

Enviro - HIRLAM

Environment – High Resolution Limited Area Model: Research and Development, Technical Support and Science Education

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Introduction

On-line integration of numerical weather prediction (NWP) and atmospheric chemical transport (ACT) models enables the utilisation of all meteorological 3D fields in models at each time step and the consideration of the feedbacks of air pollution (e.g. urban aerosols) on meteorological processes and climate forcing. The realization of the on-line integration is demonstrated using the Enviro-HIRLAM (Environment – High Resolution Limited Area Model) integrated modelling system. Preliminary tests of the on-line vs. off-line integrated versions of Enviro-HIRLAM show that the on-line integration of NWP and ACT models with consideration of feedbacks between air pollution (e.g. urban aerosols), meteorological processes and urban climate is a promising way for the development of future systems of advanced numerical weather prediction. Such developments will lead to a new generation of integrated models for climate change modelling, weather forecasting (e.g., in urban areas, severe weather events, etc.), air quality, long-term assessment chemical composition, and chemical weather forecasting.

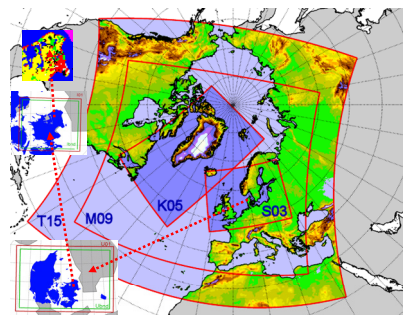


Figure : DMI-HIRLAM modelling system with NWP domains of different horizontal resolution and downscaling to urban areas.

Realisation and Development

Enviro-HIRLAM is developing since 1999 (starting at DMI and then expanding into international collaboration) as an on-line integrated system with a possibility of off-line coupling as well. The system realization includes the following steps:

- nesting of models;
- improved resolution of boundary and surface layer characteristics and structures;
- urbanization of the model;
- improvement of advection schemes, including chemical mechanisms;
- implementation of aerosol dynamics;
- realization of feedback mechanisms;
- possibility for future assimilation of air quality monitoring data.

On a perspective, Enviro-HIRLAM will be used for both operational and research purposes; and it will comprise aerosol and gas transport, dispersion, deposition, aerosol physics and chemistry, and gas-phase chemistry.

Impact on Mixing Layer Height

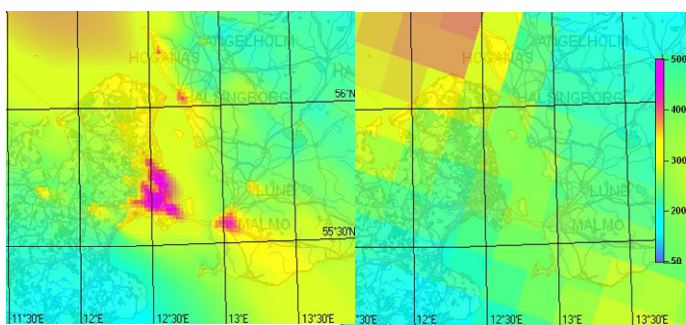


Figure : Mixing height (in meters) in ARGOS as calculated from DMI-HIRLAM with resolution of (left) 1.4 km (urban version) vs. (right) 15 km (DMI-HIRLAM T15).

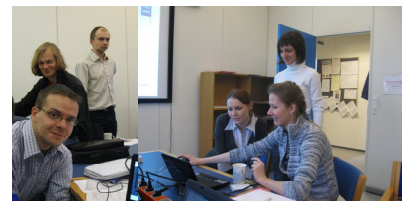
Baklanov, A., B. Fay, J. Kaminski (Eds), 2007: Overview of existing integrated (off-line and on-line) meso-scale systems in Europe. *COST-728 WG2 Del. 2.1 Report*, EC COST Publication.
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Advantages

- On-Line Approach:**
- Only one grid;
 - No spatial interpolation;
 - No temporal interpolation;
 - Physical parameterizations are same;
 - No inconsistencies;
 - All 3D meteo. variables are available at each time step;
 - No restriction in variability of meteo. fields;
 - Possibility to consider feedback mechanisms;
 - No need for meteo- pre/ post-processors.
- Off-Line Approach:**
- Possibility of independent parameterizations;
 - More suitable for ensemble activities;
 - Easier to use for the inverse modelling and adjoint problems;
 - Robustness;
 - More flexible grid construction and generation for ACT models;
 - Suitable for emission scenario analysis and air quality management;
 - Computationally less expensive.

Research Training



Aerosol Indirect Effect

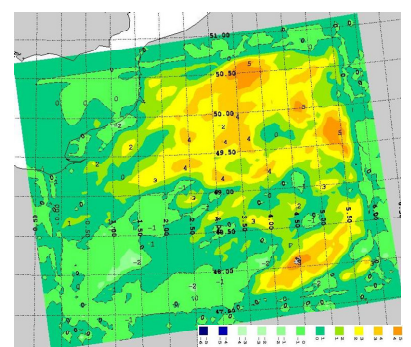


Figure : Day-time (29 Jun 2005 +036 h; 12 UTC) difference (reference - perturbation) for temperature at 2m (deg C).

On- vs. Off-Line Coupling

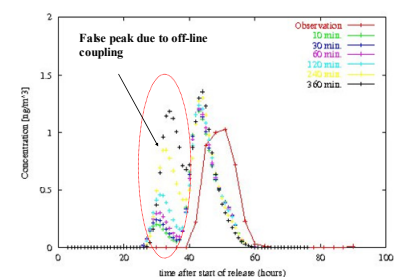


Figure : Concentration of passive tracer at DK02 station for different coupling intervals 10-360 min during ETEX experiment.

Urbanization Influence

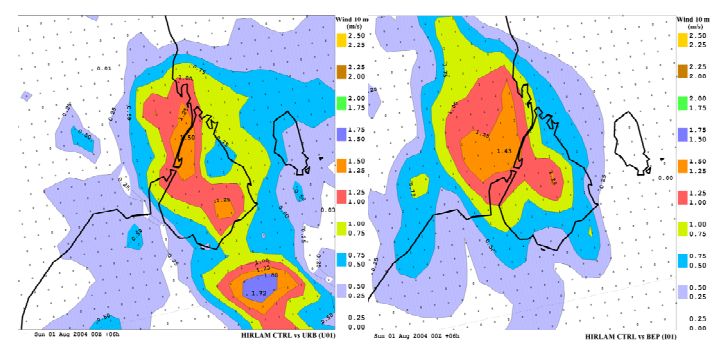
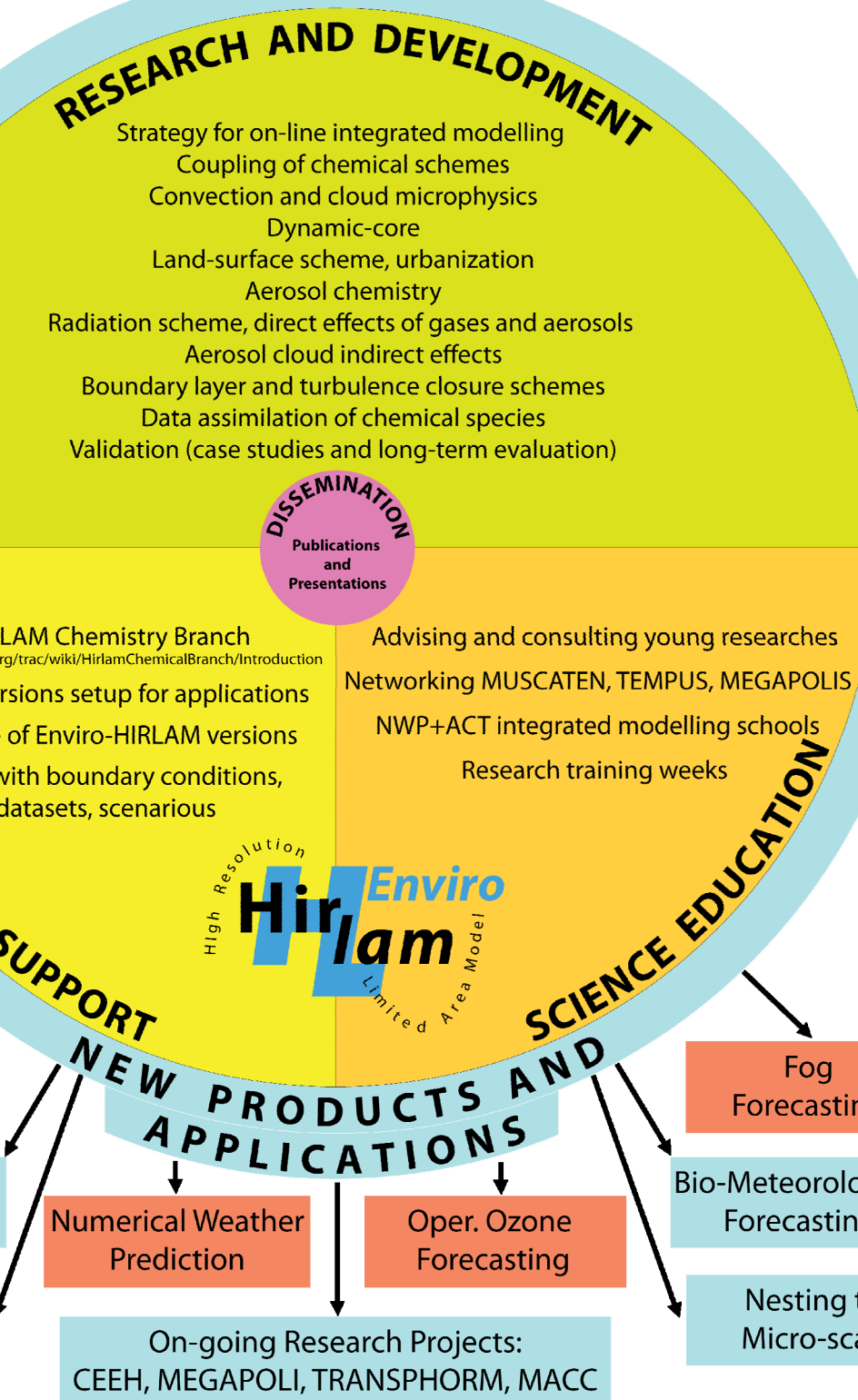


Figure : Difference plots (between outputs of the DMI-HIRLAM (non-urbanized) vs. (urbanized) left) AHF+R (Anthrop. Heat Flux + Roughness) right) BEP (Building Effect Parameterization) for wind velocity at 10 m for forecasts at 06 UTC, 1 Aug 2004.



CEEH — Danish Strategic Research Centre for Energy, Environment and Health (<http://www.ceeoh.dk>)
FP7 EC MEGAPOLI — Megacities: Emissions, urban, regional and Global Atmospheric POLLution and climate effects, and Integrated tools for assessment and mitigation (<http://megapoli.dmi.dk>)
FP7 EC TRANSPHORM — Transport related Air Pollution and Health impacts – Integrated Methodologies for Assessing Particulate Matter
FP7 EC MACC — Monitoring of Atmosphere Composition and Climate (<http://www.gmes-atmosphere.eu/>)
MUSCATEN / after NetFAM — Towards Multi-Scale Modelling of the Atmospheric Environment (<http://muscaten.ut.ee/>) / Nordic Network on Fine-scale Atmospheric Modelling (<http://netfam.fmi.fi/>)
TEMPUS — Development of Qualification Framework in Meteorology (QualiMet)
MEGAPOLIS — Integration Technologies for Evaluation of Atmospheric Pollution in Megacities on Regional and Global Scales based on Air, Space and Ground Monitoring for Reduction of Negative Consequences of Anthropogenic Impacts (<http://www.aerocosmos.info/megapolis.html>)

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