3.3 URBAN - The Influence of Metropolitan Areas on Meteorology

Model used: **Enviro-HIRLAM**

Read, the general description of the HIRLAM (HIgh Resolution Limited Area Model) model at the HIRLAM official website at:
http://hirlam.org/index.php?option=com_content&view=article&id=64&Itemid=101
See for more details the scientific documentation on the HIRLAM model at:
http://hirlam.org/index.php?option=com_docman&task=doc_download&gid=270&Itemid=70

Teacher: **Alexander Mahura** (DMI, Denmark)

Group URBAN-1	**Group URBAN-2**
Iratxe Gonzalez-Aparicio (Spain)	**Adomas Mazeikis** (Lithuania)

Introduction Background:
Recently, the urbanization is considered as one of the important steps for improvement of the numerical weather forecasts in the metropolitan areas and surroundings. These steps have been also included into the Enviro-HIRLAM model (*Korsholm et al., 2008*) developments, because due to rapidly extending urban areas, the impact of cities on the formation of meteorological fields became more evident. Since the urban areas change diurnal cycles of temperature, wind characteristics, humidity, etc., and hence, these influence the quality of forecasts from the numerical weather prediction (NWP) models.
To improve forecasting, modifications of the land surface scheme of the model are required and for Enviro-HIRLAM these modifications include the following:

- Changes in anthropogenic heat flux, roughness, and albedo (AHF+R+A) characteristics in urban areas can be used for grid cells of modelling domain which are attributed to urban areas (*Baklanov et al., 2005; Mahura et al., 2008*);
- Effects of buildings and street canyons can be implemented through the building effect parameterization (BEP) module (*Martilli et al., 2002*);
- Re-classified land-use with respect to urban types of surfaces (such as buildings, artificial surfaces with/without vegetation, etc.) and urban districts with detailed morphological characteristics can be included through the soil model for sub-meso scales urban version (SM2-U) module (*Dupont et al., 2006ab*).

These mentioned approaches (to study possible urban effects on meteorological patterns) have been preliminary tested and evaluated for the model for both specific case studies (related to low, typical, and high winds conditions) and long-term simulations (*Mahura et al., 2005; 2008*).

Main Goal:
Study influence of the selected metropolitan area on a formation of meteorological fields above the urban area and surroundings due to modification of the land surface scheme of the numerical weather prediction (NWP) model by analysis of temporal and spatial variability of diurnal cycle for meteorological variables of key importance

Specific Objectives:
1. Modify the land surface scheme of the Enviro-HIRLAM model:

- by changing the AHF+R+A - (a) anthropogenic heat flux, (b) roughness, and (c) albedo for urban grid cells;
- by implementation the BEP (Building Effects Parameterization) module;

2. Perform simulations for selected specific cases/dates (meteorological conditions with dominating low and typical wind conditions over the metropolitan area and surroundings) in two modes - the control run and the modified run (with changes: AHF+R+A vs. BEP);
3. Evaluate diurnal cycle variability for – (a) air temperature, (b) wind velocity, (c) relative humidity, (d) sensible heat flux, (e) latent heat flux, and etc. – for two types of runs; estimate extension and direction of boundaries under influence of metropolitan areas, magnitude and signs of changes due to urban areas, etc.;
4. Summaries findings and results of the exercise in a form of an oral presentation (max 15 minutes).

Literature List:

Before the Summer School, the students should read, at least, the first 3 required papers; the three other papers are highly recommended to read to be useful for the discussions/talks; the additional readings might be useful too.

REQUIRED READINGS

Korsholm U.S., A. Baklanov, A. Gross, A. Mahura, B.H. Sass and E. Kaas, **2008**: Online coupled chemical weather forecasting based on HIRLAM – overview and prospective of Enviro-HIRLAM. *HIRLAM Newsletter, **54**: 1-17.*

Korsholm U.S. **2009**: Integrated modeling of aerosol indirect effects. http://www.dmi.dk/dmi/sr09-01.pdf

Baklanov A., Mahura A., Nielsen N.W., C. Petersen, **2005**: Approaches for urbanization of DMI–HIRLAM NWP model. *HIRLAM Newsletter* **49**: 61-75.

Mahura A., Petersen C., Baklanov A., B. Amstrup, U.S. Korsholm, K. Sattler, **2008**: Verification of long-term DMI–HIRLAM NWP model runs using urbanization and building effect parameterization modules. *HIRLAM Newsletter* **53**: 50-60.

RECOMMENDED READINGS

Martilli, A., Clappier, A., and Rotach, M. W., **2002**: An Urban Surface Exchange Parameterisation for Mesoscale Models, *Boundary-Layer Meteorol*. 104: 261-304.

Dupont S., P. Mestayer, **2006a**: Parameterization of the Urban Energy Budget with the Submesoscale Soil Model. *J. of Appl. Meteor. and Climat., 45: 1744-1765.*

Dupont S., P.G. Mestayer, E. Guilloteau, E. Berthier, H. Andrieu, **2006b**: Parameterization of the Urban Water Budget with the Submesoscale Soil Model. *J. of Appl. Meteor. and Climat., 45: 624-648.*

ADDITIONAL READINGS:

Baklanov A., P. Mestayer, A. Clappier, S. Zilitinkevich, S. Joffre, A. Mahura, N. W. Nielsen, **2008**: Towards improving the simulation of meteorological fields in urban areas through updated/advanced surface fluxes description. *Atmos. Chem. Phys., 8: 523-543*.

Mahura A., S. Leroyer, P. Mestayer, I. Calmet, S. Dupont, N. Long, A. Baklanov, C. Petersen, K. Sattler, N. W. Nielsen, **2005**: Large eddy simulation of urban features for Copenhagen metropolitan area. *Atmos. Chem. Phys. Discuss*., 5: 11183–11213.