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CONTENTS

Front cover: Dotrščina forest in Zagreb, Croatia (photo by B. Rožman)

EDITORIAL

Dear EURASAP members,

In this issue you will find contributions of two scientists who recently obtained EURASAP travel grants. These are Andrea Amicarelli from Italy (grant for 12th International Conference on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes, HARMO12, 2008, Cavtat, Croatia) and Aleksander Astel from Poland (grant for 7th International Conference On Air Quality - Science And Application, 7th ICAQ, 2009, Istanbul, Turkey).

Among events in the near future, EURASAP will support the 30th NATO/SPS International Technical Meeting on Air Pollution Modelling and Its Application San Francisco, USA, 18 - 22 May, 2009.

Finally, it is my pleasure to inform you that as of the beginning of 2009, at the EURASAP web page http://eurasap.gfz.hr/ you can find updated online information on future events and offered jobs and PhD positions. If you have any such information which you would like to have posted at the EURASAP web site, please forward it to zklaic@rudjer.irb.hr.

The Newsletter Editor

Scientists' Contributions

LAGFLUM: A 3D LAGRANGIAN MODEL FOR CONCENTRATION FLUCTUATIONS

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Abstract: A LAGrangian FLUctuation Model (LAGFLUM) has been developed by coupling a macromixing with a micromixing scheme, with the aim of determining the mean and the variance of concentration for a passive scalar in 3D turbulent flows. The macromixing scheme is based on the well-mixed condition while the micromixing is based on the IECM (Interaction by Exchange with the Conditional Mean) scheme. LAGFLUM gives the statistical moments of the probability density function of the scalar concentration. The model has been tested by comparison with experiments found in the literature, in which the dispersion of a

passive tracer in a 3D stationary flow field, in presence of obstacles, is analysed.

Key words: *concentration fluctuations, micromixing, IECM, MUST*

INTRODUCTION

Knowledge of concentration fluctuations is useful both to determine the range of the expected values of concentration for microscale dispersion and to assess the hazard in the case of a strong non-linear relationship between concentration and damage (i.e. accidents). Furthermore, knowledge of concentration fluctuations permits a better simulation of chemical reactions, which depend on the instantaneous concentration, rather than the mean. The IECM model (Pope, S. B., 1998; Sawford, B. L., 2006) is one of the more promising methods to estimate the concentration fluctuations. IECM micromixing models have been applied to several case studies: one-dimensional scalar dispersion in grid turbulence from line or area sources (Sawford B. L., 2004) and for multiple reacting pollutants (Sawford B. L., 2006), one-dimensional multiple scalar dispersion in convective boundary layers from area sources (Luhar A. K. and B. L. Sawford, 2005), one-dimensional dispersion from area sources in canopy turbulence (Cassiani, M. et al., 2005c), two-dimensional dispersion from point or line sources in neutral boundary layers (Cassiani, M. et al., 2005a; Dixon, N. S. and A. S. Tomlin, 2007) and in convective boundary layers (Cassiani, M. et al, 2005b), and from single or multiple sources in canopy turbulence (Cassiani, M. et al, 2007a; Dixon, N. S. and A. S. Tomlin, 2007; Cassiani, M. et al., 2007b).

In this context, the three-dimensional stochastic model LAGFLUM has been developed by coupling a macromixing with a micromixing scheme, to determine the low order statistical moments of concentration for a passive scalar in 3D turbulent flows. The macromixing scheme is based on the "well-mixed" condition (Thomson, D. J., 1987). This model describes the motion of marked fluid particles and is used to estimate the averaged concentrations. To estimate the concentration fluctuations, the IECM micromixing equation has been numerically integrated along the particle trajectories. All the particles move according to the macromixing scheme and exchange pollutant mass through the micromixing process. So they have their own representative instantaneous concentrations: the statistics of these concentrations in each cell of the domain can furnish all the concentration moments.

LAGFLUM has been tested by comparison with the MUST wind tunnel experiment by Bezpalcova, K. (2007) and Leitl, B. et al. (2007). In that experiment the dispersion of a passive tracer in 3D, stationary flow fields in the presence of obstacles was analysed. In the present paper, after a short description of the experiment, the LAGFLUM equations are reported and some results of the comparison between the model and the experiment are shown.

THE EXPERIMENT

The dispersion of a passive pollutant (ethane) has been performed inside an obstacle array in the WOTAN wind tunnel of the Environmental Wind Tunnel Laboratory (EWTL) at the Meteorological Institute of the University of Hamburg, Germany, with the aim of reproducing the MUST field experiment. Details can be found in Bezpalcova, K. (2007) and Leitl, B. et al. (2007).

We choose the *x*-axis to be in alignment with the obstacle array. The reference wind speed outside the array is $u_{ref}(z=7.3\text{m}) = 8$ m/s, oriented at 45° clockwise to the *x*-axis. Here we always refer to the full scale values (the wind tunnel scale is 1:75). All the velocities were measured with the two-dimensional Laser-Doppler technique. Figure 1 shows the numerical domain used in our simulations together with the obstacle arrangement (brown), the pollutant source (violet). The domain considered in the numerical simulation is the part of the wind tunnel domain nearby and leeward of the pollutant source. It represents almost a quarter of the wind tunnel domain. The obstacles have all the same dimensions ($12.5\text{x}2.5\text{x}2.5\text{m}^3$), except the smallest one, which is $5\text{x}2.5\text{x}3.5\text{m}^3$. Although the obstacle array is a little irregular, an average distance between the obstacles of 12.9 m along x-axis and 7.9 m along the y-axis can be recognised. Even though there were more obstacles in the wind tunnel than those included in our simulation, the extra obstacles were located downwind of our numerical domain. The meteorological dataset (Figure 1, upper left panel) is composed of a coarse network (green), some vertical profiles (red and black) and a fine network (blue). The coarse network covers the whole wind tunnel domain at the height of the obstacles ($z=H=2.5$m), at $z=2H$ and $z=H/2$. It collects the mean and the standard deviation of the horizontal velocities ($\bar{u}$ and σ_u along x, $\bar{v}$ and σ_v along y) at 847 monitoring points. 18 profiles of the standard deviation of the vertical velocity (σ_w), $\bar{u}$ and σ_u are

measured at 497 monitoring points. The fine network lies entirely within the numerical domain. It gives values of $\bar{u}$, σ_u, $\bar{v}$ and σ_v at 4 heights ($z=H/3$, $H/2$, $2H/3$, H) for a total of 376 monitoring points. All these monitoring point values have been interpolated to a numerical grid aligned with the coordinate axes using the inverse distance method. We use a three-dimensional interpolation for the mean horizontal velocities. Furthermore, in the first meter above the ground, a neutral logarithmic profile has been assumed with a roughness length equal to 0.0165 m. The vertical mean velocity ($\bar{w}$) has been computed from the balance equation for the air mass. The horizontal velocity variances have been referred onto the new reference axis, considering the correlation between the horizontal components of velocity. The variances were then interpolated as previously described for the means. The vertical velocity variance is only available from profile measurements. So a first vertical interpolation was performed for each profile, and then a two-dimensional horizontal interpolation at every level was made. In Figure 1 both the horizontal velocity and the velocity standard deviations, interpolated at $H/2$, are shown. The pollutant source, located at $x_s=12.54$ m, $y_s=72.90$ m, $z_s=0.15$ m, has a diameter of 0.75 m. The mean and the standard deviation of concentration $\bar{c}$ and σ_c, respectively, were measured with a Fast Ionization Flame Detector (frequency=150 Hz) in 73 monitoring points, belonging to the numerical domain, at the height $z=H/2$.

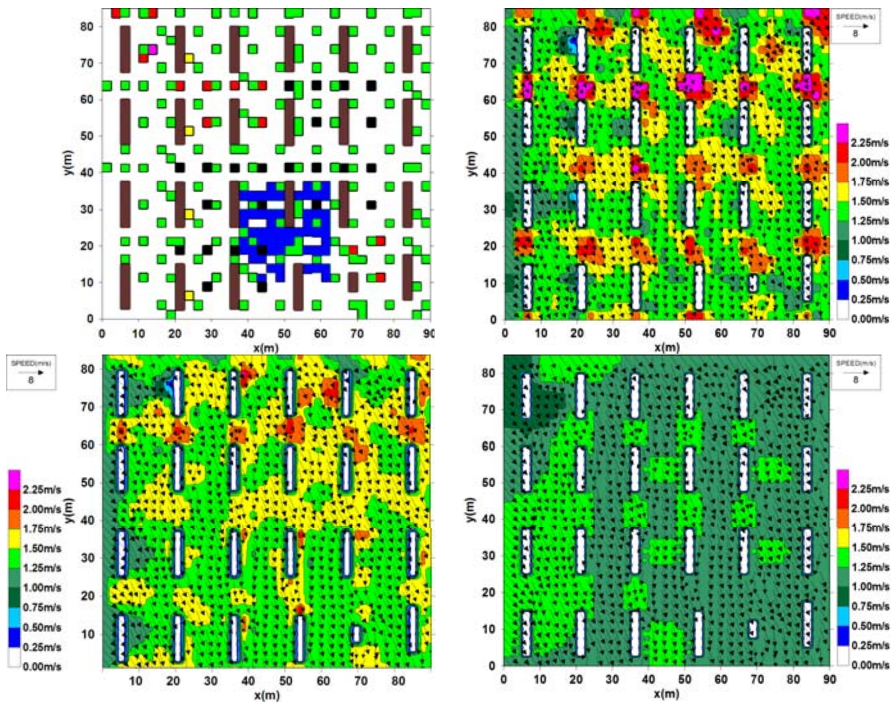

Figure. 1. Upper left: the numerical domain with the horizontal coordinates of the meteorological monitoring points (brown: obstacles, red: profiles, black: additional profiles obtained as topological correspondent red profiles, green: coarse network, blue: fine network, violet: pollutant source). Upper right: the horizontal wind speed (arrows) and σ_u (colour map) at z=H/2. Bottom left: the horizontal wind speed (arrows) and σ_v (colour map) at z=H/2. Bottom right: the horizontal wind speed (arrows) and σ_w (colour map) at z=H/2.

THE MODEL

LAGFLUM utilises both macromixing and micromixing schemes. The mean concentration is computed during the first phase of the model run by the macromixing scheme, while the concentration variance is obtained by the micromixing scheme in a second phase using the already-computed mean concentration. The macromixing scheme, which is based on the so called “well-mixed” condition, describes the motion of marked fluid particles. As pointed out by Pope, S. B. (1998), for high Reynolds numbers the mean concentration and the mean conditioned on the velocity are unaffected by the value of molecular diffusivity. Therefore, polluted fluid particles, which do not exchange pollutant mass with the surrounding ones, can be utilised to estimate the averaged concentrations. The well-mixed condition ensures a well-founded behaviour of the model in inhomogeneous turbulence. The following set of stochastic equations has been integrated (hereinafter the Einstein summation convention applies):

$$dU_i = a_i(\boldsymbol{X},\boldsymbol{U},t)dt + b_{ij}(\boldsymbol{X},\boldsymbol{U},t)d\xi_j \qquad (1)$$

$$dX_i = U_i dt \qquad (2)$$

where U_i and X_i indicate the particle velocity and position respectively, while $d\xi_j$ are the increments of independent Gaussian Wiener processes with mean zero and variance *dt*. Here the subscripts refer to the axis direction. The functions a_i and b_{ij} in stationary cases can be calculated as follows:

$$a_i = -B_{ij}\left(V^{-1}\right)_{jk}\left(U_k - \overline{u_k}\right) + \frac{\phi_i}{g_a} \tag{3}$$

$$2B_{ij} = b_{ik}b_{jk} = \delta_{ij}C_0\varepsilon \tag{4}$$

$$\begin{aligned}\frac{\phi_i}{g_a} &= \frac{1}{2}\frac{\partial V_{il}}{\partial x_l} + \overline{u_l}\frac{\partial \overline{u_i}}{\partial x^l} + \\ &+ \left(\frac{1}{2}\left(\mathbf{V}^{-1}\right)_{lj}\overline{u_m}\frac{\partial V_{il}}{\partial x_m} + \frac{\partial \overline{u_i}}{\partial x_j}\right)\left(U_j - \overline{u_j}\right) + \\ &+ \frac{1}{2}\left(\mathbf{V}^{-1}\right)_{lj}\frac{\partial V_{il}}{\partial x_k}\left(U_j - \overline{u_j}\right)\left(U_k - \overline{u_k}\right)\end{aligned} \tag{5}$$

C_0 is the Kolmogorov constant, assumed equal to 2 (according to Cassiani M. et al., 2007a), g_a is the probability density function of the Eulerian velocity, δ_{ij} is the Kronecker delta, V_{ij} is the one-point velocity covariance matrix of the turbulence (due to lack of data this matrix has been considered diagonal) and ε is the rate of dissipation of the turbulent kinetic energy. Following the work of Beljaars, et al. (1987), Kitada (1987) and Detering and Etling (1985) ε has been computed as a function of the turbulent kinetic energy (q):

$$\varepsilon = 0.3q\sqrt{\left(\frac{\partial \overline{u}_i}{\partial x_j}\right)^2} \tag{6}$$

Twenty million of particles have been released, in order to calculate both the mean $\overline{c}$ and the conditional mean concentration $\langle c|\mathbf{U}\rangle$. In the second phase of the LAGFLUM run the IECM micromixing equation is integrated. A large number of particles should be released all over the domain, uniformly distributed. Every particle should be initialized with the conditional mean concentration of the starting cell, in order to reproduce the motion of the whole fluid. Since the fluid motion has a predominant direction of motion, we can release the particles, in a more efficient way, only from the boundary of the plume. So, all the particles move according to the macromixing scheme (1, 2) and exchange pollutant mass through the micromixing process. In this way all the particles have their own representative instantaneous concentration: the statistics of these concentrations in every cell of the domain gives, in theory, all the concentration moments. In practise the lower order moments are better simulated and we focus here on the mean and variance. The micromixing model adopted here is the IECM:

$$\frac{dC}{dt} = -\frac{C - \langle c|\mathbf{U}\rangle}{t_m} \tag{7}$$

where C is the instantaneous particle concentration and t_m is the mixing time scale. As the simulation represents a large number of realisations of the turbulent regime, the conditional mean in (7) is consistent with the particles exchanging pollutant mass only with the surrounding particles belonging to a similar realisation (i.e. with a similar velocity at the particle location). The IECM scheme guarantees that the mean concentrations given by the macromixing model are unaffected by mixing, according to the balance equation for the pollutant mass. The mixing time scale is assigned consistently with the asymptotic mixing constraints (Cassiani, M. et al., 2005a):

$$t_m = 0.8\left(\frac{3}{2}\right)^{-\frac{1}{2}}\left[\left(\frac{3}{2}\right)^{\frac{1}{2}}\frac{\sigma_0^{\,2/3}}{\varepsilon^{1/3}}+\sqrt{2T_L t_f}\right] \tag{8}$$

where $T_L = 4q/3C_0\varepsilon$ is the Lagrangian integral time scale, σ_0 is the source length scale and t_f is the mean flight time of the particles, calculated on each cell during the macromixing process.

The numerical domain of $90\times 85\times 21\,\mathrm{m}^3$ is divided into $36\times 34\times 42$ cells with a horizontal spacing of $dx = dy =$ 2.5 m and a vertical one equal to dz=0.5 m. The pollutant source has been approximated with a continuous point emission. Furthermore, a geometrical reflection has been assumed for the particles hitting the ground or the obstacles.

RESULTS

Some preliminary results of the numerical simulation have been compared with the wind tunnel measurements of concentration on the horizontal plane at half obstacle height (Figure 2 and Figure 3). All the values of mean and standard deviation of the concentration

have been normalized with the reference scale Q/H^2u_{ref} , where Q is the source mass rate.

The centre of mass of the three-dimensional plume is not aligned with the wind speed reference direction, but it is rotated clockwise. In fact the obstacles channel the wind as it enters the array, due to their thin shape and the narrow canyons. However, as the distance from the source increases, the plume axis tends to the reference wind direction as the pollutant fluxes from the zones above the array begin to be important. Unfortunately, the low resolution of the flow data cannot accurately reproduce the recirculation zones downwind the obstacles, even if the maximum values of the standard deviations of velocity are correctly reproduced in the wake zones of the obstacles. Furthermore, both the mean and the variance of the velocities have been interpolated with a geometrical method, which fulfils neither the momentum balance nor the turbulent kinetic energy balance. Nevertheless, the comparison between numerical and experimental results shows a satisfying agreement. Both the plume shape and the concentration levels seem to be correctly reproduced, with the exclusion of a modest overestimation in a small zone near the source and the left side of the numerical domain. The standard deviations of the concentration are shown in Figure 3. In comparison with the mean, they show a wider lateral spread of fluctuations in the neighbourhood of the source. Such a behaviour is well visible also in the measured data and confirms, even with a little overestimation in the centre of the domain, the good performance of the model, which seems to properly reproduce the dissipation of the concentration fluctuations along the particle trajectories.

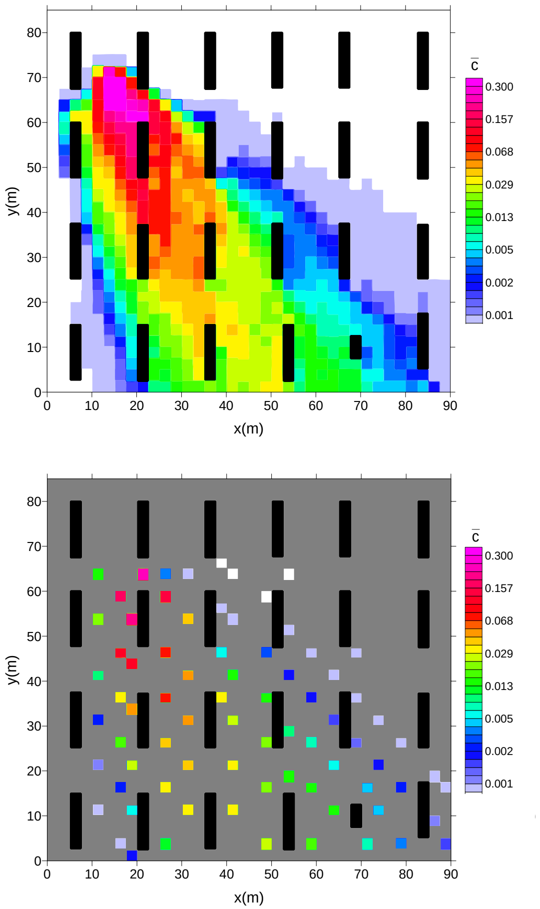

Figure 2. Comparisons between the simulated normalized mean concentrations (above) and the corresponding wind tunnel measures (below) at z=H/2. The buildings are shown in black and, for the wind tunnel results, dark grey is used to indicate no measurements available.

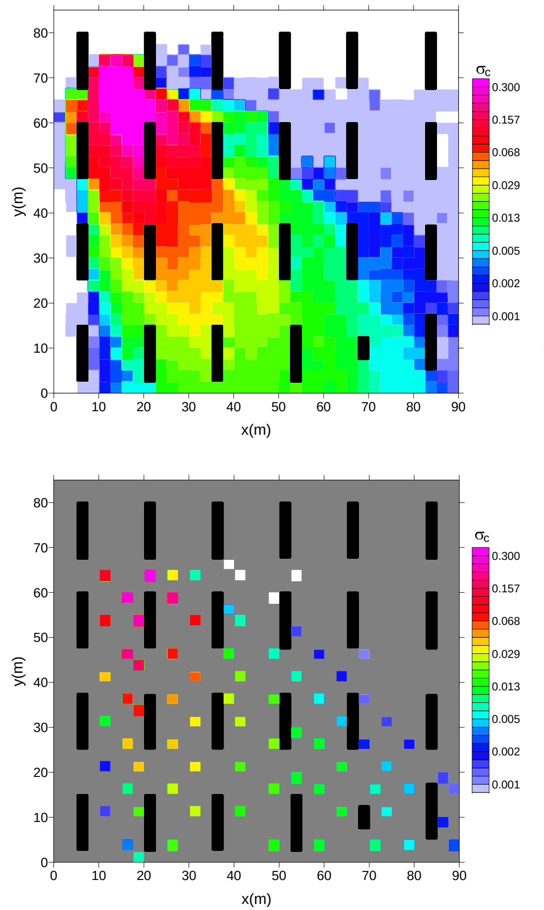

Figure 3. Comparisons between the simulated normalized standard deviation of the concentrations (above) and the corresponding wind tunnel measures (below) at z=H/2.

In Figure 4 a vertical section of the plume, parallel to the y-axis (x=21 m), is shown. It is noteworthy that the standard deviation of concentration (below) is comparable or much greater than the mean (above). Both these parameters decrease with height. As mentioned previously, we cannot represent well the cavity or interference zones inside the canopy as the meteorological data resolution is too low. This limitation could be overcome if we furnished a better meteorological field as input for the dispersion model. In particular, LAGFLUM can be coupled with k-ε or similar fluid dynamics models. The dispersion numerical grid resolution could also be improved.

In Figure 5 we report a cross section of the mean (above) and the standard deviation (below) of concentration, parallel to the x-axis (y=54 m), one canyon downwind the source location. We can see that the plume is confined by buildings and transported laterally by the wind flowing above the canopy, which is not aligned with the obstacles axis. This makes the plume act as an elevated source for the canyons closer to the side of the more polluted ones. Note that, as observed in Figure 4, the standard deviation of concentration is comparable to or much bigger than the mean. This reveals again the importance of concentration fluctuations in microscale dispersion, in a complex 3D flow, even in the presence of a canopy.

CONCLUSIONS

The numerical 3D model LAGFLUM (LAGrangian FLUctuation Model) based on the "well mixed" macromixing scheme (Thomson, D. J.,

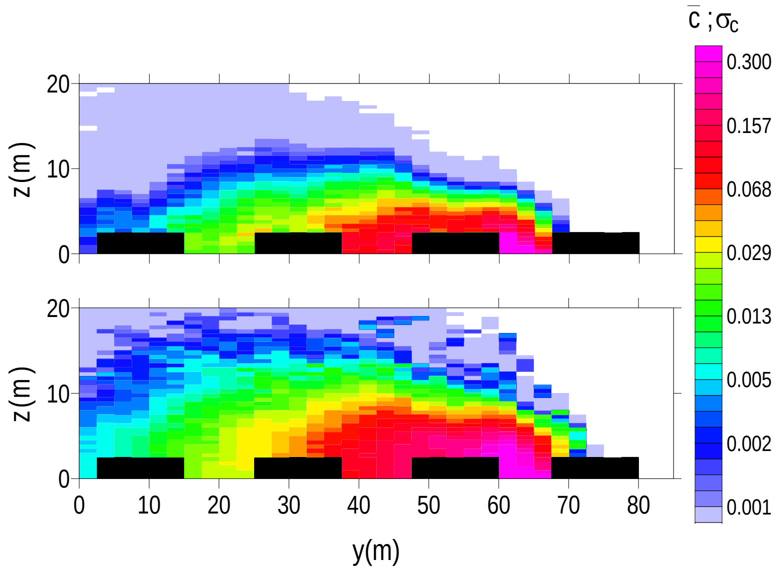

Figure 4. Mean concentration (above) and standard deviation of concentration (below) at x = 21 m.

1987), and the IECM micromixing scheme (Pope, S. B., 1998; Sawford, B. L., 2006) has been validated with the wind tunnel experiment of Bezpalcova, K. (2007) and Leitl, B., et al., (2007) on passive pollutant dispersion in the presence of obstacles. Starting from measured data, the wind field has been reconstructed by means of geometrical interpolation and the balance equation for the air mass. The simulated values of mean and variance of concentration show a reasonable agreement with the corresponding measurements (available only inside the canopy); both plume shape and

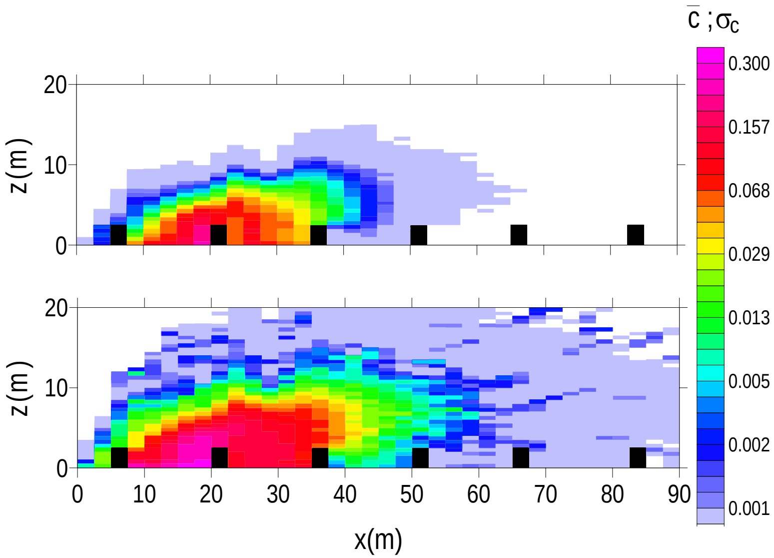

Figure 5. Mean concentration (above) and standard deviation of concentration (below) at y = 54 m.

concentration levels are reproduced satisfactorily. Some vertical cross-sections of the mean and the standard deviation of concentration are also reported. All the results underline the importance of concentration fluctuations in microscale dispersion in a 3D complex flow, even in the presence of a canopy. The model LAGFLUM seems to furnish a valid tool for the investigation of concentration fluctuations in complex turbulent fields. It can also be easily interfaced with k-ε or similar meteorological models.

Acknowledgements

The authors are grateful to Prof. Michael Schatzmann and Dr. Bernd Leitl that furnished us the MUST wind tunnel dataset. We also thank Dr. Claudio Gariazzo and Dr. Armando Pelliccioni for their support to this study. We are finally grateful to EURASAP (EURopean Association for the Sciences of Air Pollution) for its support in promoting this study.

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SOURCE APPORTIONMENT OF PM2.5 IN THE CITY OF TRIESTE

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INTRODUCTION

High immission of particulate matter (PM) is one of the most serious air pollution problems around the world. A positive correlation has been established between $PM_{2.5}$ and pathological effects on humans (Burnett et al., 2000). The serious risk to human health is a reason for many countries' declaring fine PM concentration as a criterion of air pollution and establishing allowable standards. One of priorities considered with PM is emission limitation, while the other is related to PM chemical profile description. Under some circumstances many components, especially polyaromatic hydrocarbons (PAHs), can be harmful to human health. Epidemiological studies have demonstrated an increase in lung cancer rates in people exposed to PAHs, such as coke oven workers, tobacco smokers and even city-dwellers

(Pavanello et al., 2002; Mumford et al., 1987; Barbone et al., 1995). As mentioned above, a key step in air quality management involves identification of sources of pollutants. The contribution of various sources to ambient particulate matter can be estimated by using source receptor oriented models. The aim of the present study was to identify the data structure of a $PM_{2.5}$ dataset from the City of Trieste (Italy), and to model the contribution of the identified pollution sources to the formation of the aerosol total mass contribution of possible or probable carcinogenic PAHs. Nowadays, the Italian monitoring network incorporates only 12 $PM_{2.5}$ stations. In the City of Trieste $PM_{2.5}$ is not routinely measured and this is why the presented study is of great importance.

EXPERIMENTAL

This case study presents the data concerning $PM_{2.5}$ composition that have been collected in two districts (Svevo and Muggia) of the coastal City of Trieste (Italy) within the framework of SITECOS project ("*Studio Integrato sul TErritorio nazionale per la Caratterizzazione ed il controllo di inquinanti atmOSferici*") (Amodio et al., 2008). The Svevo site is potentially influenced by both traffic and industrial activities (harbour, steel plant with coke oven) while the other sampling site is situated within a marina, close to the town of Muggia, southward along the coast in the Gulf of Trieste. The distance between the districts is approximately 3.5 km in a straight line, however the sea hinders direct travel. The City of Trieste is known in Italy for being windy, and the prevailing wind is the ENE "*Bord*" wind; gusts occur that are not infrequently above 100 $km \cdot h^{-1}$, especially during winter. Local-scale breezes prevail during summer. The sampling campaigns at the two sites were conducted from

February 1st to March 5th and from June 20th to July 24th, 2006. Major inorganic anions (Cl^-, F^-, PO_4^{3-}, SO_4^{2-}, NO_3^-, NO_2^-, CH_3COO^-, $HCOO^-$, $C_2O_4^{2-}$,), organic and elemental carbon (OC and EC) were investigated and determined in PM in agreement with procedures described earlier by Talebi and Abedi (2005) and Fermo et al. (2006), respectively. Major PAHs (benz(a)anthracene (BaA), chrysene, benzo(e)pyrene (BeP), benzo(b)fluoranthene (BbF), benzo(k)fluoranthene (BkF), benzo(a)pyrene (BaP), dibenzo(a,h)anthracene (DBahA), benzo(g,h,i)perylene (BghiP), indeno(1,2,3-c,d)perylene (I123P)) were analysed on half of each filter. Those PAHs were chosen since a variety of information is available, and because they are suspected to be more harmful than some of the others. Additionally, a set of non-carcinogenic PAHs was analysed as well: naphthalene, acenaphtylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene and pyrene.

The principal component regression of the collected data was performed by using the STATISTICA software package 8.0 (Statsoft, Inc.) and MS Excel 2003 (Microsoft, Inc.). Before environmetric analysis, the non-carcinogenic PAHs' concentrations were summarized and presented as one variable (NC_PAH_tot).

RESULTS AND DISCUSSION

PM composition of urban air in the City of Trieste was characterized by using almost 130 samples collected at the Muggia and Svevo sites during summer and winter field campaigns (the following abbreviated notation was applied: MS, MW, SW, SS (M: Muggia, S: Svevo, W: winter, S: summer)). The amount of $PM_{2.5}$ mass explained by the chemical species measured in comparison with $PM_{2.5}$ total mass was, on average, equal to 44% (range 25%–62%), 68% (range 45%–98%), 46% (range 25%–83%) and 52% (range 24%–70%), respectively, for MS, MW, SS and SW. The ratio between the $PM_{2.5}$ total mass and $PM_{2.5}$ calculated as a mass of chemical species measured approaches 0.5 and, hence, is acceptable, taking into consideration a lack of heavy metals determinations and strong comparability with the results presented by Perrone et al. (2006), who observed main ionic components accounting for up to 38% of the PM total mass.

For Muggia and Svevo districts four independent PCA analyses of the seasonally divided dataset were performed. The factor layout for both sampling sites and both seasons is similar but not identical, due to the distance between them and the quality of possible pollution sources. Obtained PCs explain the majority of the total variance as follows: MS – 80.9%, MW – 77.9%, SS – 82.9% and SW – 86.3%. In the case of MS four major factors were obtained. PC1 explains over 35% of the total variance and includes strongly positively correlated non-carcinogenic PAHs, BaA, BbF, BkF, BaP, DBahA, BghiP and I123P. PC1 reflects automobile and truck exhaust, including internal engine combustion and unburned emission such as evaporation of vehicle exhausts and hence, conditionally named "traffic". PC2 has a mixed nature, explains over 27% of the total variance and includes strongly positively correlated SO_4^{2-}, NO_3^-, $C_2O_4^{2-}$, OC, EC, and negatively correlated non-carcinogenic PAHs. PC2 reflects the co-emission of SO_4^{2-} and NO_3^- precursors (SO_2, NO_x) connected with the combustion of fossil fuels and burning of biomass, and this is why it was conditionally named "secondary emission and combustion". PC3 explains over 11% of the total variance and is influenced only by BeP. This suggests that PC3 could be identified either as "site-specific anthropogenic source" or as a factor that should be combined with the "traffic" factor. The last

significant factor (PC4) can be interpreted as marine aerosol (conditionally named "sea spray"), based upon high weight of Cl^-. This explanation seems reasonable because of the specific location of the City of Trieste and the local scale breezes prevailing during summer.
In the case of MW only three major factors were obtained. The most informative, PC1 (47% of explained variance), includes strongly positively correlated BaA, chrysene, BeP, BbF, BkF, BaP, DBahA, BghiP and I123P. As with the conclusion presented above, PC1 in this case was renamed as "traffic" factor. Analogically to the PC2 composition in the summer season, a factor recognized as "secondary emission and combustion" in winter at the Muggia site was influenced mainly by SO_4^{2-}, NO_3^-, $C_2O_4^{2-}$ and OC. PC3 was composed of inversely proportionally correlated EC and non-carcinogenic PAHs. Thus, PC3 could be identified either as "site specific anthropogenic source" for the winter sample collection, or as a factor that should be mixed with the "traffic" factor. In contrast with the summer season, no "sea spray" factor was identified.

In the case of SS four major factors were obtained. PC1 explained over 48% of the total variance and included strongly positively correlated non-carcinogenic PAHs, BaA, chrysene, BeP, BbF, BkF, BaP, DBahA, BghiP and I123P. Analogically to PC1 at Muggia district in the summer season, the first factor was identified as "traffic". In contrast to Muggia district both "secondary emission" and "combustion processes" factors were distinctly separated. The "secondary emission" factor explains 17%, while "combustion processes" 11% of the total variance. The last significant factor can be interpreted as marine aerosol and explains 8% of the total variance.

In the case of SW four major factors were obtained. Once more the most informative factor (47% of the total variance) was interpreted as "traffic" and was influenced by chrysene, BeP, BbF, BkF, BaP, DBahA, BghiP, and I123P. Combined "secondary emission" and "combustion processes" factors explain almost 20% of the total variance. Strong positive correlation of OC observed both for mixed factor and for EC suggests that combustion processes indicate a variety of types and reflects to factor layout. The last significant factor (PC4) can be interpreted as "site specific anthropogenic source". It was influenced by only two variables (non-carcinogenic PAHs and BaA) but can be joined as well with the "traffic" factor. Consecutively, PCs' scores were computed for each identified PC. These were converted to Absolute Principal Component Scores (APCSs), and mass as a sum of analytes of each sample (in $\mu g \cdot m^{-3}$) was regressed on the APCSs. The model yielded a significant intercept (i.e. impact of undefined sources named "unexplained mass") only for Svevo district in the summer season, equal to 1.7 $\mu g \cdot m^{-3}$ (R^2=0.94). In Table 1 the source apportionment results for each district in the winter and summer seasons are presented.

The results from the model show that the average combination of particulate matter in the Muggia site during summer time is such that "secondary emission and combustion" is contributing the greatest share of the particulate matter (74%). The "traffic" contribution is almost ten times lower than "secondary emission and combustion" and covers 8%, while "sea spray" is 13%. The model overestimates total mass by an only symbolic 2%. In the summer season in Muggia district the combination of $PM_{2.5}$ sources is relatively stable in the case of "traffic" and diversified for mixed "secondary emission" and "combustion" processes. This phenomenon indicates that the "traffic" source of a low emission is less susceptible to meteorological factors, while the "secondary emission" and "combustion" processes as associated with high emission are more influenced by wind strength and direction. The average combination of $PM_{2.5}$ in Muggia district during winter indicates the highest contribution of "secondary emission and combustion" and "traffic" equal to 91% and 16%, respectively. An increase of "secondary emission and combustion" and "traffic" during the winter season might be explained by intensification of heating and prolonged starting of diesel engines. In the case of MW both "specific source" and the unexplained part appear non-significant,

Table 1. Contribution from PCA identified source for Muggia (n=595 (summer) and n= 442 (winter)) and for Svevo n=595 (summer) and n= 544 (winter)).

	Mass source contribution			
	Muggia		Svevo	
	Summer	Winter	Summer	Winter
traffic	8% (0.8±0.4 μg·m^{-3})	16%* (2.3±2.0 μg·m^{-3})	4%* (0.5±0.5 μg·m^{-3})	2% (0.3±0.5 μg·m^{-3})
secondary emission	74%* (7.8±3.8 μg·m^{-3})	91%* (12.9±5.1 μg·m^{-3})	45%* (5.1±2.8 μg·m^{-3})	69%* (10.0±6.8 μg·m^{-3})
combustion			39%* (4.4±2.1 μg·m^{-3})	37%* (5.4±3.8 μg·m^{-3})
specific source	-	-	-	4%* (0.6±1.2 μg·m^{-3})
sea spray	13%* (1.4±0.5 μg·m^{-3})	-	-	-
unexplained	7% (0.7±0.3 μg·m^{-3})	-	15%* (1.7±0.2 μg·m^{-3})	-
R	0.96	0.96	0.97	0.98
R^2	0.92	0.91	0.94	0.96

* Significant component in PCR regression model

and the PCR model overestimates particulate matter by about 7%. In the case of Svevo district in the summer season the model shows comparable contributions of "secondary emission" and "combustion" equal to 45% and 39%, respectively. The lowest share of particulate matter (4%) emission is connected with "traffic", while 15% cannot be explained by the model. Analogically, as in the case of MS, the combination of $PM_{2.5}$ sources is relatively stable for "traffic" and diversified for mixed "secondary emission" and "combustion" processes. Moreover, the PCR model indicates only a symbolic, 3% overestimation. The highest overestimation, but one that is still acceptable in the case of the source apportionment models was calculated in the case of Svevo district in the winter season. The total estimated mass was higher than that measured, by about 12%. Observed overestimations are not systematic biases since they vary in the range of a symbolic 2–3% to 12%. They could be explained by natural variability of environmental measurements and consecutive uncertainties related to PCA and PCR modelling steps.

The modelled results show that the average combination of particulate matter in the Svevo site during winter time is such that "secondary emission" and "combustion" are contributing the greatest share of the particulate matter (69% and 37%, respectively). As presented in Table 1 the percentage termed contribution for both, summer and winter seasons, are similar while mass concentration indicates decrease of "secondary emission" and "combustion" in summer for about 30%. The observed decrease can be explained by the shutting down of heating systems, especially domestic systems, during the summer season. The "traffic" contribution is minimal and calculated at 2%, while "specific source" is 4%. Similarly to MW, the highest peaks for "secondary emission" and "combustion" processes are observed more frequently during mid-winter, and this might be related to decreasing temperature and intensified heating. Taking into consideration mass contributions, the contribution of "secondary emission" and "combustion" processes is almost one third higher in the winter season for both locations than in the summer. The percentage termed contribution of the "traffic" source is generally higher in the Muggia district than at the Svevo site. In spite of the fact that the percentage contribution of the "sea spray" source differs between both districts both seasonally and quantitatively, the mass termed contribution is similar and comparable to results presented by Salvador et al. (2004) for Madrid city, which is also located near the Mediterranean Sea. As presented in Table 1, except for MW the contribution of the "traffic" source does not exceed 1 $\mu g \cdot m^{-3}$. In spite of the relatively small contribution of the "traffic" source, it represents a substantial hazard for human health because of the high influence of possibly or probably carcinogenic PAHs.

CONCLUSIONS

In this work a source apportionment modelling has been successfully applied to identify and characterize $PM_{2.5}$ sources in the City of Trieste. The application of principal component analysis allowed the identification of "traffic", "secondary emission", "combustion" and "sea sprays" as the main $PM_{2.5}$ sources in the urban Muggia and Svevo districts. The contribution of these sources to $PM_{2.5}$ mass concentration was calculated using multilinear regression analysis. Road "traffic" reflected mainly automobile and truck exhaust gases and explained, in general, not more than 10% of the total mass, with one exception, winter in Muggia district, when it explained 16%. In spite of the relatively small contribution of the "traffic" source it is a substantial hazard for human health because of the high influence of possibly or probably carcinogenic PAHs. Mixed or separated processes reflected various burning activities ("secondary emission" and "combustion processes") and explained the majority of total PM mass. This source demonstrated seasonal variation. In spite of similar percentage termed contribution for both districts and seasons, mass concentration indicates decrease of "secondary emission" and "combustion" processes in summer of about 30%. In the case of Muggia and Svevo districts the marine influence was close to negligible.

Acknowledgements

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Jobs and PhD Positions

Professor in Ecological Modelling of Marine Systems, National Environmental Research Institute (NERI), University of Aarhus, Department of Marine Ecology (MAR)

Job description

National Environmental Research Institute (NERI), University of Aarhus, Department of Marine Ecology (MAR) http://www.dmu.dk/International/Water/ in Roskilde hereby announces a new position as Professor in Ecological Modelling of Marine Systems to be filled by 1 September 2009.

The Department of Marine Ecology has a staff of approx. 70 employees comprising 35 scientists, 10 technicians, 10 PhD students, 10 Master's students, and 5 administrative employees. The department conducts both basic and applied research in marine systems and is the focal point for environmental monitoring activities in Danish marine areas. Research activities focus on issues where human activities alter or are affected by the state of the marine environment. Main topics are eutrophication, bio-geochemical cycling of elements, effects of 'global change' on marine systems and ecotoxicology. Monitoring activities include development of new methods for monitoring, database management, development of statistical methods, and indicators for interpretation of monitoring results. Modelling activities include a variety of models, e.g. empirical models and mechanistic-dynamic ecosystem models both in 1D and 3D.

Field of activity

The new position is expected to strengthen the overlap between physical and biological modelling in the department by conducting basic and applied research within complex dynamic biogeochemical modelling. The research will primarily include work on complex three-dimensional models that both include physical and biological processes. A number of models are currently used in NERI, including a global general circulation model as well as models covering North Sea and Baltic Sea areas as well as local fjords in Denmark and in Greenland. The research is expected to develop the linkages between the ecological models in the department and experimental research in the field and in the laboratory, as well as include analyses of observations from monitoring programmes. The focus should be on development and application of different types of models, with level of complexity suited to the purpose of the modelling activity. The models should include both coupled 1D or 3D hydrodynamic/bio-geochemical models.

Key research topics for the modelling work include:

- Quantification of relationships between nutrient inputs and ecological status of marine systems
- Effects of 'climate change' on Danish and Arctic marine systems
- Productivity in pelagic systems and relationships with factors such as irradiance, nutrient inputs and hydrography
- Ecophysiology of marine organisms and interactions between the physical/chemical environment and growth

Linking research with management issues is important for the department, so focus should also be on areas where this can be

strengthened, e.g. the connection between nutrient input and productivity of marine areas. The dissemination of results to stakeholders, managers and politicians is a key activity, and ability and motivation in this regard is important in the position. The successful candidate is expected to develop the scientific environment in the department by initiating seminars, coordinating new research initiatives and strengthening the network both at national and international level. Within the department the candidate must be able to serve as a driving force within the linking of physical and ecological modelling. The ability to attract students from universities and substantial external funding is also a criterion for success.

Qualifications

The successful applicant is a Research Scientist with outstanding scientific qualifications and a proven record of scientific output at an international level within marine physical and biological modelling. A significant record of publications in international peer-reviewed journals and substantial experience in delivering scientific presentations are required.

We are looking for an individual with documented experience in combining modelling research within aquatic ecology with analyses, scenarios and predictions of marine systems. Broad experience within aquatic ecology is preferred, in addition to research experience with food-web interactions and ecology of marine organisms and their environment. Since the work in the department is based on administrative and political requirements for ecological models, you must have proven ability in establishing connections between the basic and the applied sciences within this field of research.

Teaching activities and examination of students at university level is required in order to facilitate dissemination of the knowledge in the department to universities at all levels. You are expected to play an active role in recruitment and supervision of PhD students and research scientists, and to contribute to development of courses.

Terms of employment and salary
The tenure of the professorship will be limited to a period of five years, with a possible extension of up to three years. There is a possibility of further extensions. The position is classified as grade 37 and will be filled according to the Agreement between the Danish Ministry of Finance and the Danish Confederation of Professional Associations. The salary may be subject to individual negotiation.

For more information please follow this link: www.workindenmark.dk

The applicants will be assessed according to the Ministry of Science Technology and Innovation Executive Order no. 170 of 17 March 2005.

Place of work: Roskilde (Sealand)

Further information can be obtained from the departmental Director of Research, Bo Riemann, tel.: +45 4630 1360.

General guidelines for employment as professor at NERI can be obtained from the HR Department tel. +45 4630 1200.

Your application marked 031-01150, including CV, documentation of academic degrees and publication list, in addition to any further material documenting your scientific experience you may wish to submit in support of your application, should be sent by email to: nytjob@dmu.dk

Larger attachments should be sent by post in four copies to:

National Environmental Research Institute
University of Aarhus
Frederiksborgvej 399
Postboks 358
DK-4000 Roskilde, DENMARK

The application and enclosures must be received at NERI no later than 1 February 2009.

NERI encourages applications from all qualified candidates, regardless of gender, age or ethnic background.

The Environmental Research Institute (NERI) is a part of the Aarhus University. NERI is a nonsmoking institute. NERI is located in Roskilde (Sealand), Silkeborg and Kaloe (Jutland), Denmark. *Aarhus University (www.au.dk/en) has 35,000 students, 8,500 members of staff and a turnover of DKK 4.8 billion. The University´s strategy and development contract are available at http://www.au.dk/en/strategy.*

Research Assistantship Opportunity: Northern Illinois University, DeKalb, IL, USA

The principal investigators of an NSF grant seek a motivated research assistant who is interested in pursuing research on how the urban heat island augments convection as part of his/her M.S. thesis. The ideal candidate will possess a strong background in geographic information systems and meteorology and/or climatology. Experience in using ArcGIS and/or Intergraph Geomedia, as well as an interest in thunderstorm environments is a plus. Two academic years plus summer funding under a Research Assistantship is available to the selected M.S. candidate. The funding includes a competitive stipend and full-tuition waiver. To receive full consideration, please apply by 1 February 2009.

For application materials and information, follow these links:
<http://www.grad.niu.edu/audience/prospective_students.shtml> and <http://globe.geog.niu.edu/gradstudies/Graduate_Studies.shtml>.
For more information concerning this research opportunity please contact Dr. Mace Bentley (mbentley@niu.edu) or Dr. Walker Ashley (washley@niu.edu).

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Post Doctoral Research Assistant position at the Department of Meteorology, University of Reading for up to 5 years working with Dr Janet Barlow on the Advanced Climate Technology Urban Atmospheric Laboratory (ACTUAL) project

We seek someone who will play a central role in the ACTUAL project by developing instrumentation platforms in London (Doppler lidar, eddy covariance systems, etc), analysing data and liaising with project partners. This involves designing experimental deployment, performing measurements, maintaining instrumentation, quality checking data and maintaining the database. Secondly, the PDRA will undertake data analysis to develop understanding of London's urban climate, in particular the response of the urban boundary layer to the underlying heterogeneous surface, and the relationship between street scale and city scale climate. Within the project simple models of urban climate processes will be developed with application to engineering areas such as wind engineering, renewable energy generation, etc. In particular, the PDRA should develop appropriate ways to disseminate results to non-specialist project partners (Greater London Authority, Arup, The Met Office) and engage with them during the project.

Candidates will have relevant experience in scientific instrumentation, preferably including fieldwork; a PhD in a physical science, engineering or similar field; and strong communication skills, both written and verbal; and preferably should be able to drive. The position is full-time, fixed-term for 5 years, at Grade 6 (£27,183 to £30,594 per annum). Further information and application forms are available at www.reading.ac.uk/Jobs or telephone 0118 378 6771 (voicemail) or contact Dr Janet Barlow

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Two Postdoctoral Fellows - mesoscale modelling and urban climate - at University of Hong Kong

We are looking for two Postdoctoral Fellows at the Built Environment Group, Department of Mechanical Engineering, University of Hong Kong. The possible working areas include development of the porous turbulence models for urban air flows, integration of air flow models (porous turbulence model based) in urban environment and mesoscale models (such as MM5 and WRF). Our aim is to carry out detailed air environment and ventilation studies of mega cities such Hong Kong and Shanghai. The post-doc is also expected to participate actively in the new Initiative on Clean Energy and Environment (ICEE) in the University of Hong Kong.

We are looking for candidates with a PhD degree within the recent two years in the areas of mesoscale modeling, urban meteorology/climate and/or fluid mechanics.

A highly competitive salary commensurate with qualifications and experience will be offered. Annual leave and medical/dental benefits will also be provided.

Review of applications will continue until the posts are filled. Candidates who are not contacted within 3 months of the date of their applications may consider their applications unsuccessful.

For application, please send a CV and a statement of interest to:

Professor Yuguo Li, liyg@hku.hk
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The University of Hong Kong
Pokfulam Road, Hong Kong
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Postdoctoral position at JRC Ispra

PROJECT REFERENCE NUMBER: IES-300901

Post-doctoral Research Project Title: Surveillance of SO_2 and NO_x emissions from ships

Project Description: The JRC is launching a project in order to screen potential surveillance techniques allowing identifying ships that are not complying with legally binding limits for the sulphur content of ship fuels or standards for NOx emissions. The techniques of interest must be based on measurements on ship exhaust plumes, using remote sensing techniques or airborne measurements. In this context we are looking for candidates to set up an international field campaign to compare methods for such

measurements. The candidate will identify research groups with potential capabilities in this field, organise the logistics for a several-day lasting field intercomparison and participate in evaluating the results. As an outcome of this work, a European methodology should be developed and assessed. The candidate shall interact with several research groups and with local authorities in the country chosen for the field campaign.
Qualifications: The ideal candidates has a PhD in natural science, with preference in environmental science or physics/ chemistry (or a university degree in environmental science, physics/chemistry or similar and 5 years of research experience after the university degree giving access to the doctoral studies). Knowledge of techniques for measurements of atmospheric trace gases, particularly laser based and spectroscopic remote sensing methods, would be an advantage. Experience in setting up large field experiments is an asset. Good writing skills and good knowledge of spoken and written English are required.

Duration: 24 months
Scientific Responsible: Jens Hjorth
Application details: http://ies.jrc.ec.europa.eu/call-for-grantholders

Two postdoctoral positions at Cambridge University

Vacancy Reference No: NA04750 Salary: £27,183-£35,469
Limit of tenure applies*

Two Postdoctoral Research Associate (PDRA) positions are available as part of the EPSRC-funded Energy Efficient Cities Initiative

(EECi) at the University of Cambridge. This initiative aims to strengthen the UK's capacity to address energy demand reduction and environmental impacts in cities through cross-disciplinary research in building and transport technologies, district power systems, urban planning and environmental impacts. Prospective applicants will work as part of the EECi multidisciplinary team of researchers and collaboratively develop models for investigating energy use and environmental conditions in urban environments.

1. Energy and Micro-environmental Modelling of Urban Blocks (contact: Ruchi Choudhary). The researcher will be responsible for developing the Building Cluster Module within the EECi in the following ways: (a) develop system level simulation models that can be used to map energy demand of urban blocks and assess the impact of interventions in building technologies, urban infrastructures, and energy supply systems, (b) integrate effects of microclimate and air quality in building clusters, (c) coordinate research findings and links between urban planning, building level modelling, and transport technologies with other researchers in the team. Candidates applying for this post must have a doctoral degree in a relevant engineering or science discipline, and a particular expertise in energy modelling of buildings, heat transfer, and building ventilation. Applicants who have experience in numerical modeling of physical systems, life-cycle assessment, and data analysis will be preferred.

2. Urban Environmental Impact Modelling (contact: Steven Barrett). This aim of this position is to quantify the environmental impacts of possible future energy, building and transport technologies on the urban environment. For example, future

transport modes with alternative fuels may lead to changes in pollutant emissions, leading to changes in air quality and the urban microclimate. Previous experience with simulation tools such as MM5/WRF and CMAQ or equivalent would be an advantage. Candidates who can bring expertise in urban atmospheric modelling to the project are particularly sought after. Topics of interest include urban heat islands, pollution dispersion and atmospheric chemistry as applied to determining urban public health and climate impacts.

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Head of Air Quality research unit

The Swedish Meteorological and Hydrological Institute, SMHI, supports decision making processes in sectors being highly dependent on weather and environmental conditions. We posses a broad competence in the fields of meteorology, hydrology and oceanography. Our products are used by Swedish and international enterprises as well as by public authorities, e.g. in the sectors of transport, environment and energy and in trade, forestry and media.

Would you like to lead the development of air quality models and support the decision-making process within both the private and public sectors when it comes to the effects of air pollutants? We are looking for a Head of the Air Quality unit at the Research Department of SMHI, the Swedish Meteorological and Hydrological Institute.

The activities of the Air quality research unit at SMHI cover modelling of atmospheric dispersion, chemical and physical transformations and deposition of substances from global to local scales. A range of different models are developed and applied. The main goal is to support SMHI and Swedish national authorities with research and development in the field of Air Quality, which implies involvement in both national and international research projects.

As unit head you lead and develop the research unit currently with a staff of eight. As head you have responsibility for personnel, budget, as well as the scientific development. You are also part of the management team for the Research Department and thus involved in the steering and development of research at SMHI including six research units. Important tasks include; to interact with other R&D environments nationally and internationally, find external and internal research funding and to combine research with development of methods and tools that improve the efficiency of the unit and which benefits users both within and outside SMHI. Emphasis is put on the ability to motivate and stimulate your co-workers and on ability to communicate results both within and outside SMHI.

In order to be a successful candidate we believe you should have;

- Experience in leading research groups or experience as project leader for major research projects.
- PhD in natural sciences or comparable working experience with focus on air quality modelling, including experience of scientific publication
- and supervision.

A good network in the field air quality research and experience of finding external research funding nationally and internationally.

Applicants should be fluent in English as well as having a good command of the written language. A successful non-Swedish speaking candidate will be required to learn Swedish as soon as possible (within the first eight months).

Application including CV and marked with reference number 562 should reach SMHI no later than the 16th of April 2009, via mail to SMHI, SE-601 76 Norrköping, Sweden or via e-mail to registrator@smhi.se. Contact persons are Joakim Langner head of Research Department, e-mail: Joakim.Langner@smhi.se or phone

+46-11-495 8450 and Karin Aspeqvist, Human Resources Department, e-mail: Karin.Aspeqvist@smhi.se or phone: +46-11-495 8110. Union representatives are Lennart Robertson, SACO, e-mail: Lennart.Robertson@smhi.se, or phone: +46-11-495 8281 and Barry Broman, ST, e-mail: Barry.Broman@smhi.se or phone: +46-11-495 8332.

Swedish Meteorological and Hydrological Institute is an Equal Opportunity employer.

Future events

SECOND INTERNATIONAL CONFERENCE ON ENVIRONMENTAL MANAGEMENT, ENGINEERING, PLANNING AND ECONOMICS (CEMEPE 09) & SECOTOX CONFERENCE
Mykonos, Greece, 21-26 June 2009
Information at: http://www.cemepe.prd.uth.gr/

2009 NORTHEAST AMERICAN SOCIETY OF ENGINEERING EDUCATION (NE ASEE) CONFERENCE
'ENGINEERING IN THE NEW GLOBAL ECONOMY'
University of Bridgeport, Bridgeport, CT, USA, 3-4 April, 2009
Information at: http://www.asee2009conference.org/

THE JOINT SIXTH INTERNATIONAL SCIENTIFIC CONFERENCE ON THE GLOBAL ENERGY AND WATER CYCLE AND THE SECOND INTEGRATED LAND ECOSYSTEM-ATMOSPHERE STUDY (iLEAPS) SCIENCE CONFERENCE
Melbourne, Australia, 24-28 August 2009.
Information at: http://gewex.org/2009gewex_ileaps_conf.html and http://www.ileaps.org/.

INTERNATIONAL CONFERENCE "MEGACITIES: RISK, VULNERABILITY AND SUSTAINABLE DEVELOPMENT"
Leipzig, Germany, 7 – 10 September 2009
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