# Minutes of the Eighth COST 715 Meeting of Working Group 2

# Sofia, Bulgaria, 16, 17 and 18 October 2002

**Participants:**

Jerzy Burzynski
Marco Deserti
Ari Karppinen
Clemens Mensink
Douglas Middleton
Martin Piringer
Maria Tombrou

1. The WG meeting was held in short sessions after the lectures of the harmonisation conference on Oct. 16 and 17 and after the MCM on Oct. 18. Clemens Mensink participated at this meeting on behalf of Koen De Ridder.

2. The agenda was adopted slightly revised and is given in Annex 1.

3. The minutes of the Rome meeting have been adopted without change.

4. Status of WG 2:
   Since Joao Ferreira did not react to the question of his further commitment to WG 2, MP removed him from the list of WG 2 members. The actual list of Working Group 2 members and participants is given in Annex 2.

5. Review of Toulouse decisions:
   D 1: done (see item 4 of these minutes)
   D 2: future Belgian participation assured
   D 3: Toulouse workshop proceedings were edited by J. Kukkonen and MP and were sent to the EC printing office in July 2002.
   D 4: not successful. However, test of parameteisation schemes similar as foreseen in the study contract proposal will possibly be undertaken with the Cracow data. MT has included schemes for urbanisation in MM5 and will try to include also LUMPS and TEB for Athens.
   D 5: done
   D 6: Mathias Rotach has been contacted, will provide contribution on BUBBLE results of surface energy balance and mixing height for the final report.
   D 7: done

D 8: SJ and DM indicated on which chapters of the final report they intend to contribute (see Annex 3 revised). SJ is also willing to help with the final edit. Contributions to the progress report to the TC (responsible: B. Fisher) arrived and are added to these minutes as a “measure of progress” of WG 2 in Annex 6.

D 9: JB informed on successful funding of new Polish project and distributed a short description of measurements undertaken in Cracow and Katowice (Annex 4). He also distributed a CD-Rom with data from the August 2002 experiment. Experiments are on-going.

D 10: ENV-e-CITY – homepage: http://www.env-e-city.org

6. Fumapex:

   AK informed that Fumapex is about to start. The kick-off meeting will be held end of November in Copenhagen.

   **D 1**: AK will send summary information on Fumapex activities to WG 2 members.

7. Mixing height overview paper:

   MP reported on an intended mixing height publication of WG 2 based on the overview of AB given at the Toulouse workshop. A draft outline of chapters sent by AB and the output of the discussion is given in Annex 5.

   **D 2**: WG 2 welcmes this effort and will support AB in drafting the paper. Those interested (see Annex 5) provide AB with results (max. 2 pages with interpretation/statistics). MP will contact S. Emeis concerning the Hannover results if there are no objections from WG 2 members.

8. WG 2 Web page:

   On behalf of the WG, MP thanks AK for maintaining the WG 2 web page (http://cost.fmi.fi)

   **D 3**: AK will further update the web page. MP will provide AK with an updated list of WG publications.

9. Final report:

   See item 5, D 8, these minutes.

   The final report of WG 2 will concentrate on activities of WG 2 members within the scope of the WG. Experimental, theoretical and modelling efforts will be included. The final version of the progress report to the TC can be a new starting point of the final report.

Recommendations from experiments, publications and workshops will be of utmost importance. In the course of the work, a revision of the draft outline of sections (Annex 3) might be necessary; the draft of the final report distributed by MP before the meeting might already be too detailed.

10. Workplan:
    Work of WG 2 will concentrate on the drafting of the mixing height paper and on the final report.

11. Reports on past/future symposia/projects:
    not discussed

12. AOB: none

**Annex 1:** Agenda

1. Welcome of participants
2. Adoption of agenda
3. Adoption of minutes of WG 2 meeting at Rome
4. Status of WG 2
5. Review of Rome decisions
6. Fumapex
7. Mixing height overview paper
8. WG 2 web page
9. Final report
10. Workplan
11. Past/future symposia/projects
12. AOB

**Annex 2**: List and addresses of participants and WG 2 members

| Name | Institution and Address | Tel./Fax/e-Mail |
|---|---|---|
| Martin Piringer, chairman | Central Institute for Meteorology and Geodynamics (ZAMG)<br>Hohe Warte 38<br>A-1190 Vienna Austria | Tel : +43 1 36026 2402<br>Fax : +43 1 36026 74<br>e-Mail : piringer@zamg.ac.at |
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**Annex 3**: Draft outline of structure of final report (revised)

Executive summary
List of figures
List of tables
List of acronyms and symbols

1. Introduction (SJ)
2. Review of theoretical concepts of the structure of the urban boundary layer (Convenor: PM; SJ)
3. Review and assessment of pre-processors, schemes and models for the surface energy budget (Convenor: PM)
   - 3.1 The surface energy budget
   - 3.1.1 Equations
   - 3.1.2 Urban modifications in the HPDM pre-processor
   - 3.1.3 Local-scale Urban Meteorological Pre-processing Scheme (LUMPS)
   - 3.1.4 The Town Energy Balance (TEB) scheme
   - 3.1.5 The Finite Volume Model (FVM)
   - 3.1.6 Urban parameterisations in SUBMESO
   - 3.2 Results of intercomparisons of different schemes against each other and against data
   - 3.3 Effect of strong heterogeneity on radiative fluxes
   - 3.4 Surface temperature
   - 3.5 Temperature roughness
   - 3.6 Input data requirements
4. Review and assessment of pre-processors, schemes and models for determining the mixing height (Convenor: AB; SJ)
   - 4.1 Methods based on radiosoundings
   - 4.2 Methods based on parametrisation schemes
   - 4.2 Methods based on NWP model outputs (DM)
   - 4.3 Effect of internal boundary layer development on the mixing height
   - 4.4 Results of intercomparisons of different schemes against each other and against data
   - 4.5 Input data requirements
5. Review and assessment of ongoing and recent urban experiments and their data availability (Convenor: MP)
   - 5.1 UBL/Escompte, Marseilles (PM)
   - 5.2 Basle experiment BUBBLE (Rotach, Vogt)
   - 5.3 Bologna (MD)
   - 5.4 Krakow (JB)
   - 5.5 Birmingham (DM)
   - 5.6 Helsinki (AK, SJ)
   - 5.7 Athens (MT)
   - 5.8 Vienna (MP)
   - 5.9 …..
6. Assessing the suitability of remote sensing tools to estimate canopy characteristics and surface fluxes (Convenor: KR)
   - 6.1 Satellite remote sensing
   - 6.2 Remote sensing from ground (JB)
7. Recommendations and needs (Convenor: MP; SJ)
   - 7.1 Improvement of existing pre-processors, schemes and models for the surface energy budget
   - 7.2 Improvement of existing pre-processors, schemes and models for the mixing height
   - 7.3 Outlook for development of new schemes
   - 7.4 Improvement of input data availability and quality for research and model validation
   - 7.5 Monitoring strategy for required parameters
   - 7.6 Need and planning of future field campaigns (DM)

List of references

**Annex 4:**

# SHORT DESCRIPTION OF MEASUREMENTS

MADE IN THE FRAMEWORK OF EXPERIMENT

MADE FOR ACTION „COST-715"

# IN CRACOW AND KATOWICE, POLAND

The main objective of the experiment is determination of specific features of meteorological conditions in Atmospheric Boundary Layer (ABL) of selected urbanized environments of Southern Poland. The experiment belongs to the EU Action COST-715 „Meteorology applied to urban pollution problems"; it is part of the active participation of Poland in the activity of different Working Groups (WGs) of the Action. The Working Groups are following:

- WG1 – Urban wind field
- WG2 – Near-surface energy balance and mixing layer depth in urbanized regions;
- WG3 – Meteorological measurements during smog episodes;
- WG4 – Input data to the pollution dispersion models in urbanized areas.

The data from measuring campaigns may be applied, in different ways, in the activity of Working Groups 1, 2, 4. In the work plan following detailed objectives may be found:

## WG1

**Objective 1:** Analysis of wind data from urban and non-urban environments.

**Objective 2:** Comparison of data from measurements made in different locations in urbanized region. Example investigated: City of Cracow, meterological measurements in the network of the Environment Inspectorate and in the Central Urban Observing Station of the Institute of Meteorology and Water Management (the Station acronym CSO). Finding the local variability specific for sensor location.

**Objective 3:** Calculation and verification (comparison with measurements data) of wind profile data in the Urban ABL (including the applications of LES model).

**Objective 4:** Application of the remote-sensing information (Doppler Sodar, Radar) for estimation of the wind field in urban environment.

## WG2

**Objective 1:** Verification of the radiation balance models; comparison with the measurement data.

**Objective 2:** Verification of the Mixing Layer Height models – comparison of model and measurement data.

**Objective 3:** Implementation of the mixing height parameterization model based on the measurements of concentrations of Radon derivatives.

**Objective 4:** Application of the LES model to the calculation of turbulent flow characteristics (Reynolds Number, kinetic energy turbulence TKE, mixing layer, roughness coefficient, roughness velocity, radiation flux, etc.) for ABL, in order to verify pollution dispersion parameterization in other widely used models (like Gauss plume model, Gauss cloud model) for local meteorological conditions.

## WG4

**Objective 1:** Verification of wind data derived from the mezoscale models with measurement data.

**Objective 2:** Verification of wind data derived from CALMET preprocessor – with measurement data. Analysis of impact of parameterization method and derived input data on the final results in calculation of pollution field.

## Background:

Starting the experimental and research part of the project became possible thanks to the financing from the Polish Committee of Scientific Research, in framework of a research grant. Unfortunately, the financing has been delayed and the quantity of financing means was substantially reduced. As the result, the research activity had to be reduced in comparison with initial plans. It was necessary:

- to reduce the number of measuring campaigns from 4 to 3, and their duration from 10 days to 6 days;

- to perform the first experiment without application of 3D sonic anemometer (which is necessary for estimation of turbulent and kinetic fluxes of heat); the procedures for purchase of the instrument are now in course; we hope that the instrument will be used in later experiments.

## Experiment

The first experiment has been organized in the period 20-25. Aug. 2002. at the CSO Station in Cracow. Supplementary data have been collected from the Airport Station (outside the urbanized area), from 2 meteo-measuring points of the Monitoring Network of Cracow, and from the Upper Silesian Monitoring Network. The locations of measuring points are plotted on the map enclosed.

**GROUND_BASED MEASUREMENTS AT „CSO" STATION**

We were making use of informatic system of the „CSO" station and of the automatic station STAWAG developed in the Institute of Meteorology and Water Mngmt.

The location of instruments is shown at the picture enclosed.

| 1. **THE MEASURED PARAMETER** | Height of the sensor | Type of the sensor | Time resolution | Measuring block | Time of averaging |
|---|---|---|---|---|---|
| Humidity | 2m | | 6s | Comp. Card | 1h |
| Pressure | 2m | | 6s | Comp. Card | 1h |
| The fluctuation | 2m, 10m | Pt | 6 s | STAWAG | 10 min |

| | | | | | |
|---|---|---|---|---|---|
| of the temperature | | | | | |
| Temperature | 2m, 10m | Pt | 6 s | STAWAG | 10 min, 1h |
| Temperature | 2, 6, 10m | Pt | 10 min | CSO | 10 min |
| Temperature | 0.1 m | Pt | 10 min | CSO | 10 min |
| u, fi | 25m | Zootechnika | 10 min | CSO | 10 min |
| u, fi | 10m | Zootechnika | 10 min | CSO | 10 min |
| u, fi | 2m, 10m | Zootechnika | 6 s | STAWAG | 10 min, 1h |

(u, fi – wind velocity and direction)

**REMOTE-SENSING MEASUREMENTS**

| Instrument | Range [m] | Time resolution [s] | Vertical resolution [m] | Dead zone [m] |
|---|---|---|---|---|
| **Aerosol Lidar** | 5000 | 60 | 10 | 100 |
| **Monostatic vertical sodar** | 1000 | 6 | 4 | 30 |
| **Doppler Three antennas** | 600 | 6 | 4 | 10 |

**TETHERED BALLOON**

Measurement of the vertical profiles of:

- Temperature

- Temperature of wet thermometer
- Pressure
- Humidity
- Wind speed (approximated)

The balloon was able to reach heights up to 1000 m. Real sounding ceiling was determined each time accordingly to guidelines given by Flight Control Center at Balice Airport.

**RADIATION MEASUREMENTS**

- Black-white pyranometer Philipp Schenk type 8101 measuring short-wave radiation, wavelength 0.3 – 3 um.
- Double-side radiation sensor Philipp Schenk type 8111 measuring radiation in the wavelength diapason 0.3 – 60 um.

Both instruments are measuring radiation flux in W/m$^2$ and they are connected to the computer-measuring chart.

**MEASUREMENTS OF RADON DERIVATIVES NEAR SURFACE FOR ESTIMATION OF MIXING HEIGHT**

The measurements of concentration of the short-living derivatives of Radon decomposition were made with use of the method of measuring the filter activeness. Detection of alfa radiation was made with use of a semi-conductor detector ULTRACAM-1700-AM. The filtration of the air was made with use of the filter Osmonics INC type Poletics, Polycarbonate, 0.8 um thickness. The activity of isotopes at the filter was growing as the effect of filtering (air pumping) and, at the same time, it was decreasing as the effect of radioactive decomposition, in the period of 1 hour. The measurement of filter radioactivity was made after pumping. The number of registered counts determines the values, which, in this case, were the mean concentrations of Polone isotope (Po 218) in the time of pumping.

The mixing height changes were measured by means of vertical sodar SAMOS-4C and with 2 Doppler Sodars.

In the framework of experiment two 24-hrs measurements of Polone concentrations were made in Cracow-CSO, in the days with well-marked diurnal changes of mixing height magnitudes.

The measurements of Polone concentrations near the surface and investigations of their connections to mixing height are made in Katowice, on experimental basis, since 1999. Now the Institute of Meteorology and Water Management has data from 30 such experiments. On the basis of these data the mixing heights values depending on Polone concentrations are determined.

**MEASUREMENTS IN THE ENVIRONMENT INSPECTORATE NETWORK**

Temperature, wind speed and wind direction were measured on 3 auitomatic monitoring stations of monitoring network. Before the measurements the instrumentation has been checked and maintenance operations were made.

**MEASUREMENTS AT SYNOPTIC STATION BALICE**

The Synoptic Station at Balice Airport is making the complete program of measurements prescribed for stations of this kind in the Institute of Meteorology and Water Management.

**MEASUREMENTS AT UPPER-SILESIAN MONITORING NETWORK**

Mean 10-minutes values and mean-one-hour values of all main meteorological components are measured in the network situated at the area of Silesian Voivodship. The measurements are continued since July 2001.

**OTHER ACTIVITIES IN THE FRAMEWORK OF ACTION COST-715**

Accordingly to the resolutions taken at the Mtg in Rome, Poland is preparing, among others, the reports on meteorological measurements during pollution episodes, for the WG3.

The reports prepared:

- The PM10 pollution episode in Upper Silesian Industrial Region, Poland
- The PM10 pollution episode in Cracow, Poland
- Comparison of urban and rural wind speeds for Katowice agglomeration, Poland.

**Annex 5**: Preparation of draft of mixing height paper

Basis: A. Baklanov: The mixing height in urban areas – a review (see http://cost.fmi.fi)

Paper contents suggested by AB:

## The mixing height in urban areas

*Paper contents*

1. Introduction
2. Specificity and features of the urban boundary layer
3. Experimental studies of Urban Mixing Height (MH)
4. Methods for the urban MH estimation
    *4.1. Estimation of the MH or eddy profile from meteorological models*
    *4.2. Applicability of common MH parameterisations and pre-processors for urban conditions*
5. Specific methods for the urban or other IBL height estimation
6. Conclusions and practical recommendations

## Suggestions for including / rewriting:

1. Scaling of different urban factors/effects on the MH based on different experimental data sets:

To answer on the following questions for each experiment (if possible):

1. How much does the MH in urban areas differ from the rural MH ?
2. How does the temporal dynamics of MH in urban area differ from the rural MH ?
3. What is the scale of urban effects in space and time and for how long distance does the downwind 'urban plume' effect the MH ?

4. How important is the internal urban boundary layer in forming the MH?

Additionally from all available data sets to conclude about:

- Effects of climatic differences on the urban MH,
- Recommended methods for measuring the urban MH

2. Analysis (see the questions above) of several most interesting measurement compaines and, possibly, some comparisons with different MH methods:

E.g., an Austrian city, Milan, Paris, Marseilles, Basel, Helsinki

3. Deeper classification of existing MH models and theory for urban conditions, including new/additional approaches/methods

4. Rewriting the conclusions with a stronger focus on recommendations:

- List of different recommended methods for the urban MH estimation,
- Their limits of application, advantages and disadvantages.

Recommendations and suggestions from the discussions during the WG 2 meeting in Sofia:

In a discussion especially with MT and DM, the following items have been raised:

Modellers for / appliers of regulatory purposes want one representative mixing height per city and hour. More complex models might accept more detailed input.

What are routine radiosoundings and experiments delivering?

What are the gaps?

What is needed for future models?

As AB proposed, the paper should start with the findings from experiments. Only ongoing experiments and model runs with involvement of WG (COST 715) members should be included. These are:

JB (Cracow, Katowice); MD and colleagues (Bologna); MT (TEB and LUMPS for Athens; other model results?); DM (Birmingham, if mixing heights are available); AK and SJ (Helsinki); PM (Marseille area); M. Rotach (Basle); W. Müller and S. Emeis (Hannover; ceilometer, WTR, Sodar) and possibly others (Austrian cities; …)

Sodars play a role in several experiments and should therefore specifically be addressed. From these experimental and modelling results, the first and second question might be answered. Urban – rural comparisons (possible for Cracow and Bologna; other cities?) are especially valuable. Future needs are best addressed by co-operation of MT and AB.

For the methodological part of the paper, only methods not included in the COST 710 report should be addressed (e.g. section 5 in AB paper), if at all.

**Annex 6: Measure of progress (WG 2)**

Workshops and associated publications:

Antwerp: Surface Energy Balance, 12 April 2000.

Piringer, M. (editor), 2002: COST action 715, Meteorology applied to Urban Air Pollution Problems, Surface energy balance in urban areas (Antwerp, Belgium, 12 April 2000). Luxembourg Office for Official Publications of the European Communities, EUR 19447, 104 pp, available at http://www.cordis.lu/.

Piringer, M., C. S. B. Grimmond, S. M. Joffre, P. Mestayer, D. R. Middleton, M. W. Rotach, A. Baklanov, K. De Ridder, J. Ferreira, E. Guilloteau, A. Karppinen, A. Martilli, V. Masson, M. Tombrou, 2002: Investigating the Surface Energy Balance in Urban Areas – Recent Advances and Future Needs, accepted for publication in Water Air and Soil Pollution.

Zuerich: Urban Boundary Layer Parameterizations, 24/25 May 2001 (with WG 1)

Rotach M., Fisher B., Piringer M. (editors) 2001, COST action 715, Meteorology applied to Urban Air Pollution Problems, Workshop on Urban Boundary Layer Parameterisations (Zurich, 24-5 May 2001) Luxembourg Office for Official Publications of the European Communities, to be published

Rotach, M. W., B. Fisher, M. Piringer, 2002: COST 715 Workshop on Urban Boundary Layer Parameterizations. Bull. AMS 83 (10), 1501 - 1504.

Toulouse: Mixing height and inversions in urban areas, 3/4 October 2001 (with WG 3)

Piringer M and Kukkonen J (editors), 2002, COST action 715, Meteorology applied to Urban Air Pollution Problems, Mixing height and inversions in urban areas (Toulouse, 3-4 October 2001), Luxembourg Office for Official Publications of the European Communities, Report EUR 20451, 113 pp.

Other publications:

Middleton, D. R., A. Martilli, M. Piringer, 2000: COST 715 - Working Group 2 expert meeting on surface energy balance in urban areas, Antwerp, Belgium, 12 April 2000. EURASAP Newsletter 38, 12 - 22.

Baumann-Stanzer, K., M. Piringer, 2002: Diagnostic mixing heights with and without urban fetch. UAQ 4, Prague, accepted.

Deserti, M, Bonafè, G. Tagliazucca M., Trivellone G., 2002: The urban atmospheric boundary layer: experimental campaigns in Bologna (Italy), UAQ 4, Prague, submitted.

Karppinen, A., 2001. Meteorological pre-processing and atmospheric dispersion modelling of urban air quality and applications in the Helsinki Metropolitan Area. Finnish Meteorological Institute, Contributions No. 33, ISBN 951-697-552-6, Yliopistopaino, Helsinki, 94 p.

Karppinen, A., Joffre, S.M., Kukkonen, J. and Bremer, P., 2002. Evaluation of inversion strengths and mixing heights during extremely stable atmospheric stratification, International Journal of Environment and Pollution **16,** Nos. 1-6.

Joffre S.M., Kangas M, Heikinheimo M. & Kitaigorodskii S.A, 2001. Variability of the stable and unstable atmospheric boundary layer height and its scales over a boreal forest. Boundary-Layer Meteorol. 99(3), 429-450.

Joffre S.M. & M. Kangas, 2001. Simple diagnostic expressions for the stable and unstable atmospheric boundary layer height. Air Pollution 2001, Modelling, Monitoring and management of Air pollution, Ancona (I), 12-14 Sept. 2001. 7 pp.

Pénelon, T., I. Calmet & D.V. Mironov**,** Micrometeorological simulations over a complex terrain with SUBMESO: a model study using a novel pre-processor, *International. Journal of Environment and Pollution*, **16**, Nos 1-6, pp. 583-602, 2001.

Dupont, S., E. Guilloteau, P.G. Mestayer, E. Berthier and H. Andrieu, Parameterization of the urban water budget by using the Force-Restore method, submitted to *Applied Meteorology*, Août 2002

Mestayer, P.G., J.-M. Rosant, I. Calmet, N. Long, Y. Lorin and D. Gaudin UBL/CLU-Escompte, a Validation Experiment for Urban Scale Models, Proceedings from the Eurotrac-2 Symposium 2002, P.M. Midgley & M. Reuthers eds. Markgraf -Verlag, Weikersheim 2002, pp. xx-xx+3

Mestayer, P.G. & P. Durand, The UBL/CLU-Escompte experiment : description and first results, 4th symposium on Urban Climatology, 20-24 May 2002, Norfolk, VA. Proceedings AMS, pp. 19-20

Pénelon, T. , S., I. Calmet & P. Mestayer, Influence of a Small-Scale Topography on the Dynamics of Atmospheric Boundary Layer Flows, 15th Symposium on Boundary Layers and Turbulence, 15-19 July 2002, Wageningen, The Netherlands, AMS proc. pp. 566-567

Dupont, S., Modélisation dynamique et thermodynamique de la canopée urbaine: réalisation du modèle de sols urbains pour Submeso. Doctoral thesis, 20 september 2001, University of Nantes, France

Dupont, S., E. Guilloteau & P.G. Mestayer, Energy balance and surface temperatures of urban quarters, AMS 3rd Symposium on Urban Environment, Davis, California, 14-18 August 2000, proceedings pp. 149-150.

Dupont, S., I. Calmet & P. Mestayer, Urban canopy modelling influence on urban boundary layer simulation, 4th symposium on Urban Climatology, 20-24 May 2002, Norfolk, VA. Proceedings AMS, pp. 151-152

Akylas, E., M. Tombrou, D. Lalas and S. S. Zilitinkevich, (2001), "Surface Fluxes under Shear-Free Convection" Quarterly Journal of the Royal Meteorological Society, 127, pp. 1183-1197.

Akylas E., Y. Tsakos, M. Tombrou and D. Lalas, (2001) "Measurements of surface fluxes over complex terrain under convective conditions", Quarterly Journal of the Royal Meteorological Society, accepted for publication.

Dandou, A., E. Bossioli, M. Tombrou, N. Sifakis, D. Paronis, N. Soulakellis, D. Sarigiannis (2001), 'The importance of mixing height in characterising pollution levels from aerosol optical thickness derived by satellite', *The 3rd International Conference on Urban Air Quality, 19-23 March 2001, accepted in Water, Air and Soil Pollution: Focus*

Experiments:

Marseilles, UBL/Escompte

5 urban stations along north – south axis of Marseilles, roughly parallel to the shoreline, equipped with micro – meteorological masts (continuous measurement of turbulent and radiation fluxes; 3 masts raise 12 to 20 m above urban canopy with 2 measurement levels; meas. at 12 m at site Observatoire, 10 m at Vallon Dol). Central site additionally equipped with array of 19 radio-thermometers to monitor surface temperature of selected elementary surfaces. Two scinitllometers evaluated integrated heat flux over city centre.

2 suburban sites equipped with Sodars. Observatoire site equipped with UHF wind profiler radar and tethered balloon (20 – 300 m, thermodynamic and ozone profiles). Site Vallon Dol hosted Rass-Sodar and two 3-D scanning Lidars ($O_3$, particles, wind).

Two types of IOPs: 5 Escompte IOPs for a total of 15 days during situations of land-sea – breeze mixed with light Mistral (airplanes to document UBL); 4 infrared IOPS: thermal infrared mapping of urban canopy by light aircraft at different times of day.

Satellite images: about 150 AVHRR images from NOAA-12, -14 and –16. 66 images from MODIS on TERRA satellite. Single high-resolution ASTER image on 27 May 2001 and 2 August 2002.

Escompte data base includes in addition to all these data maps from statistical analysis of 3-D data base BDTopo of French Nat. Geog. Inst.

Basle, BUBBLE

Two urban ('U'), one suburban ('S') and 3 rural reference ('R') surface sites have been set up. Such a site usually consists of the following components:

- Profiles up to a height larger than twice the obstacle height.
- U-sites: 6 levels of sonic anemometers (some of the levels: fast response hygrometers); S- and R-sites: 2 to 3 levels.
- Full radiation balance

Based on these data, C. S. B. Grimmond, Indiana University, USA, will investigate the urban energy balance.

A continuous detection of the urban boundary layer height will be available from the backscatter LIDAR signal at an urban site. As a standard algorithm to retrieve the BL height from the LIDAR signal, the derivative of the backscatter signal profile will be used.

Bologna

Heat island mapping based on measurements of 21 thermometers positioned in- and outside the town (inside primarily on rooftop). Turbulence and mixing height measurements by means of a SODAR, a sonic anemometer and a high frequency hygrometer located on the top of a building in Bologna downtown. Measurement campaigns were made during typical summer and winter weather conditions.

Methods: CALMET preprocessor runs on a daily base

Publication: IJEP, vol. 16 Nos1 - 6 (2001)

Ongoing in Emilia - Romagna (Italy):

The results of the study will provide basic information for the design of an urban meteorological network in the Emilia Romagna region and to improve meteorological pre-processors running on a daily base to estimate SEB and MH.

Cracow

The first of three planned experiments was organized in the period 20-25 Aug. 2002 at the CSO Station in Cracow. Supplementary data have been collected from the Airport Station (outside the urbanized area), from 2 meteo-measuring points of the Monitoring Network of Cracow, and from the Upper Silesian Monitoring Network (12 meteo measuring points). The data were collected, data sets were prepared and now is available for the COST 715 activity. Completed data set will be distributed from the COST 715 web page. The data set will be used for the calibrations of the formulas for the mixing heights and heat fluxes determination.

Birmingham

Middleton et al. (2002) described an experiment to measure surface fluxes in Birmingham, UK using meteorological masts and instrumentation at a site within a large factory (courtesy of Dunlop Tyres Ltd). Some urban-rural differences were seen in the data. The paper also introduced the work that has been started to examine some meteorological pre-processors using the data, with a focus on the ADMS model's heat flux. In later work we wish to test other models.

Current dispersion models rarely make any explicit attempt to describe changes in the heat flux that might be due to the urban heat storage effect. Likewise anthropogenic heat sources are rarely included. Oke's (1990) text book provided useful curves comparing urban and rural fluxes. It was a perceived lack of measurements of heat flux and stability from UK cities which prompted the setting up of the Birmingham experiment. This experiment has provided a data set of urban wind speeds and surface fluxes for a UK city. The experiment was improved in the third trial by adding a sonic anemometer at the Coleshill synoptic station. This was prompted by the discussions in Working Groups of the COST 715 Action. Just by adding this one instrument to an existing standard observing station provides essential measurements of variables that are very important in influencing dispersion near the ground: the friction velocity  and Monin Obukhov length L. Traditionally, these are not often routinely observed, but could be a valuable addition to synoptic networks.

References:

Ellis N L and Middleton D R (2000) Field measurements and modelling of urban meteorology in Birmingham, UK. Turbulence and Diffusion Note No 268. Meteorological Office, London Rd, Bracknell, Berks RG12 2SZ, UK

D R Middleton, N L Morrison, G G Rooney, D J Thomson (2002): A comparison of dispersion model met pre-processing with urban flux measurements from Birmingham U.K. Presented at the Eighth International Conference on Haromonisation Within Atmospheric Dispersion Modelling For Regulatory Purposes, Sofia, Bulgaria, 14-17 October 2002, p. 226.

<u>Helsinki</u>

Comparison on mixing heights estimates (especially in stable situations) utilising data from Kivenlahti radio tower and NWP-model (HIRLAM) predictions continues.

The possibility of utilising the meteorological measurements (surface, sounding, wind profiler) by Vaisala company (http://www.vaisala.com/weather/) located in the Helsinki Metropolitan area is being studied.

<u>Vienna:</u>

Diagnostic methods based on radiosoundings from Vienna, July 1 to August 31, 1995, and on tethersonde profiles, July 20 – 22, August 6, 7, 12, 1995

Methods: OML pre-processor, simple parcel (Stull), critical inversion (Heffter)

Publication: BLM 89, 25 – 45 (1998)

Ongoing in Austria:

Climatology of Alpine Boundary Layer Heights (Austrian Research Fund, grant P 15078, principal investigator: U. Pechinger): based on the MAP data set of corrected radiosonde data in Central Europe, period 1991 – 1999, and on the data of the MAP upper air station network between Sept. 7 and Nov. 15, 1999, a set of schemes to derive the mixing height will be tested: Richardson number, parcel methods, analysis of measured temperature, humidity, wind profiles

Advances:

SEB:

Detailed surface exchange parameterisations like the Town Energy Budget (TEB) scheme (Masson, BLM 94, 357 – 397), the Finite Volume Model (FVM, Martilli et al., BLM 104, 261 - 304), SM2-U (SEB – model of SUBMESO, see references of Dupont above): Compared to the initial model that had been presented at the Antwerpen meeting by Guilloteau, the present version of SM2-U includes canopy parameterizations for the radiative trapping, derived from TEB of Masson (2000) under the form of a parameterized effective albedo, and a parameterisation of the heat storage in building walls. SM2-U is presently tested against UBL/CLU-Escompte data. Sylvain Dupont is presently working with Jason Ching at the US EPA, where he developed a new version of SM2-U including the porosity-drag approach of Martilli (2001) for the lowest atmospheric layers within the canopy; this newer version is incorporated in MM5.

Bologna: Comparison between surface sensible heat fluxes in urban and rural areas. Global and net radiation data in urban and in rural areas.

The main conclusions from Birmingham to date:

1. The experiments have provided a useful set of urban data from three different times in the year for a UK city. Information on roughness lengths, and the differences in wind speeds, temperatures, and heat flux were recorded, Ellis and Middleton (2000).

2. The data are being used to investigate the application of existing met pre-processors to the urban environment, commencing here with the ADMS model. One question to be addressed is the possible choice of the default limit to be set upon 1/L when modelling an urban area in

stable conditions. Further investigation of pre-processor outputs, and extension to other models such as Aermod is required.

3. Some of the data have also been used to examine NWP outputs, especially in the context of air quality forecasting at morning and evening transition, using the Met Office Lagrangian NAME model. Such work (by Morrison) may be reported at a later date.

4. The conclusions reported here should be regarded as tentative pending further investigations and additional work.

5. With regard to future work, applications of the Birmingham data in verifying surface energy balance schemes and for use in urban mesoscale modelling were of great interest, although the mast height of 45 m was judged low at the time for the mesoscale verifications. Since then the Office has begun a joint study with Qinetiq, Salford University, and Essex University to achieve greater heights over an urban area via remote sensing. This project uses newly developed Doppler lidar technology.

MH:

General: most diagnostic methods equally appropriate for daytime convective conditions; still large uncertainties for "mechanical" mixing heights (esp. night-time)

Bologna: Large differences between several methods tested to calculate MH (stable MH estimated with sonic anemometer data, convective MH with sodar data) were found. Comparison between sonic anemometer and sodar estimations and the numerical MH calculations (Holtslag and Van Ulden energy budget method): the numerical method seems to underestimate nighttime MH and overestimate daytime MH in Po valley

Finland: FMI is participating in the FUMAPEX –project (EU), starting November 2002. One aim of the project is to improve the parameterisations for urban turbulence and mixing height; part of the work will be done before the end of the COST 715 Action.

Finland: Theoretical work on the parameterisation of the mixing height based on closing the equation of turbulent kinetic energy, and yielding a general dependence on atmospheric scales and roughness have been performed. (Joffre et al., 2002). This scheme introduces the dependence of the mixing height on non-local parameters (The Brunt-Väisälä frequency). Comparison with several sets of data obtained over various roughness and stability conditions showed good agreement.