HIRLAM/HARMONIE-ACT models integration session

- The main idea of the section is to get together for NWP and ACT modellers, discuss and build our joint strategy for developing integrated system(s) based on HIRLAM.
- DMI is actively working with development of the on-line integrated system Enviro-HIRLAM, considering aerosol forcing mechanisms, etc.
- There are also several attempts to build off-line integrations of HIRLAM with own ACT models (CAC, Chimere, DERMA, EMEP, MATCH, SILAM).
- Such work was also included in the HIRLAM-A development plan (S4.10/4.5 Task: Coupling with atmospheric chemistry).
- The 'Integration' WG2 in COST 728 involves 5 HIRLAM member-institute representatives (DMI, FMI, Met.no, SMHI, Estonian Tartu Univ.), and they are willing to consolidate and coordinate joint efforts in this work for coupling HIRLAM with ACT models.

HIRLAM-ACTM related presentations

10.50 - 11.10 **Coupling of air quality and weather forecasting - progress and plans at met.no.** Viel Ødegaard
11.15 - 11.50 **ENVIRO-HIRLAM: on-line integrated system**. Ulrik Korsholm
11.50 - 12.30 ***HIRLAM/HARMONIE-ACT models integration session****, first part*
Definition of the discussion topics, start of discussions.
Conveners: Alexander Baklanov and Sander Tijm
12.30 - 13.30 *Lunch break*
13.30 - 15.10 *HIRLAM/HARMONIE-ACT models integration session, second part*
Discussions continue
Included in the session (15 min):
Some experiences using the non-hydrostatic model AROME as driver for the MATCH model. Lennart Robertson and Valentin Fontescu.
15.30 - 15.50 **Aerosol species in the AQ forecasting system of FMI: possibilities for coupling with NWP models**. Mikhail Sofiev
17.00 - 17.20 **Running the SILAM model comparatively with ECMWF and HIRLAM meteorologycal fields - a case study in Lapland**. Marko Kaasik

COST-728: MESOSCALE METEOROLOGICAL MODELLING CAPABILITIES FOR AIR POLLUTION AND DISPERSION APPLICATIONS

Working Group 2: Integrated systems of MetM and CTM/ADM: strategy, interfaces and module unification (http://cost728.dmi.dk/)

The overall aim of WG2 is to identify the requirements for the unification of MetM and CTM/ADM modules and to propose recommendations for a European strategy for integrated mesoscale modelling capability.

NWP Communities Involved:

- ***HIRLAM, COSMO, ALADIN/AROME, UM communities***
- MM5/WRF/RAMS users/developers

HIRLAM presented by DMI (A.Baklanov), ***FMI*** (M.Sofiev), ***SMHI*** (V.Foltescu), ***UT*** (A.Mannik)

Tasks/Sub-groups:

1. Off-line models and interfaces
2. Model down-scaling/ nesting
3. On-line coupled modelling systems
4. Data assimilation
5. Models unification and harmonization

S4.5: Coupling with atmospheric chemistry

One of the challenges of HIRLAM-A is the development of SRNWP-models towards earth system models. One of the first steps foreseen in this, is the coupling of the NWP model to regional atmospheric chemistry models, such as MATCH, EMEP and Chimere.

S4.5.1: Short term actions

Groups within several HIRLAM countries (Finland, Netherlands, Norway) have begun work to couple the HIRLAM model to different air chemistry and air quality models; this is, or is planned to be, done by means of a simple one-way atmosphere-to-chemistry coupling mechanism. In the course of 2007, these groups will be brought together, with a view to decide on a common approach in the research in this area and the assessment of its outcome.

Time: June 2007
Staff resources for 2007: Wichers Schreur (1mm)
Priority: medium
Responsible project leader: Tijm
Contributions from ALADIN staff: none

S4.5.2: Longer term strategy

In the years after 2007, the investigation of more involved ways of coupling atmosphere and air chemistry and aerosols is envisaged. The likely importance of chemistry and aerosols in an NWP context such as HIRLAM will be assessed in a strategy document, on the basis of existing expertise within the HIRLAM countries (built up within projects such as COST-728). In particular, the possible role of aerosol feedbacks should be investigated, and ways to develop chemical weather forecast systems in the future are to be assessed. Aerosols have been shown to have an important impact on the visibility and formation of fog, so from that point alone it is necessary to include aerosols into the model.

Time: 2008 and onwards
Staff resources for 2007: none
Priority: low for 2007.
Responsible project leader: Tijm
Contributions from ALADIN staff: none

S4.10: Coupling with atmospheric pollutants

(suggested by DMI in 2006)

One of the challenges of HIRLAM-A is the development of SRNWP-models towards integrated earth system models, considering feedback mechanisms, e.g. between aerosols and meteorological processes. Through the development of the DMI-ENVIRO-HIRLAM system and the on-line coupling between NWP and ACT models, this work has recently been initiated by DMI and the WG2 COST Action 728. One of the steps foreseen, with activities commencing during 2006, is the coupling of the NWP model with atmospheric pollutants. At first, a simple sensitivity study of the off-line and on-line coupled variants of DMI-Enviro-HIRLAM will be realized and a report / strategy plan for the development and further coordination of a fully on-line integrated system in the HIRLAM consortium will be elaborated. The report shall be presented for the Scientific Advisory Committee. Scientific Advisory Committee can then decide which further steps shall be done in this direction.

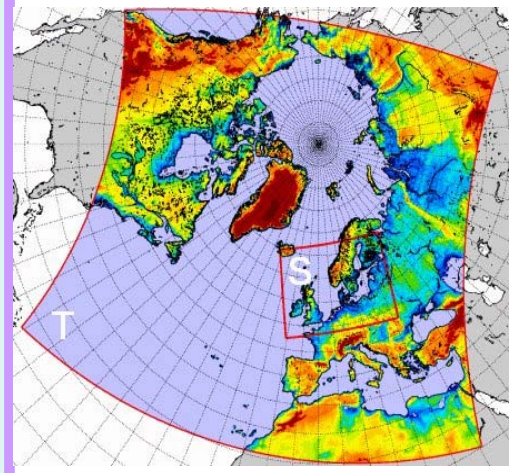
Time: 2006 – 2007

Staff resources: Contact persons - Wichers Schreur, Robertson, Baklanov (adv), Gross (*), Korsholm (*)

Structure of the Danish nuclear emergency modelling system

DMI-HIRLAM system

- T version: 0.15°
- S version: 0.05°
- L version: 0.014°



ECMWF global model

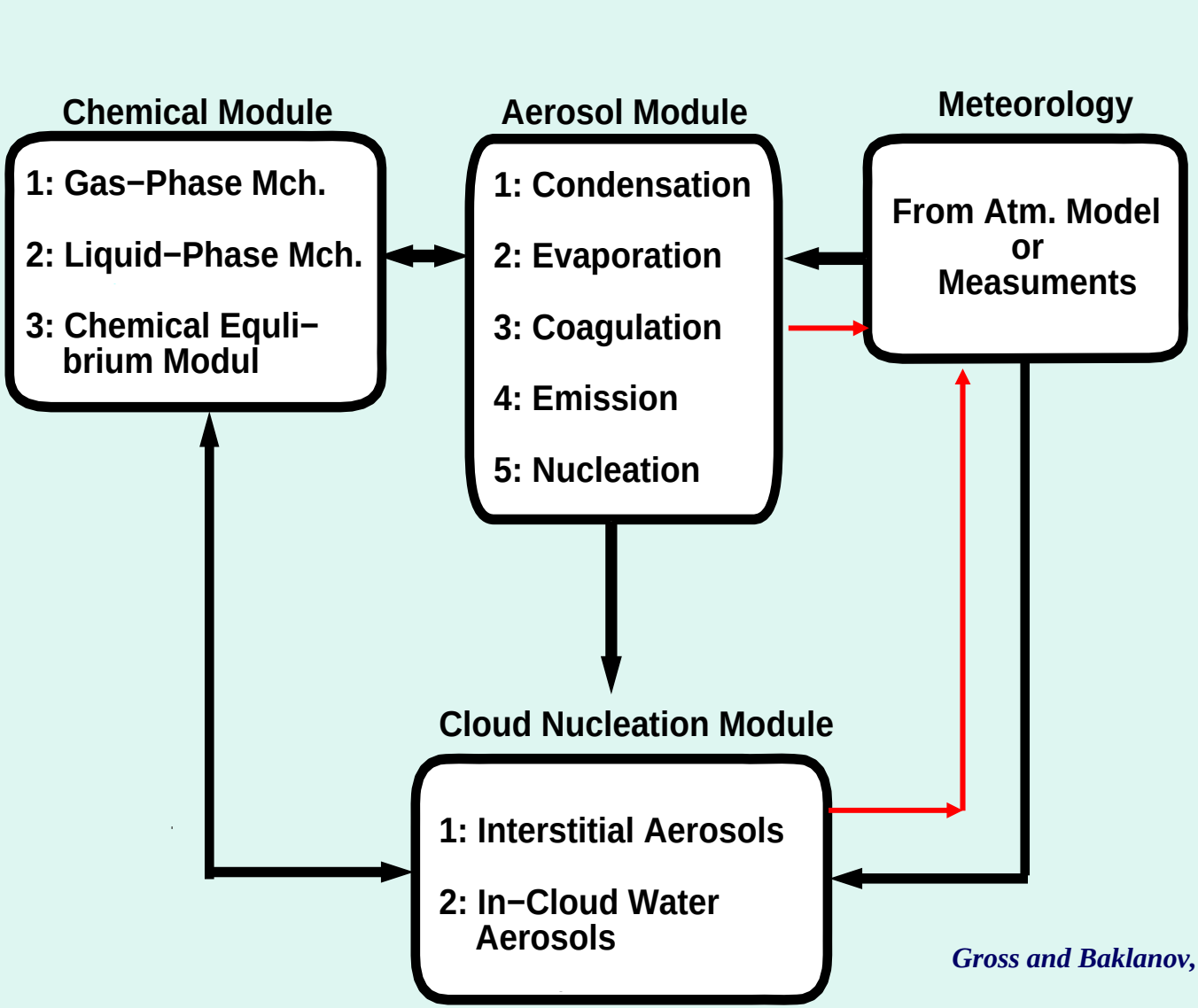
DERMA model

- 3-D trajectory model
- Long-range dispersion
- Deposition of radionuclides
- Radioactive decay

ARGOS system

- Radiological monitoring
- Source term estimation
- Local-Scale Model Chain
- Health effects

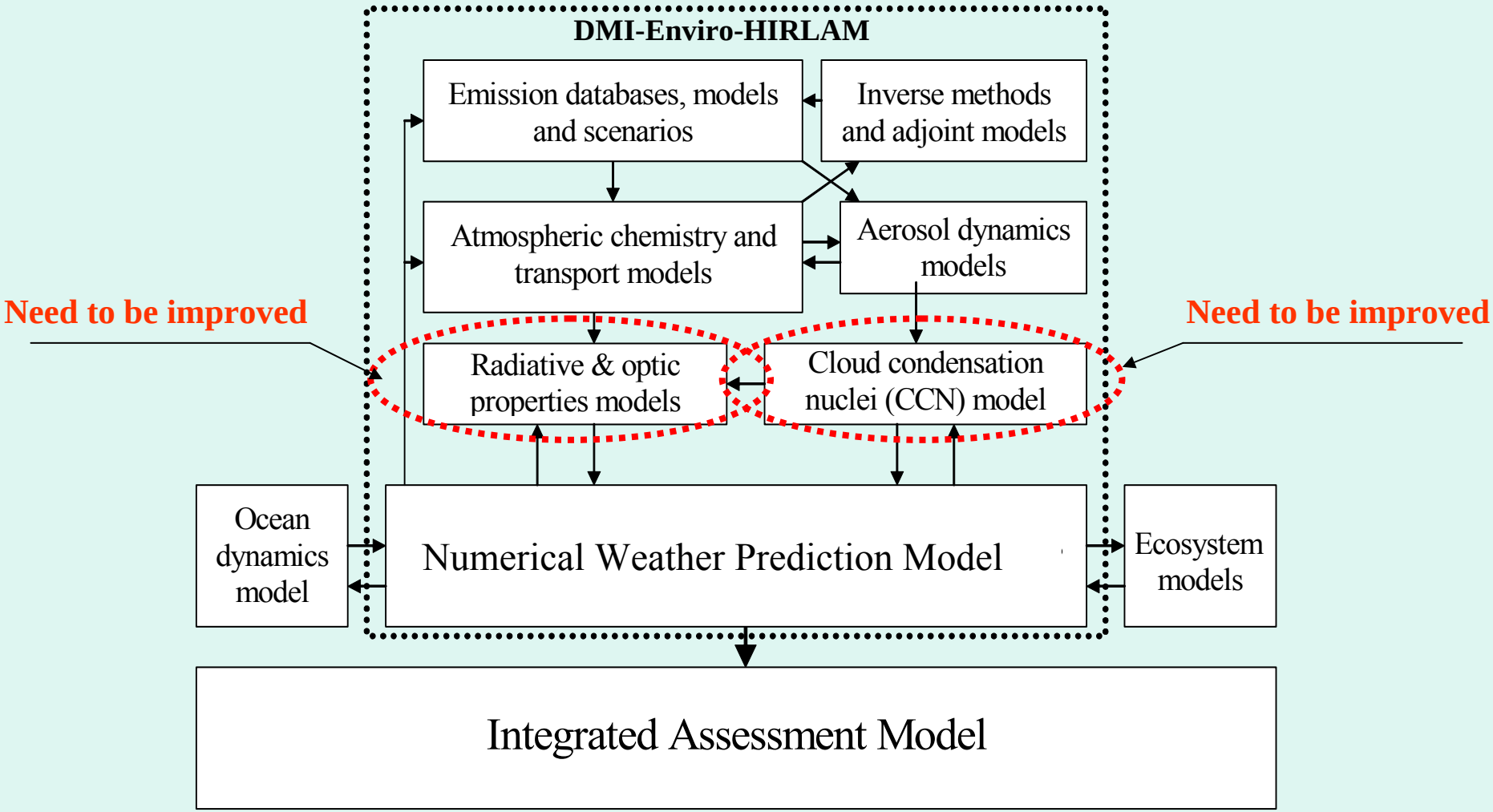
DMI Chemistry-Aerosol-Cloud (CAC) Model
and its implementation into Enviro-HIRLAM



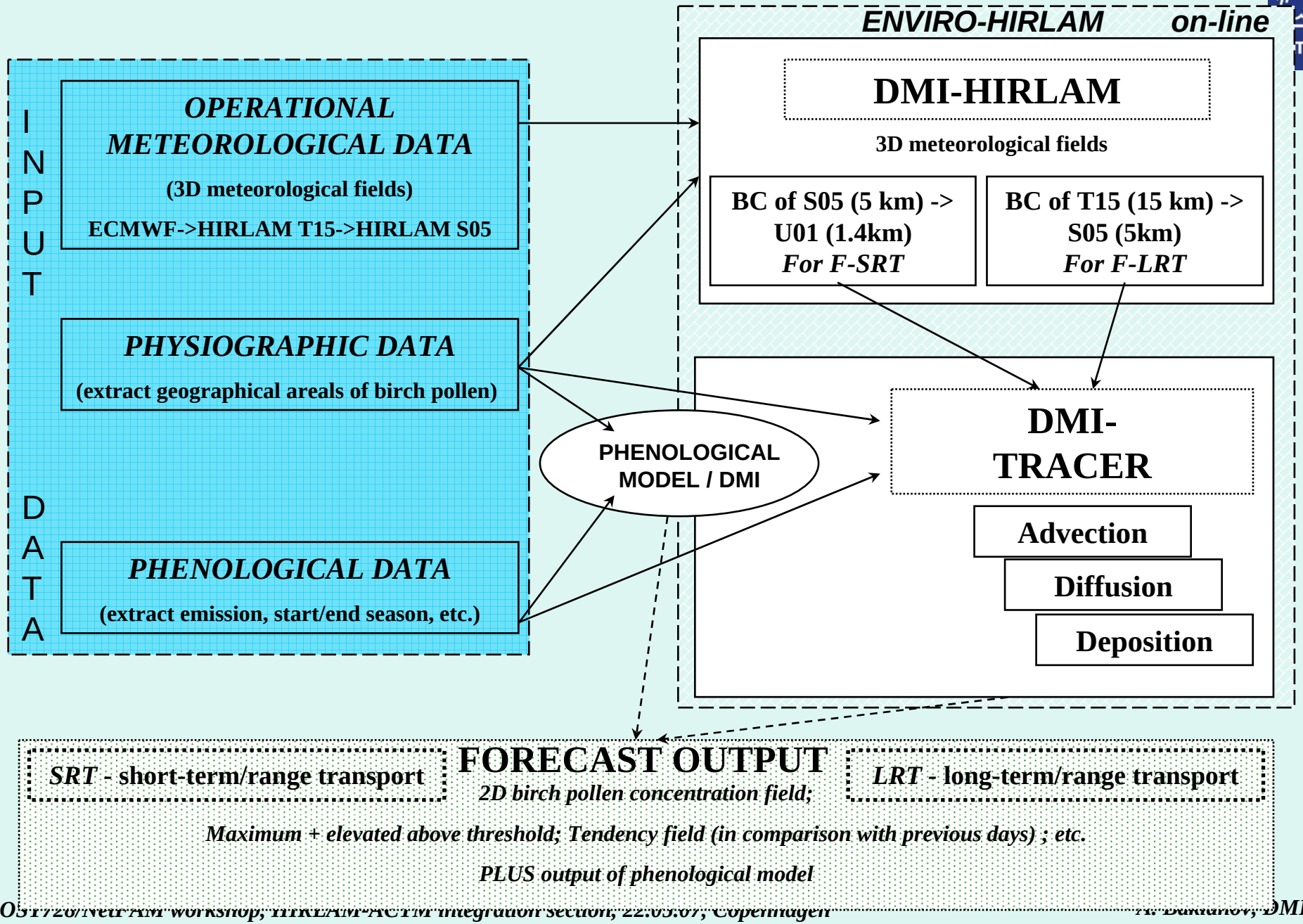
Gross and Baklanov, IJEP, 2004, 22, 51

DMI-Enviro-HIRLAM

New integrated (on-line coupled) modeling system structure for predicting the atmospheric composition



BIRCH POLLEN FORECAST / DMI-ENVIRO-HIRLAM



Plan for DMI-ENVIRO-HIRLAM development and applications

(2005 -2010), PI - ALB

1. DMI-HIRLAM related continued (2005 – 2007), after FUMAPEX:

URBANIZATION (Responsible persons - ALB, AMA, CP)

- DMI module (cont. cooperation with S. Zilitinkevich, HU, Finland), (involved NWN)
- SM2_U module (cont. cooperation with ECN, France), (involved NWN, KSA)
- BEP module (cont. cooperation with EPFL, Switzerland), (involved NWN, KSA)
- High resolution HIRLAM output for Urban ARGOS (cooper. DEMA, RISØ), (involved JHS)

ISBA LSS and PHYSICS PARAMETRIZATIONS (PR – AMA, involved NWN, BHS, KSA, ALB)

LUC and CGF FOR HIGH RESOLUTION MODELLING (RP – KSA, involved AMA, USN, AGR, AR)

ABL HEIGHT PARAMETRIZATIONS (RP – ALB, involved NWN, AMA)

2. Environment Integrated Modelling related (DMI, COGCI, COST728):

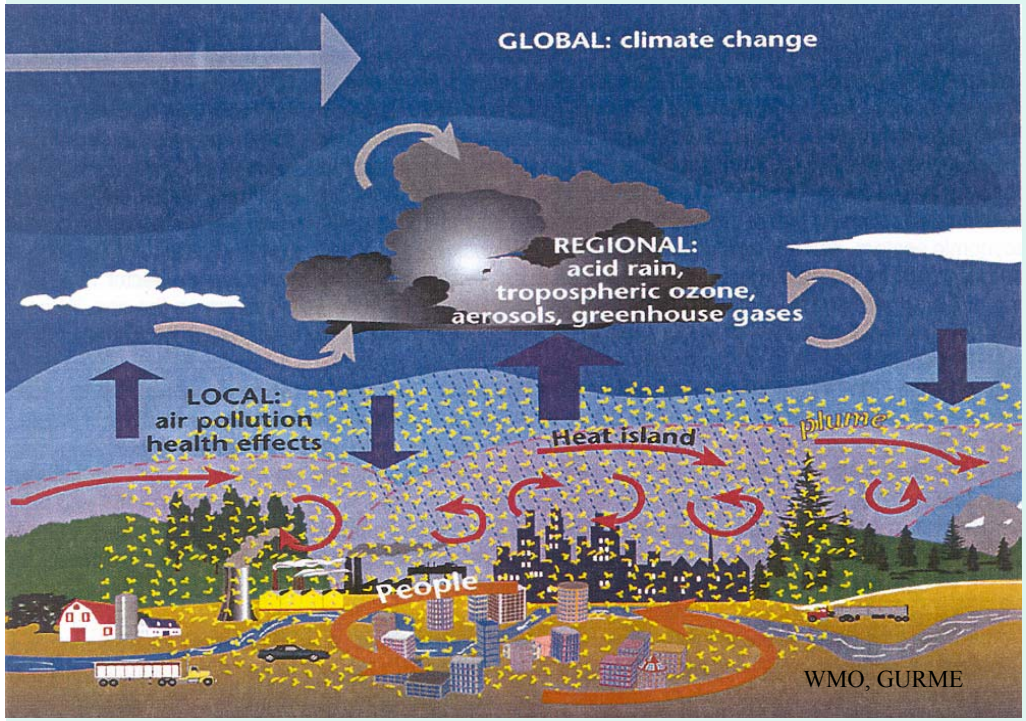
- **SI-CISL advection scheme** (2005-2006), (RP – KLI, involved USN, EK)
- **AEROSOLS** (2005 – 2007), (RP – USN, involved ALB, AGR)
- **POLLEN** (2005 – 2007), (RPs – AR, AMA, ALB, cooper. FMI)
- **CHEMISTRY** (2006 – 2008), (RP – AGR, involved ALB, USN)
- **RISK** (incl. Enviro-RISKS project) (2005 – 2008), (RP – ALB, involved JHS, AMA, AR, AGR, USN; cooper. RISØ)
- **FEEDBACKS** (2007 – 2009), (RP – USN, involved ALB, AGR)

3. Data assimilation /Ph.D. Student/ (2008 – 2010), (involved XYH, ALB, JHS, AGR)

What ACTMs expect from HIRLAM:

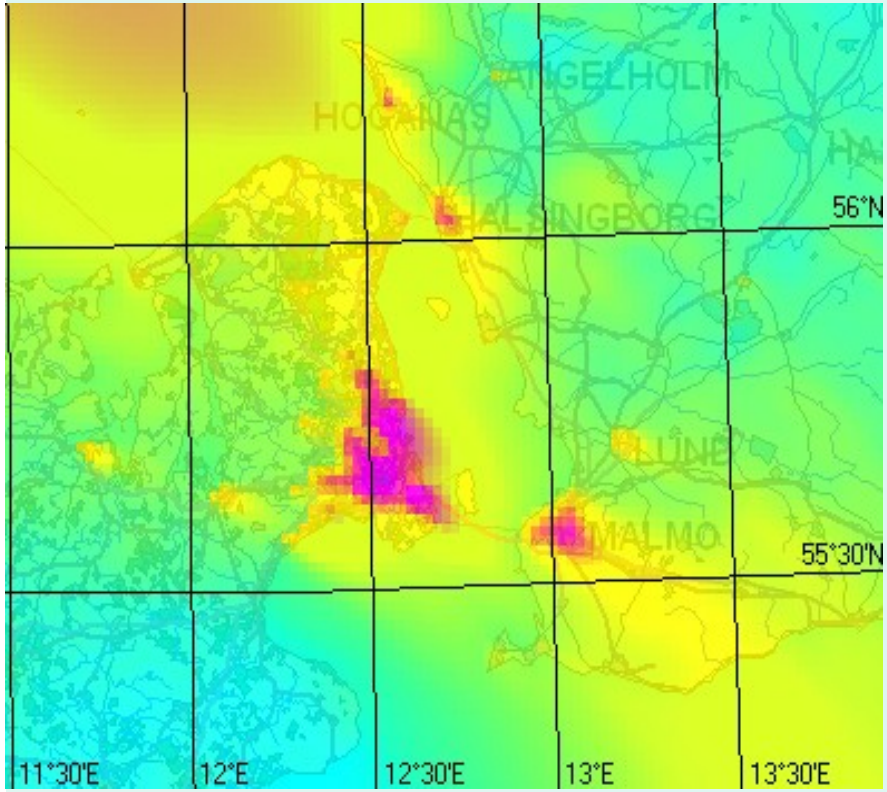
- Modifications of microphysics/clouds module (for on-line),
- Modifications of radiative and optical properties module (for on-line),
- Modifications of the cloud 3D data outputs (for off-line),
- Improved description of PBL(SBL first of all), especially for urban, coast and forest areas (for all ACTMs),
- Open module structure is very important,
- …..

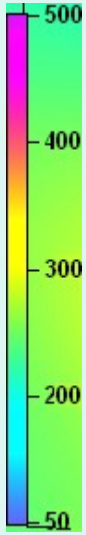
Megacities: Urban features in focus:

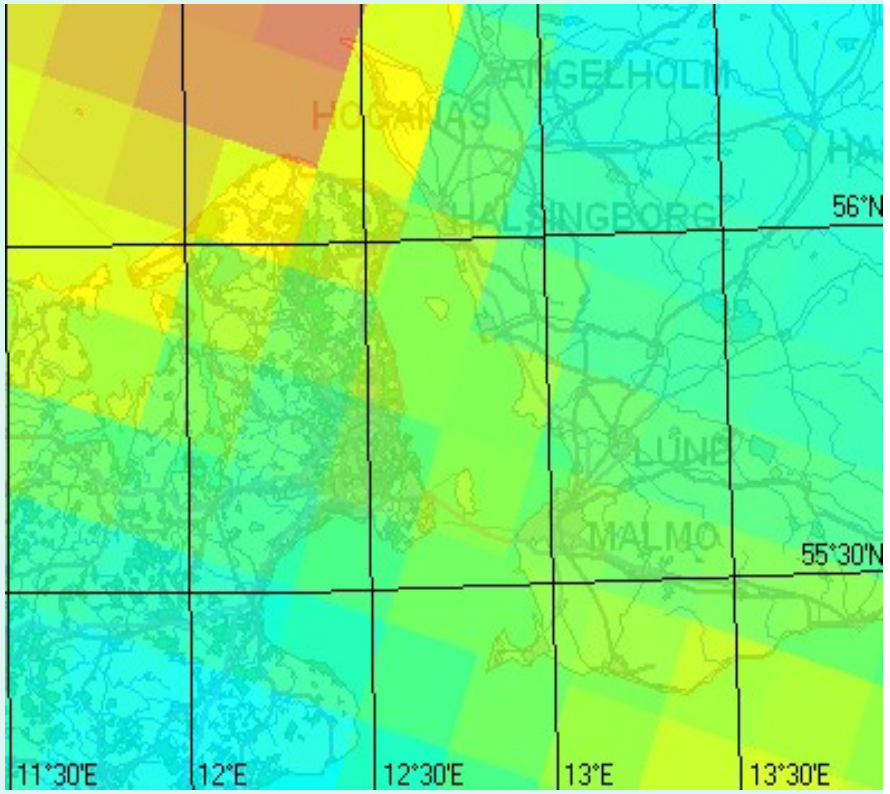


- **Urban pollutants emission, transformation and transport,**
- **Land-use drastic change due to urbanisation,**
- **Anthropogenic heat fluxes, urban heat island,**
- **Local-scale inhomogeneties, sharp changes of roughness and heat fluxes,**
- **Wind velocity reduce effect due to buildings,**
- **Redistribution of eddies due to buildings, large => small,**
- **Trapping of radiation in street canyons,**
- **Effect of urban soil structure, diffusivities heat and water vapour,**
- **Internal urban boundary layers (IBL), urban Mixing Height,**
- **Effects of pollutants (aerosols) on urban meteorology and climate,**
- **Urban effects on clouds, precipitation and thunderstorms.**

Mixing height in ARGOS as calculated from different versions of DMI-HIRLAM



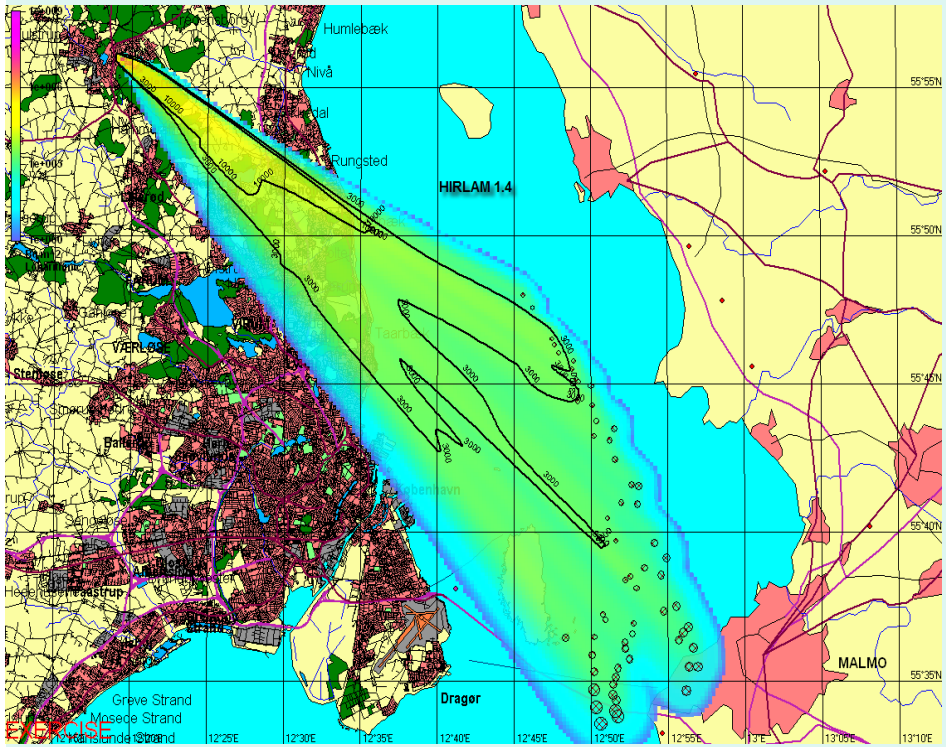




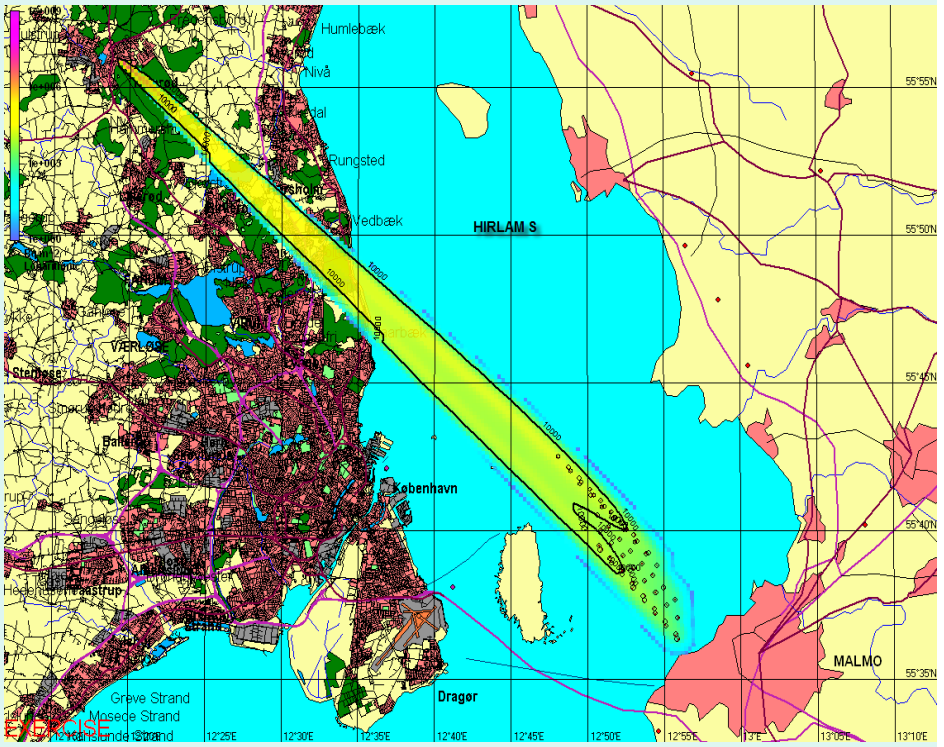
urbanised 1.4 km

operational 15 km

Sensitivity of ARGOS dispersion simulations to urbanized DMI-HIRLAM NWP data



urbanised U01, 1.4 km resolution



operational S05, 5 km resolution

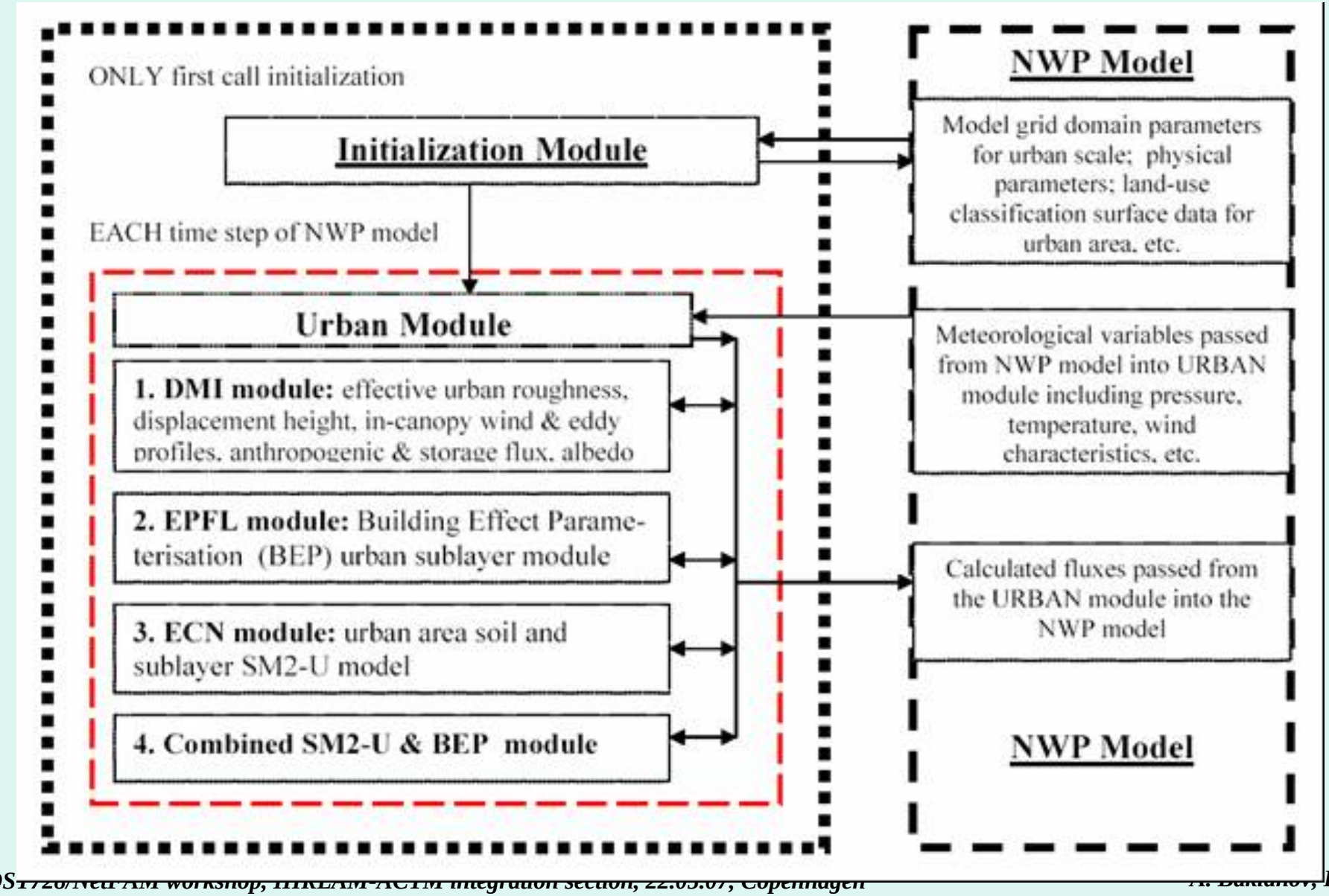
Cs-137 air concentration for different DMI-HIRLAM data
A local-scale plume from the ^{137}Cs hypothetical atmospheric release in Hillerød at 00 UTC, 19 June 2005 as calculated with RIMPUFF using DMI-HIRLAM and visualised in ARGOS for the Copenhagen Metropolitan Area.

Urbanisation of NWP models:

1. Model down-scaling, including increasing vertical and horizontal resolution and nesting techniques (one- and two-way nesting);
2. Modified high-resolution urban land-use classifications, parameterizations and algorithms for roughness parameters in urban areas based on the morphologic method;
3. Specific parameterization of the urban fluxes in meso-scale models;
4. Modelling/parameterization of meteorological fields in the urban sublayer;
5. Calculation of the urban mixing height based on prognostic approaches;
6. Assimilation surface characteristics based on satellite data into Urban Scale NWP models.

Integrated Fumapex urban module for NWP models

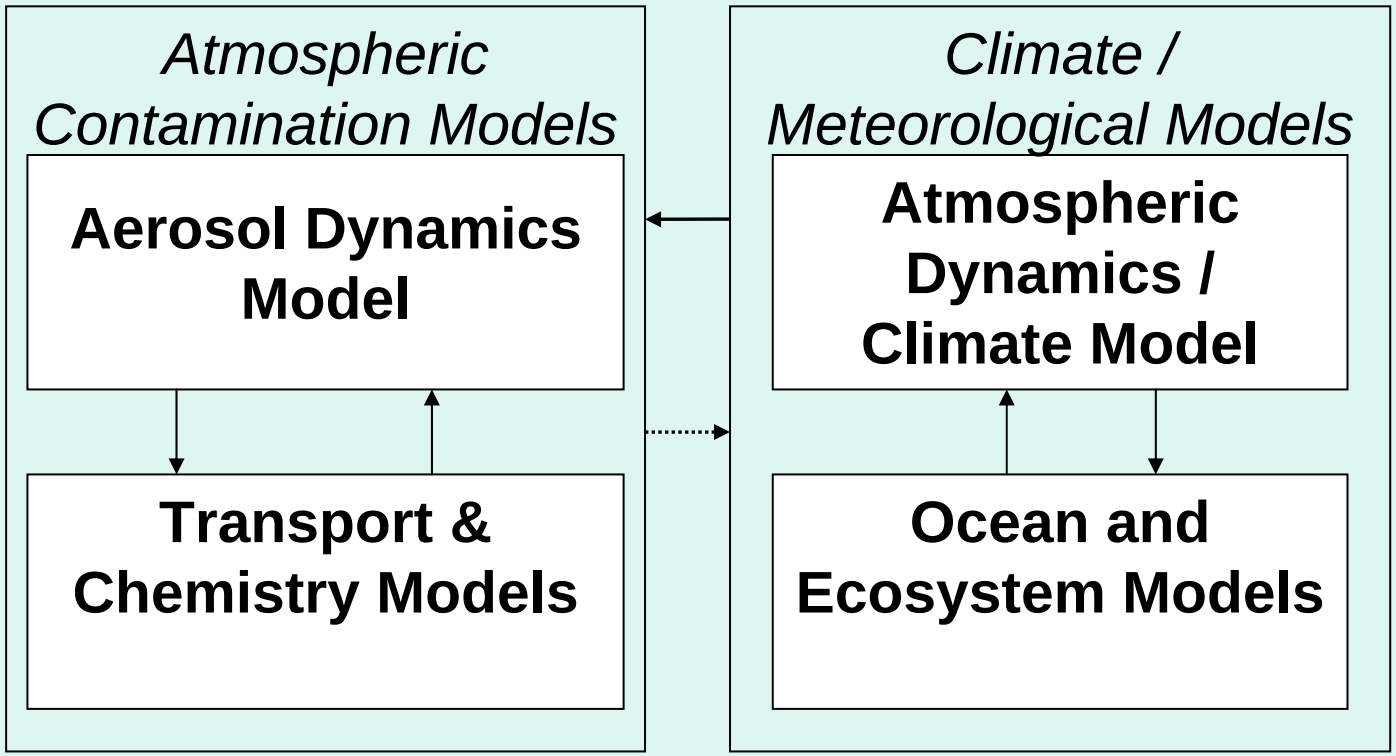
including 4 levels of complexity of the NWP 'urbanization' (see *fumapex.dmi.dk*)



Approaches applicability

- The first module is the cheapest way of "urbanising" the model and can be easily implemented into operational NWP models as well as in Regional Climate Models.
- The second module is a relatively more expensive (≈ 5-10 % computational time increase), but it gives a possibility to consider the energy budget components and fluxes inside the urban canopy. However, this approach is sensitive to the vertical resolution of NWP models and is not very effective if the first model level is higher than 30 meters. Therefore, the increasing of the vertical resolution of current NWP models is required.
- The third module is considerably more expensive computationally than the first two modules (up to 10 times!). However, it provides the possibility to accurately study the urban soil and canopy energy exchange including the water budget. Therefore, the second and third modules are recommended for use in advanced urban-scale NWP and meso-meteorological research models.

Integrated Atmospheric System Model Structure



One-way: 1. HIRLAM meteo-fields as a driver for ACTM (off-line);

2. ACTM chemical composition fields as a driver for R/GCM (or for NWP)

Two-way: 1. Driver + partly feedback (data exchange, with or without iterations);

2. Full feedbacks included on each time step (on-line coupling)