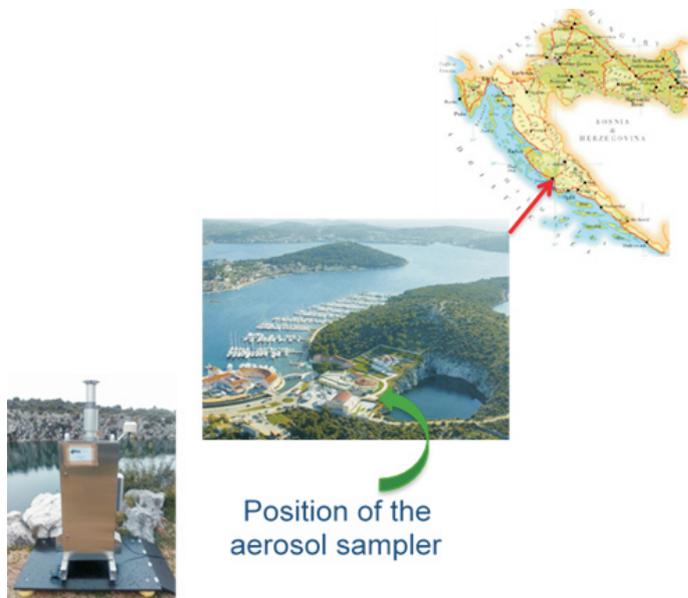
I. Ciglencečki-Jušić, Rudjer Boskovic Institute,  
Department for Marine and Environmental Research, Zagreb

In the frame of the project „The Sulphur and Carbon Dynamics in the Sea- and Fresh-water Environment“ (SPHERE, 1205), funded by Croatian science foundation, sulphur (S) and carbon (C) dynamics between different environmental compartments (atmosphere, water, sediment, biota) of the sea- and fresh-water environment are studied. Main focus is on the distribution between organic, inorganic, dissolved, colloidal, and nanoparticulate fraction. An important part of the project is focused on the characterization of marine and freshwater aerosols mainly by electrochemical, chromatographic, and ICPMS methods.

The unique, highly eutrophic, and euxinic (anoxic water with free hydrogen sulphide in the water column) marine lake, Rogoznica Lake in central Dalmatia (Middle Adriatic, 43°32'N 15°58'E) is selected as one of the important study site (see Figure). This lake is considered as an extreme, naturally eutrophic system which feels all effects of the Adriatic atmospheric and ocean conditions. Influence of these conditions due to the lake semi-closed nature might be several times stronger than in other coastal and open sea Adriatic waters.

In order to get better insights into aerosol characteristics and dynamics between the atmosphere and the lake water column, our study is designed to comprise seasonal data of the marine aerosols as well as the sea surface microlayer (SML) and underlying water samples (ULW, from 0.5 m depth) at the Rogoznica Lake. The aerosol samples (aerodynamic diameter <2.5  $\mu\text{m}$ ) are collected on the glass fibre GF/F filters ( $\phi=47$  mm) by low volume sampler (2.3  $\text{m}^3/\text{h}$ , sampling time: 24 and 48h) (see Figure). The SML samples are collected by the Garrett screen method using a stainless steel screen. Isolation

and physico-chemical characterization of the water soluble organic matter (WSOM) from aerosol, SML and ULW samples are investigated mainly by electrochemical methods for surface active substances and reduced sulphur species determination, in combination with measurements of total and dissolved organic carbon (TOC, DOC) by high temperature catalytic oxidation (HTCO), and trace metals by ICPMS measurements. In collaboration with the National Institute of Chemistry (NIC), Ljubljana, Slovenia and an STSM grant obtained for our PhD student, further characterization of organic and inorganic components of marine aerosols by ion chromatography (IC) and laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) are performed.



Position of the  
aerosol sampler

The figure shows the map of Croatia with indicated position of Rogoznica lake, an air photo of Rogoznica lake with indication of the aerosol sampler position.

## Computational Intelligence Methods

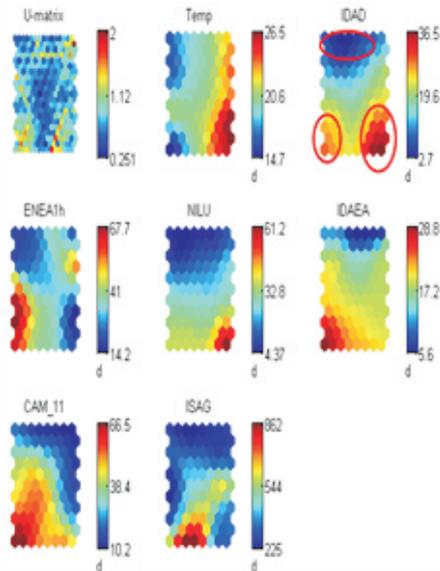
K. Karatzas, Environmental Informatics Research Group, Aristotle University, GRC

Sensors “speak” the language of data but in order to “hear” and “understand” them, we have to employ proper computational approaches. For this reason, our research group investigates and applies Computational Intelligence methods in order to get better insights in terms of sensor and environmental system behavior analysis and pattern identification. This also leads to better data

modeling results that may serve real world applications and services. An example of such an analysis is shown in the Figure presenting the results of the self-organizing maps unsupervised learning algorithm applied to sensor data (ozone) collected during the Aveiro joined intercomparison exercise (October 2014, Aveiro, Portugal; organised in the frame of the EuNetAir COST Action:

[http://www.eunetair.it/cost/newsletter/Newsletter\\_EuNetAir-Issue5December2014.pdf](http://www.eunetair.it/cost/newsletter/Newsletter_EuNetAir-Issue5December2014.pdf)

Science & Tech Talk



Reference measurements (IDAD) as well as the U-matrix indicate that there are three main areas, each one related to a different part of the ozone behaviour (marked with red ellipses in the IDAD SOM): the upper area corresponds to low ozone concentrations and coincides with medium to low temperatures, thus it can be attributed to low ozone productivity dynamics in the Aveiro area. The lower right area denotes high ozone values and appears in parallel with the highest temperature values, thus suggesting the typical ozone production mechanism comes along with solar radiation. There is also a third area (lower left on IDAD SOM), that suggests medium to high ozone concentrations, but it appears in parallel with low temperature values, relatively high RH and low NO values (the latter two not shown here), this indicating possible ozone transportation in the Aveiro area during the night. This is an example that we are going to use Computational Intelligence for analysing data that will result from the (currently running) Belgrade intercomparison exercise, organized again in the framework of the EuNetAir COST Action.

The figure presents the U-matrix (upper left) and the self-organizing maps of available temperature and ozone measurements (values in °C and  $\mu\text{g}/\text{m}^3$  respectively).

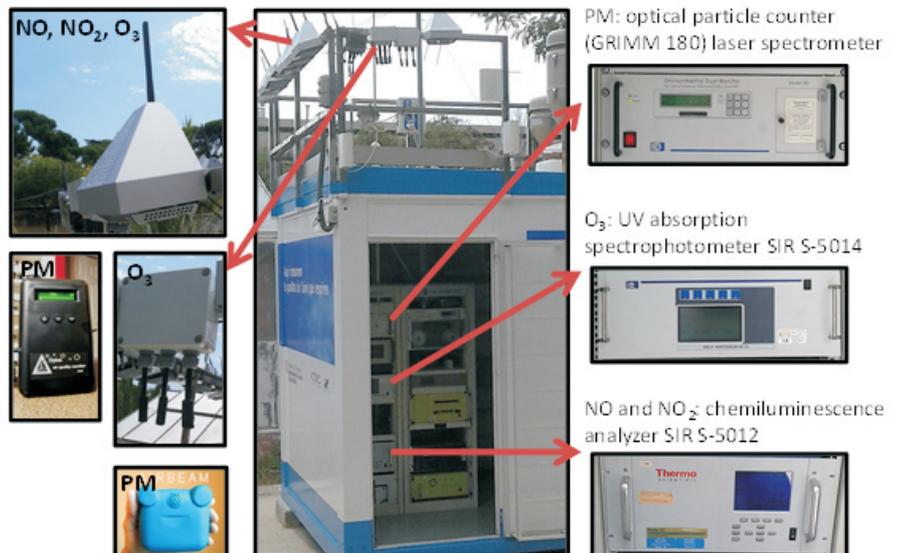
## Air quality sensors validation in real-world conditions

M.C. Minguillón, M. Viana, Institute of Environmental Assessment and Water Research (IDAEA), CSIC, Spain

Sensor technologies have been identified as a useful tool to complement existing air quality monitoring networks, and their potential use is increasing. However, assessments of their real-world performance (as opposed to laboratory performance) found large divergences between sensor and reference data, and even between different units of the same sensor type. At IDAEA-CSIC, the field performance of current low-cost sensors for air quality monitoring under real-world conditions has been assessed for the past years. Inter-comparison exercises have been carried out at the Palau Reial urban background monitoring site in Barcelona for sensors monitoring gaseous and particulate pollutants, for periods ranging between 1 month and more than 1 year. The assessed parameters were: correlation with regard to the reference data, drifts across time, and comparability between units of the same sensor. Results evidenced a significant improvement in the performance of electrochemical sensors, especially for  $\text{NO}_2$  and

$\text{O}_3$ , while  $\text{NO}$  sensor performance was good from the beginning. Metal-oxide  $\text{O}_3$  sensors tested showed good performance. The particulate matter (PM) sensors are the ones with more limitations, in terms of their possibility to be deployed outdoors and for long-term periods. The results so far for laser-based tested sensors are encouraging for the fine fraction of PM ( $<2.5 \mu\text{m}$ )

IDAEA-CSIC is one of the partners of the H2020 project (Information and Communication Technologies (ICT) call) named CAPTOR on the design and application of an  $\text{O}_3$  sensor node, starting in January 2016.



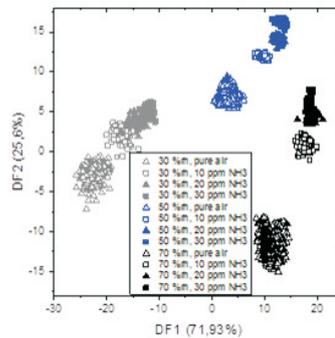
Science &  
Tech Talk:  
STSM reports

## Measuring ammonia and humidity selectively with a low cost system

M. Schüler, Saarland University, Germany

In November 2014, I spent two weeks at ICMUB in Dijon, France, to complete an STSM and further investigate so called MSDI (molecular semiconductor – doped insulator) sensors in the group of Marcel Bouvet. MSDI sensors exhibit outstanding electronic and sensing properties, using a heterojunction between a molecular semiconductor (MS) and a doped insulator (DI).

Measurements were carried out with a newly developed, low-cost



impedance spectroscopy. The figure shows a result of these studies: LDA (linear discriminant analysis) plot of different humidity and ammonia exposures, calculated with FoBIS (Fourier based impedance spectroscopy) data. The measurements with the low-cost impedance spectroscopy are able to selectively measure humidity and ammonia, which affect the electrical properties of the MSDI sensor in different ways.

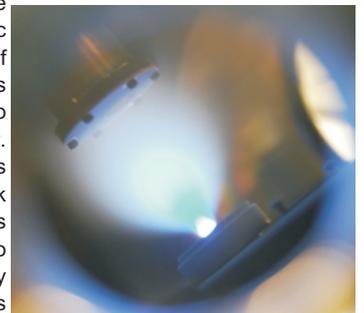
We also envisaged on publishing the results. The STSM in Dijon was scientifically enriching and confirmed me in the choice of my field of study at Saarland University.

## Li doped tungsten oxide films for SiC-FET and MOS sensing layers using pulsed laser deposition

M. Rodner, Saarland University, Germany

The main idea of my stay was the production of tungsten oxide thin films for SiC-FETs and MOS gas sensors and to dope them with Li<sup>+</sup>-ions in order to improve sensitivity and selectivity. During the four weeks of my STSM, I was fully introduced to pulsed laser deposition (see figure) as a technique for producing thin film layers of tungsten oxide with high purity. Using different parameters in the deposition process, layers with different morphology could be realized. The work with tungsten oxide and PLD is the main expertise of Jyrki Lappalainen's group in Oulu. Additionally, all the produced layers have been characterized regarding their morphology and structural

properties. The sensors were tested using a cyclic electrochemical polarization of the films to provide gas sensors with multi-signal generation to achieve a better selectivity. Besides my introduction in this field of research and the work within Jyrki Lappalainen's group, the social integration into the team made my stay very interesting and comfortable as well.



## Training in observational platforms for monitoring air quality

M. Davidović, Vinča Institute, University of Belgrade, Serbia

During my stay at NILU (Kjeller, Norway), I was welcomed by Prof. Alena Bartonova and Dr. Philipp Schneider. They demonstrated some of the



previously developed physical and statistical methods for creation of air pollution maps which utilize data from observational platforms to enhance the quality of the maps. In particular, data fusion techniques were showcased using an example of Oslo NO<sub>2</sub> basemap. It was then enhanced using measurements from observational platforms. I studied possibilities to adapt presented methods to create air pollution maps for Belgrade. During my STSM visit, I enhanced the basemap for Belgrade using historical data from observational platforms (monitoring stations), thus adding value to both the basemap and historical data. On the last day of my stay, I participated in a campaign where mobile observational platforms were used to measure air quality near Majorstuen, thus presenting us with a wonderful opportunity to enjoy a sunny day in Oslo and gather useful data.

The picture shows the fused NO<sub>2</sub> map and positions of observational platforms in Belgrade.

Science &  
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## Developing forecasting techniques and low-cost sensing technologies for urban air pollution control

M. Catalano, Department of Civil, Environmental, Aerospace and Materials Engineering (DICAM), University of Palermo, Italy

Main goal of this STSM was to visit the Newcastle University Transport Research Group and develop models and methods for air pollution forecast in order to support urban transport policies and traffic management actions. In detail, the main objective of the STSM was to compare artificial intelligence (neural networks) with the time series statistical approach in modeling transport-related pollutant concentrations.

In collaboration with Dr. Fabio Galatioto and with support from Prof. Margaret Bell, ARIMAX models and neural networks were compared in relation to their ability to predict nitrogen dioxide (NO<sub>2</sub>) hourly mean concentration values in London, at Marylebone Road. There, the hourly threshold established by the EU environmental law for NO<sub>2</sub>

concentration is exceeded several times a year. It was also investigated how the forecasting performance of models deteriorates as the projection time interval widens. Moreover, the use of carbon monoxide (CO) concentration to capture the impact on NO<sub>2</sub> density of traffic dynamics was tested.

Table 1 compares the neural network and the seasonal ARIMAX model in predicting NO<sub>2</sub> hourly mean concentrations in London (in µg/m<sup>3</sup>), depending on the traffic volume (in cars/hour), the average wind speed (in km/h), the average wind direction (in degrees), and the NO<sub>2</sub> hourly mean densities one hour and one day back (cyclical effect). Furthermore, it displays the ARIMAX model forecasting performance when the traffic impact is captured by the hourly mean concentration of CO (mg/m<sup>3</sup>) as proxy.

The table shows the comparison between the neural network and the ARIMAX models: hourly mean density of NO<sub>2</sub> in London, Marylebone Road (2006).

Models	Observations - Predictions Correlation	Mean Absolute Percent Error	Actual exceedances predicted
ARIMAX (traffic volume)	90.5%	18.6%	77.0%
Neural Network (traffic volume)	91.1%	16.5%	71.6%
ARIMAX (CO density as proxy of traffic dynamics)	91.5%	17.0%	87.0%

## Training in data fusion and data assimilation techniques to monitor air quality

D. Topalović, Vinča Institute, University of Belgrade, Serbia

The aim of the STSM visit to NILU Norwegian Institute for Air Research was to discuss with experienced researchers and implement the basic principles of air pollution modeling using data fusion and data assimilation techniques. During the STSM visit, I devoted special attention to the latest developments in data assimilation algorithms, e.g. Ensemble Kalman filter, which is extremely popular for applications in the process of data assimilation.

During the STSM visit, I also became familiar with the special calibration procedure for mobile low-cost sensors (whose measurements can be used for creation of "base" maps that provide a starting point for AQ information) in a control test atmosphere. This has been established and successfully used for many years within the laboratories of NILU. I would like to express my gratitude to the Dr. Alena Bartonova, Dr. Franck

Rene Dauge and Dr. Philipp Schneider for their help and cooperation during my stay in Norway.

The figure presents the graphical representation of calibration results for a low-cost NO sensor (blue line) and the reference monitor (orange line) for the period of one day.



Science &  
Tech Talk:  
STSM reports

## Physical-chemical characterization of the water soluble fraction of the marine aerosols

A. Cvitesic, Ruđer Bošković Institute, Croatia

I am a 1st year PhD student of Oceanology at the Faculty of Science in Zagreb, Croatia. My study is within the laboratory for physical chemistry of aquatic systems (LPCAS), Ruđer Bošković Institute (RBI) in Zagreb and my research is focused on a multidisciplinary investigation of marine aerosols using electrochemical and state-of-the-art mass spectrometry and chromatographic techniques.

Since aerosol investigations are at the very beginning within the group at my home institution, the cooperation between RBI, Zagreb and National

Institute of Chemistry (NIC), Ljubljana was a great opportunity for me to learn about modern analytical techniques and their application in the atmospheric chemistry as well as in marine environments.

The focus of my STSM in Ljubljana was on the chemical characterization of the water soluble fraction in the marine aerosols and in the sea surface microlayer collected at the Rogoznica Lake in central Dalmatia, Croatia. During my stay at National Institute of Chemistry in Ljubljana, we analysed my samples collected at Rogoznica Lake by using ion chromatography (IC), liquid chromatography-mass spectrometry (LC-MS) and inductively coupled plasma mass spectrometry (ICP-MS). For me, it was an excellent experience working in a very motivating environment.

Overview on  
EuNetAir  
Events

## Events & Announcements

### 4th Scientific Meeting EuNetAir – Working Groups and Management Committee – in Linköping, Sweden

D. Puglisi, A. Lloyd Spetz, Linköping University, Sweden

The 4th Scientific Meeting EuNetAir was held at Linköping University, Campus Valla, Sweden, and hosted by the Division of Applied Sensor Science at the Department of Physics, Chemistry and Biology, IFM, from 3rd to 5th June 2015. The Meeting was attended by 51 participants from 19 countries. Linköping Mayor, Helena Balthammar, and Department Dean, Prof. Kenneth Järrendahl, attended the Welcome Address Session.

The meeting focused both on outdoor and indoor environment quality applications with a keynote session on key enabling technologies for Air Quality Control. All speakers presented the latest results of their scientific works stimulating interesting questions and comments from the

audience, and opening the discussion for the Working Groups (WGs) and Special Interest Groups (SIGs) sessions.

During evenings, on the first day the participants had the possibility of a guided tour in Gamla Linköping, the old town, with its picturesque outdoor and indoor environments, and after the poster session on the second day they had a guided visit at the Ångström building in Campus Valla, housing Arwen, one of the world's sharpest transmission electron microscopes (TEM).

The Management Committee (MC) Meeting on the third day started with a celebration of the World Environment Day (WED). This year's WED slogan was 'Seven Billion Dreams. One Planet. Consume with Care'.

Open access AMA-Science Proceedings from the Meeting are available online: [www.ama-science.org/proceedings/listing/1885](http://www.ama-science.org/proceedings/listing/1885)



## Overview on EuNetAir Events

### EuNetAir at EuroNanoForum 2015, Riga, Latvia

M. Penza, Action Chair, ENEA, Italy

COST Action TD1105 EuNetAir, represented by Action Chair (Michele Penza, ENEA, Italy) participated with an Invited Talk on the Action overview in the COST Workshop devoted to COST Highlights on Nanotechnology and Advanced Materials, managed by COST Association, during the conference EuroNanoForum 2015 (ENF 2015), organized by European Commission, and in Riga (Latvia) on 10 - 12 June 2015. This COST Workshop, chaired by the Science Officer Maria Moragues Canovas, was attended by 5 speakers from Actions, Head of COST Science Operations (Prof. Tatiana Kovacicova), with at least 100+ participants. This was a very good opportunity to disseminate EuNetAir networking activities in a targeted audience at European top-class.

ENF 2015 was attended by about 1000 delegates. The abstract of the Lecture on COST Action TD1105 given by Action Chair at the Special Session COST can be obtained from the conference Proceedings. Please see the link to the COST workshop ENF 2015: <http://euronanoforum2015.eu/session/workshop-cost-highlights/>



### Summary of 5th EuNetAir WG Meeting and of 2nd EuNetAir Air Quality Joint-Exercise Intercomparison 2015, Belgrade, Serbia

M. Jovašević Stojanović, Vinča Institute, University of Belgrade, Serbia

The EuNetAir WG Meeting was organized by Vinča Institute in cooperation with Public Health Institute of Belgrade and hosted by Faculty of Mechanical Engineering (University of Belgrade), on 13-14 October 2015.

The meeting was attended by participants from 11 countries: Australia, Bulgaria, Croatia, Greece, Italy, Latvia, Norway, Portugal, Serbia, Turkey and United Kingdom. The two-day meeting was held with prolonged oral presentations of participants through six plenary sessions: Welcome Address, Plenary Session, Method for Air Quality Monitoring, Air Quality Modelling and Sensors, and Sensor-Systems for Air Quality Monitoring Environmental. Beside the other members at WG

meeting in Belgrade Prof. Zoran Ristovski (Faculty of Engineering, Queensland University of Technology, Brisbane, Australia) participated for the first time at EuNetAir and gave brief presentations about development on their real time reactive oxygen species sensors.

On 12 October 2015 the 2nd EuNetAir Air Quality Joint-Exercise-Intercomparison started organized by Vinča Institute when there were installed at Air Monitoring Station (AMS) in the city center of Belgrade some platforms that are developed by ENEA (Italy) and Aristotle University of Thessaloniki (Greece). After two weeks devices sent by CSIC (Spain) were added. At AMS, devices that Institute Vinča used for research activities were also installed. In a duration of 4-6 weeks, till November 25th, 7 different platforms and sensors collected air pollution data at AMS in city center of Belgrade.



## Overview on EuNetAir Events

### EuNetAir and ESSC at ISOEN 2015, Dijon

A. Schütze, WG2 leader & ESSC WG IQ Leader, Saarland University, Germany

ISOEN 2015, the 16th International Symposium on Olfaction and Electronic Noses, was held in Dijon, in the heart of Burgundy, France, from 28 June - 1 July, 2015. The motto of the conference was "20 years of E-nose, time to take stock". The conference spectrum was defined by six plenary talks and three plenary sessions on e-sense systems, applications, and data processing. The latter was opened by Dr. Steve Semancik of NIST with a special tribute to Alex Vergara, a promising young scientist with broad international experience who passed away much too soon. ISOEN 2015 was co-organized by Anne-Claude Romain of the University of Liège, member of the EuNetAir steering committee. EuNetAir members from Belgium, France, Germany, Great Britain, Italy, Spain and Switzerland contributed to the



**isoen** 28 June -1 July 2015  
International Symposium on  
Olfaction and Electronic Nose  
Dijon France



successful conference with numerous presentations, both in the oral sessions as well as with poster contributions covering a broad range from sensor technologies to applications. Our COST action EuNetAir was highlighted in flash presentations session 3 with an overview on goals challenges, organization and especially common initiatives like the successful training schools and the Aveiro Joint-Exercise for intercomparison of low-cost sensors and reference analyzers. Finally, attendees were invited to contribute to the EuNetAir Symposium planned at EMRS Spring Meeting 2016 in Lille, France, May 2-6, 2016. In the same session, the vision and objectives of the European Sensor Systems Cluster ESSC were presented together with a Call for Participation, especially to the roadmap activities to define research priorities in Europe.

## Announcements Upcoming Events

**4th International Workshop of the COST Action TD1105 on Innovations and Challenges for Air Quality Control Sensors**  
February 25-26, 2016, FFG (National AT COST Office), Wien, Austria

**4th International Training School on Modelling, Methods and Technologies for Air Quality Control**  
April 19-22, 2016, Emdrup Campus, Aarhus University, Copenhagen, Denmark

#### EMRS Spring Meeting and Exhibit 2016

Symposium by Action: Functional Materials for Environmental Sensors and Energy Systems Applications  
May 2-6, 2016, Lille, France.  
<http://www.emrs-strasbourg.com/>

#### IMCS 2016, International Meeting on Chemical Sensors

July 10-13, 2016, Jeju Island, Korea.  
<http://www.imcs2016.org/>

The International Meeting on Chemical Sensors (IMCS) is the world's largest interdisciplinary forum for all aspects of Chemical Sensors. It is the mission of the IMCS not only to be an interdisciplinary forum in the field of Chemical Sensors that includes physics, chemistry, materials science, and engineering disciplines (including biomedical engineering) or to boost research and application in the field of Chemical Sensors, but it is also the leading international platform for discussion and exchange between experienced researchers and younger students. Therefore, it is a must for researchers working in the field of Chemical Sensors, which greatly overlaps with the aims and scope of EuNetAir!

In 2016, IMCS will be held in Jeju, Korea, from July 10 – July 13. Chaired by Prof. Chong Ook Park and co-chaired by Prof. Jong-Heun Lee, who both are renowned experts in the field of gas sensing, theory and application of gas sensors for Air Quality measurement and control will be a key topic. The list of plenary and invited focused session speakers is already available on the web site. It shows the great coincidence with EuNetAir's topics. Important: Deadline will be 31. December 2015. For more information, please go to <http://www.imcs2016.org/>

Ralf Moos, Chair of the Executive Steering Committee of IMCS

#### 6th SCIENTIFIC MEETING: WGs Meeting and 9th MC Meeting on New Sensing Technologies for Outdoor Air Quality Monitoring

October 5-7, 2016, Czech Academy of Sciences, Prague, Czech Republic

## Publications of EuNetAir participants

## List of publications related to EuNetAir

M.C. Minguillón, M. Viana, C. Reche, X. Querol, J. García Vidal, O. Trullols, J.M. Barceló, M. Viader, P. Speranza  
Is the performance of sensor technologies for air quality monitoring improving?  
European Aerosol Conference EAC 2015  
Milan, Italy, 6-11 September 2015

R. Popek, H. Gawrońska, S.W. Gawroński  
The level of particulate matter on foliage depends on the distance from the source of emission  
International Journal of Phytoremediation 17 (2015) 1262-1268

N. Weyens, S. Thijs, R. Popek, N. Witters, A. Przybysz, J. Espenshade, H. Gawronska, J. Vangonsveld, S.W. Gawronski  
The role of plant-microbe interactions and their exploitation for phytoremediation of air pollutants  
International Journal of Molecular Sciences 16 (2015) 1-x

C. Borrego, M. Coutinho, A.M. Costa, J. Ginja, C. Ribeiro, A. Monteiro, I. Ribeiro, J. Valente, J.H. Amorim, H. Martins, D. Lopes, A.I. Miranda  
Challenges for a New Air Quality Directive: The role of monitoring and modelling technique  
Urban Climate 14 (2015) 328-341

C. Hummelgard, I. Bryntse, M. Bryzgalov, J. Henning, H. Martin, M. Norén, H. Rødjegard  
Low-cost NDIR based sensor platform for sub-ppm gas detection  
Urban Climate 14 (2015) 342-350

M. Penza, D. Suriano, G. Cassano, V. Pfister, M. Amodio, L. Trizio, M. Brattoli, G. De Gennaro  
A case-study of microsensors for landfill air-pollution monitoring applications  
Urban Climate 14 (2015) 351-369

N. Castell, M. Kobernus, H.-Y. Liu, P. Schneider, W. Lahoz, A. J. Berre, J. Noll  
Mobile technologies and services for environmental monitoring: The Citi-Sense-MOB approach  
Urban Climate 14 (2015) 370-382

J. Brink  
Boundary tracking and estimation of pollutant plumes with a mobile sensor in a low-density static sensor network  
Urban Climate 14 (2015) 383-395

S. N. Behera, M. Sharma, P.K. Mishra, P. Nayak, B. Damez-Fontaine, R. Tahon  
Passive measurement of NO<sub>2</sub> and application of GIS to generate spatially-distributed air monitoring network in urban environment  
Urban Climate 14 (2015) 396-413

C. A. Skjøth, P. Baker, M. Sadyś, B. Adams-Groom  
Pollen from alder (*Alnus* sp.), birch (*Betula* sp.) and oak (*Quercus* sp.) in the UK originate from small woodlands  
Urban Climate 14 (2015) 414-428

M. Sadyś, C. A. Skjøth, R. Kennedy  
Determination of *Alternaria* spp. habitats using 7-day volumetric spore trap, Hybrid Single Particle Lagrangian Integrated Trajectory model and geographic information system  
Urban Climate 14 (2015) 429-440

A. Järvinen, H. Kuuluvainen, J.V. Niemi, S. Saari, M. Dal Maso, L. Pirjola, R. Hillamo, K. Janka, J. Keskinen, T. Rönkkö  
Monitoring urban air quality with a diffusion charger based electrical particle sensor  
Urban Climate 14 (2015) 441-456

P.V. Ørby, R.G. Peel, C. Skjøth, V. Schliunssen, J.H. Bønløkke, T. Ellermann, A. Brændholt, T. Sigsgaard, O. Hertel  
An assessment of the potential for co-exposure to allergenic pollen and air pollution in Copenhagen, Denmark  
Urban Climate 14 (2015) 457-474

G.G. Mandayo, J. Gonzalez-Chavarri, E. Hammes, H. Newton, I. Castro-Hurtado, I. Ayerdi, H. Knapp, A. Sweetman, C.N. Hewitt, E. Castaño  
System to control indoor air quality in energy efficient buildings  
Urban Climate 14 (2015) 475-485

A. Mendes, S. Bonassi, L. Aguiar, C. Pereira, P. Neves, S. Silva, D. Mendes, L. Guimaraes, R. Moroni, J.P. Teixeira  
Indoor air quality and thermal comfort in elderly care centers  
Urban Climate 14 (2015) 486-501

B. de Fonseca, J. Rossignol, D. Stuerger, P. Pribetich  
Microwave signature for gas sensing: 2005 to present  
Urban Climate 14 (2015) 502-515





# EuNetAir



## Newsletter COST Action TD1105 EuNetAir

Action Chair Dr. Michele Penza, ENEA, IT - [michele.penza@enea.it](mailto:michele.penza@enea.it)  
 Editor-in-Chief Prof. Ralf Moos, University of Bayreuth, DE - [functional.materials@uni-bayreuth.de](mailto:functional.materials@uni-bayreuth.de)  
 Editorial Board Manager Dr. Daniela Schönauer-Kamin, University of Bayreuth, DE  
 Graphic design Dr. Jaroslaw Kita, University of Bayreuth, DE

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