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NetFAM School and Workshop on
"Integrated Modelling of Meteorological and Chemical Transport Processes / Impact of Chemical Weather on Numerical Weather Prediction and Climate Modelling"

Zelenogorsk (near Saint-Petersburg), Russia
7-15 July 2008

NetFAM:
Nordic Network on Fine-scale Atmospheric Modelling

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Content:

1. Information Letter

NetFAM Summer School and Workshop on "Integrated Modelling of Meteorological and Chemical Transport Processes / Impact of Chemical Weather on Numerical Weather Prediction and Climate Modelling"

Zelenogorsk (near St. Petersburg), Russia, 7-15 July 2008

Introduction

The NetFAM announces the young scientist summer school and workshop on topics of integrated modelling of meteorological and chemical transport processes to understand the impact of chemical weather on numerical weather prediction and climate modelling. The school will take place from 7 till 12 July 2008 and the workshop - from 14 till 15 July 2008.

The aim of this event is to join young scientists and researches of the HIRLAM (HIgh Resolution Limited Area Model) community in order to elaborate, outline, discuss and make recommendations on the best strategy and practice for further developments and applications of the integrated modelling of both meteorological and chemical transport processes into the HIRLAM/HARMONIE modelling system. The main emphasis is on fine-resolution models applied for chemical weather forecasting and feedback mechanisms between meteorological and atmospheric pollution processes.

Organizers of the summer school and workshop welcome interested participants from countries and associated members of the HIRLAM consortia (http://www.hirlam.org).

Young Scientist Summer School, YSSS (7-12 July 2008)

The summer school will start on Monday, 7 July 2008 and last five days. The school includes lectures (from 9.00 till 15.45) and practical exercises (from 15.45 till 18.00) within groups of students (4-5 persons).
On Friday 11 July 2008, the part of the day will be spent for finalization of the exercises, analyses, and presentations by groups of students. The students will give oral presentations from 16 to 18.00.
The Ice Breaking Party for participants will be arranged on Monday, 7 July 2008 starting at 19.15.

During the summer school the main taught topics will include general introduction to aspects of meteorological modelling (numerical weather prediction, parameterizations and physics, numerics, advection, land-use, radiation, clouds, aerosols, urbanization); off-line vs. on-line atmospheric-chemical-aerosol (ACA) modelling; possible feedbacks and their impact from ACA on short and long time-range atmospheric circulation models; etc.

See details of the YSSS programme:
for lectures at: http://netfam.fmi.fi/YSSS08/YSSS08_programme.pdf
for practical exercises at: http://netfam.fmi.fi/YSSS08/YSSS08_exe.html, and
for requirements for the student's background in order to attend the school at: http://netfam.fmi.fi/YSSS08/ Requirements.pdf.

Workshop (14-15 July 2008)

Presentations on the following topics are especially welcome:

- Examples of integrated modelling - on-line and off-line air quality models coupled to HIRLAM;
- Implementation and testing of feedback mechanisms, direct and indirect effects of aerosols, etc.;
- Advanced interfaces between HIRLAM and atmospheric chemistry transport models;
- Validation and verification studies for specific meteorological and air quality related cases.

The followed after the School the Workshop will start at 10.00 on Monday, 14 July 2008 and end at midday on 15 July 2008.
The Poster Session will take place on 14 July 2008, 16.00-18.00.

- **Oral presentations by participants** (max 30 min each),
- **Discussions / Round Table** to build a joint strategy, recommendations and requirements.

The list of accepted oral and poster presentations will be available at NetFAM website.

Participation and Deadlines

For school participants:
To participate in the school and/or workshop, please, fill out the *summer school application form* (http://netfam.fmi.fi/YSSS08/SchoolApplicForm.doc and *registration form* (http://netfam.fmi.fi/YSSS08/ SchoolRegisForm.doc) and send as attachment file by e-mail to the local organizer Sergey Smyshlyaev, RSHU (smyshl@rshu.ru) with copies to Allan Gross, DMI (agr@dmi.dk), and Laura Rontu, FMI (laura.rontu@fmi.fi) till **30th March 2008**.

For workshop participants:
To participate in workshop, please, fill out the *workshop registration form* (http://netfam.fmi.fi/YSSS08/WShopRegisForm.doc) and send also a title of your oral or poster presentation till **15th April 2008** to local organizer Edward Podgaisky, RSHU (podgaisky@rshu.ru) with copies to Alexander Mahura, DMI (ama@dmi.dk) and Laura Rontu, FMI (laura.rontu@fmi.fi).

Short abstracts (max 1 page) for the workshop are welcome till **15th May 2008**.
Papers (max 8 pages for oral and 4 pages for poster presentations) for the workshop proceedings are welcome till **31th July 2008**.
It is also possible to participate without making a presentation.

There is **no registration fee** for the summer school and workshop.

The working language of the summer school and workshop is **English**.

Information about travel options, visa requirements, and accommodation in St. Petersburg can be found at the page of practical information (http://netfam.fmi.fi/YSSS08/TravelInfo.pdf); contact also Tatiana Ermakova from the RSHU International Relation Office (Phone/Fax: +7-812-444-5636; E-mail: ermakova@rshu.ru).

Note, the limited support for travel expenses is available:
For NetFAM and HIRLAM members –
From NetFAM list (http://netfam.fmi.fi/YSSS08/ListNetFAM.pdf)
For others –
From the TEMPUS project, Russian Foundation for Basic Research, and COST Actions
upon request from the *school and workshop registration forms* and based on evaluation (recipients will be informed by e-mail).

Organizers

International organizing committee:
Lev Karlin (co-chairman), Sergey Smyshlyaev, and Andrey Belotserkovskiy (Russian State Hydrometeorological University, RSHU – http://www.rshu.ru);
Alexander Baklanov (co-chairman), Allan Gross, and Alexander Mahura (Danish Meteorological Institute, DMI – http://www.dmi.dk);
Jaakko Kukkonen, Mikhail Sofiev, and Laura Rontu (Finnish Meteorological Institute, FMI – http://www.fmi.fi);
Sergej Zilitinkevich, Hannu Savijarvi (not confirmed), and Markku Kulmala (not confirmed) (University of Helsinki - http://www.helsinki.fi/university/);
Jeanette Onvlee and Sander Tjim (Koninklijk Nederlands Meteorologisch Instituut, KNMI - http://www.knmi.nl/);
Eugenie Genikhovich (Main Geophysical Observatory, MGO - http://www.mgo.rssi.ru/).

The summer school and workshop are arranged in the framework of cooperation with the

- Nordic Network on Fine-scale Atmospheric Modelling, NetFAM (http://netfam.fmi.fi/),
- TEMPUS TACIS Joint European Project, COMBAT-METEO "Development of a competency-based two-level curricula in meteorology" (http://www.combat-meteo.net),
- Russian Foundation for Basic Research (RFFI) (http://www.rfbr.ru/),
- COST Action ES0602 "Towards a European Network on Chemical Weather Forecasting and Information Systems" (http://www.chemicalweather.eu), and
- COST Action ES0603 "Assessment of production, release, distribution and health impact of allergenic pollen in Europe - EUPOL" (http://www.cost.esf.org/index.php?id=1080).

The local organizer and host is the Russian State Hydrometeorological University (RSHU) (http://www.rshu.ru). The responsible organizer for the school lectures and scientific programme is the Danish Meteorological Institute (DMI) (http://www.dmi.dk).

Contact e-mail for
School issues: Sergey Smyshlyaev (smyshl@rshu.ru) or Allan Gross (agr@dmi.dk); and
Workshop issues: Edward Podgaisky (podgaisky@rshu.ru) or Alexander Mahura (ama@dmidk).

2. Work Programme of the Summer School

Lectures Programme of the Summer School

"Integrated Modelling of Meteorological and Chemical Transport Processes / Impact of Chemical Weather on Numerical Weather Prediction and Climate Modelling"

The idea with the lectures at the Summer School is that the students get an understanding of the basic components that are included in integrated meteorological-chemical-aerosol-cloud-transport models. These include both the physical/chemical components and how these components numerically can be realised and implemented into these models.

All lectures are 45 minutes long followed by a 15 min. break.

Day 1: Monday, 7 July 2008

08:00 – 09:00: Registration

09:00 – 09:15: Official Opening by Prof. L. Karlin, RSHU

09:15 – 09:30: Welcome

- What is required from the students to receive a diploma from the School?
- Short description of the exercises.

09:30 – 10:15: Introduction Lecture
(Prof. Alexander Baklanov, DMI, Denmark)

Introduction to Integrated Modelling of Meteorological and Chemical Transport Processes
Meteorological modelling, integration of gases and aerosols, on-line versus off-line, feedbacks, etc.
Objective: what will be the basic subjects of the school, short overview of all these subjects.

Block 1: Meteorological Modelling *(9 Lectures)*

10:30 – 11:15: Lecture 1
(Dr. Niels W. Nielsen, DMI, Denmark)

General Introduction into the Atmosphere
Definitions, chemical composition, vertical structure, layers of the atmosphere, main meteorological characteristics/variables (importance for Numerical Weather Prediction (NWP)), basic forces, basic dynamics, thermodynamics, etc.

11:30 – 12:15: Lecture 2
(Dr. Niels W. Nielsen, DMI, Denmark)

Atmospheric Motions and Numerical Weather Prediction (NWP)
Temporal and spatial scales of atmospheric motions.
Basic system of equations for atmospheric motions (continuity, temperature, momentum).
NWP – general introduction (briefly – climate modelling).
versions of HIRLAM with respect to horizontal and vertical resolutions, time steps, applications for different tasks/activities, etc.

12:30 – 13:15: Lecture 3
(Dr. Sander Tijm, KNML, The Netherlands)

HIRLAM Numerical Weather Prediction (NWP)
Overall general introduction.

- Equations briefly (based on Lecture 2).
- Numerics/methods for solution.
- Input/Output HIRLAM data.
- Physics – generally (radiation, clouds and condensation, surface and soil processes, orography effects, etc.)
- Data assimilation and initialization.

13:15 – 14:30: Lunch

14:30 – 15:15: Lecture 4
(Prof. Sergey Zilitinkevich, FMI/UH, Finland)

Atmospheric boundary layer
Definitions, spatial and temporal variability, classification, mixing layer height, briefly description of approaches and parameterizations used in HIRLAM.

- ABL definition, +surface layer,
- spatial structure, temporal diurnal evolution,
- classes-types (SBL, CBL, UBL, etc.),
- mixing layer height, parameterizations in NWP

15:30 – 16:15: Lecture 5
(Dr. Bent Sass, DMI, Denmark)

Atmospheric radiation, precipitation, clouds
Definitions, spatial and temporal variability, +briefly approach and parameterizations used in HIRLAM: STRACO, Rasch-Kristjansson, Kain-Fritsch, etc. Approaches in HIRLAM.

- Atmospheric radiation: general – definitions, sun vs. Earth, balance, spatial and temporal variability;
- Clouds: general – definitions, classification, spatial and temporal distribution (focus on troposphere),
- Precipitation: general – definitions, water phase changes in atmosphere, CCN, humidity, spatial and temporal variability (focus on ABL);

16:15 – 18:00: Exercises
Introduction to practical use of Enviro-HIRLAM:

- How to run Enviro-HIRLAM?
- Making the first simple tests.

Afterwards the students go into groups and discuss the scientific problem they shall solve during the summer school. The scientific problems/exercises (see details at web-site of the summer school).

19:15 – Ice Breaking Party

Day 2: Tuesday, 8 July 2008

09:00 – 09:45: Lecture 6
(Dr. Bennert Machenhauer, DMI, Denmark)

Advection
Definition, different numerical approaches and numerical schemes.

10:00 – 10:45: Lecture 7
(Dr. Bennert Machenhauer, DMI, Denmark)

Advection
Continuation of lecture 6.

11:00 – 11:45: Lecture 8
(Dr. Sander Tijm, KNML, The Netherlands)

Diffusion
Diffusion, turbulence closures

12:00 – 12:45: Lecture 9
(Dr. Alexander Mahura, DMI, Denmark)

Treatment of Land-use and Urbanization
Land-use, classification, datasets, land surface schemes, urban classification.
Urbanization approaches, anthropogenic heat flux, roughness, albedo; building effects parameterizations; soil model for submesoscales; city districts (centre, high buildings, industrial commercial, residential); examples.

13:00 – 14:00: Lunch

Block 2: Atmospheric Chemical Transport Modelling *(13 Lectures)*

14:00 – 14:45: Lecture 1
(Dr. Mikhail Sofiev, FMI, Finland)

General Introduction to the Physical and Chemical Atmospheric Processes.
The basic Atmospheric Chemical Transport Modelling (ACTM) processes are shortly introduced. This includes: advection, diffusion, deposition, emission, chemistry, aerosols, and clouds. These processes will be handled in more details in the following lectures.

15:00 – 15:45: Lecture 2
(Dr. Mikhail Sofiev, FMI, Finland and Prof. Eugene Genikhovich, MGO, Russia)

Physical Atmospheric Processes, characteristics of atmospheric composition and air quality, model evaluation.
Definitions, diffusion, deposition and land use. How are they solved in CTM. Different numerical treatments. Means of characterization of atmospheric composition, appropriate measures and consequences for the CTM evaluation.

15:45 – 18:00: Exercises

Each group will give a short summary of the problem they will look at and how they will solve it (max. 10 min.). Afterwards will the students continue their exercise in groups.

Day 3: Wednesday, 9 July 2008

Chemistry Block

09:00 – 09:45: Lecture 3
(Dr. William Stockwell, Howard University, USA)

Fundamentals of Atmospheric Gas-Phase Chemistry
State of the art and future challenges (where are improvements of our knowledge needed)

10:00 – 10:45: Lecture 4
(Dr. William Stockwell, Howard University, USA)

Development of Chemical Gas-Phase Mechanisms for Air Quality Modelling
How do we treat gas-phase chemistry in ACTM. Development of lumped mechanisms.

11:00 – 11:45: Lecture 5
(Dr. Allan Gross, DMI, Denmark)

Liquid Phase Chemistry
Basic reactions, differences between cloud and aerosol chemistry.

12:00 – 12:45: Lecture 6
(Dr. Allan Gross, DMI, Demark)

Implementation of Chemistry in ACTM
Numerical treatment (Gear solver versus fast solvers), applications of Air Quality Models to Assessment and Forecasting, how is chemistry treated in Enviro-HIRLAM and other ACTMs

13:00 – 14:00: Lunch

Aerosol Block

14:00 – 14:45: Lecture 7
(Dr. Hannele Korhonen and Dr. Antti Lauri, UH, Finland)

Aerosol/ Cloud Composition
Treatment of aerosols in ACTM.

- Aerosols, fog and cloud compositions particle components
- Size distribution, size structures
- Numerical treatment (as bins, as normal mode distributions (modals)
- Evolution of size distribution over time

15:00 – 15:45: Lecture 8
(Dr. Hannele Korhonen and Dr. Antti Lauri, UH, Finland)

Aerosol/ Cloud Composition
Aerosols emissions and nucleation, coagulation, condensation, evaporation, deposition and sublimation.

15:45 – 18:00: **Exercises**
The students continue their exercise.

Day 4: Thursday, 10 July 2008

09:00 – 09:45: Lecture 9
(Dr. Hannele Korhonen and Dr. Antti Lauri, UH, Finland)

Aerosol Physics
Continuation of lecture 8.

10:00 – 10:45: Lecture 10
(Dr. Hannele Korhonen and Dr. Antti Lauri, UH, Finland)

Cloud Formation
Formation and growth of clouds by aerosols: cloud condensation nuclei formation, growth of clouds by aerosols, numerical treatment in ACTM.

11:00 – 11:45: Lecture 11
(Dr. Anatoli Bogdan, UH, Finland)

High-altitude cold cirrus clouds
Impact on climate, observations, problems, modelling, aerosol-droplet-freezing, and laboratory study.

Biological Air Quality Block

12:00 – 12:45: Lecture 12
(Dr. Carmen Galán, UCO, Spain and Dr. Mikhail Sofiev, FMI, Finland)

Biological Air Quality Modelling
Pollen Grains as Biological Particles Involved in Different Aerobiological Processes. Role of other sub-Micronics and pauci-Micronics biological particles. Relationship with other pollutants. Health impacts. Pollen allergy. Pollen dispersion modelling.

13:00 – 14:00: Lunch

14:00 – 14:45: Lecture 13
(Dr. Carmen Galán, UCO, Spain and Dr. Mikhail Sofiev, FMI, Finland)

Biological Air Quality Modelling
Continuation of lecture 12.

Block 3: Possible Feedbacks of Gases, Aerosols, Clouds *(5 Lectures)*
on Climate and Meteorological Models

Objective: description of the main feedback mechanisms of the chemical weather (atmospheric green-house gases and aerosols) impact on NWP and climate processes, in order to understand how important it is to include feedbacks from gases, aerosols, clouds, etc. in NWP and climate models. The goal is to give an orientation/understanding of which feedback processes are the most important: impact of feedbacks from gases, aerosols (direct, semi-direct, indirect effects), clouds, etc. on short and long time-range meteorological models. This subject is the main focus of the school. First part focuses on physical processes behind these feedbacks, second - on model examples.

15:00 – 15:45: Lecture 1
(Prof. Alexander Baklanov, DMI, Denmark)

Physical description
Possible feedback processes of aerosols and clouds in atmospheric chemical aerosol cloud transport models.

15:45 – 18:00: Exercises
The students continue their exercise.

Day 5: Friday, 11 July 2008

09:00 – 09:45: Lecture 2
(Prof. Sergey Smyshlyaev, RSHU, Russia)

Physical description
Possible feedback processes of gases in atmospheric chemical aerosol cloud transport and climate models.

10:00 – 10:45: Lecture 3
(Prof. Alexander Baklanov, DMI, Denmark)

Model examples
The importance of feedbacks on NWP and climate models based on model examples: scales (time and space), gases, aerosols, important of different mechanisms, prioritization of different tasks, etc.

11:00 – 11:45: Lecture 4
(Prof. Sergey Smyshlyaev, RSHU, Russia)

Model examples

12:00 – 12:45: Lecture 5
(Dr. William Stockwell, Howard University, USA)

Model examples

13:00 – 14:00: Lunch

14:00 – 16:00: The students finish their exercise and presentations

16:00 – 18:00: Oral Presentations (max 15 minutes per group) from the student groups.

18:00 – 19:00: Official Closure of the Summer School

(1) Exercises:

All exercises will be based the 3-dim. models : Enviro-HIRLAM and SILAM. Enviro-HIRLAM is an on-line integrated meteorological-chemical-aerosol-cloud-transport model developed at the Danish Meteorological Institute (DMI). SILAM is an off-line atmospheric chemical transport model developed at the Finnish Meteorological Institute. Enviro-HIRLAM and SILAM will be installed and tested at computers at the summer school venue.

In June 2008, the students (accepted at the summer school) have been asked to select one of the exercise subjects outlined below. Based on incoming wishes of the students, they were grouped into teams consisted of 4-5 persons (the organizers of the summer school followed the students wishes as much as possible).

At initial preparation stage, before the summer school has started, the students shall read and make a relevant literature research about the subject of the exercise. Furthermore, the students shall have an idea of which model simulations they would like carry out during the exercises.

During the first day of the exercises (Monday, 7 July 2008) the students in different groups shall discuss the outcome of their home readings and assignments. The outcome from these groups discussions shall be a short resume of the research they will perform during the next following days of the school. This shall include:

- The scientific relevance of their selected problem?
- How will they solve the problem?

A short resume of the conclusions from the different groups shall be given to the entire class. The resume should take not more than 10 minutes per each group.

List of problems/exercises for students of the summer school:

- The First European Tracer Experiment (Advection);
- The Pollen Scenario;
- The Impact of Indirect Effects of Aerosols on Meteorology;
- The Dynamical and Thermal Effects of Metropolitan Areas on Meteorology.

(2) Exercises:

The exercises have been distributed among the summer school students. In total there are 4 exercises and 8 groups (see below). The **teachers** on exercises will be: Sergey Smyshlyaev (RSHU), Allan Gross (DMI), Mikhail Sofiev (FMI), and Alexander Mahura (DMI) – who will assist students with practical exercises and some guidance. The **curators** – William Stockwell (Univ Howard), Alexander Baklanov (DMI), Bennert Machenhauer (DMI), Sander Tijm (KNMI), Eugenie Genikhovich (MGO) - will be also presented during the time of exercises and can be also asked by students on different theoretical topics/issues.

See details – main goal, objectives, required readings, etc. - for each exercise at the Summer School web-site: http://netfam.fmi.fi/YSSS08/YSSS08_exe.html

1. The First European Tracer Experiment (The Advection)

(Model used: Enviro-HIRLAM and SILAM)
Teacher: **Mikhail Sofiev** (FMI, Finland), **Sergey Smyshlyaev** (RSHU, Russia), and **Allan Gross** (DMI, Denmark)

Group 1.1		**Group 1.2**	
Brian Sorensen	(Denmark)	**Ayoe Buus Hansen**	(Denmark)
Georgi Gadjev	(Bulgaria)	**Gantuya Ganbat**	(Russia)
Olga Patlina	(Latvia)	**Konstantin Konstantinov**	(Russia)
Polina Zimenko	(Russia)	**Maxim Motsakov**	(Russia)
Ekaterina Mekryukova	(Russia)	**Mirjam Paales**	(Estonia)

2. The Pollen Scenario

(Model used: SILAM)
Teacher: **Mikhail Sofiev** (FMI, Finland)

Group 2.1		**Group 2.2**	
Laura Veriankaite	(Lithuania)	**Pilvi Siljamo**	(Finland)
Sara Ortega Jimenez	(Spain)	**Lukasz Grewling**	(Poland)
Anton Svetlov	(Russia)	**Ekaterina Yakovleva**	(Russia)
Anastasia Gernega	(Ukraine)	**Ekaterina Khoreva**	(Russia)
Elena Filatova	(Russia)		

3. The Impact of Indirect Effects of Aerosols on Meteorology

(Model used: Enviro-HIRLAM)
Teacher: **Sergey Smyshlyaev** (RSHU, Russia) and **Allan Gross** (DMI, Denmark)

Group 3.1		**Group 3.2**	
Andy Delcloo	(Belgium)	**Svetlana Lazareva**	(Russia)
Joana Soares	(Finland)	**Julia Palamarchuk**	(Ukraine)
Marko Zirk	(Estonia)	**Artur Kertov**	(Russia)
Angelina Todorova	(Bulgaria)	**Marje Prank**	(Finland)
Iakov Gontsov	(Russia)	**Joakim R. Nielsen**	(Denmark)

4. The Dynamical and Thermal Effects of Metropolitan Areas on Meteorology

(Model used: Enviro-HIRLAM)
Teacher: **Alexander Mahura** (DMI, Denmark)

Group 4.1		**Group 4.2**	
Allan Christensen	(Denmark)	**Yulia Gavrilova**	(Russia)
Anna Kanukhina	(Russia)	**Adomas Mazeikis**	(Lithuania)
Andres Luhamaa	(Estonia)	**Ekaterina Suvorova**	(Russia)
Suleiman Mostomandi	(Russia)	**Torrigiani Tommaso**	(Italy)
Elena Savenkova	(Russia)		

3. Workshop Programme

Monday, 14 July 2008

Opening and Introduction

09.00–09.45 – ***Registration***

09.45–10.00 – Opening of the meeting
– Lev Karlin, Rector of RSHU

10.00–10.15 – Info about practical arrangements
– Tatiana Ermakova (RSHU)

10.15–10.45 – "HIRLAM strategy and connection with ACT"
– Sander Tijm (HIRLAM Consortium)

10.45–11.15 *Coffee break*

Session: Enviro-HIRLAM – as a Basis for a New HIRLAM Chemistry Branch

chaired by Rein Room (University of Tartu) and Edward Podgaisky (RSHU)

11.15–11.45 – "On-line integrated Enviro-HIRLAM system: strategy, current status, and further development"
– Alexander Baklanov (DMI)

11.45–12.15 – "Developments and tests of a new heterogeneous chemical mechanism Chem-NWP implemented in Enviro-HIRLAM"
– Allan Gross (DMI)

12.15–12.45 – "On the importance of urban-aerosol-meteorology feedbacks in pollutant concentrations"
– Ulrik Korsholm (by Allan Gross, DMI)

12.45–13.15 – "On the importance of urbanization in operational online forecasting"
– Alexander Mahura (DMI)

13.15–14.30 *Lunch break*

Session: Posters

chaired by Sergey Smyshlyaev (RSHU) and Edward Podgaisky (RSHU)

14.30–15.45 – Short oral presentations of posters by participants (max 5 minutes per poster)

15.45–16.00 *Coffee break*

16.00–18.00 – **Poster Session**

Tuesday, 15 July 2008

Session: Other aspects of NWP and ACTM modelling

chaired by William Stockwell (University of Howard) and Edward Podgaisky (RSHU)

09.00–09.30 – "Recent and future changes in HIRLAM physics and their impact on atmospheric chemistry transport modelling"
– Sander Tijm (KNMI)

09.30–10.00 – "Chemical solver benchmark testing"
– Sergey Smyshlyaev (RSHU)

10.00–10.30 – "Modeling atmospheric chemistry and the effect of emissions from the biosphere on air pollution and climate"
– William Stockwell (University of Howard)

10.30–11.00 – "On influence of NWP driver and NWP-CTM interface on dispersion ensembles"
– Mikhail Sofiev (FMI)

11.30–12.00 – "Large moisture in the upper troposphere: a mystery or a lack of understanding of cirrus microphysics"
– Anatoli Bogdan (University of Helsinki)

12.00–13.00 *Lunch break*

Session: Initiating the HIRLAM Chemistry Branch – working plans

13.00–15.00 – **Round Table Discussions**
chaired by Alexander Baklanov (DMI), Sander Tijm (KNMI), and Edward Podgaisky (RSHU)

Definition of the discussion topics with brief intro (5-10 minutes) to start discussions by Sander Tijm (HIRLAM, KNMI), Alexander Baklanov (DMI, Univ of Copenhagen), Rein Room (Univ of Tartu), Mikhail Sofiev (FMI), Sergey Smyshlyaev (RSHU) and other participants in order to outline working plans with contributions of groups and collaboration, build a joint strategy, recommendations and requirements, etc.

15.00 – ***Closure of the meeting***

4. Abstracts

Oral presentations:

O-01. Sander Tijm: HIRLAM strategy and connection with ACT

Sander Tijm

Royal Netherlands Meteorological Institute, KNMI, The Netherlands
(tijm @ knmi.nl)

The three main goals of the HIRLAM-A project are the:
(i) development of an accurate mesoscale model, (ii) development of a reliable short term ensemble prediction system, (iii) extension of the HIRLAM model to an earth system model.
At this moment the HIRLAM model is primarily a numerical weather prediction model with parameterizations that are aimed at the short range weather forecast only. This means that the model is not used very much in other types of research and applications, such as climate research, hydrological research and air-quality modelling (except where the HIRLAM model output is used to drive ACT models). To enable this type of use one of the three major scientific goals of the HIRLAM-A project is to evolve towards an earth system model.
The components of such a model are the atmosphere, the land surface and biosphere (vegetation), the ocean surface and atmospheric chemistry. The atmospheric part can be taken from the current HIRLAM model, as can the land surface and biosphere. However, en extension of the last two with components such as a model that mimics the impact of towns, buildings and other anthropogenic influences is necessary. The second missing component from the current HIRLAM model is a coupled ocean model, which can give the right feedback from the sea surface to the atmosphere.
To enable a better use of the meteorology (e.g. every time step) in the Air Chemistry Transport modelling, and the interaction between the chemistry and meteorology, e.g. cloud-aerosol interaction, we are aiming at a HIRLAM version with online chemistry coupling. We want the system to be flexible enough to enable the plugging in of any chemistry component that one would like to use.
Many chemistry models and modules are currently used in the different HIRLAM countries, and even more outside these countries. This variety of chemistry models is caused by the different needs and possibilities in the countries that use them. We aim for a system that is flexible and easy enough that one can plug whatever chemistry module in HIRLAM that is chosen in a specific country. The common HIRLAM chemistry platform may also act as a catalyst for more cooperation within the HIRLAM countries and within Europe in ACT.
In the presentation the general HIRLAM plans, the more specific plans with chemistry that have been made so far and the path towards the HIRLAM chemistry branch will be presented.

O-02. Alexander Baklanov: On-line integrated Enviro-HIRLAM system: strategy, current status and further developments

Alexander Baklanov [1], Ulrik Korsholm [1], Allan Gross [1], Alexander Mahura [1], Bent Hansen Sass [1], Eigil Kaas [2]

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The strategy of for developing new-generation integrated Numerical Weather Prediction (NWP) / Meteorological Model (MetM) and Atmospheric Chemical Transport Model (ACTM) systems, based on the HIRLAM/HARMONIE meteorological corner, is discussed on example of the online integrated Enviro-HIRLAM system. Advantages and disadvantages of on-line integration in comparison with, the more common, off-line coupling of MetMs and ACTMs are mentioned using Enviro-HIRLAM as a specific example.
Current progress in the Enviro-HIRLAM system development and its on-line coupled modelling applications is considered. Several sensitivity tests of off-line versus on-line coupling in Enviro-HIRLAM at DMI as well as verification versus the ETEX experiment are considered and results are discussed. The way of online integration modeling considering feedback mechanisms is more promising for the future and could be beneficial for model improvements in both communities: NWP and atmospheric environment / chemical weather forecasting. This paper was prepared as a starting point for further planning of the future joined HIRLAM/HARMONIE-ACTM integration and development activities.

O-03. Allan Gross: Developments and tests of a new heterogeneous chemical mechanism Chem-NWP implemented in Enviro-HIRLAM

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The chemical mechanism is the central part in Regional Air Quality Models (RAQMs) since these are used to understand the effects anthropogenic and biogenic sources have on the complex chemical composition of the troposphere, which includes thousands of different chemical species and reactions. A large variety of lumped gas-phase chemical mechanisms have therefore been developed during the last couple of decades, examples of such mechanisms are EMEP, RACM, CB-IV), CB05 and SAPRC-99. For an online coupled model such as Enviro-HIRLAM the complexity of these lumped mechanisms is too high if it shall be used for chemical weather forecasts. Based on the newest atmospheric chemical knowledge a high condense heterogeneous chemical mechanism (Chem-NWP) has been developed and implemented in Enviro-HIRLAM (which also includes aerosol dynamics).
The purpose of this talk is to present the usability of Chem-NWP as atmospheric chemical mechanism. This will be done through 0D scenario studies and 3D model tests Enviro-HIRLAM over an area covering Northern-France, Belgium, Luxemburg and Southern-Germany. The area includes the metropolitan areas of both Paris and Rhine-Ruhr.

O-04. Ulrik Korsholm: On the importance of urban-aerosol-meteorology feedbacks in pollutant concentrations

Ulrik Korsholm

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Enviro-HIRLAM (High Resolution Limited Area Model) is an online coupled model for both short- and long-term simulations of environmental meteorology. It has the ability to forecast both meteorological and chemical weather and includes feedbacks, in the form of direct aerosol effects and the first and second indirect effects, between air-pollutants and meteorology.
Enviro-HIRLAM has been employed in a case study of the importance of feedbacks on the transformation of pollutants. The metropolitan area of Paris was used as test-base during low wind conditions with precipitation development. With a horizontal resolution of approximately 5 km model simulations with feedbacks and urban characteristics were compared to a baseline run. Results will be presented and discussed.

O-05. Alexander Mahura: On the importance of urbanization in operational on-line forecasting

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This study aims to evaluate effects of urbanization in operational on-line forecasting on simulated meteorological operational (as well as climatological patterns) over the urbanized areas and surroundings. As an example, the Copenhagen metropolitan area, Denmark was selected.
The objectives include the following to (i) Modify the existing meteorological models land surface scheme using anthropogenic heat flux and roughness module, building effect parameterization module, and soil model for sub-meso scales urban version module, (ii) Perform simulations of meteorological fields using DMI-HIRLAM (High Resolution Limited Area Model) in two modes (control vs. urban runs), and for two types (case studies and long-term simulations) for selected specific dates reflecting different atmospheric conditions such as low, typical, high winds and high precipitation conditions, (iii) Evaluate effects of urbanization on temporal-spatial structure and variability of meteorological fields by estimation on a diurnal cycle the differences between control and urban runs for meteorological variables (temperature, wind velocity, relative humidity) as well as the net radiation, sensible and storage heat fluxes for different urbanized districts.
It is concluded that long-term operational runs with the high resolution urbanized model showed improvement for the overall model performance, and this improvement is more visible over the urbanized areas such as Copenhagen.
The results can be further applied for improvements in land use classification and climate generation properties, distinguishing and selection of types of urban districts and their properties and urbanization of climate regional and global models.

O-06. Sander Tijm: Recent and future changes in HIRLAM physics and their impact on atmospheric chemistry transport modelling

Sander Tijm

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The model physics in HIRLAM is slowly evolving and this has its impact on the characteristics of the meteorological output of the model. Changes in meteorology can strongly impact downstream applications that make use of the HIRLAM output. Therefore, it is important that all downstream users of HIRLAM know the impact of the physics changes on the model meteorology so they can make an educated guess of the impact that these changes will have on their applications.

Three processes that have a strong impact on the meteorology of the model have undergone and will undergo large changes. First of all, currently we have STRACO (Smooth Transision to Convection) as the reference convection and condensation scheme in HIRLAM, and we will change over to KF-RK (Kain Fritsch & Rasch Kristjansson). With this change the behavior of the convection and condensation will change significantly. Initially this change will cause an increase in small precipitation amounts from relatively shallow clouds, a feature that has improved strongly over the last years in STRACO. The small precipitation amounts promise to be much better with the next version of RK that probably will be a part of the HIRLAM 7.3 release.
Another big difference between STRACO and KF-RK is the behavior of the convection itself. STRACO has the tendency to produce convective cells with circulations that have a length scale of 5-10 ΔX. Cross sections of e.g. the cloud water and the vertical velocity clearly show these cells, which have a typical size of 100 km in an 11km model. KF-RK does not show this interaction between the convection/condensation scheme and the dynamics.
Another feature that has improved drastically in STRACO over the last year is the formation and development of fog over the sea. In earlier HIRLAM versions the seas around Europe would fill in with fog whenever air with a dew point close to the SST would move over the sea. In addition to that the temperature would also become much too low in the fog layer, sometimes up to 8 degrees colder than the SST. In the current version of STRACO (to be a part of the HIRLAM 7.2 release) this behavior has improved drastically.
The last scheme that has changed considerably over the last few years has been the vertical diffusion scheme CBR. In old versions of this scheme the vertical diffusion was much too strong under stable conditions, leading to too weak low-level jets and too strong winds close to the surface. In the HIRLAM 7.2 version of CBR the mixing under stable conditions has been optimized, with less mixing under stable conditions. This leads to wind profiles that are much closer to the observed profiles and low-level jets that are in agreement with the observations.
These changes and the impact they can have on atmospheric chemistry transport modelling will be shown.

O-07. Sergey Smyshlyaev: Chemical solver benchmark testing

Sergey Smyshlyaev

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Present Chemistry Transport Models (CTM) involve complex and coupled phenomena including transport, chemistry, radiative, and mass transfer process. The performance of numerical technique in solving differential equations of gas-phase chemistry is the most important factor in determining the overall computational cost for any CTM. Operator splitting technique is the fundamental computational framework of the almost all CTMs. Consequently, chemical transformations may be treated separately and effective chemical solvers may be constructed to use in the atmospheric models of different type.
In this work we explored how the different simplified chemical solvers affect the accuracy and computational cost of the box chemistry model based on comparison to benchmark calculations for the several spatial points. Among the chemical solvers selected, one is fully implicit solver, one chemical solver using quasi-steady state approximation, and two are hybrid solvers. The chemical solver constructed based on Shimazaki scheme has the best overall performance both for stratosphere and troposphere and is pointed to be the most robust in dealing with CTM and Air quality models. By applying this solver to a global interactive three-dimensional Chemistry-Climate-Model (CCM) we demonstrate that this solver may be effective for sophisticated atmospheric modeling.

O-08. William Stockwell: Modeling atmospheric chemistry and the effect of emissions from the biosphere on air pollution and climate

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Biological emissions include nitrogenous, sulfurous, mercuric and organic compounds. Biogenically emitted organic compounds are especially reactive and produce large amounts of ozone, organic particles and other air pollutants. Measurements of biologically emitted compounds from a number of sites including Howard University’s Research Site at Beltsville, Maryland are being used to test and improve the chemical mechanisms used in regional air quality models.
When air quality models under-perform, problems are usually attributed to emissions (including their quantity and the speciation of organic compounds); to meteorology and to sub-grid scale effects. All too often atmospheric chemical mechanisms are not questioned. Recent studies have shown that models do not predict full range of concentrations (from minimum to maximum) of ozone and other pollutants. Forecasted pollutant concentrations do not respond as much as measured concentrations to emission changes. There are significant problems in modeling the measuring the total oxidation rates of NO_2. These problems suggest that there remain significant gaps in the chemical mechanisms in regional atmospheric chemistry models.

New research has lead to a new version of the gas-phase Regional Atmospheric Chemistry Mechanism, version 2, (RACM2), has been developed as a replacement the RACM1 and the older Regional Acid Deposition Mechanism (RADM). The updated version includes improved mechanisms for the atmospheric chemistry of isoprene and for aromatic compounds, and updated cross-sections and quantum yields for the photolysis reactions. Field data and environmental chamber data are being used to evaluate RACM2 mechanism's ability to simulate ozone, NO, NO_2 and volatile organic compounds (VOCs). However it should be recognized that there remains too much uncertainty in the chemical kinetics database, including product yields and rate constant temperature dependences and that testing is limited to restricted concentration ranges (in chambers) and field data is collected mostly during summer pollution episodes.
Collaborating with the U.S. National Oceanic and Atmospheric Administration (NOAA) and the U.S. Environmental Protection Agency (EPA) the RACM2 is being implemented in the Community Multiscale Air Quality (CMAQ) model, widely used for air quality assessment and forecasting in the United States and internationally. Preliminary studies suggest that biogenically emitted organic compounds may be strong sources of aerosol particles with a possibly strong effect on climate.

O-09. Mikhail Sofiev: On influence of NWP driver and NWP-CTM interface on dispersion ensemble

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A problem of construction of a modelling ensemble for air quality assessment and forecasting is considered. One of potential dimensions along which the ensemble can be compiled is the treatment of NWP data, different weather prediction models as sources of the data, and NWP-to-CTM interface. Using simple examples (also an example of ETEX advection exercise of the school), it is shown that one of the problems of ad-hoc created ensembles is the sufficient representation of the uncertainty range by the ensemble members. In many cases simple change of the CTM model parameterization is not enough, neither variation of emission information within its confidence limits is sufficient to cover the actual variability. In these cases a utilization of alternative NWP driver can simplify the problem and eventually lead to an ensemble better reflecting the objective uncertainties of the problem.

O-10. Anatoli Bogdan: Large moisture in the upper troposphere: a mystery or a lack of understanding of cirrus microphysics

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Greenhouse effect is sensitive to the changes in the upper tropospheric (UT) moisture because water vapour is the dominant greenhouse gas and plays an essential role in radiative feedback mechanisms and cirrus cloud formation. In the UT, moisture is often expressed as relative humidity with respect to ice, RH_i, because liquid water does not exist below homogeneous freezing temperature, Th ≈ 233 K. Cold cirrus clouds (< 210 K) are believed to limit the accumulation of water in the UT because the growth and sedimentation of ice crystals redistribute moisture to lower levels. However, large RH_i is often observed in the upper troposphere where cirrus clouds are formed in situ i.e., not influenced by a deep convective water vapour source (*Jensen et al., 2008*). The large RH_i up to 230-250% are often observed both inside and outside cirrus (*Jensen et al., 2008*).
The existence of large clear-sky RH_i is not surprising, considering that cirrus form by homogeneous freezing of concentrated aqueous droplets. Using temperatures of homogeneous freezing of H_2SO4/H_2O, $(NH4)2SO4/H_2O$, and $(NH4)HSO_4/H_2O$ droplets, M. Molina with co-workers (*Koop,et al., 1998; Bertram et al., 2000*) reported that before cirrus start developing the clear-sky RH_i could reach ~170 %. More intriguing is how the large in-cloud RH_i can exist after the formation of ice crystals. Models of cirrus, which consider that cloud particles are pure ice only, do not permit in-cloud RH_i >100% because moisture is rapidly depleted by fast deposition of H_2O on the ice crystals. Several attempts, which were undertaken to explain large in-cloud RHi, included microphysical conceptions. (i) Organic film on the surface of aqueous droplets could hinder the uptake of water vapour or/and suppress surface ice nucleation (*Jensen et al., 2008*). (ii) Small ice crystals may possess the deposition coefficient of H_2O molecules < 0.01. (iii) A new class of HNO_3-containing ice particles, so called Δ-ice, could be a reason of large in-cloud RH_i. By different reasons, these suggestions do not satisfactorily explain the large in-cloud RH_i. Our laboratory measurements show that other microphysical processes can be responsible for the build up and maintenance of the large RH_i. These involve the effects of ions on homogeneous ice crystal nucleation and growth in cold cirrus formed by freezing aqueous droplets.

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Poster Presentations:

P-01. Sara Ortega Jimenez: Evaluation of three tropospheric ozone simulations in Catalonia (NE of Spain)

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In order to determine the accuracy of an air quality model, three periods of summer 2003 have been simulated and evaluated for Catalonia (North-east of Spain). The air quality model used is called AQM.cat and it consists of MECA as emission model, MM5 as meteorological model and CMAQ as photochemical model (off-line).

Modelling domains consist of a coarse 27-km grid domain that covers south of Europe and a 9-km grid domain that covers north-east of Spain (Catalonia). In Catalonia, there is a large industrialized area parallel to the coastline and around Barcelona. Emissions have been computed for an area of 252x252 km^2 with a grid resolution of 9x9 km^2, in order to simulate gas-phase processes related to tropospheric ozone formation. Emissions for coarse domain are interpolated from EMEP data.

Two periods corresponding to high temperatures and local wind patterns are studied because some measurements of ozone exceeded the European population information threshold in the area. The other period corresponded to a dominant synoptic regime which in Catalonia produced north-west winds accompanied by moderate temperatures and low tropospheric ozone levels. During the three periods non-cloudy skies were present.

Simulations show a good response in low ozone episode, whereas in the other two episodes some difficulties appeared in reproducing high ozone values. Since meteorological evaluation showed good agreement between model and measurements, these low values obtained from the photochemical model have been analyzed in terms of emissions, that are the major source of inaccuracy in air quality modelling systems.

P-02. Julia Palamarchuk: Evolution of the forecast error at various parameterization schemes in the MM5 model

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An ideal forecasting system should produce not only an estimate of the flow state, but also an estimate of the associated uncertainty. One of major sources of forecast errors is the model fitness including parameterization of sub-grid processes. Various parameterization schemes for the planetary boundary layer (PBL), cumulus convection, microphysics and radiation processes are used in this study in order to estimate the systematic error of the MM5v3.7 model. Integrations with different schemes were carried out under the same initial and boundary conditions. Model results were compared against ERA40 reanalysis for the geopotential, temperature and humidity fields over the extended range of the winter season of 2002. A simulation domain covers the North Atlantic and European continent regions. The results are presented in terms of the temporal evolution, spatial distribution and vertical profiles of the systematic model error as well as spectra of the model and reanalysis variables.
Results show that the most optimal parameterization scheme set, in general, is the following: the Reisner mixed phase for microphysics; the Kain-Fritsch scheme for cumulus; the MRF scheme for PBL and CCM2 scheme for radiation. The spatial distribution of the systematic model error for geopotential and temperature shows a barotropic structure. The model overestimates geopotential and temperature over the North Atlantic throughout the whole troposphere and underestimates these variables over the European continent. In difference, the relative humidity systematic model error changes a sign in the vertical. Within the low troposphere, the model overestimates humidity, while in the middle and upper troposphere humidity is underestimated, i.e., the model redistributes water vapour downwards. This provokes overestimation of convective precipitation, especially over warm regions and, in particularly, in the East Mediterranean. For large scale precipitation, the systematic model error is mainly related to intensive synoptical patterns and manifests in the form of the phase error. This means that the magnitude of precipitation form is reproduced well enough but is placed in wrong position. Spectra show that the model rather realistically reproduce the atmospheric variability over the ocean, but sufficiently enforces low-frequency variability like blocking (10 days and extended) and redistribute intensity of synoptical activity (3-7 days) from longer to shorter periods.
Feedbacks from finer to larger scales usually lead to better behavior in the simulated state. However, this is mainly true for the atmospheric properties characterized by smooth patterns with large scale structure functions, such as geopotential and temperature. Contrary, the humidity model error in the nesting mode is sensitive to the choice of a parameterisation scheme.

P-03. Pilvi Siljamo: Analysis and forecasts of the birch pollen season in Europe using atmospheric and biological models

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The paper presents a forecasting system of birch pollen long-range transport. The system was developed jointly by Finnish Meteorological Institute (FMI), the Aerobiology Unit of the University of Turku and the Department of Forest Ecology of the University of Helsinki in close collaboration with European Aeroallergen Network and 5 other European institutes - within the scope of POLLEN project of Academy of Finland and ESA-PROMOTE GMES Service Element.
Pollen is a known source of allergy-related deceases. The overall prevalence of seasonal allergic rhinitis in Europe is approximately 15%. Observational evidence and a theoretical ground are mounting that the pollen grains of the wind-pollinating plants, despite their large size, can be transported over hundreds and even thousands of kilometres and significantly affect pollen concentration in many regions making it less dependent on the local conditions.
Conventional predictions of pollen concentrations are made using phenological and pollen observations, pollen calendar and weather forecasts. The method works well when the local flowering has started, but is not able to forecast long-range transported pollen before or after local pollination. However, allergic persons should start their medication in advance of exposure to allergens and this can happen even weeks before start of local flowering. Because pollen does not know territorial borders, European wide numerical pollen concentrations forecasts are needed.
The pollen forecasting system consists of several sub-models. The system is based on a numerical weather prediction model (HIRLAM or ECMWF) which gives information to an atmospheric dispersion model (SILAM), to a phenological model (thermal time type) for starting date of flowering and to a pollen release model.
Numerical forecasts of birch pollen concentration in springs have been done at FMI since 2005 and model has been developed throughout these years. User experience at the University of Turku, Aerobiology Unit is positive and the model has improved pollen forecasts, especially in cases of long-range transport.
The recent status of the system and results for a few past years will be presented and their main features and quality will be discussed.

P-04. Marko Kaasik: Tracing the aerosol nucleation events with atmospheric transport model SILAM

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This paper is intended to clarify the geographical extent of processes leading to a nucleation event and the role of atmospheric transport in it. The study is based on the inverse (adjoint) runs of atmospheric advection-diffusion model SILAM and general knowledge on basic mechanisms and time scales of nanometer-sized particle formation in the atmosphere. Results of two aerosol measurement campaigns were used as sensitivity source data for backward tracing:
• in Värriö, Finland, Eastern Lapland, April – May 2003;
• in Preila, Lithuania, Kura isthmus, May – August 2006.
The footprint areas of seven observed nucleation events suggest that spatial scale of a nucleation event may reach about 1000 km and impact of atmospheric transport to the aerosol processes recorded by an Eulerian (ground-based) observer may be significant. The nucleation events tend to be related with high-pressure areas and outbreaks of air masses from the north. Formation of an intense event over extensive forested areas supports the theory on the role of biogenic VOC emissions. Need for coupling the models of atmospheric transport and aerosol dynamics was stressed.

P-05. Allan Christensen: A locally mass conserving semi-Lagrangian transport scheme using partition of unity

Allan Christensen

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A locally mass conserving semi-Lagrangian scheme is presented on a poster. The scheme, which has been developed by Eigil Kaas, is equivalent to the cell-integrated semi-Lagrangian (CISL) transport schemes. The scheme consists of using a interpolation method to find the mass giving off by each Eulerian cell surrounding the departure point. This is done for every departure point. Thereby it is possible to find how much mass each Eulerian cell is giving off to the surrounding departure points. This depends on the order of interpolation method used, where I use cubic interpolation. In traditional semi-Lagrangian scheme the mass is conserved globally, but not locally, this means that the mass giving off by an Eulerian cell at time level n can exceed or be less than the amount of mass by that particulary grid point, and thereby add or remove mass locally. This scheme maintains the mass by using the grid cell average instead of the grid point values. It is not strictly mass conserving, but it is equivalent to any other CISL-schemes.

P-06. Ayoe Buus Hansen: New accurate methods for modelling of the continuity equation

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A new efficient and accurate numerical method for solving of the continuity equation is proposed. Aiming to fulfil two of the ten desirable properties, namely local mass conservation and computational efficiency, by Rasch and Williamson (1990) and Machenhauer et al. (2007). The new method is developed using cascade interpolation by Nair et al. and a locally mass conserving modification of traditional semi-Lagrangian cubic interpolation scheme (LMCSL-scheme) by Kaas (2008).
The cascade interpolation reduces the number of interpolative operations needed, thereby enabling a scheme with higher computational efficiency.
However, the scheme requires more memory than the LMCSL scheme due to the intermediate step in the cascade interpolation. The method has been tested on a slotted cylinder as described by e.g. Zerroukat et al. (2002) and we aim to implement it in a full scale chemical transport model.
Locally mass conserving semi-Lagrangian transport based on cascade interpolation is especially efficient when more (e.g. chemical) tracers are considered since they need not be recalculated for every specific tracer.

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P-07. Angelina Todorova: Preliminary results from numerical simulations of high PM10 level episodes in January-April 2003

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The goal of this study is to perform numerical experiments aiming at: (i) to examine the ability and the limitations of US EPA Models 3 system to adequately reproduce air pollution episodes; (ii) outline the influence of meso-scale meteorology on air pollution transport; (iii) to evaluate the effect of horizontal grid resolution on Models 3 system performance.
The case study focuses on the meteorological situation in Germany in February and March of 2003 during which three major PM10 episodes could be identified: Between Feb 10 and Feb 14 with observed peak PM10 concentrations from 11 to 13 Feb, the core episode between Feb 21 and Mar 5 with peak PM10 concentrations from Feb 28 to Mar 4, and the episode between 24 and 31 Mar with PM10 maxima at 27-28 Mar.
The US EPA Models 3 system (the meteorological pre-processor MM5 and the chemical transport model CMAQ) is applied as the modelling tool. Model domains and nesting: the MM5 downscaling abilities are applied to define three nested domains with 90, 30 and 10 km horizontal resolutions, the innermost domain covering the territory of Germany. As input data the US NCEP Global Analyses data for 2003 is used as a large scale meteorological input for the MM5 model. The emission input for the CMAQ is prepared on the basis of the TNO emission inventory. Speciation and temporal variation are introduced according to the methodology developed in USA EPA.
For simulations, the MM5 has been run on both outer grids (90 and 30-km) simultaneously with “two-way” nesting mode on. Then, after extracting the 10-km initial and boundary conditions from the resulting fields MM5 is run on the finest grid as a separate simulation with “one-way” nesting mode on. All simulations are made with 23 σ-levels going up to 100 hPa height. CMAQ has been run day by day on both inner domains. The pre-defined (default) concentration profiles are used for initial conditions in both domains at the beginning of the simulation. The concentration fields obtained at the end of a day’s run are used as initial condition for the next day. Default profiles are also used as boundary conditions of the 30-km domain during all period.
Based on numerical experiment results it was found that the simulated meteorological fields agree well with the patterns described in the case study definition. The

simulated PM10 agreement with measurements is as good (or "as bad") as many other model runs demonstrate for many other cases. As a conclusion: the simulation results obtained so far are tentative. The numerical experiments are still going on, testing the effect of varying model options and parameters.

P-08. Andres Luhamaa: New micro-physics module for non-hydrostatic HIRLAM

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Non-hydrostatic extension for the weather prediction model HIRLAM has been available for several years now. Non-hydrostatic dynamics is considered to be an important component of mesoscale, 3-1km horizontal resolution modeling. With the help of this extension, the HIRLAM model can be used more efficiently for mesoscale simulations. On the other hand, the current HIRLAM development strategy suggests using and improving AROME for mesoscale modeling instead, and thus, other parts of HIRLAM are not optimal for mesoscale usage, especially representation of clouds and microphysics.

This work is an effort to introduce more detailed microphysics module to the HIRLAM environment. Main goal is better representation of moist, deep convective processes, which require explicit representation of frozen cloud particles, hydrometeors and rain in three-dimensional grid. Therefore, new microphysics scheme, which uses five variables for liquid and ice phases, is used.

Besides moist convection, improved microphysics could be feasible also for aerosol-cloud feedback and radiation studies at synoptic scale modeling.
Current status of the model development and the first modeling results with the new microphysics in combination with the hydrostatic HIRLAM are represented.

P-09. Joakim Refslund Nielsen: Combining a spatial filter with a new locally mass conserving transport scheme

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An efficient locally mass conserving spatial filter is implemented into a new locally mass conserving semi-Lagrangian transport scheme developed by Kaas (2008). The new scheme uses modified interpolation weights at the upstream departure points to ensure local mass conservation. The new filter efficiently ensures monotonicity and positive definiteness and surprisingly it enhances accuracy especially near sharp gradients and discontinuities. Through detection of regions with non-monotonic behavior, target values are setup and the mass is then redistributed under the strong constraint of local total mass conservation. The properties of the filter are tested in a one dimensional model and presented.

References:
Kaas, E., 2008. An accurate and efficient transport scheme. part i: A new locally mass-conserving semi-Lagrangian solution to the continuity equation.

P-10. Brian Sørensen: An improved vertical remapping scheme

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An improved vertical remapping scheme will be presented on a poster. The scheme is being implemented into a Locally Mass Conserving Semi-Lagrangian Scheme (LMCSL), developed by Kaas (2008).

In an ordinary Semi-Lagrangian scheme, the vertical levels are remapped to Eulerian model levels after each time step. This introduces an undesirable tendency to smooth sharp gradients in the vertical levels. This can be reduced by keeping the Lagrangian levels, and only interpolate the tendencies between the Lagrangian levels and Eulerian levels. Because tendencies are small compared to the absolute values, their gradients will be significantly smaller and therefore they can be interpolated with less smoothing. At each time step the Lagrangian levels will be used as model levels for the following time step. The Eulerian model levels will be kept at each step as well. This has to be done in order to calculate the physics in the model, and also in order to have some fixed levels in the semi-implicit calculations. After several time steps (dynamically calculated or a fixed number), the Lagrangian levels will be interpolated to Eulerian model levels to insure that they do not change too much, and the process will start again.

References:
Kaas, E., 2008. An accurate and efficient transport scheme. part i: A new locally mass-conserving semi-Lagrangian solution to the continuity equation.

P-11. Mirjam Paales: Tracing the sources of aerosol events registered in Preila (Lithuania) during summer 2006

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This paper is intended to clarify the sources and source areas of aerosol measured in a field campaign in Preila, Lithuania, Kura isthmus, May – August 2006. The atmospheric advection-diffusion model SILAM is applied for that purpose in both source-oriented (forward) and receptor-oriented (inverse) modes. Nucleation bursts and high concentration episodes of sub-micron and PM10 particles are studied. Emissions of anthropogenic primary particles (EMEP data), SO2, wildfires and sea salt are taken into account.

P-12. Anna Kanukhina: Long-period variations of stationary planetary waves

Anna Kanukhina

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Strong inhomogeneity of meteorological fields is one of the main characteristics of stratospheric dynamics during winter. The fundamental problem of atmospheric dynamics including seasonal and interannual variability and climatic trends of temperature and planetary wave activity within troposphere and stratosphere, as well as possible effects within middle atmosphere caused by these becomes increasingly relevant for climate research. The reason for this is the need to study dynamical and photochemical processes impacts on observed climatic changes of atmospheric temperature.
The main goals of the work includes the analysis of the long-term changes of the zonally averaged temperature, wind, geopotential height and wave activity of the SPW1 and SPW2 during the last decades using NCEP/NCAR assimilated fields from 1948 to 2007, simulation of the SPW propagation on the basis of the observed changes of the zonal-mean wind in the troposphere as an input parameter for the linearized model of planetary waves and finally the comparison of observed and simulated changes of SPW. Because of the lack of satellite data reanalysis data not only in the southern hemisphere are less reliable before 1978, and results of trend analyses crossing that data have to be considered with special care. The detailed analysis of the climatic trends in the zonally averaged temperature, zonal mean wind, and activity of SPW1 and 2 in winter period has been performed already. The results obtained show a noticeable climatic variability of the intensity and position of the tropospheric jets that are caused by temperature changes in the lower atmosphere. As a result we can expect that this variability of the mean flow will cause the changes of the SPW propagation conditions.

The simulation of the SPW1 performed with the linearized model supports this assumption and shows that during the last 40 years the amplitude of the SPW1 calculated in the stratosphere and mesosphere increased substantially. The analysis of the SPW amplitudes extracted from the geopotential height and zonal wind NCEP/NCAR data supports the results of simulation and shows that during the last years there exists an increase in the SPW1 activity in the lower stratosphere. These changes in the amplitudes are accompanied by increased interannual variability of the SPW1 also. Analysis of the SPW2 activity shows that changes of its amplitude have a different sign in the winter (northern) hemisphere and at low latitudes in the summer (southern) hemisphere. Value of the SPW2 variability differs latitudinally and can be explained by non-linear interference of the primary wave propagation from below and secondary SPW2.

P-13. Yulia Gavrilova: Possible modification of the Enviro-HIRLAM NWP model to include urbanization effects for Saint-Petersburg

Yulia Gavrilova

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A city can strongly modify the structure of the Atmospheric Boundary Layer. The urban areas have significant influence on the meteorological processes and atmospheric flow, its turbulence regime, the microclimate, and, accordingly modify the transport, dispersion, and deposition of atmospheric pollutants within these areas. The urban effects must be parameterized in a grid cell of about one km. Experimental studies have shown that parameterizations usually applied over smoother surfaces are not valid for urban areas. As a consequence, numerical models often experience problems in reproducing pollutant concentrations in cities at ground level (where people live). At the current moment the urban classes and urban scale parameterizations are not well represented in the Numerical Weather Prediction (NWP) models. Due to a high resolution of modern NWP models, reaching the city scale, the improvements of existing parameterizations of urban atmospheric processes and urban physiographic data classifications became needed.

Enviro-HIRLAM model includes three modules related to urbanization problem. The first, module is diagnostic analytical parameterization of the wind profile into the urban canopy layer and corrections to the surface roughness (with the incorporation of the displacement height) for urban areas and heat fluxes (additional AHF, e.g., via heat/energy production/use in the city, heat storage capacity, and albedo change) within existing physical parameterizations of the surface layer in NWP models with higher resolution and improved land-use classification. The second, the Swiss Federal Institute of Technology (EPFL) module - Building Effect Parameterization (BEP) - is based on the urban surface exchange parameterization submodel. The third, the Ecole Centrale de Nantes (ECN) module - Soil Model for Sub-Meso Scales Urbanized version (SM2-U) - is based on the detailed urban area soil and sublayer model.
The aim of this study is to evaluate effects of urbanization of numerical weather prediction (NWP) model on simulated meteorological and pollution patterns over the urbanized areas and surroundings (on example of Saint-Petersburg metropolitan area, Russia). The objectives are to modify the existing NWP land surface scheme using: 1) anthropogenic heat flux and roughness (AHF+R) module, 2) building effect parameterization (BEP) module.

P-14. Iakov Gontsov: Enviro-HIRLAM sensitivity to the wet and dry deposition

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Analysis of sensitivity to the different options already present in ENVIRO-HIRLAM system is performed. Dry deposition is the removal of gaseous and particulate nuclides or other pollutants from the atmosphere to the earth surface by vegetation or other biological or mechanical means. In wet deposition, there are always some atmospheric hydrometeors which scavenge aerosol particles. Usually the wet deposition is treated in a standard way with a wash out coefficient for a bellow-cloud scavenging and a rainout coefficient for in-cloud scavenging. The washout coefficient is strongly depends on the particle size. This dependence, however, is not included in most atmospheric models. Therefore, a revised formulation of the wet deposition parameterizations of particles of different size is suggested. Possible ways to implement different parameterization of the dry and wet deposition are observed.

P-15. Marje Prank: Contributions of different kinds of aerosols to aerosol optical depth

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Dispersion calculations for pollution from anthropogenic, biogenic and wild-fire sources were performed for an episode during April-May 2006, when unusually hot and dry period with low-wind conditions resulted in a build-up of contamination over Eastern Europe, which was accompanied by widespread wild-land fires over western Russia and intensive birch flowering in the same region. Analysis of the case showed that for total modeled aerosol optical depth at 550 nm, the largest contributions come from sulphates, nitrates and fine mode primary PM, while coarse particles and sea salt contributions are negligible. Wild-land fires appeared to be one of the major contributors of both PM and reactive gases in Europe during the episode.

5. List of the Summer School and Workshop Participants

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COMMENTS:
1st column: *Summer school status : S – student, L – lector;* **2nd column**: *Participation in events : S – summer school only, W – workshop only, S+W – both events*

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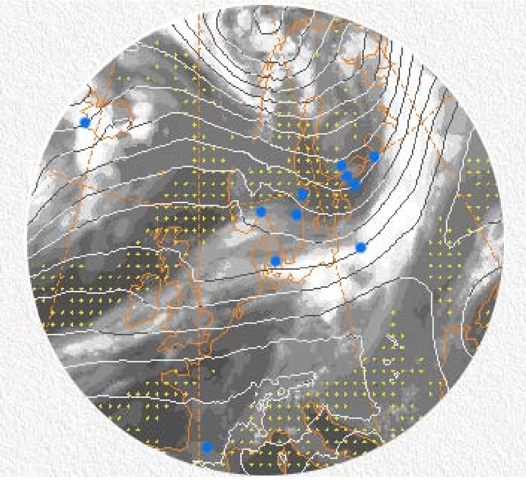
***1st column**: Summer school status : S – student, L – lector; **2nd column**: Participation in events : S – summer school only, W – workshop only, S+W – both events*

6. Nordic Network on Fine-scale Atmospheric Modelling (NetFAM)



Nordic Network on Fine-scale Atmospheric Modelling NetFAM (http://netfam.fmi.fi/) unites 20 Nordic, Baltic, Russian, and French meteorological institutes into research and training network funded by

norden
NordForsk

(NordForsk (http://www.nordforsk.org/), former NorFA):

"Nordic Network of Fine-scale Atmospheric Modelling (NetFAM) aims at complex and comprehensive promotion of fine-scale atmospheric modeling of Nordic-Baltic regional weather and climate processes and man--environment interactions, with strong emphasis on specific qualities of Nordic natural environment and the Baltic Sea influence. To achieve these objectives, the network is designed to cover the whole chain from basic research and researcher training towards the application of the models. The network shares modelling tools, observational and physiographic data, computing and educational resources, in order to strengthen the expertise in the area of fine-scale atmospheric modelling in the Nordic countries and adjacent areas around the Baltic Sea." (from the project plan)

NetFAM national teams : 10 national teams, each representing different institutes:

Denmark	Danish Meteorological Institute	http://www.dmi.dk/
	Department for Geophysics, University of Copenhagen	http://www.gfy.ku.dk/ gfy_welcome_eng.html
Estonia	Estonian Meteorological and Hydrological Institute	http://www.emhi.ee/
	Department of Environmental Physics, University of Tartu	http://meteo.physic.ut.ee/kkfi
Finland	Finnish Meteorological Institute	http://www.fmi.fi/en/
	Division of Atmospheric Sciences, University of Helsinki	http://www.atm.helsinki.fi/
France	National Research Center, Meteo France	http://www.cnrm.meteo.fr/
	Department of Aerology, University of Toulouse	http://www.aero.obs-mip.fr/
Iceland	Icelandic Meteorological Office	http://www.vedur.is/
	University of Iceland	http://www.hi.is/
Latvia	Latvian Environment, Geology, and Meteorology Agency	http://www.meteo.lv/public/
Lithuania	Lithuanian Hydrometeorological Service	http://www.meteo.lt/
	Department of Hydrology & Climatology, University of Vilnius	http://www.vu.lt/
Norway	Norwegian Meteorological Institute	http://www.met.no/
	Department for Geosciences, University of Oslo	http://www.geo.uio.no/
Russia	Russian State Hydrometeorological University	http://eng.rshu.ru/
	Main Geophysical Observatory	http://www.mgo.rssi.ru/
	North-Western RosHydromet	http://www.meteo.nw.ru/
Sweden	Department of Meteorology, University of Stockholm	http://www.misu.su.se/
	Swedish Meteorological and Hydrological Institute	http://www.smhi.se/