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In this issue

Front cover: From Sofia

Dear EURASAP members,

Following the establishment of EURASAP in Aveiro, the financial issues of the Association are now being undertaken by the university of Aveiro. Please, note, that the Membership forms should be sent to Prof. Carlos Borrego in Aveiro, Portugal.

One of the EURASAP grant holders for the UAQ, conference, Klára Bezpalcová*, presents the topic of her PhD in the present newsletter.*

The EURASAP Newsletter Editor

FLOW AND DISPERSION IN A SIMPLIFIED STREET CANYON WIND TUNNEL STUDY

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Abstract

The street scale is important for urban air pollution studies. A physical model of a street canyon is the main topic of this work. Wind tunnel simulation was used to study patterns of the flow and pollution dispersion inside and in the vicinity of a simplified street canyon model with one line source situated in the middle of the street within suburban boundary layer under neutral stratification. Detailed fields of mean values of the wind speed, turbulence intensity, turbulent shear stress, and concentration were measured for a situation with wind perpendicular to the street canyon axis. Also for the far fields, independence on Building Reynolds Number is shown. A sufficient averaging time within street scale is suggested. Comparison of wind tunnel flow fields and concentrations measurements carried out in similar studies (Kastner-Klein, 2001; Pavageau and Schatzmann, 1999) is followed out. Final aim of this work was interpretation of measured values to real situation.

Key words: Atmospheric Boundary Layer, Air Pollution, Physical Modelling, Street Canyon, Urban Dispersion.

1. Introduction

Pollutant dispersion in urban areas is a subject of interest to policy makers, regulating agencies, building designers, health physicists and, of course, building occupants. Urban emissions are mainly from traffic transport and occur within the canopy layer where the atmospheric flow is heavily disturbed by buildings and other obstacles. In order to minimize potential damage of human activity, it is not only to reduce emission of harmful pollutants but also understand and accurately describe pattern of flow and pollutant dispersion. An urban street canyon with main pollutant emitting source (traffic vehicles) as a one of the fundamental elements of urban environment should be the first step to understand a complex behaviour of the canopy layer (see more in Berkowicz, 1998).

Dispersion of pollutants in the atmosphere can be studied either directly (in situ) by monitoring methods (e.g. Rotach, 1995), which are often expensive and mostly provide only partial results, or by methods of mathematical (e.g. Leitl and Meroney, 1997; Gidhagen et al., 2004) and physical modelling (e.g. Rafailidis, 1997). For complicated cases it is useful to use the methods of physical modelling – i.e. simulation of atmospheric processes in the wind tunnels. These methods can provide useful information of pollutants dispersion in urban agglomerates at high spatial and temporal resolution, which is frequently very difficult or almost impossible to obtain by direct monitoring methods.

There are many in situ and wind tunnel measurements in urban areas, especially in street canyons. Unfortunately the majority of them are carried out only at a few points, see chapter 4.3 (e.g. Meroney et al., 1996, Schatzmann et al., 1998, Di Sabatino et al. 2003, Pavageau et al. 1999, Rafailidis 1997, Kastner-Klein et al. 2001, Kastner-Klein et al. 2003). In particular, in most wind tunnel experiments, concentrations are usually measured only on building walls or at street level. Sampling should be extended to points within the street cavities as numerical models are expected to provide concentrations at all points in space. Physical simulation was used to study a fine field of flow with high spatial resolution and pollution dispersion in a very simple model of a street canyon.

Although it may appear redundant to focus again on this widely studied case, the difference between this analysis and earlier works lies in the very fine description of the turbulent characteristics and concentration field inside the test street canyon.

It was decided to model the street canyon with very simple geometric configuration, which should exclude three-dimensional effects, under neutral stratification. Therefore, the street canyon was idealized as two rectangular buildings with flat roofs, which extended over the whole width of the test section. The wind direction was perpendicular to the street canyon in order to study a quasi- two-dimensional case, which typically corresponds to the poorest street canyon ventilation rates (see Kastner-Klein et al. 2001) and only one line source was situated in the middle of the canyon.

In order to examine the transport mechanism in the canyon the velocity field was measured with Laser Doppler Anemometry (LDA). Flame Ionisation Detector (FID) was used to obtain mean value of the tracer gas concentration.

2. Fundamental principles

The basic physical model is a boundary layer formed over a wind tunnel working section. It has been demonstrated by couple of authors (e.g. Plate, 1981), that the following similarity criteria must be fulfilled when investigating urban flow and dispersion phenomena in the neutrally stratified atmospheric boundary layer.

Reynolds number (Re) is the most important similarity criterion for street scale problems. It is normally impossible to match atmospheric Reynolds Numbers in the wind tunnel. However, as it was found by Townsend (1956) dimensionless mean turbulent quantities become independent of Re if Re is above a critical value. The value of critical Reynolds Number depends on particular situation. For our configuration the Building Reynolds Number exceeds the value of 3400 suggested by Hoydysh et al. (1974).

Building Reynolds Number (some authors use obstacle Reynolds Number) is defined $Re_B = U_H H \nu^{-1}$, where H [m] is the characteristic height of building, U_H [m s^{-1}] is the mean wind speed in the building height (calculated from measured reference velocity and vertical velocity profile) and ν is the kinematic viscosity. Re_B is better parameter for description of processes in the lower part of ABL than classic Re with thickness of a boundary layer δ and the wind speed above a boundary layer U_{δ}. Absolute value of Re_B is smaller than absolute value of classic Re in the same situation.

The Roughness Reynolds number $u_* z_0/\nu$, where u_* denotes friction velocity, and z_0 denotes roughness length, was approximately 10. Snyder (1981) recommended values of Roughness Reynolds number larger than 2.5.

In addition to make the dimensionless equations of motion similar by requiring equality of the corresponding similarity parameters for model and prototype systems, the boundary conditions must be similar if two systems should behave in a similar manner. These boundary conditions include geometric similarity, distributions of temperature, and roughness over the area of interest, longitudinal pressure variation, and vertical temperature, velocity, main turbulence characteristics and concentration distribution of the approaching flow.

3. Experimental set-up and measurement technique

3.1. Wind tunnel

The experiment was performed in the atmospheric boundary layer wind tunnel (BLASIUS) of the Meteorological Institute of Hamburg University, shown in Fig.1. The wind tunnel consists of an inlet nozzle, flow straighteners (honeycombs), vortex generators, a flow establishment section, a test section, anti-swirl devices (honeycombs and grids) and a squirrel-cage centrifugal fan. A DC motor with a thyristor type control system maintains test-section wind speeds ranging from 0 to 15 m s^{-1}. The effective working section is 1 m high, 1.5 m wide and 4 m long following a 7.5 m long development section just downstream of the boundary layer simulation system.

Three vortex generators – spires – were spaced laterally and symmetrical to the tunnel centreline (Fig.2). Surface roughness was provided by Lego™ elements placed on floor in a regular array following staggered pattern.

The boundary layer was generated in the scale 1:300 and was about 0.4 m thick that means about 120 m in the full scale. A power law or a logarithmic law in the region where the boundary layer is fully developed may describe the vertical velocity distribution. Also vertical distributions of turbulence intensity (Fig. 3), frequency spectra and correlations correspond with neutrally stratified suburban atmospheric boundary layer were well establish according to guidelines from Snyder (1981) and ASCE (1997). The turbulent shear stress should be constant in inertial sublayer within 10%. This border is slightly overreached, but in acceptable limits. Parameters of modelled boundary layer in full scale were:

- Roughness length z_0=0.16 m,
- Power law exponent n=0.21,
- Zero plane displacement d_0=0.5 m.

Different ceiling positions were used to ensure negligible longitudinal pressure gradients (<0.25 Pa m^{-1}) for studied configuration. The overall blockage of the wind tunnel by the obstacles did not exceed 15%, which is within the acceptable limits in wind tunnel modelling.

3.2. Street canyon design

Wooden 80 mm x 40 mm bars were used to model two-dimensional multi-story flat-roofed buildings (Fig. 4). The model was manufactured in the scale 1:300, it means that both building height and width of the street canyon were 24 m in the full scale. We consider the two dimensional case which corresponds to a street canyon completely spanning the width of the tunnel and perpendicular to the wind direction. To reduce secondary flows induced by street canyon vortex interaction with the side-wall-wind-tunnel boundary layers, end plates were added 100 mm from each wall.

3.3. Line source design

Line source was used to simulate exhaust from the vehicles moving along a street. The vehicle exhaust is best represented by a source of low vertical momentum since the most vehicle exhausts are directed horizontally. The vehicle exhausts can be assumed as neutrally buoyant gas flow, for even though the hot exhaust is initially buoyant, the accelerations induced by buoyancy forces will be neglected compared to a vehicle induced turbulence and street canyon circulations. Presuming uniform mixing of exhaust from slowly moving traffic, uniform gas flow distribution along a line source is a good approximation of street traffic exhausts.

There are three kinds of line sources described in the literature. Some were made from pipes or tubes in which regularly spaced holes were drilled. Another line source can be silicon or Teflon tubes filled with suitable liquid (usually ethanol or methanol), which permeate through a tube wall (Zelinger et al., 1999).

The mostly widely used are line sources that use a plenum chamber, which distributes the gases beneath drilled plates or section of sintered porous material. After huge testing campaign focused on this kind of line source (Meroney et al., 1996) the best type of line source was established.

The key characteristic influencing the gas flow from source is the pressure drop through the exhaust holes. To achieve high discharge pressure drop, each hole was replaced by 25-mm long hypodermic tube of 0.1 mm internal diameter. The design is depicted in Fig. 5.

3.4. Measurement techniques

3.4.1. Velocity

The wind velocity was continuously recorded by both a Prandtl tube and the 2D fibre-optics Laser-Doppler-Anemometer (FVA-LDA, Dantec Inc.) with 500 mm focal distance. The LDA probe head was therefore far enough from the sampling volume to ensure non-intrusive flow measurement. Micro-particles were added to the flow by a smoke generator. Zero- and one-order moments of the velocities were processed with at least 10000 samples and minimum averaging time of 120 s. In contrast to stack emission studies where the reference height is the height of stack, for the street canyon situation there is no standard for the position at which reference velocity should be measured. In this case the reference height was chosen to be 850 mm above the floor in the free-stream region. The sampling frequency was approximately 300 Hz.

3.4.2. Concentration

Ethane was used to simulate the dispersion of pollution in the model street canyon. Instantaneous concentration measurements were carried out with slow Flame-Ionisation-Detector (FID, Hydrocarbon Analyser, model 400A, Rosemount Analytical, Inc.). Mean values of concentration were obtained after 120 s of averaging time with 2 Hz sampling frequency. The flow rate was 34 litre per hour. FID was calibrated against laboratory prepared mixtures of the hydrocarbon gas. Sampling and concentration detection error is about ± 5%. The concentration measurement are presented in terms of the dimensionless concentration $K^* = C\ U_H\ H\ L\ Q_S^{-1}$, unless indicated otherwise, where C [ppm] is the measured concentration, U_H [m s^{-1}] is the reference velocity at characteristic height of building H [m], Q_S [$m^3\ s^{-1}$] denotes ethane flow rate from the line source and L [m] is the source length (0.75 m in our case).

3.5. *Experimental details*

Slight misalignment of a few degrees in the bar(s) and the source with one another and/or the tunnel axis produced asymmetric lateral deviations in the concentrations measured downstream. To avoid such systematic errors, both the bars and the line source were carefully aligned to be parallel to each other and perpendicular to the main flow. Furthermore, to avoid interaction of street canyon vortices with sidewall boundary layers that might distort two-dimensionality, end plates were erected at both ends of the line source parallel to the direction of the flow.

4. Results

4.1. *Field of flow*

Field of flow was measured inside the street canyon and in the vicinity of the street canyon (together about 400 points). Points where the measurement took place are marked on each figure by black dots. The Re_B was 12000. The average values of wind speed (Fig. 6), the intensity of turbulence for u_1 (longitudinal wind component) (Fig. 7), the intensity of turbulence for u_3 (vertical wind component) (Fig. 8) and the dimensionless turbulent shear stress (Fig. 9) were measured. The dimensionless turbulent shear stress is defined

$$-\frac{\overline{u_1^{'}u_3^{'}}}{u_*^2},$$

where u_1’ and u_3’ depicted deviation of instantaneous values of longitudinal and horizontal wind speed from mean values, u_* is friction velocity which was not inferred from measurements of turbulent-flux profiles but from a curve fitting of vertical profiles of mean velocity in the lower 20 cm of the boundary layer. Velocity component u hinted down the stream and velocity component w hinted upwards. It means that positive value of dimensionless turbulent shear stress indicates downward momentum transport.

Dependence on Building Reynolds Number was hard to establish on the base of flow measurement. Repeatability of the measurements and the averaging were sufficient, errors were smaller than 5%.

The mean flow field is shown in Fig. 6. For the studied street canyon geometry four recirculation areas are observed. The first one is in front of upwind building, the second one on the roof of upwind building, the third one (the biggest one) is inside the street canyon and the last one is behind downwind building. It should be noted that at some points, especially at those which lie on the border between street canyon and free stream, the pattern of flow was strongly intermittent (velocity histogram had two peaks, mostly one negative and one positive), so the mean values at these points were mostly near zero. These points are visible in the figures of intensity of turbulence fields (Fig. 7 and 8) and they have typical values of the turbulence intensity higher then 150 % (the intensity of turbulence was calculated as a ratio of wind speed standard deviation and mean wind speed at the particular point, so if the mean wind speed is close to zero we obtain very high intensity of turbulence). These points can also indicate borders of recirculation areas.

Dimensionless turbulent shear stress is positive in the centre of big street canyon vortex in the upper part of the canyon, it means that transport of momentum is in downward direction. The bottom canyon corners are areas of upward momentum transport. The most intense downward transport we can see behind upwind building slightly above roof. The most intense upward transport off the canyon we can see in front of upwind building slightly above roof.

4.2. Field of concentration

Field of concentration of the passive tracer gas was measured inside and in the vicinity of the street canyon (about 200 points). As a trace gas was used ethane, which was being detected by the FID. Obtained data were recalculated to dimensionless form K* (Fig. 10). Measurement conditions were: Re_B = 22000, Q_S = 8.6 l h^{-1}. Points where the measurement took place are marked. The highest values of concentration were found in upwind part of the street canyon because of opposite direction of flow on the bottom of the street canyon as was shown in the flow field in Fig. 6. Clean air is drawn into the canyon by an intermittent eddy circulating down into the canyon. The canyon region almost appears to inhale and exhale. The flow forms a canyon vortex, the vortex occasionally washes out of the canyon, the free-stream penetrates canyon, and another vortex forms. A roof-top eddy, which begins at the upwind upstream building roof corner, conveys canyon gases onto the roof. Significant pollution concentrations are measured on the upstream building roof, indicating that gas from the canyon is transported into the roof bubble before eventually being carried out by the oncoming flow.

To verify the dependence of dimensionless concentration on Reynolds number (Fig.11) we have chosen six representative test points. Their positions are shown in the small picture on the top right hand corner in Fig.11. Measurements were carried out with different flow rate from line source because of fixed measurement range of FID. Independence on Re_B is evident for points with relatively small mean value of concentration in the range $Re_B \in$ (10000; 35000). Points E and A were investigated more precisely (Fig. 12).

Whereby the line source flow rate was held constant through the second measurement campaign. Point A belongs to the area with higher values of concentration, but it is quite far from the source. There is no dependence on Re_B even on flow rate from source Q_S in the whole range of measurement $Re_B \in$ (3500; 35000). Point E is very close to line source and it provides strong dependence on both Re_B and Q_S. The dependence on Q_S is weaker in the case of higher Re_B.

We can conclude that independency of the dimensionless concentration K* on Re_B was proven for far field (1/8 of H at downwind half of the street canyon and 1/4 of H at upwind side). In the near field, we obtained dependency on Re_B and Q_S. But close field is out of our interest, since there are lots of other intrusive elements (our source isn't queue of vehicles, there is no car induced turbulence in our model, etc.)

Our measurements took place in the interval of Re_B and K*, which is marked with an oval in Fig. 12.

We took several time series for rough estimate of intermittent behaviour (Fig. 13 and 14.). The slow FID hasn't fast frequency response (approximately 2Hz) and it provides partial integration, so every time series are slightly smoothed and not accurate, but they can provide useful overview of situation. Position of points where time series were taken shows small picture on the top right hand corner in Fig. 13 and Fig. 14. Both Fig. 13 and Fig.14 show the time process of dimensionless concentration. There are three time scales. The first is time on model, the second one is dimensionless value $t^* = t\,U_H\,H^{-1}$, and the third one is time in full scale (model 1:300, $U_H = 4\ m\ s^{-1}$). Spread of values is quite huge (±60 %), but behaviour of the first time series in Fig.13 is quite stable. Pattern of the second time series is completely different (Fig. 14). This point lie within downwind part of the street canyon, which is an area of small mean values of concentration ($K^*_{mean} = 9$), minimum value reaches $K^*_{min} = 4$, but maximum is $K^*_{max} = 66$. This maximum value is nearly twice higher than maximum value in the first time series. The episodes with very high concentration (hot spots) are worth to observe. They last about 3 minutes in full scale (the lowest x-axis).

These are very interesting results and the time series of pollutant concentration should be monitored with more sufficient equipment like a fast FID (some turbulent characteristics of concentration field were given in Pavageau and Schatzmann, 1999). These time series can also show what the sufficient time to get mean value in our case is (Fig. 15). It is clear that it must be more than 130 s of model time (it means more than 4 hours in full scale) when the error should be smaller than 5% and 50 s (1.67 hour in full scale) of averaging is necessary for error smaller than 10%, it means more than 3 hours in full scale. But majority of in-situ measurement last less than one hour.

4.3. Comparison with previous experiments

Rafailidis (1997) measured flow field above the same model of street canyon. Flow inside idealised rectangular street canyon was measured by P. Kastner-Klein and it was published in Di Sabatino et al., 2003 and Kastner-Klein et al. 2001. Profiles of longitudinal mean flow velocity component and standard deviation values of longitudinal fluctuation in the center of the canyon are shown in Fig.16. Scaling parameter in this case is velocity measured in the center of the street canyon in the roof level. This value is strongly dependent upon vortex center position, which is indicated by minimum of longitudinal velocity. In presented study the center of the vortex (Fig.6) is close to the canyon top in contrast with study of Kastner-Klein et al., 2001 where it is observed at half a building height. In the current study the width of building was equal to 0.5 H, but in the conferred study it was H. This can be reason for shifting of vortex center, however more detailed study is necessary for discussion about this phenomena.

Because of shifting of the vortex the scaling velocity U_H is equal to 0.13 m/s. This rather low value originates high values in profiles in Fig.16. Different position of vortex can explain disagreement between presented data and Kastner-Klein, 2001 data.

Mean concentration field was presented by Pavageau and Schatzmann, 1999. In Fig. 17 is comparison of the vertical profiles on the walls. Presented data had to be recalculated because Pavageau and Schatzmann, 1999 used free stream velocity U_{ref} in the formula for dimensionless concentration K* calculation. Fig. 17 shows good agreement between both data.

5. Interpretation

Final aim of our work was interpretation of the measured values to real situation. There were lots of very simple assumptions used. We estimated the average flux of pollutants from vehicles Q_E on the base of work of Samaras and Sorensen (1998). The average production of one vehicle (mean values from passenger cars, trucks, buses) in the speed 60 km h^{-1} is 1.5 g km^{-1} of nitrogen oxides (NO_X), 0.6 g km^{-1} of carbon monoxide (CO), and 1.1 g km^{-1} of volatile organic compounds (VOC). Then we computed flux from line source, which is created by a queue of vehicles (speed of vehicles is 60 km h^{-1}, one vehicle is 5 m long and distance between vehicles is 5 m, too). We also made a model situation with these parameters: the height of building is 24 m and wind speed in roof level is 4 m s^{-1}. After we recomputed the measured values (Fig. 10) we obtained field of concentration of NO_X as Fig. 15 shows. The values can be interpreted as 5-hour mean values.

There are no legislated limit values for NO_X in the European Union, but there are standards for NO_2. Average concentration of NO_X exceeds 400 ìg m^{-3} in upwind lower part of the street canyon. Concentration of unsuitable NO_2 is connected with concentration of NO_X, O_3 and amount of UV radiation in the photochemical reaction cycle. Numerical models with chemistry module (e.g. model HEAVEN, Wesseling et al. 2004) can be used for estimate of NO_2 concentration.

The same shape of concentration field we can obtain for CO, but emission limits for carbon monoxide are not exceeded in our model situation. There are no emission limits for organic volatile compounds as an entity.

In the real situation ought to be lower concentration of NO_X because of other processes which were not taken to account in our study. The ventilation of the street canyon is significantly improved by car-induced turbulence (Gidhagen et al., 2004; Kastner-Klein et al., 2001). Also heat released from vehicles and buildings, and heat caused by sunshine can improved air quality. However low wind speed episodes will noticeably worsen situation.

6. Conclusion

Physical simulation was used to investigate pattern of the flow and the pollutant dispersion on the street scale. 2-D street canyon inside the urban area has been modelled on the scale 1:200 in the Blasius wind tunnel of Hamburg University. High resolution fields of mean flow and turbulence characteristics as well as tracer gas concentrations were measured inside and above the street canyon while previous investigations published in the literature typically focused on measurements near building walls (e.g. Schatzmann et al., 1998, Zelinger et al., 1999).

From the experiment work described above a number of conclusions may be drawn:

- The use of a stable homogeneous line source is one of the key requirements for simulation of the vehicle pollution in an urban model study. The important design parameter is the pressure difference across the discharge holes (Meroney et al., 1996).
- Four recirculation areas were found in the street canyon.
- The centre of the main street vortex is shifted from the middle to the canyon top.
- The flow pattern is highly intermittent.
- The Building Reynolds Number dependence was found out in the close vicinity of the line source, far field was independent in the range $Re_B \in (3500; 35000)$. This result is in good agreement with Hoydish et al. (1974) conclusion.
- Current presented flow data contradict measurement presented in Kastner-Klein, 2001, however there where slight difference between experiments.

- Current presented concentration data agree with and complement results presented in Pavageau and Schatzmann, 1999.
- The local observations of the concentration field with flame-ionisation-detector have indicated that the structure of the concentration fluctuations inside the street canyon is dominated by spots of high and low concentration which originate in the structure of the inlet flow. It is now fully recognized that in many cases the mean value of concentration from in-situ measurements, which lasts one half an hour can be irrelevant. For example, a toxic level may be exceeded when the instantaneous concentration exceeds a certain value, no matter what the mean value might be. It is therefore useful to measure statistical properties of the concentration field.
- After recalculation dimensionless values in some model situation it was carried out NO_x concentration field inside the street canyon.
- Presented data could be model situation for micro-scale numerical models validation.

7. Acknowledgement

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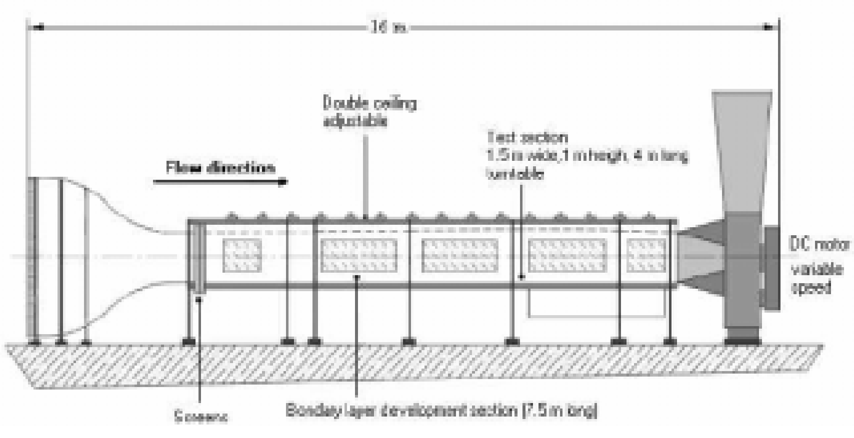

Fig. 1: Sketch of wind tunnel (BLASIUS) for atmospheric boundary layer modelling, Hamburg University.

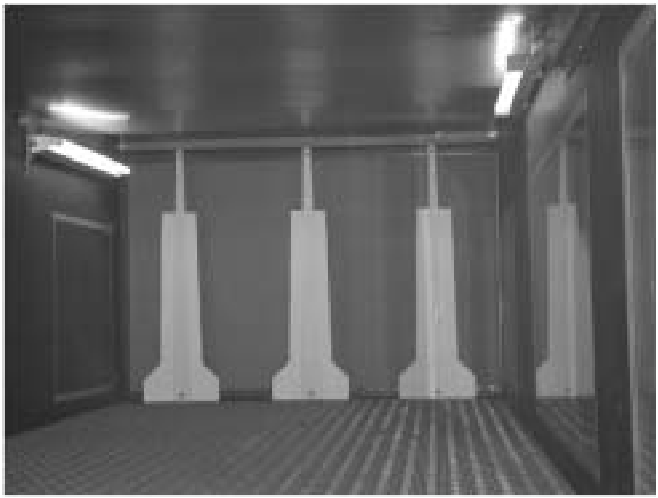

Fig. 2: Vortex generators and roughness elements (Lego™ cubes with dimensions 7.5 x 10 x 15.5 mm) inside BLASIUS wind tunnel.

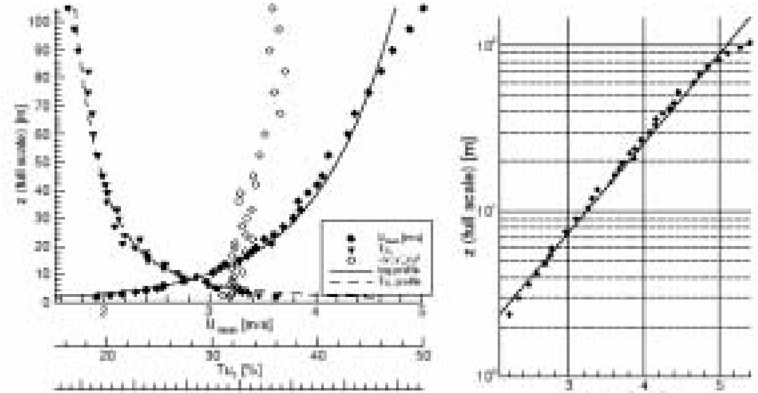

Fig. 3: Approach flow characteristics: mean velocity, intensity of turbulence for longitudinal and vertical velocity components and Reynolds shear stress compared with recommended profiles by Snyder (1981) and ASCE (1997) (lines); Mean velocity profile in a semi-logarithmic scale.

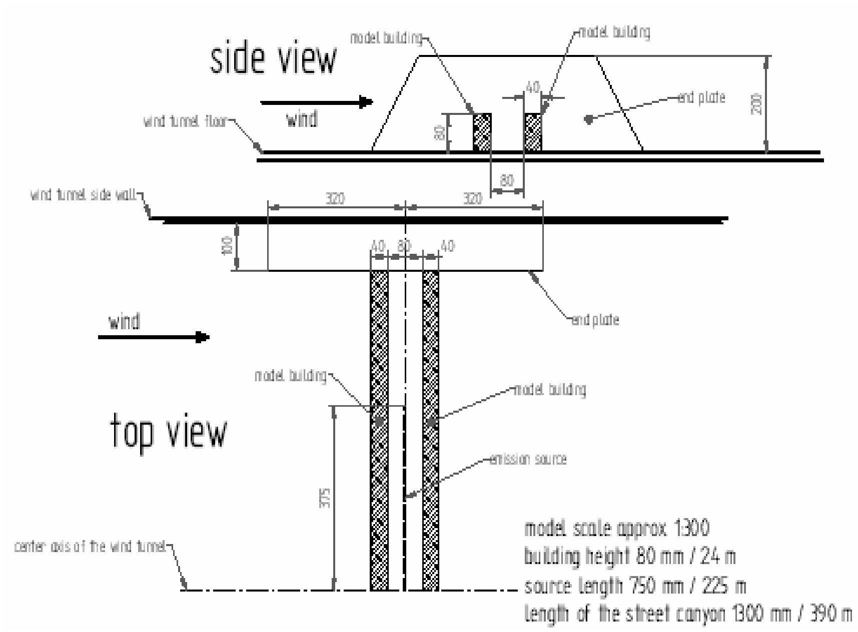

Fig. 4: The street canyon model scheme.

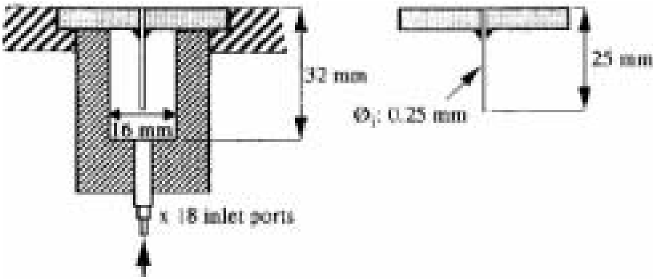

Fig. 5: Line source design, transverse cross section.

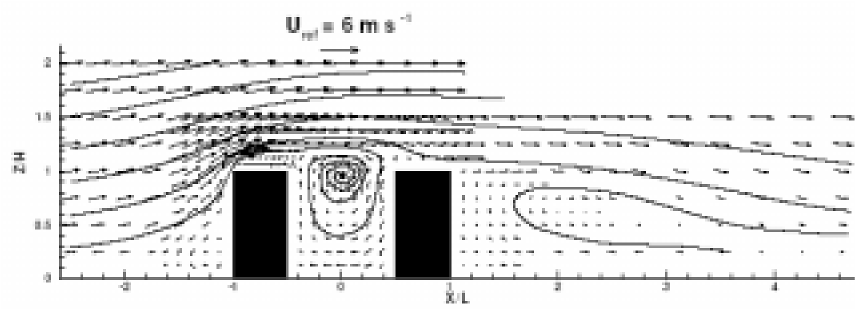

Fig. 6: Field of mean wind speed, length of arrow is proportional to the absolute value of mean wind speed, Re = 22 000

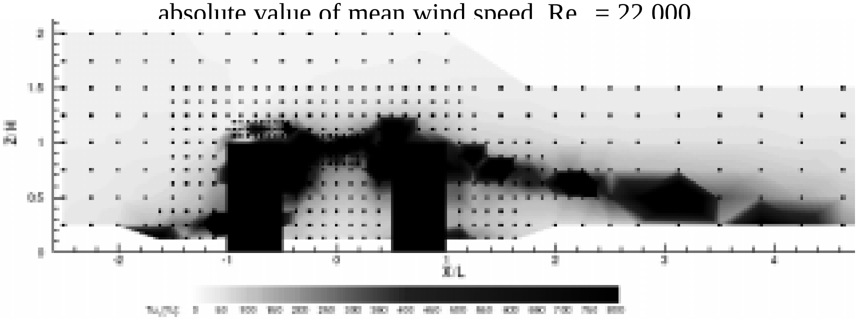

Fig. 7: Field of intensity of turbulence for u_1 (longitudinal wind component), Re = 22 000

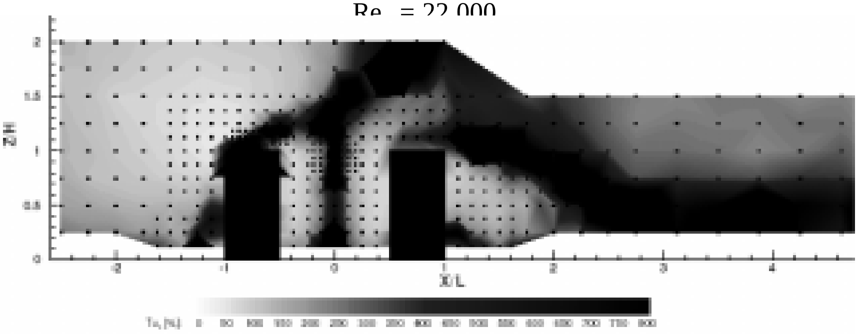

Fig. 8: Field of intensity of turbulence for u_3 (vertical wind component),

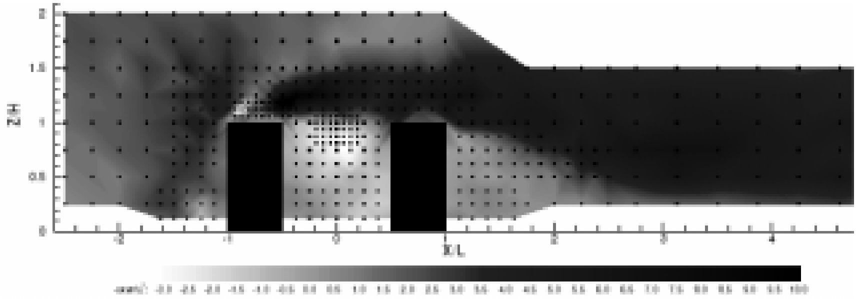

Fig. 9: Field of dimensionless shear stress, Re_B = 22 000.

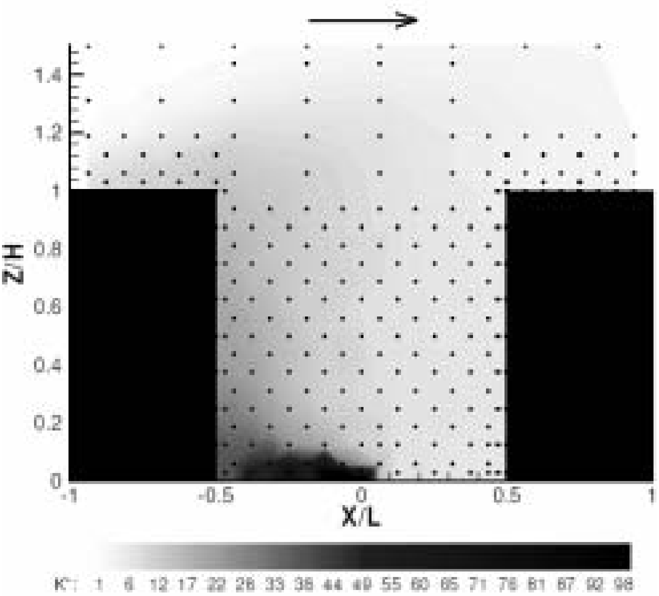

Fig. 10: Field of dimensionless concentration K* of the tracer gas (ethane),

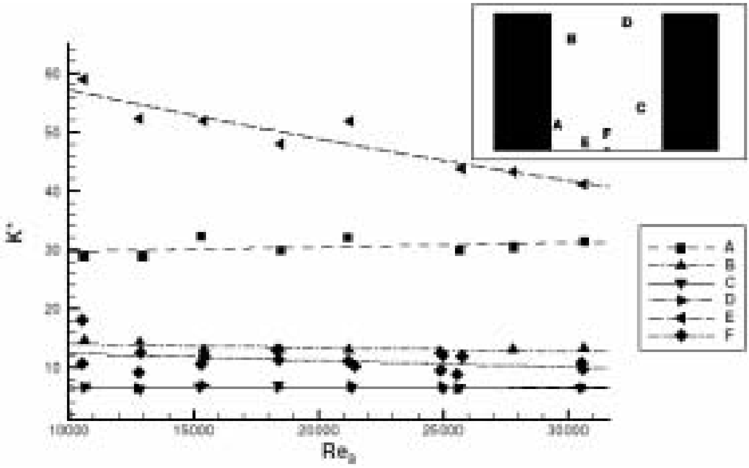

Fig. 11: Dependence of dimensionless concentration K* on Re_B in testing points in the range $Re_B \in (10000; 35000)$.
(Positions of the points are outlined in small sketch).

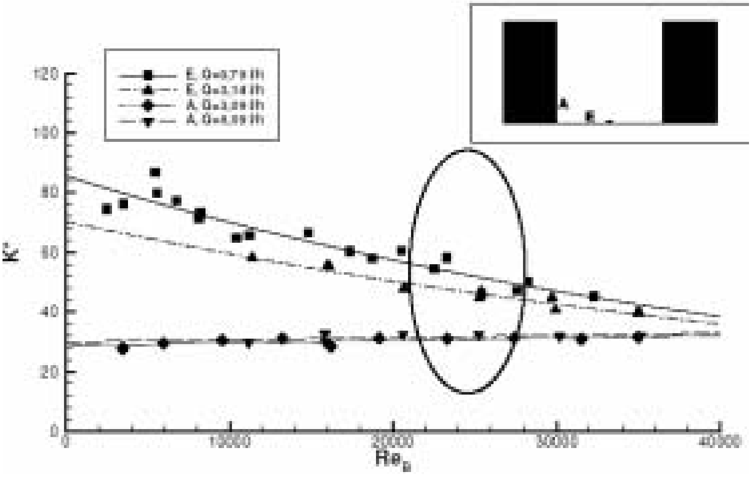

Fig. 12: Detailed dependence study of K* on Re_B in testing points A and E in the range $Re_B \in (3500; 35000)$.

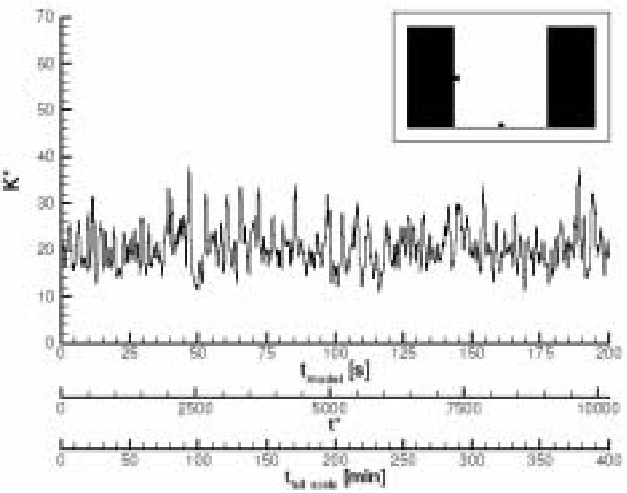

Fig. 13: Time series at the point 4 with dimensionless coordinates (-0.47; 0; 0.5).

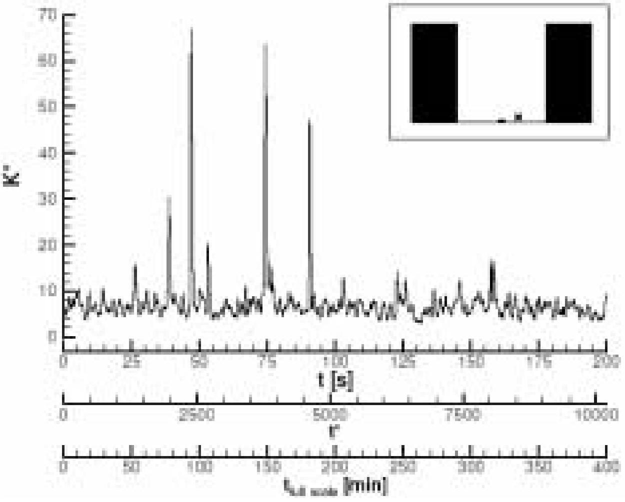

Fig. 14: Time series at the point 6 with dimensionless coordinates (0.19; 0; 0.06).

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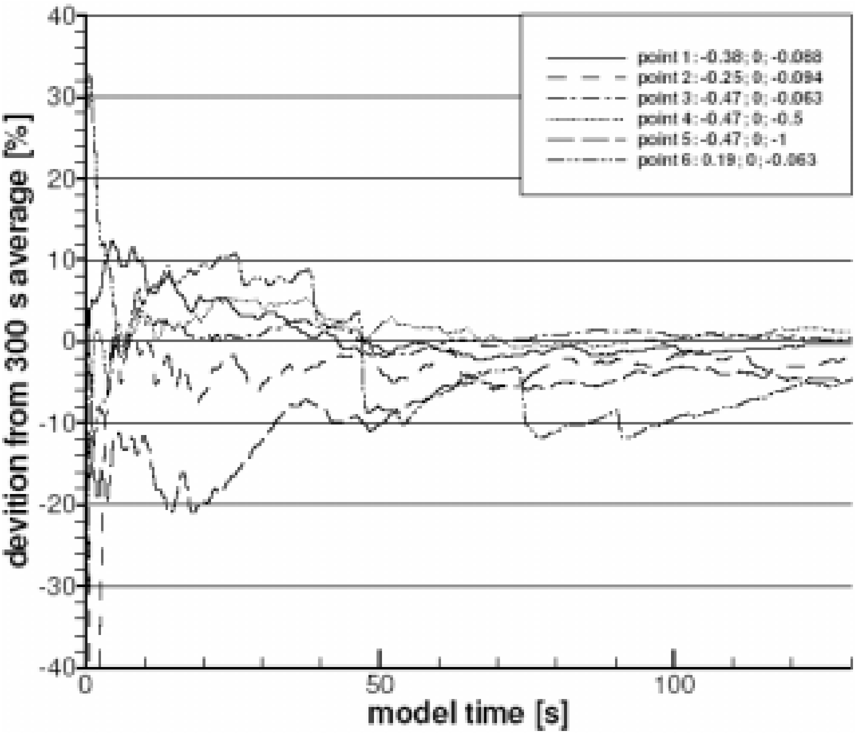

Fig. 15: Time dependence of normalised deviation from 300 s average value of K*. There are model time on X-axis and normalised deviation from 300 s average value, which is defined as $\frac{\overline{K^*_{300}} - \overline{K^*_t}}{\overline{K^*_{300}}}$, where $\overline{K^*_{300}}$ is average value for 300 s and $\overline{K^*_t}$ is average value for first t s. Legend denote dimensionless coordinates of testing points.

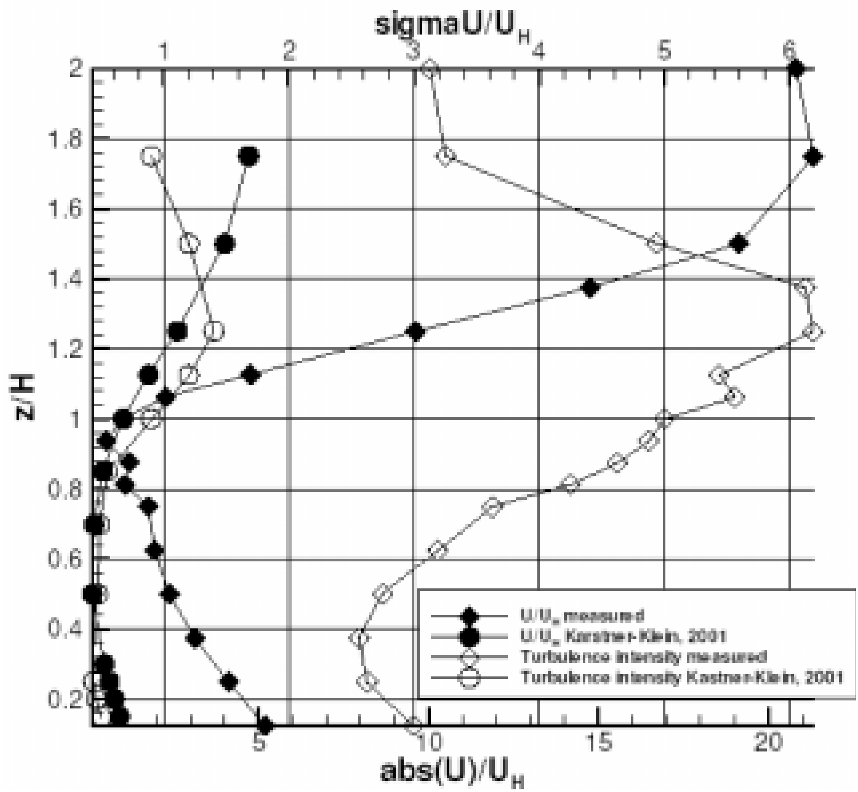

Fig. 16: Comparison of longitudinal mean flow velocity component and rms values of longitudinal fluctuation normalized profiles in the center of the canyon.

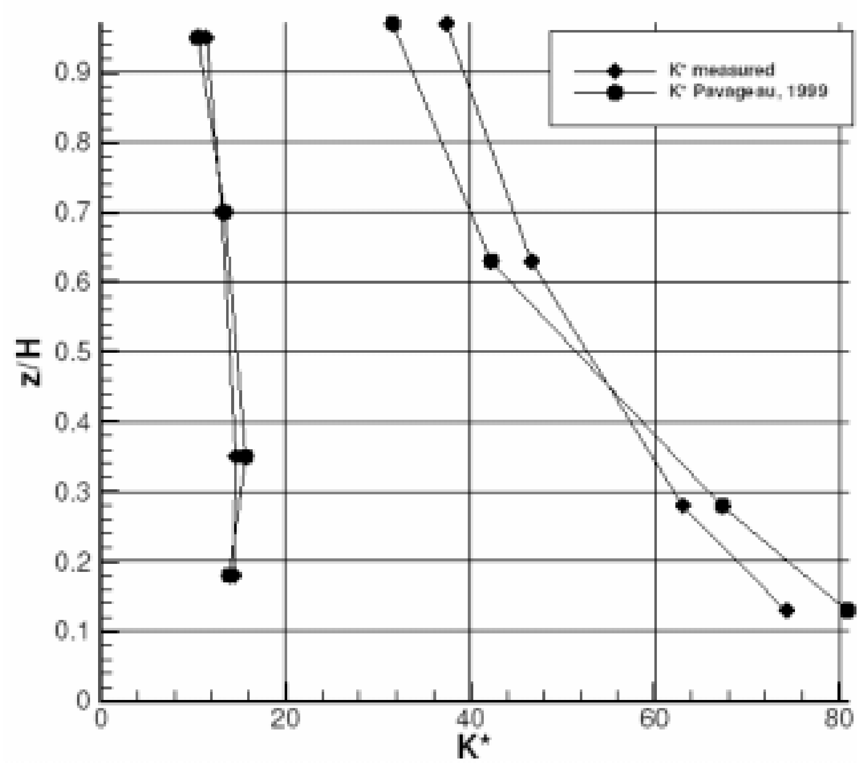

Fig. 17: Comparison of dimensionless concentration on the walls. The left hand side profiles belong to downwind building wall (x/H=0.5) and the right hand side profiles belong to upwind buildings wall (x/H=-0.5).

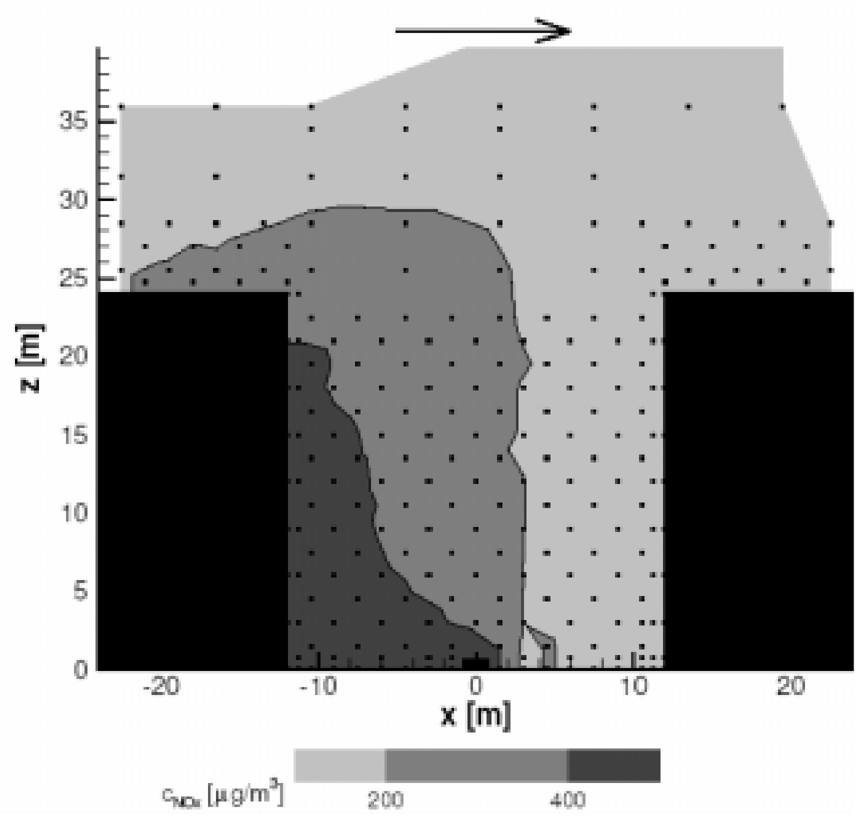

Fig. 18: Field of average concentration of NO_x in real situation.

Recently, under The ACCENT Transport and Transformation of Pollutants (T&TP) Joint Research Programme a workshop was organized by Prof. Moussiopoulos, Aristotle University, Thessaloniki, Greece. http://www.accent-network.org/portal/joint-research-programme/transport-and-transformation-(tandtp)

ATMOSPHERIC TRANSPORT AND TRANSFORMATION AT THE URBAN AND LOCAL SCALES

An ACCENT T&TP hosted workshop, Valencia, 1 April 2005

After the Minutes of the General Discussion
Prof. Nicolas Moussiopoulos

Seven presentations were given at the ACCENT T&TP hosted workshop covering a wide range of subjects such as the GURME project and WMO's desire to work closely with ACCENT, the CAFE research priorities as these have been formulated so far, a presentation of the CLEAR cluster (also relevant to ACCENT priorities), a brief overview of the ACCENT Network of Excellence and in particular the T&TP subproject, as well as three presentations related to major scientific aims of ACCENT. After a few presentation specific Q&A, a more general discussion took place. The remainder of this note summarise the main conclusions of this discussion.

Co-operation potential between ACCENT T&TP and other networks/clusters

A closer look to the work programme of certain scientific networks and programmes (e.g. COST728, CLEAR projects) shows that to a large extent they deal with similar issues and have objectives comparable to those of ACCENT T&TP. Hence, there is an obvious overlap in various tasks and therefore it appears advisable for ACCENT T&TP to concentrate on specific themes (e.g. interrelation between air quality and climate change, health impacts of poor air quality) with the aim to establish a network of exchange of information between the different programmes, since by definition ACCENT does not have a specific research work programme.

The above ‘networking’ on specific scientific issues could conveniently be managed through interactions in joint workshops and conferences. Such events could help dealing with the common priority/uncertainty issues. Synergies must be established as well as substantial sharing of data and information. This can lead to joint research recommendations and response to policy makers, joint proposals and an ‘integrated’ research strategy.

An important aspect related to this information exchange would be to strengthen the links between the ‘global scale’ and ‘mesocale’ communities. Indeed, the discussion revealed that there is no real reason to differentiate between the scales. On the contrary, there is increasing awareness that the different scales should be treated in an integrated manner. Although the scientific community and policy makers largely agree on the pressing science needs related to CC and AQ, the links between the two domains are still poorly understood, this being perhaps the most challenging scientific objective for ACCENT T&TP. Forthcoming international research programmes should aim at addressing critical issues related to this objective.

In particular, it would be possible to increase the opportunities for coupling models and for prescribing suitable boundary conditions towards the aim of dealing appropriately with the multiscale character of atmospheric transport and transformation. Moreover, a stronger link could be developed between communities dealing with global/regional/urban and local emissions, as scientists working in these different scales hardly communicate so far. It would also be an opportunity to look into the possibility of a ‘Global Emission Inventory’, building firstly on existing European emission inventories (city, national, EMEP), but also to think of developing software tools and a web portal for ease of downloading on a global common grid. Given the priority of the LRT issue and the linkage between AQ and CC, this appears as an emerging priority issue in itself.

Also, it would be very useful to suggest a model inventory common for all projects/networks (ACCENT, COST 728, CLEAR projects) and prepare a joint database with all information related to model intercomparisons and validation (see also the presentation by Nicolas Moussiopoulos on the “Database on Model Evaluation” in the UAQ5 Conference).

The particular ‘legal’ framework for the collaboration with other clusters/ projects (as associate members or other) and the benefits of an ‘official’ collaboration remain to be discussed. Especially COST728 and ACCENT have much in common and it was decided that a joint meeting should be held to discuss common scientific problems and approaches, also in relation to the major uncertainty issues emerging from the current workshop and ACCENT’s scientific priorities. Finally, it was pointed out that it is important to do as much as possible at the national level also. Researchers working in national organisations and local authorities should be brought in contact with the international community and collaborate with scientists working on all scales (local, regional, global).

Discussion on future funding opportunities and research priorities

Research issues that the workshop participants can jointly work on should be defined soon. A strategy should be developed for short term and long term funding (FP6, FP7), as both are important. It was noted that FP7 priority funding can still be influenced by this scientific community, if funding ‘gaps’ and further research needs can be defined.

Concerning the definition of the research priorities and following also the CAFE priorities, it was suggested that these should be distinguished in three pillars: (a) Climate Change, (b) Health, (c) Environment. These are also the pillars on which air pollution research should be built in the years to come. These should be considered as the three primary scientific challenges coming from society to the air pollution science community. They should be regarded as challenges/objectives in their own right. ACCENT's studies of atmospheric composition change should help society to find solutions for each of them. As a diagram this would mean that ACCENT T&TP would be in the middle, with CC, Health and Environment around it, each hit by an arrow from the subproject. The connection of these three issues should be discussed, as well as the challenges and what can be delivered (by the community as a whole) at EU scale.

However, the reduced funding opportunities for the urban-regional scale (meteorology and AQ) compared to the global scale (CC) was also noted. It was mentioned that there are inherent problems that this scientific community has, e.g. the troposphere is much more diversed and hence it is difficult to get a clear message across to the public and to the funding agencies, whereas the 'stratospheric' community has less problems in this respect. However, it is important that there is clarification by the scientific community on how their work relates to the local scale (local authorities) and direct help to assessment must be made available. User friendly interfaces could help, and in any case more efforts towards better air quality assessments are needed. Air pollution issues are everywhere of high priority, and clear messages should be sent out to the EU citizen in this respect in their own language. Citizens are aware of the environmental problems, but clear/straightforward messages of the scientific results must be conveyed.

Also, what are the key uncertainties in the relationship between air pollution and (i) climate change, (ii) health and (iii) environmental impact? These topics must be addressed and a clear/concrete reply must be provided.

Finally, it is necessary to highlight a small number of headline priorities that really need to be addressed. In removing an artificial distinction between two separate atmospheric science research communities - climate and air quality it is a great opportunity to simplify the process of prioritisation. It this list of priorities, people’s concerns, social sciences and the link with the public must also be included. Ordinary European citizens do not see the distinction between the two areas of study. Therefore, headline research priority must be to provide robust scientific underpinning for the decision-making of individuals and businesses as well as local, regional, and national governments. All the details and intricacies of photochemical oxidation capacity, nested scales of urban dispersion, harmonisation of emissions scenarios, etc., can then fit as sub-headings below the main, clear priority. The priority is to address the current areas of research in such a way as to fit better into the bigger picture, to address better the needs of the citizen.

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http://aix.meng.auth.gr/lhtee/

Past Events

Future Events

ACCENT/GLOREAM WORKSHOP (HOSTED BY T&TP) ON MODERN DEVELOPMENTS IN TROPOSPHERIC CHEMICAL TRANSPORT MODELLING

Apeldoorn, the Netherlands, 7-9 September, 2005

The workshop will take place in the frame-work of the NoE ACCENT, Transport and Transformation of Pollutants-T&TP. The workshop is a follow-up to the EUROTRAC-GLOREAM /EURASAP workshops. The general aim of the workshop is to present and discuss results concerning recent developments in tropospheric CTMs.

Aspects of main interest will be aerosol modelling, data assimilation, modelling in view of the EU-Air quality directives, forecasting/chemical weather, meteorological impact on chemical constituents.

The scientific committee is formed by Jorgen Brandt (NERI), Hendrik Elbern (EURAD), Martijn Schaap and Peter Builtjes (TNO).

Only oral presentations will be accommodated. Please send title, authors, affiliation and abstract (one page maximum) by e-mail to Builtjes@mep.tno.nl

Deadline for abstracts: 15 July, 2005; Deadline for registration: 15 August, 2005; Registration fee: EUR 100 (more information on registration)

Address of the workshop venue:
TNO, Laan van Westenenk 501, Apeldoorn.
For questions and suggestions, please contact
Martijn Schaap (schaap@mep.tno.nl) or
Peter Builtjes (builtjes@mep.tno.nl)

28TH NATO/CCMS INTERNATIONAL TECHNICAL MEETING ON AIR POLLUTION MODELLING AND ITS APPLICATION

15-19 May 2006, Leipzig, Germany

Pilot country: PORTUGAL
Carlos Borrego, Department of Environment and Planning, University of Aveiro
Campus Universitário, 3810-193 Aveiro, Portugal
e-mail: itm@ua.pt
http://www.dao.ua.pt/itm

Host country: GERMANY
Eberhard Renner, Institute for Tropospheric Research
Permoserstrasse 15, D 04303 Leipzig, Germany
e-mail: itm2006@tropos.de
Tel. 0049 341 235 2320; Fax. 0049 341 235 2139

Conference Location

Leipzig is located in the east of Germany in the north-western part of Saxony and has currently about half a million inhabitants.

Young Researchers

The increase of the participation of younger researchers is incited with a competition for the best paper/poster from researchers with less than 35 years. (more information is given on the ITM web site).

Key Topics

1. Local and urban scale modelling (including the effects of building wakes, street canyons, urban canopy, urban energy balance)
2. Regional and intercontinental modelling (including observational and modelling of current and future scenarios, and impacts on meeting and maintaining air quality standards)

3. Data assimilation and air quality forecasting (including new research on fusing ground- and satellite-based observations into model outputs in creating high-resolution spatial maps of air quality, network design)
4. Model assessment and verification (including performance evaluation, diagnostic evaluation, dynamic evaluation, and probabilistic evaluation as part of comparison of model outputs with observations)
5. Aerosols in the atmosphere (aerosol dynamics, aerosol formation, interaction with multiphase chemistry)
6. Interactions between climate change and air quality (observational analysis and modelling analysis of the effects of air pollution on climate and the impact of changing climate on future air quality)
7. Air quality and human health (including air quality trend assessments, the effects of regulatory programs on ambient air quality and human exposure)

Abstract Submission: Abstracts (maximum of 300 words) should be sent to **itm@ua.pt** until **30th June 2005.**

* * *

6TH INTERNATIONAL CONFERENCE ON URBAN CLIMATE

Göteborg, Sweden, June 12th - 16th 2006

The International Association for Urban Climate (IAUC, www.urban-climate.org) and Göteborg University, in co-operation with the World Meteorological Organization warmly invite you to the Sixth International Conference on Urban Climate (ICUC-6). ICUC-6 welcomes papers seeking to understand the nature of the atmosphere in urban environments or to the application of such knowledge to the better design and operation of settlements. Scales of interest range from individual built elements (roofs, walls, roads) through whole buildings, streets, factories, parks, clusters of buildings and neighborhoods, to whole cities and urban regions and their impacts on weather and climate at scales up to those of global change. The focus can be original research into the physical, biological and chemical atmospheric processes operating in built areas; the weather, climates and surface hydrology experienced in built areas; the design and testing of scale, statistical and numerical models of urban climates; or reports on the application of climatic understanding in architectural design or urban planning. Papers may relate to new concepts, methods, instruments, observations, applications, forecasting operations, scenario testing, projections of future climates, etc. Sessions that focus on major field studies or other projects or topics may be proposed.

The deadline for submission of abstracts is 10th November, 2005. Abstracts will be submitted via the web (http://www.urban-climate.org)

Prof. Sven Lindqvist is the chair of the local organizing committee (sven@gvc.gu.se). For further information, please see http://www.urban-climate.org (links: ICUC, then ICUC6) or email Prof. Sue Grimmond (grimmon@indiana.edu). The official language of ICUC-6 is English.

Prof. Sue Grimmond, President IAUC
Atmospheric Science Program
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Grimmon@indiana.edu
Phone (812) 855 7971
Fax (812) 855 1661
http://www.indiana.edu/~climate
http://www.indiana.edu/~geog/

CALENDAR: *CONGRESSES, CONFERENCES, WORKSHOPS*

Conference	When and Where	Deadlines	Contact	Note
ACCENT/GLOREAM Workshop (hosted by T&TP) on Modern Developments in Tropospheric Chemical Transport Modelling	Apeldoorn, the Netherlands, 7-9 September, 2005	Deadline for abstracts: 15 July, 2005	Martijn Schaap (schaap@mep.tno.nl) or Peter Builtjes (builtjes@mep.tno.nl) TNO-Apeldoorn Environmental Quality Department Phone + 31 55 5493385 (Martijn) + 31 55 5493038 (Peter) Fax + 31 55 5493252	More details in the current EURASAP Newsletter
EnviroInfo 2005 The 19th international conference Informatics for Environmental Protection	Brno, Czech Republic, 7-9 September 2005	Abstracts by February 1, 2005	For details see the web site of the conference: http://www.enviroinfo2005.org	More details in the EURASAP Newsletter 55
EMS Annual Meeting and the ECAM Conference – EMS5/ECAM7	Utrecht Netherlands 12-16 Sept 2005		The website for the EMS Annual Meeting 2005 is at http://www.emetsoc.org/EMS5/	

Conference	When and Where	Dead-lines	Contact	Note
Second International ICSC Symposium on Information Technologies in Environmental Engineering (ITEE'2005)	Magdeburg, Germany September 25 - 27, 2005 Otto-von-Guericke-Universität	papers by April 15, 2005	Otto-von-Guericke-Universität Magdeburg Faculty of Computer Scienceм Department Business Informaticsм Universitätsplatz 2, 39106 Magdeburg Germany Phone: +49 -391-67 1 83 86 Fax: +49 -391-67 1 12 16 gomez@iti.cs.uni-magdeburg.de rauten@iti.cs.uni-magdeburg.de http://www-wi.cs.uni-magdeburg.de/itee2005/info/ ICSC Interdisciplinary Research (Head Office), P.O. Box 279 Millet, Alberta T0C 1Z0, Canada Phone: +1-780-387-3546 Fax: +1-780-387-4329 Operating Division:operating@icsc.ab.ca Planning Division: planning@icsc.ab.ca	More details in the EURASAP Newsletter 55
Third International Conference on Plants & Environmental Pollution	Lucknow India 29 Nov 2 Dec 2005		http://geocities.com/isebindia/ National Botanical Research Institute Rana Pratap Marg Lucknow-226001, India. isebnbrilko@satyam. net. in Phone: +91-522-2205831 to 35 Fax: +91-522-2205836 / 2205839	More details in the EURASAP Newsletter Issue 54

Conference	When and Where	Deadlines	Contact	Note
3rd INTERNATIONAL SYMPOSIUM on AIR QUALITY MANAGEMENT at Urban, Regional and Global Scales	**Istanbul, Turkey** 26-30 September 2005	Abstracts by 1 March 2005	Prof. Selahattin INCECIK Istanbul Technical University Faculty of Aeronautics and Astronautics Department of Meteorology Maslak 34469,Istanbul-TURKEY Tel: +90 212 285 3143, Fax: +90 212 285 2926 web.deu.edu.tr/tuncap/aqm2005	More details in the EURASAP Newsletter Issue 54
10th International Conference On The Harmonisation Within Atmospheric Dispersion Modelling For Regulatory Purposes	**Crete, Greece** 17-20 October, 2005	Abstracts by 14 March 2005	www.harmo.org/harmo10 www.kalimerakriti.gr/conference.asp Dr. Andreas N. Skouloudis, IES TP.272, JRC, Ispra (Va), I-21020, Italy; andreas.skouloudis@jrc.it Dr. John Bartzis, N.C.S.R. “Demokritos“, Agia Paraskevi, Attikis, GR-15310, Greece Dr. Pavlos Kassomenos, Lab. of Meteorology, Physics Dept, Univ. of Ioannina, GR-45110, Ioannina, Greece	More details in the EURASAP Newsletter Issue 54

Conference	When and Where	Deadlines	Contact	Note
28th NATO/CCMS International Technical Meeting on Air Pollution Modelling and its Application,	15-19 May 2006, Leipzig, Germany	Abstracts by 30th June 2005	Pilot country: PORTUGAL Carlos Borrego, Department of Environment and Planning, University of Aveiro Campus Universitário, 3810-193 Aveiro, Portugal e-mail: itm@ua.pt http://www.dao.ua.pt/itm Host country: GERMANY Eberhard Renner, Institute for Tropospheric Research Permoserstrasse 15, D 04303 Leipzig, Germany e-mail: itm2006@tropos.de Tel. 0049 341 235 2320 Fax. 0049 341 235 2139	More details in the current EURASAP Newsletter issue

MARCH 2005

EUROPEAN ASSOCIATION FOR THE SCIENCE OF AIR POLLUTION

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