COST 715 WG2 : Measure of progress

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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)

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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.

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Helsinki

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.

Vienna:

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.