ISSN 2070-2582
Key title: Newsletter (European Association for the Science of Air Pollution. Online)
Abbreviated key title: Newsletter (Eur. Assoc. Sci. Air Pollut., Online)
Parallel title: EURASAP newsletter

Articles, Letters and other Contributions
for the EURASAP Newsletter since 2008
to
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ISSN 2070-2582

EURASAP

Newsletter 66
December 2008

Vegetation of northern Velebit, Croatia (photos by B. Rožman)

European association for the science of air pollution

CONTENTS

EDITORIAL

Dear EURASAP members,

The EURASAP Committee met in October 2008 during the 12th International Conference on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes in Cavtat, Croatia. At the meeting, Dr. Clemens Mensink of VITO Flemish Institute for Technological Research, Mol, Belgium was welcomed as a new Committee member from Belgium after Prof. Jan Kretzschmar resignation. A new EURASAP Treasurer is Miss Rosa Freire of IDAD, Aveiro, Portugal.

The committee will continue to support the participation of scientists from countries in transition at upcoming activities that are carried out in cooperation with EURASAP. Shortly coming are:

- the 7th ICAQ, Istanbul, Turkey, March 2009.
- the 30th NATO/SPS ITM on air pollution modelling and its application in San Francisco, USA, May 2009.

For more information on these two conferences, please see section 'Future events', this issue.

Wish you all Happy Holidays and sucesfull year 2009!

The Newsletter Editor

Scientists' Contributions

AIR QUALITY FORECASTING SYSTEM AT FERIHEGY AIRPORT – HUNGARY

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INTRODUCTION

Aviation has experienced rapid expansion as the world economy has grown, and this has produced a number of major environmental challenges. As the contribution to urban air pollution from industrial emissions is steadily reducing in cities of European countries, other emission sources are becoming comparatively more relevant. The contribution to air pollution levels from emissions produced by the operation of airports located close to cities is one example in this respect.

In 2005, a new project started to determine the air pollution situation at Budapest Ferihegy Airport, combining the results of measurements and model calculation. In the joint research work, the EDMS air quality modelling system was adapted and developed at the Hungarian Meteorological Service (HMS), while three measurement campaigns were performed on the area of Budapest Ferihegy Airport by the Hungarian Research Institute of Physics (Steib et.al. 2008/1). After developing the modelling system with which the air quality can be determined at the airport, a new forecasting system development has been started. This system can forecast the concentrations of several pollutants for the next day at the area of Budapest Ferihegy Airport (Steib et.al. 2008/2).

FORECASTING SYSTEM

The newly developed forecasting system is able to produce daily average dispersion forecasts operatively for five different pollutants (NO_x, CO, SO_2, VOC, PM_{10}). The system architecture is presented in Fig. 1., while Fig. 2.

shows the aerial map of the airport.

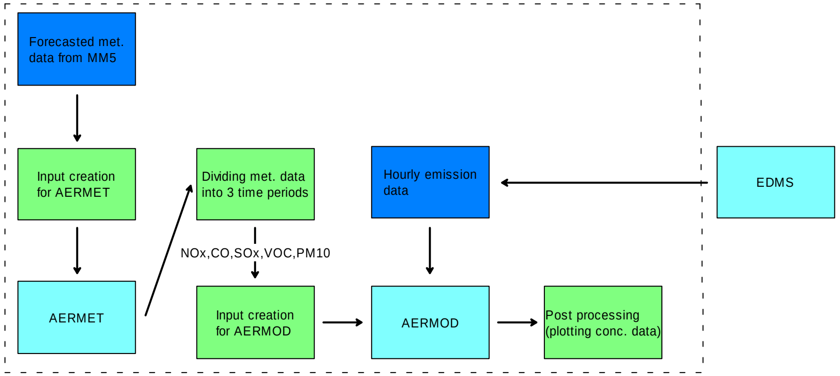

Figure. 1. Modelling system for forecasting pollutant concentrations at Budapest Ferihegy Airport.

Airport dispersion calculations are much more complex than regular dispersion calculations, because the aircraft emissions (the place of the emissions) strongly depend on the wind situation in the modelling

domain (wind direction and speed). It is possible to use different configurations in the EDMS model (depending on the wind direction and wind speed). At Budapest Ferihegy Airport aircraft movements and the direction of landing and take-off are dependent on the wind gust values parallel to the runways. For this reason we work with our own program, which uses weather dependent input emission files instead of the default configurations of EDMS. Normally, aircrafts use the 31L runway for take-off and the 31R runway for landing at Ferihegy Airport. If the 130° wind gust component is greater than 5 knots, direction of take-off and landing are changed. As a result of this, the direction of taxiing is also changed. In this case aircrafts mainly use the 13L runway for take-off and the 13R runway for landing. This effect can be very important when doing dispersion calculations, since the emission of a pollutant can be significantly different during take-off and landing. Therefore, during the modelling, the place of take-off and landing should be determined as well as possible.

The constructed 24-hour long dispersion meteorological database contains hourly data. During the model run this database is divided into three parts (0-12 a.m., 12-18 p.m., 18-24 p.m.), and the wind situation is examined in these three different periods. The time periods are asymmetrical, because in the first time period (until 6 a.m.) there is very little air traffic at the airport. The hourly wind gust components are averaged for every time period. The runway-taxiway configuration of the different time periods are determined from the calculated averages. Concentration calculations are made separately in these three different time periods with the proper hourly emission data values. In this step the AERMOD dispersion model is used (Steib and Labancz, 2005). At the end, daily average concentrations of the five different pollutants are calculated from the concentration values of the different time periods. Depending on the meteorological situation, dispersion model runs can be executed with eight different emission inputs.

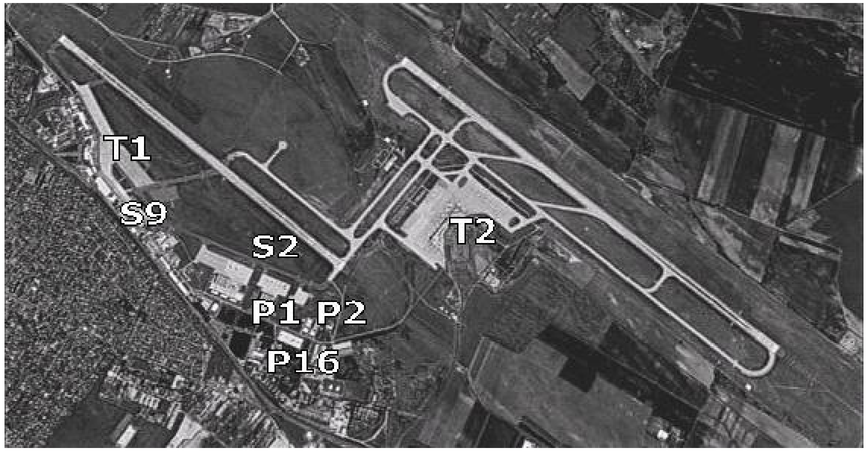

Figure 2. Aerial map of Budapest Ferihegy Airport.
P1, P2, P16: stationary sources; T1, T2: terminals; S2, S9: monitoring sites.

The input meteorological data for the dispersion model are coming from the MM5 numerical weather prediction model.

RESULTS

Figs. 3.1.-7.3. represent the concentration distribution of NOx, SOx, PM10,VOC and CO in three different weather situations. The concentration distributions were examined in the time period

between the 29th and the 31st of August 2008. This time period was chosen, because the weather was changing rapidly during these three days. In the early morning hours of August the 29th a cold front just touched Hungary, which caused a few showers in the eastern parts of the country. After this cold front we had relatively strong wind (strongest wind gusts: 12 m/s) from northwest during the whole day. The cold front was moving fast, so the next day the core of the high pressure system was almost over us. Although the core of the anticyclone was not far, the pressure gradients were significant, so we still had fresh wind (strongest wind gusts: 11 m/s), but the wind direction was changing during the day as the pressure field changed too. On August the 31st the core of the anticyclone was east of us, so we had light wind (strongest wind gusts: 6 m/s) from southeast during the whole day.

Locations where the concentrations are estimated are known as receptors. In the modelling domain Cartesian receptor network were used with different resolutions. Near the main emission sources the resolution of the receptor network is higher (100 m), elsewhere lower (500 m). The reference point of the modelling domain is the 0-point of the airport (latitude: 47.44°, longitude: 19.26°, elevation: 146 m). The size of the modelling domain is 9x8 km. 25 (5x5) grid point values are read from the MM5 meteorological files (nearest to the 0-point). These values are averaged and passed to the meteorological pre-processor AERMET. The place of a receptor point is represented with two coordinates. The first coordinate (x-coordinate) shows the distance of the receptor point from the 0-point in east-west direction. In case of positive x-coordinate the receptor point lies east of the 0-point, in case of negative x-coordinate west of the 0-point. The second coordinate (y-coordinate) shows the distance of the receptor point from the 0-point in north-south direction. In case of positive y-coordinate the receptor point lies north of the 0-point, in case of negative y-coordinate south of the 0-point.

The calculated concentrations do not include the background concentration of the modelling domain. Only airport dependent emissions and the emissions of Road Nr. 4 (a main motorway), which runs near the airport, were took into account during concentration calculations. Fig. 3.1., 4.1., 5.1., 6.1. and 7.1. represent the forecasted daily average concentration distributions on the 29th of August 2008 (wind from northwest), while Fig. 3.2., 4.2., 5.2., 6.2. and 7.2. show the same on the 30th (wind changes during the day), Fig. 5.3., 4.3., 5.3., 6.3. and 7.3. show the concentration distributions on the 31st of August (wind from southeast). In the figures, the black solid line is Road Nr. 4, white solid lines indicate the runways, while the white polygons indicate the two terminals. The main features of the modelled concentrations of the five pollutants are the following:

NO_x

The highest concentrations can be found near the terminals and at take-off place. Other local maximum place is the vicinity of Road Nr.4. Concentration distribution and the concentration values are dependent of the weather situation. The maximum NO_x concentration value varies between 30 and 200 μg/m^3.

SO_x

The highest concentrations can be found near the terminals. Other local maximum place is the take-off place of the aircrafts. Concentration distribution and the concentration values are

dependent of the weather situation. The maximum SOx concentration value varies between 4 and 35 μg/m^3.

PM_{10}

The highest concentrations can be found near the terminals. Concentration distribution and the concentration values are dependent of the weather situation. The maximum PM_{10} concentration value varies between 2 and 12 μg/m^3.

VOC

The highest concentrations can be found in the vicinity of Road Nr.4. Other local maximum place can be found near Terminal 2. Mainly the concentration values are dependent of the weather situation. The maximum VOC concentration value varies between 16 and 100 μg/m^3.

CO

The highest concentrations can be found in the vicinity of Road Nr.4. Mainly the concentration values are dependent of the weather situation. The maximum CO concentration value varies between 180 and 1400 μg/m^3.

High NO_x, SO_x and PM_{10} concentration values near the terminals are caused by the GSE (Ground Support Equipments) and APUs (Auxiliary Power Units). Although the total NO_x and SO_x emission of the aircrafts is higher than the NO_x and SO_x emission of GSE and APUs, and the total NO_x emission of the modelled vehicles (Road Nr. 4) is also higher than the NO_x emission of GSE and APUs, but aircrafts and vehicles emit the pollutants in a much bigger area. Therefore, the effect of the GSE and APUs to the NO_x and SO_x

concentration values is very significant. Because the aircraft traffic is about 25% of the whole traffic at Terminal 1, the concentration values at Terminal 1 are not as high as near Terminal 2. Aircrafts are responsible for high NO_x concentration values at take-off places (31L and 13L). The NO_x emission of the aircraft engines is the highest during take-off phase, so it is not surprising that the mentioned local maximum place can be found at the take-off place of the runways. High CO and VOC concentration values in the vicinity of Road Nr. 4 are caused by the high amount of vehicles on this road. On the 29th of August the highest NO_x and SO_x concentration values caused by aircrafts can be found near the 31L point of the runway (wind blows from northwest), in the next day near 31L and 13L (wind changes direction during the day), and on the 31st of August near 13L (wind blows from southeast). In the second case the concentration values at take-off places are about half of the values of the first case because of the separate use of the 31L and 13L take-off places. The modelled concentration values are the lowest in case of the highest wind speed (29th of August) and highest in case of the lowest wind speed (31st of August). The change of the concentration distribution during the three modelled days is only significant in case of the pollutants NO_x, SO_x and PM_{10}.

As the sources at airports show large temporal and spatial variation, and so far we can use observed data measured during short time campaigns, in this first stage of model development we aimed to get a first survey of our results. For this purpose, diurnal variation of measured hourly averaged concentration values were compared with the modelled hourly values in the period of May 31– June 2, 2006.

Based on the results of the measurement campaigns, air pollutant concentrations are going to be monitored continuously at the airport. *Fig. 8.* shows the results of the model calculations for hourly NO_x concentrations compared with the observed data, at stations 2 and 9, during the examined period. The modelled values are increased compared with the ambient NOx concentration measured at K-puszta (48° 58' N, 19° 33' E) background monitoring station. The course and order of the modelled and observed data series are very similar, and in most cases, the peaks can be found at the same time at both measuring sites. This result shows good promise for that we will be able to determine the time and value of the highest peaks of NO_x concentration at both sites.

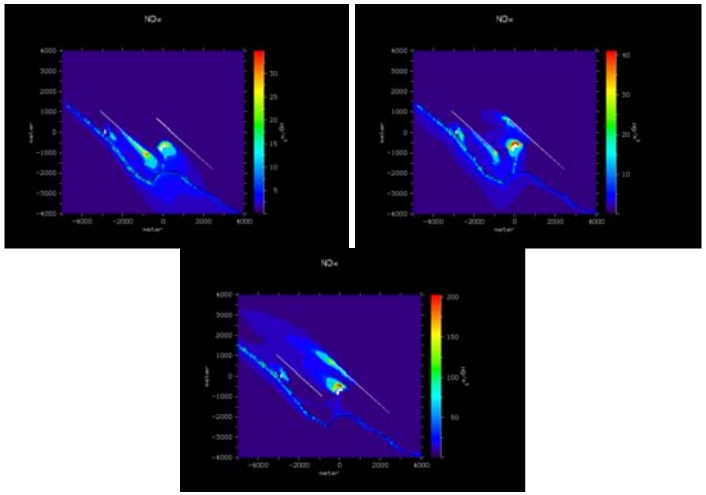

Figure 3.1.-3.3. Forecasted daily average NO_x concentration distribution at Ferihegy Airport in the last 3 days of August 2008.

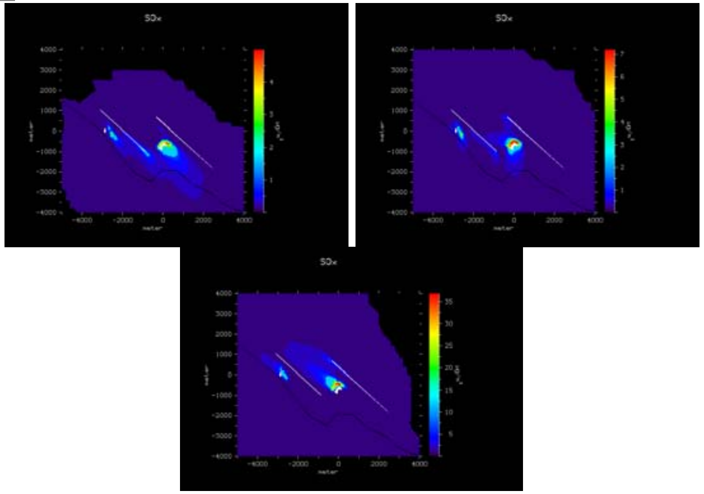

Figure 4.1.-4.3. Forecasted daily average SO_x concentration distribution at Ferihegy Airport in the last 3 days of August 2008.

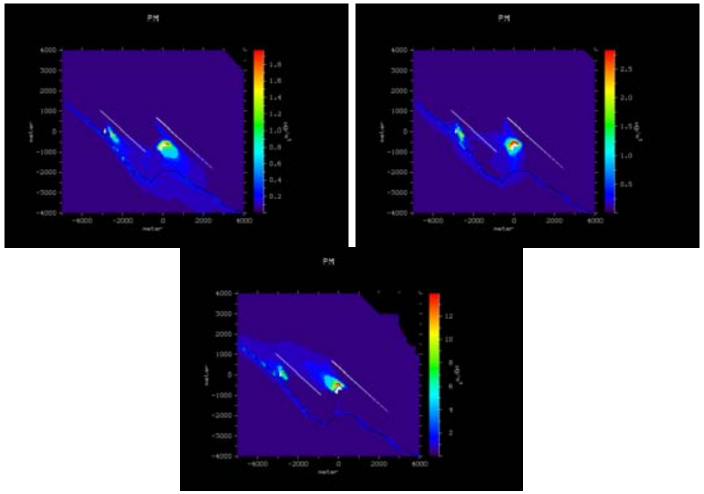

Figure 5.1.-5.3. Forecasted daily average PM_{10} concentration distribution at Ferihegy Airport in the last 3 days of August 2008.

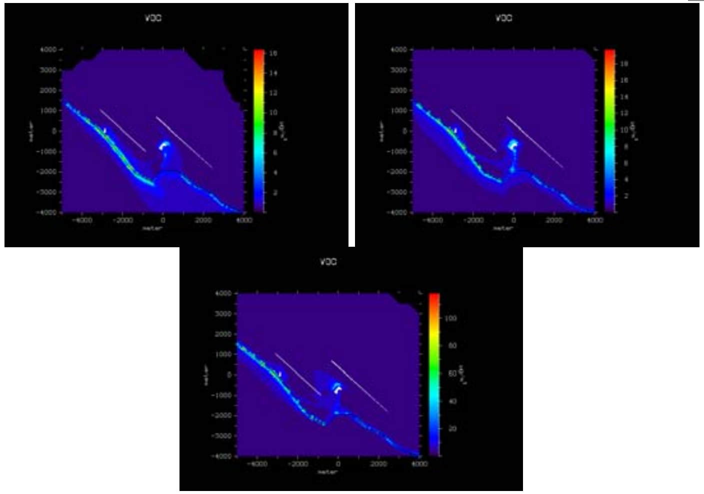

Figure 6.1.-6.3. Forecasted daily average VOC concentration distribution at Ferihegy Airport in the last 3 days of August 2008.

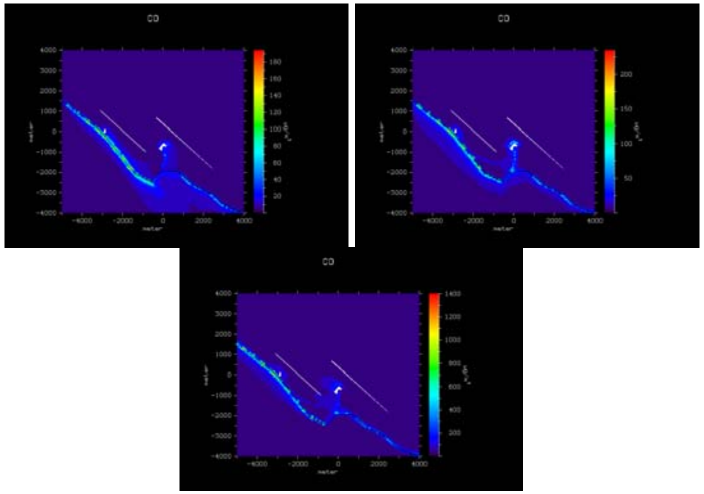

Figure 7.1.-7.3. Forecasted daily average CO concentration distribution at Ferihegy Airport in the last 3 days of August 2008

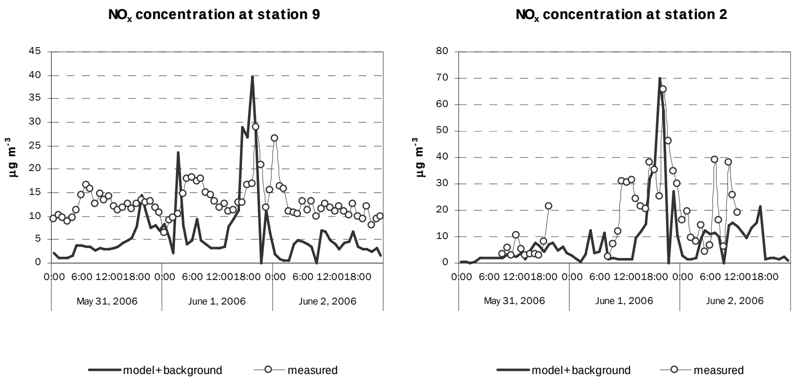

Figure 8. Comparison of the modelled and measured hourly averages of NO_x concentration at station 2 and 9, during May 31 – June 2, 2006.

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Jobs and PhD Positions

Urban SURFAce ENERGY, WATER, Carbon EXChanges:
In situ observation, REMOTE SENSING, Analysis and Modelling Post (ref: G5/DAR/012/08)

We seek to employ a Research Assistant/Associate who will work on two European Union FP7 funded research projects to evaluate urban surface energy, water and carbon exchanges through in situ observations, remote sensing analyses and modelling. The KCL component of these projects involves the determination of fluxes for London using the techniques outlined below. Results will be used (1) to develop a decision support system for sustainable urban planning, accounting for urban metabolism; and (2) to assess impacts of megacities on local, regional, and global air quality and climate. The research objectives will be to determine the magnitude and spatial variability of the fluxes and their controls in relation to these applications.

A variety of methods will be deployed during the research, including micrometeorological techniques (e.g. eddy covariance, large aperture scintillometry) to determine local scale fluxes, and analysis of ground-based, airborne and satellite optical hyper-spectral and thermal IR data to determine the surface energy balance. Numerical modelling will involve urban land surface schemes and their application in WRF.

The post holder will work with Professors Sue Grimmond (sue.grimmond@kcl.ac.uk) and Martin Wooster (Martin.Wooster@kcl.ac.uk) and their existing research teams to deliver cutting-edge research into urban surface energy, water and carbon exchanges.

Urban Meteorology

The EMM Group's research on urban meteorology has centred around its investigation of energy, water and carbon exchanges using micrometeorological techniques, numerical modelling and remote sensing methods in a variety of urban areas (North America, Africa, Europe). This research has been led by

Professor Sue Grimmond and Prof Martin Wooster, and the current post will work within their existing research teams. Recent publications can be found here:
http://www.kcl.ac.uk/ip/suegrimmond/news.htm
http://www.kcl.ac.uk/schools/sspp/geography/people/acad/wooster/pubs.html

Application deadline: 31st October 2008 or until the post is filled. Application procedure and more details about the job can be found at:
http://www.kcl.ac.uk/depsta/pertra/vacancy/external/
http://www.kcl.ac.uk/depsta/pertra/vacancy/external/pers_detail.php

Professor Sue Grimmond
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Environmental Monitoring and Modelling Group
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PhD Studentship: CEH/KCL - Quantifying evaporation pathways in the suburban environment
PhD CASE Studentship (Must be eligible for NERC PhD funding)

Suburban evaporation is controlled by the mosaic nature of land cover and drainage practice, leading to higher evaporation rates than from both neighbouring rural and urban built-up areas; these result from vast water supply importation combined with fragmented green spaces, and increased energy availability from anthropogenic heat emissions. Increasing population, wealth and lifestyle expectations, and changing climate combine to exert pressure on suburban water balance, on regional water resources, and for the development of sustainable water use. Damaged and aging water distribution networks, and modern surface water drainage techniques increase local water availability to plants and thus evaporation, in turn leading to changes in heat fluxes and carbon exchange.

Pressures on greenspace (e.g. off-road parking) has lead to a dramatic reduction in numbers of urban gardens, replaced with impermeable or semi-permeable surfaces, with very different water-storage and evaporative characteristics. It is essential to quantify the contributions to the total evaporation from different land surface types, taking into account local hydraulic and soil conditions. Understanding these evaporation pathways will allow the prediction of water cycle changes in response to future land use change and drainage practice.

Research will address the small-scale (e.g. transpiration of individual trees), integrating up to large area measurements of evaporation at 2 km^2 scale at which land-atmosphere models and satellite observations operate. The student will:

i) Measure large scale suburban evaporation using a large aperture scintillometer and the land surface energy balance.
ii) Tree and plot scale evaporation will be measured using e.g. sap-flow gauges, and lysimeters.
iii) Plot-scale measurements will be up-scaled by land-class mapping, to compare with (i).
iv) Inferences from (iii) will improve the modelling of suburban evaporation in land-atmosphere climate models (currently poor due to lack of good observations).

Training will be given in observations/instrumentation, data analysis, programming and small model development.

To apply for this project please send a CV and covering letter with details of two referees to the contact supervisors (jge@ceh.ac.uk; and sue.grimmond@kcl.ac.uk).

Application Deadline: 30 January 2009.

Part of a multi-disciplinary team project on the suburban water cycle, the student will be based at CEH Wallingford and King's College London (Prof Sue Grimmond), with fieldwork in southern England. The project requires a combination of micrometeorological and plant physiological field instrumentation, data analysis and modelling - training will be given. A background in physics, meteorology, engineering, ecology and/or geography with good numeracy is desirable.

Eligibility: If you have or expect to receive a 2.1 degree or higher, you are a UK citizen and you have always lived in the UK you are eligible to apply. If you have a 2.2 degree, but have also obtained a masters qualification, you are also eligible.

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GKSS PhD position - Code-No. 2008/KS 7
Model supported management of the Baltic Sea fairways

The GKSS Research Centre is located in Geesthacht near Hamburg, Germany, with a further centre in Teltow near Berlin, and is a ember of the Helmholtz Association of German Research Centres (HGF). With its approximately 800 employees it undertakes, in collaboration with universities and industry, research and development in the areas of coastal research, materials research, regenerative medicine, and structure research with neutrons and synchrotron radiation.

The Institute for Coastal Research in Geesthacht (near Hamburg, Germany) invites applications for a PhD position - Code-No. 2008/KS 7 Model supported management of the Baltic Sea fairways.

Appointment will begin as soon as possible and will be for three years.

The Department of Data Analysis and Data Assimilation, at the Institute for Coastal Research, hosts a number of highly motivated end expertised researchers in the field of numerical modelling of regional coastal circulation and biogeochemical processes, surface waves, sediment transport, data assimilation, remote sensing. The Department is partner in the International Research Project "The potential of currents for environmental management of the Baltic Sea maritime industry (BalticWay)", which aims at a substantial decrease of environmental risks by minimizing the consequences of potential accidents. The research approach is based on a smart use of semi-persistent current patterns, which considerably affect propagation of pollutants. Areas of reduced risk will be sought for fairways and locations of high-risk offshore structures. Identifying areas of reduced risk will be based on a massive use high-resolution coupled circulation and wave models, as well as Lagrangean techniques, data analysis, and model validation for Baltic Sea and some specific coastal regions.

The successful applicants will have a Masters Degree in Physics, Mathematics, Oceanography, Atmospheric Science or related discipline. Needed qualifications include: ability to work as part of a team. Preferred candidates will have experience with numerical modelling. Good skills in scientific programming (FORTRAN) as well as working with computers (Unix/Linux) are expected, as well as good knowledge of the English language (written and oral).

We offer an appropriate salary, related to TV-AVH as well as the usual public sector social benefits. GKSS is an equal opportunity/affirmative action employer seeking to increase the proportion of female faculty members. Qualified women are therefore especially encouraged to apply. Physically handicapped persons will be favoured if they are equally qualified.

Applicants should send a statement of interest, curriculum vitae including a list of publications, and the names and addresses of three references to: GKSS Forschungszentrum Geesthacht GmbH, Personalabteilung, Max-Planck-Str. 1, 21502 Geesthacht, Germany, or personal@gkss.de. Closing date for applications is January, 5th, 2009. Late applicants will be considered until the position is filled. Please mention EARTHWORKS when responding to this advertisement.

Prof. Emil Stanev
emil.stanev@gkss.de
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Max-Planck-Strasse 1, D-21502 Geesthacht, Germany
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Post-Doc to Conduct Research on NSF-Sponsored Grant on Surface Boundary Layer Characterization in Urban Areas

Dr. Hanna has been carrying out a long-term study to understand the basic physical principles of boundary layer flow, turbulence and stability in urban areas. The research has led to publications emphasizing analysis of street-level and rooftop sonic anemometer observations obtained during field experiments in Oklahoma City (Joint Urban 2003 or JU2003) and in Manhattan (Madison Square Garden 2005 or MSG05 and Midtown 2005 or MID05). Several papers have been published describing the results (Hanna et al. 2006 and 2007, Hanna and Baja 2009, Hanna and Zhou 2009). Current research addresses variations of urban boundary layers across the urban area (using the Oklahoma City field data), and extension of the turbulence analysis to additional urban data sets (e.g., Basel BUBBLE, London DAPPLE, Marseille UBL/CLU-ESCOMPTE, Goteburg, and COSMO). Specific questions include:

1. When there are several meteorological instruments in the built-up downtown area, what is the spatial variability of fast response observations of turbulent energies and fluxes in the urban canopy layer?
2. What is the best way to define the surface scaling parameters (e.g., u* and T*) derived from urban boundary layer observations and used as inputs to various types of models?
3. Can the variations in winds, turbulence, and stability in an urban area from the built-up downtown area to the upwind and downwind rural areas be parameterized?

4. Can the vertical variation of stability, from near street level to several times the mean building height, be parameterized in the suburban and downtown areas?
5. Because routine detailed meteorological measurements are not usually available from urban areas, is it possible to use routine observations from airports or mesonetworks to parameterize the winds, turbulence, and stability in the urban area?

A full-time post-doctoral position is available in the Program of Exposure, Epidemiology and Risk at the Harvard School of Public Health (see http://appserver.sph.harvard.edu/eer/) in Boston to participate in this research for a one year period, beginning on 1 April 2009, with the possibility of renewal for an additional year. The candidate could also assist in related studies such as application of urban wind flow and dispersion models to estimate the effects of particle pollution due to traffic in urban areas.

Interested persons should contact Dr. Hanna by e-mail (shanna@hsph.harvard.edu

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Past events

AMGI/EURASAP Workshop
Air quality management, monitoring, modelling, and effects
May 24-26, 2007, Zagreb, Croatia

Peter Builtjes[1] and Zvjezdana Bencetić Klaić[2]
[1] TNO, Apeldoorn, The Netherlands
[2] AMGI, Zagreb, Croatia

The AMGI/EURASAP workshop on the Air quality management, monitoring, modelling, and effects was organized at the Andrija Mohorovičić Geophysical Institute (AMGI), Department of Geophysics, Faculty of Science, University of Zagreb. It was supported by EURASAP and it was attended by 40 participants of various institutions. The main goals of the workshop were:

- To provide background on different aspects of science and policy for air quality improvement at local, regional, and global scales.
- To share information among different disciplines in the atmospheric, meteorological and health sciences.
- To provide a public forum for explaining the nature and potential impacts of waste-to-energy facilities and other stationary industrial sources.

During the first day, the major air quality concerns in Croatia and Europe were discussed. Afterwards, overview presentations providing an update on the recent knowledge regarding decision making, health, visibility and radiation balance effects, modelling and monitoring, were given by US scientists. The second day was mainly devoted to the updates on the

Croatian air quality policies and scientific studies. Finally, stationary sources, and particularly thermal waste treatment plants were in the focus of the last day presentations and discussions.

Panel discussions resulted in summarization of the research and regulatory needs for Croatia, as well as in the recognition of the need for improvement of the current interactions among institutes and other entities.

More details could be found at the workshop web site http://www.gfz.hr/eng/workshop.php.

Workshop Attendees, Zagreb, May 24, 2007

12th International Conference on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes (HARMO12), October 6-9, 2008, Cavtat, Croatia

Lukša Kraljević
MHS, Zagreb, Croatia

12th International Conference on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes was organized in Cavtat, Croatia by Croatian Meteorological and Hydrological Service (MHS). There were 158 participants from 27 countries. 88 talks were held, and 65 posters were presented during the conference. EURASAP supported participation of three PhD students. The conference was organized in following sessions:

- Model evaluation and quality assurance
- Environmental impact assessment
- Regulatory models - country review
- Use of modelling in support of EU air quality directives
- Short distance dispersion modelling
- Meso-scale meteorology and air quality modelling
- Urban scale and street canyon modelling
- Concentration fluctuations and odour
- COST 732 action on quality assurance of models

Full list of talks and posters, together with presentations and extended abstract can be seen at the conference website at: http://www.meteo.hr/harmo12/

HARMO12 participants, Cavtat, October 2008

Future events

7TH INTERNATIONAL CONFERENCE ON AIR QUALITY - SCIENCE AND APPLICATION (FORMERLY URBAN AIR QUALITY CONFERENCE)
Istanbul, Turkey, 24-27 March 2009
Information at: http://www.airqualityconference.org/

30TH NATO/SPS INTERNATIONAL TECHNICAL MEETING ON AIR POLLUTION MODELLING AND ITS APPLICATION
San Francisco, USA, 18 - 22 May, 2009
Information at: http://www.int-tech-mtng.org/30th/index.html

FIFTH INTERNATIONAL SYMPOSIUM ON NON-CO2 GREENHOUSE GASES (NCGG-5)
SCIENCE, REDUCTION POLICY AND IMPLEMENTATION
Wageningen, The Netherlands, June 30 - July 3, 2009
Information at: http://www.ncgg5.org/

INTERNATIONAL CONFERENCE "MEGACITIES: RISK, VULNERABILITY AND SUSTAINABLE DEVELOPMENT"
Leipzig, Germany, 7 – 10 September 2009
Information at: http://www.megacity-conference2009.ufz.de/

New books

Regional / Transboundary Transport of Air Pollution. An Introductory Science Review. Dimitrios Melas (Ed.), Urbano Fra Paleo (Ed.). Universidad de Extremadura, ISBN: 978-84-7723-784-6. More information at: http://www.xente.mundo-r.com/science/transboundary/index.html

EUROPEAN ASSOCIATION FOR THE SCIENCE OF AIR POLLUTION
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