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)		