Introduction into Enviro-HIRLAM SSRPs: *PART 1*

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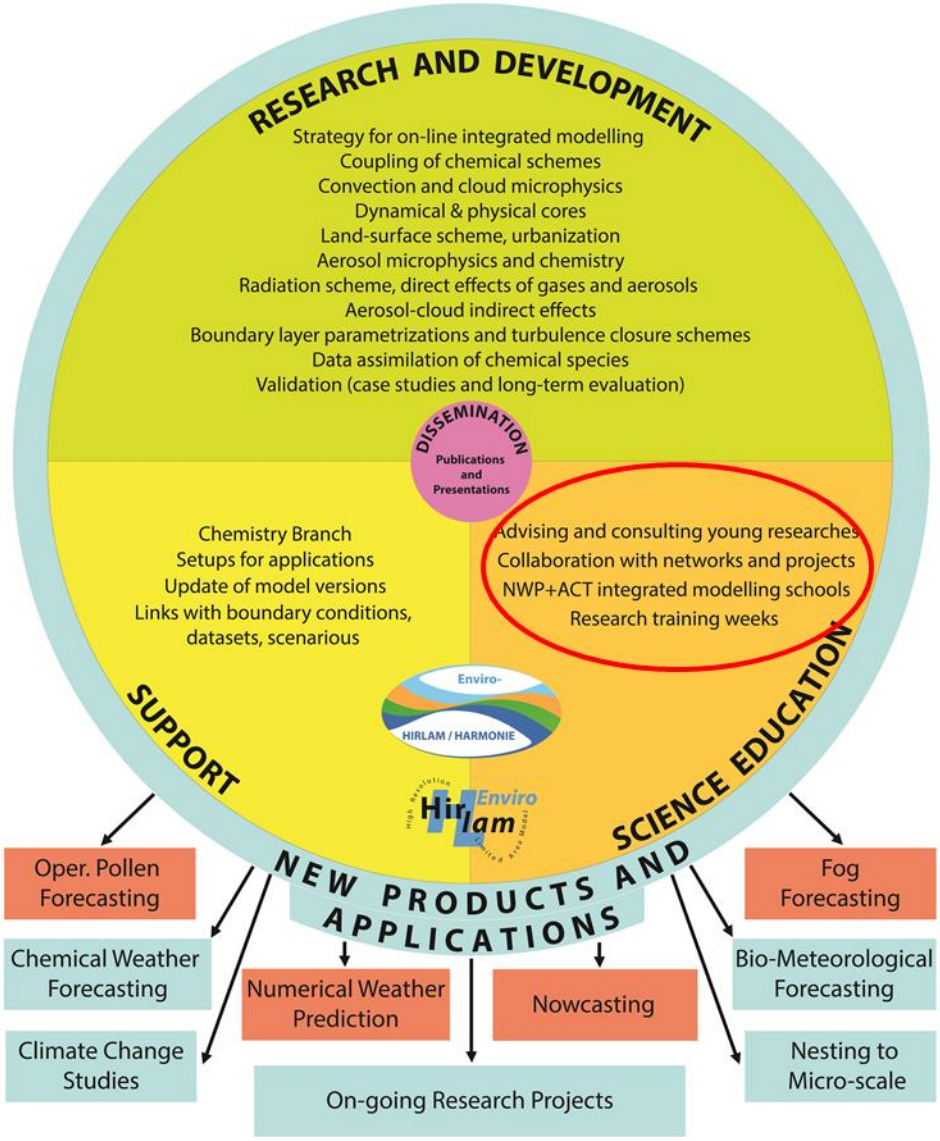
Online Young Scientist School

Multi-Scales and -Processes Integrated Modelling, Observations and Assessment for Environmental Applications

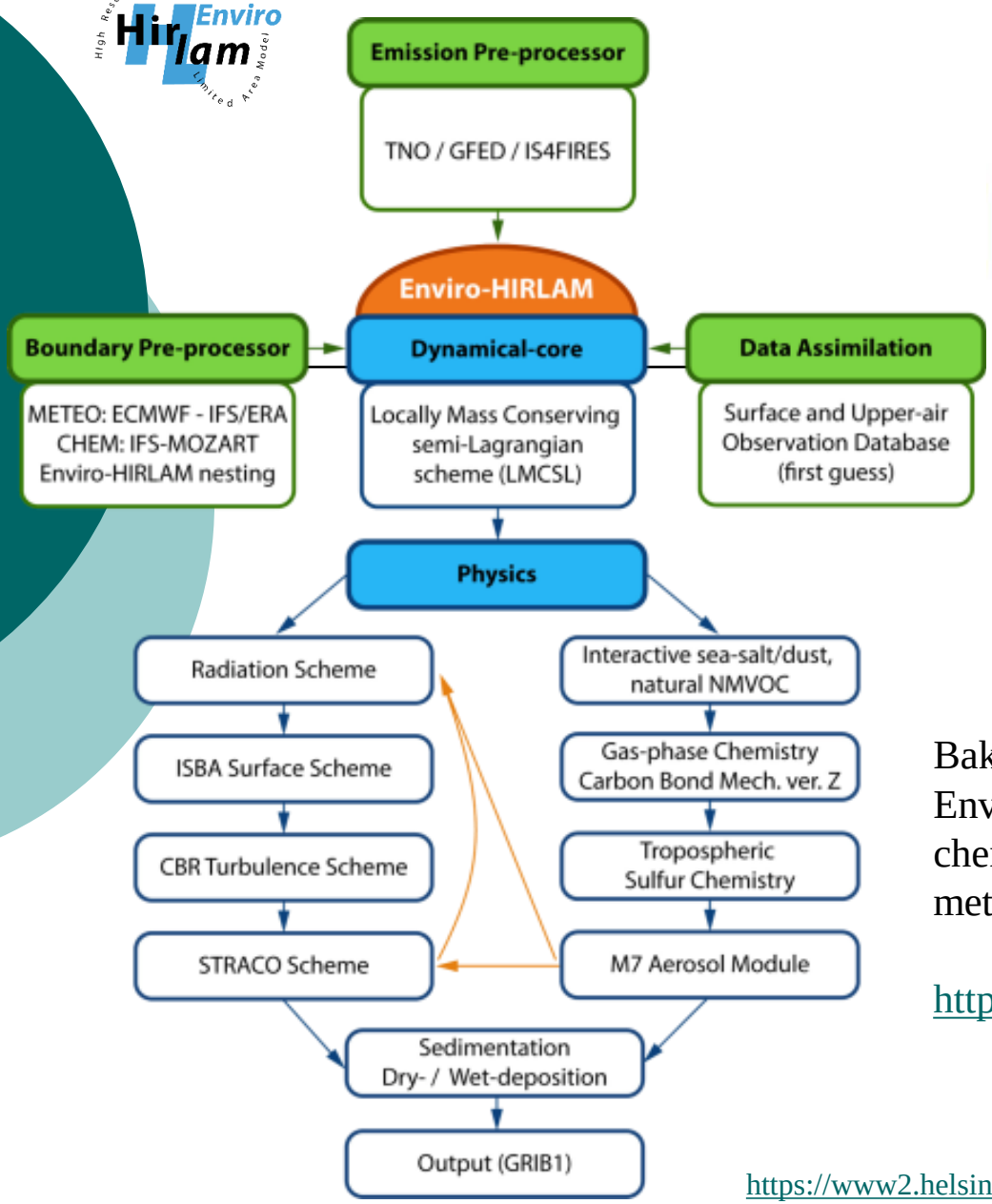
MEGAPOLIS-2021

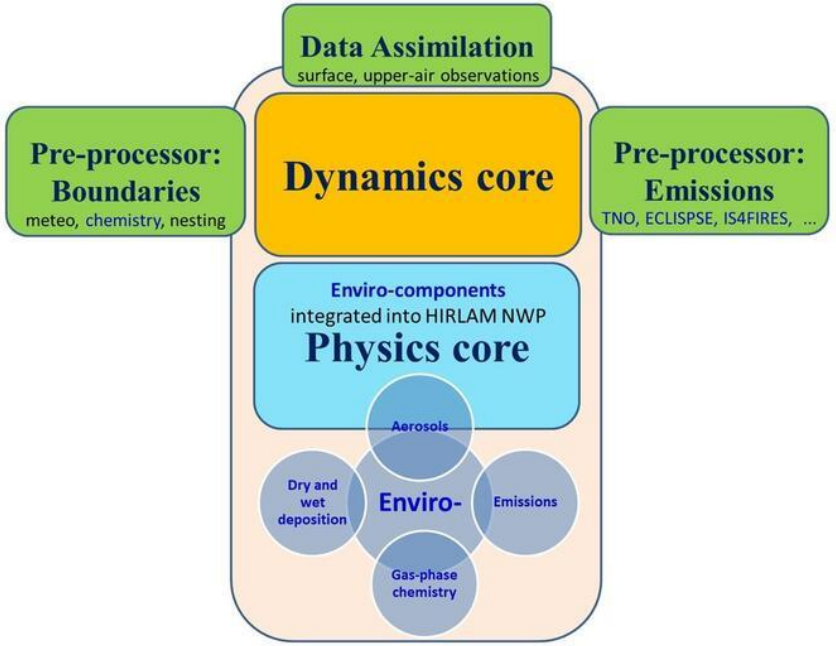
15 Nov – 3 Dec 2021

Enviro-HIRLAM Science Education:
Training & Schools



Enviro-HIRLAM Modelling System: Schematics





Baklanov et al. (2017)
Enviro-HIRLAM online integrated meteorology–chemistry modelling system: strategy, methodology, developments and applications

https://gmd.copernicus.org/articles/10/2971/2017/

https://www2.helsinki.fi/en/researchgroups/multi-scale-modelling/enviro-hirlam

Zoom-Meetings
on Enviro-HIRLAM SSRPs

Starting at 16:00 pm of Helsinki time/ Finland

Tue, 16 Nov – intro in Enviro-HIRLAM model/ 1h

Thu, 18 Nov – intro in SSRPs Part-1/ 1h

Tue, 23 Nov – intro in SSRPs Part-2/ 1h

Thu, 25 Nov – zoom for questions /1+h

Wed, 1 Dec – zoom for questions /1+h

& Finals

Fri, 3 Dec – Presentations/ Defences of SSRP by Groups/Teams

& Awarding The MEGAPOLIS-2021 YSSchool Certificates

Small–Scale Research Projects (Case Studies/ Episodes)

===Enviro-HIRLAM-1===

Aerosol effects on regional scale for North-West Russia and Northern Europe

Case study/ episode - Aug 2010

Runs (15 km) and REF/CTRL & DAE & IDAE

===Enviro-HIRLAM-2 ===

Effects of model resolution on meteorology & pollution dispersion over Kola Peninsula

Case study/ episode - Jul 2017

Downscaling runs (5-1.5 km) – REF/CTRL

===Enviro-HIRLAM-3===

Effects of model urbanization on meteorology over the Paris metropolitan area

Case study/ episode - July 2009

Downscaling runs (15-5-2.5 km) - REF/CTRL

& urbanization at 2.5 km (with AHF+BEP)

===Enviro-HIRLAM-4===

Aerosol-meteorology interactions in Siberian Arctic

Case study/ episode - July 2017

Downscaling runs (5-2 km) - REF/CTRL & DAE & IDAE

Enviro-HIRLAM Runs / DEMO

A quick jump - Tue, 23 Nov – intro in SSRPs Part-2/ 1h

(1) Demonstrate setup and run of Enviro-HIRLAM model at CSC's HPC/ Finland

(2) Suggest list of tasks & questions to be answered in each SSRP (programme minimum vs. maximum)

(3) Provide access to already simulated Enviro-HIRLAM model outputs for mentioned 4 SSRPs (with focus on Case Studies)

*** Teachers – demo setup & run of the Enviro-HIRLAM model for selected geographical domain and episode**

*** Students – will start to realize jointly SSRP in own groups (*downloading modeling results, starting visualization & analysis of these, analysis/description of meteorological situation for case study/episode, drafting presentation*)**

Data Visualisation & Analysis Tools

Software for Manipulating or Displaying Geophysical Data

https://www.unidata.ucar.edu/software/netcdf/software.html

2 main output formats used in geophysics community are GRIB(1,2) & netCDF4 (in particular, in numerical weather prediction, atmospheric chemical transport modelling, climate, etc.

GRIB (GRIdded Binary) - file format for storage and transport of gridded meteorological data
netCDF (network Common Data Form) - file format for storing multidimensional scientific data

Enviro-HIRLAM is NWP (HIRLAM) + ACT (Enviro-) modelling system

uses GRIB1-format

CDO / NCO/ WGRIB

- **CDO (Climate Data Operators) - collection of command line operators (>600) to manipulate and analyse Climate and NWP model Data /supported data formats - GRIB, netCDF/**

https://code.mpimet.mpg.de/projects/cdo

downloads (https://code.mpimet.mpg.de/projects/cdo/files)

docs (https://code.mpimet.mpg.de/projects/cdo/wiki/Cdo#Documentation)

cdo -f nc copy grib_filename netcdf_fielane.nc

- **NCO (netCDF Operator) - toolkit manipulates and analyses data stored in netCDF-accessible formats**

http://nco.sourceforge.net

- **wgrib – manipulate, inventory and decode GRIB files: https://www.cpc.ncep.noaa.gov/products/wesley/wgrib.html**

- **IDV (Integrated Data Viewer) - 3D geoscience visualization and analysis tool (on Win, Mac, Linux platforms): https://www.unidata.ucar.edu/software/idv**

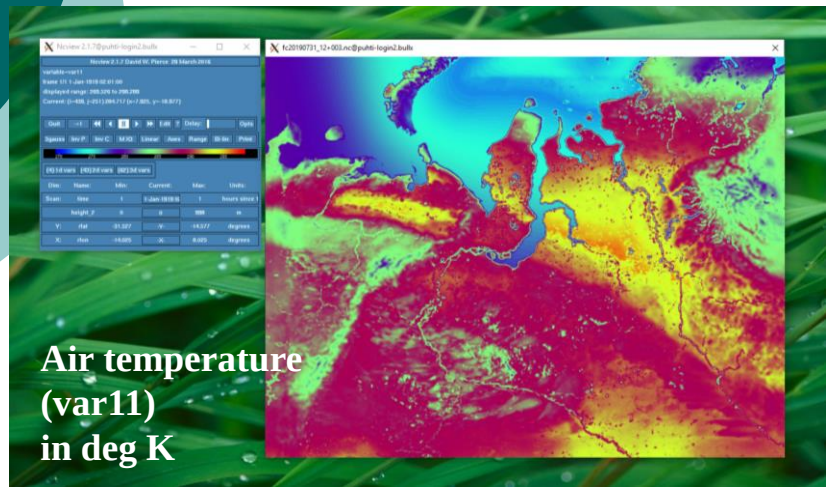
NCVIEW

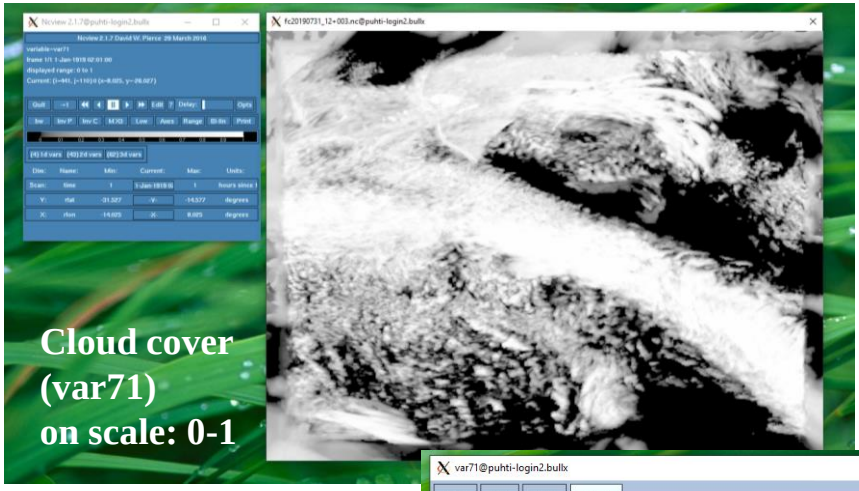
- Ncview - visual browser for netCDF format files

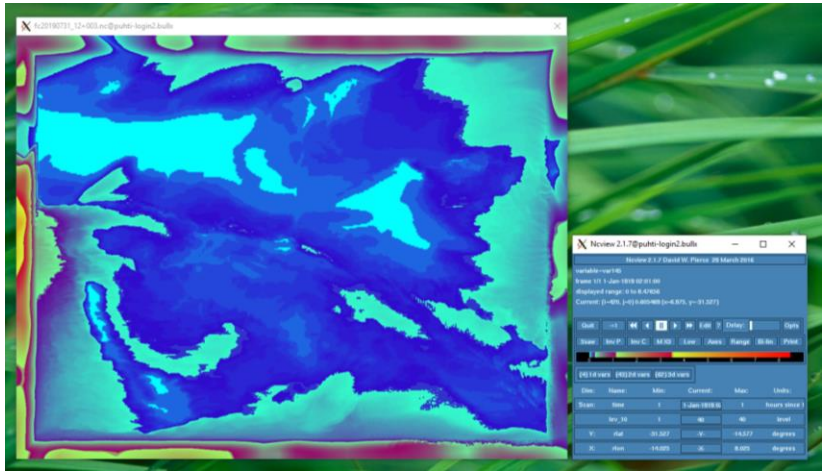
http://meteora.ucsd.edu/~pierce/ncview_home_page.html

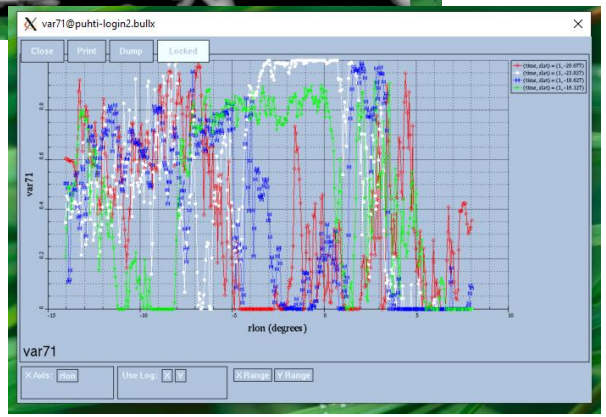
Use it to get a quick-easy-push-button look at netCDF files

examples o the Enviro-HIRLAM model output



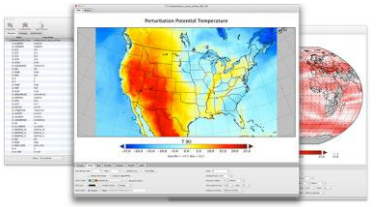






MassConc BlackCarbon /AitkenMode-Soluble/ (var145) / level 40 in ppbm

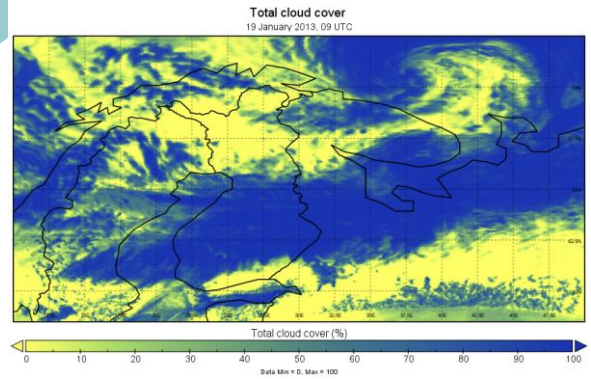
PANOPLY

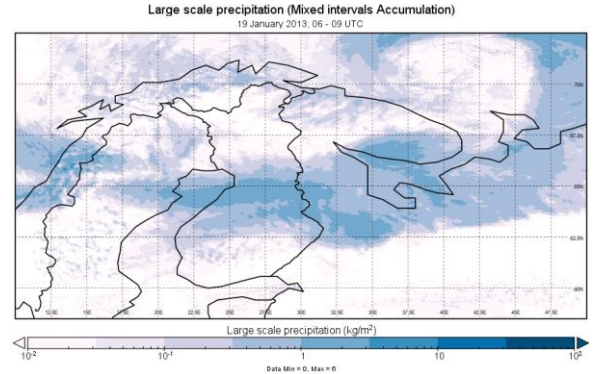


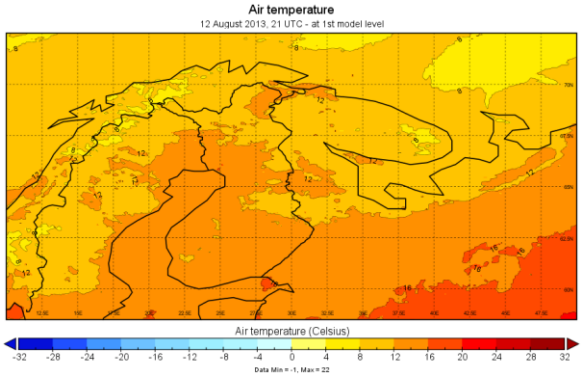
- **Panoply – for plotting geo-referenced and other arrays from GRIB, netCDF, HDF and other datasets (runs at Linux, Windows, Macintosh)**

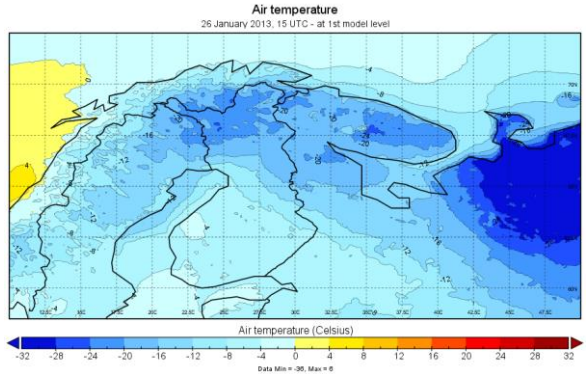
https://www.giss.nasa.gov/tools/panoply

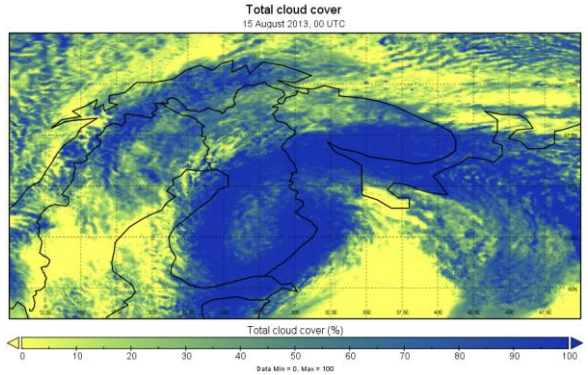
examples o the Enviro-HIRLAM model output

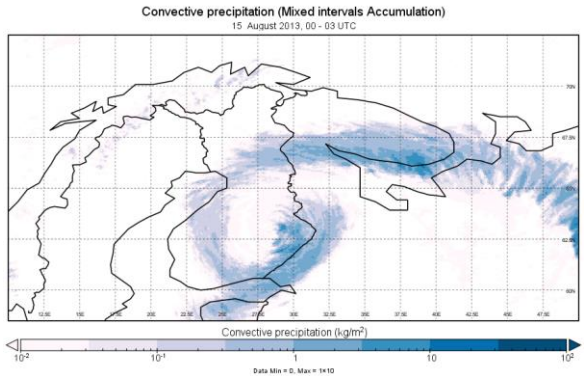












PYTHON

Python is also powerful tool

creating scripts for visualization and analysis of data

Install ANACONDA - https://docs.anaconda.com/anaconda/install (on different platforms)

By default there are already in package:

Python 3 (https://www.python.org/downloads) & Numpy (https://numpy.org/) & Matplotlib (https://matplotlib.org)

Extra install:

NetCDF4 (https://unidata.github.io/netcdf4-python) & Cartopy (https://scitools.org.uk/cartopy/docs/latest/) & Pygrib (only for Linux/Macos users; https://jswhit.github.io/pygrib) & PyNGL+PyNIO (https://www.pyngl.ucar.edu)

See also numerous examples of visualization and analysis with python-scripts:

https://geocat-examples.readthedocs.io/en/latest/index.html

https://matplotlib.org/stable/gallery/index.html

https://github.com/matplotlib/cheatsheets

Model Output - 1

fc20190702_06+003 **fcyyyymmdd_hh+lll**
history file: modelled parameters (meteo+aerosols) at model levels
fc20190702_06+003md **fcyyyymmdd_hh+lllmd**
diagnostics file: modelled meteo.parameters at & on surface
fc20190702_06+003ve **fcyyyymmdd_hh+lllve**
verification file: modelled meteo.parameters

The model writes its primary output to history file (**fcyyyymmdd_hh+lll**) - complete snapshot of the model state described by NWP model for a particular time.
In addition, model output including post-processing/diagnostic fields is written to file (**fcyyyymmdd_hh+lllmd**)
&
pressure and single level parameters for field verification and observation verification (**fcyyyymmdd_hh+lllve**)
&
wet, dry deposition and sedimentation for aerosol components
EHIR_SEDEPO_2019070206+006.nc (**EHIR_SEDEPO_yyyymmddhh+lll.nc**)

Model Output - 2

- State variables on model level
- State variables and diagnostics on pressure levels
- Surface and soil variables

- Near-surface diagnostics
- Diagnostics at the top
- Accumulated surface fluxes
- Vertically-integrated quantities
- Surface subtypes

More elaborated list (i.e. the modelled parameters) is at HIRLAM website
http://hirlam.org
https://hirlam.org/trac/wiki/HirlamSystemDocumentation/Forecast/Outputlist

& after this zoom-meeting
will be sent separately by e-mail to Enviro-HIRLAM SSRPs participants

Aerosol Feedbacks - 1

Direct effect - decrease solar/thermal-infrared radiation and visibility:

- ***Processes involved*: radiation (scattering, absorption, refraction, etc.);**
- ***Key variables*: refractive indices, extinction coefficient, single-scattering albedo, asymmetry factor, aerosol optical depth, visual range;**
- ***Key species*: cooling: water, sulphate, nitrate, most OC; warming: BC, OC, Fe, Al, polycyclic/nitrated aromatic compounds;**

Semi-direct effect - affect boundary layer meteorology and photochemistry:

- ***Processes involved*: boundary layer, surface layer, photolysis, meteorology-dependent processes;**
- ***Key variables*: temperature, pressure, relative and water vapour specific humidity, wind speed and direction, clouds fraction, stability, PBL height, photolysis rates, emission rates of meteorology-dependent primary species (dust, sea-salt, pollen and other biogenic);**

Seamless/ online coupled multi-scales & processes modelling approach allows to simulate such effects

Aerosol Feedbacks - 2

First indirect effect (so called the Twomey effect) – affect clouds drop size, number, reflectivity, and optical depth via CCN or ice nuclei:

- ***Processes involved*: aerodynamic activation / resuspension, clouds microphysics, hydrometeor dynamics;**
- **Key variables: int./act. fractions, CCN size/compound, clouds drop size / number / liquid water content, cloud optical depth, updraft velocity;**

Second indirect effect (also called as the lifetime or suppression effect) - affect cloud liquid water content, lifetime and precipitation:

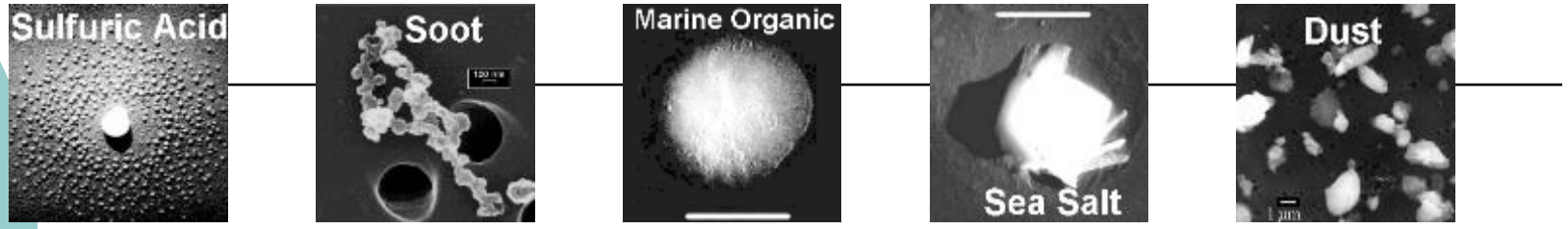
- ***Processes involved*: clouds microphysics, washout, rainout, droplet sedimentation;**
- ***Key variables*: scavenging efficiency, precipitation rate, sedimentation rate.**

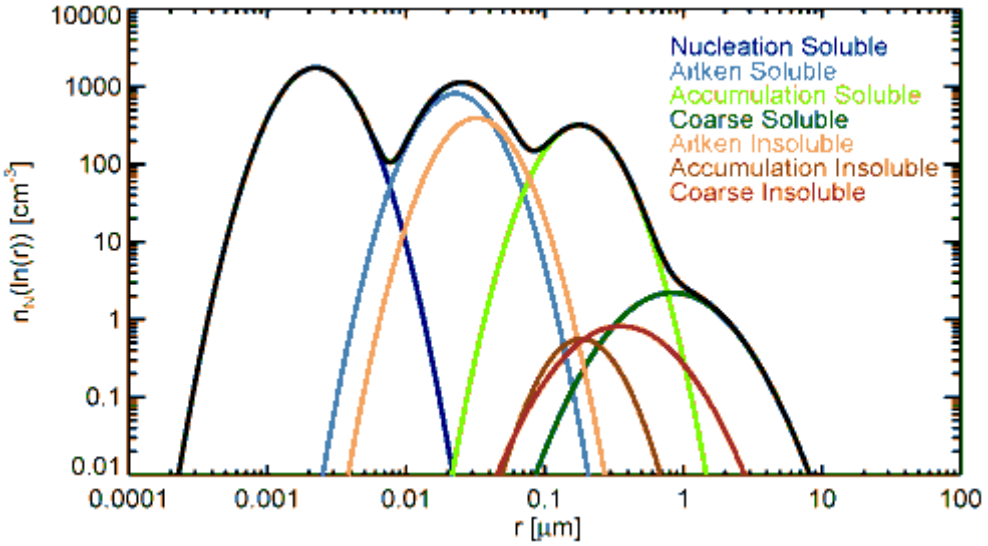
Seamless/ online coupled multi-scales & processes modelling approach allows to simulate such effects

Aerosols Microphysics M7

Considered Compounds:

Sulfate | Black Carbon | Organic Matter | Sea Salt | Mineral Dust





Sulf: nucl./ait./accu./coars – soluble

BC: ait. – soluble/insoluble,
accu./coarse – insoluble

OC: ait. – soluble/insoluble,
accu./coarse – insoluble

SS: accu./coarse – soluble

Dust: accu./coarse – soluble,
accu./coarse – insoluble

& after this zoom-meeting
will be sent separately by e-mail to Enviro-HIRLAM SSRPs participants

SSRPs Communication

POINTS TO MENTION

- Consider the school exercise as a **small-scale research project**, SSRP
- As a **team/group**, you may realise your **own research programme**: minimum vs. maximum

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- **Utilize** your **best skills** working **as a member** of your team
- **Collaborate between teams/groups** involved into other Enviro-HIRLAM SSRPs
- You can **ask questions** during scheduled **zoom-meeting/ consulting**
- Oral presentation (**each person** should have a **speech part/contribution** in the final oral talk)
- **Start** making your presentation **from the start**

*Additional **useful materials** for meteorological situation analysis for case study/episode)*

- Meteorological archives: https://www.wetterzentrale.de
- Vertical sounding http://weather.uwyo.edu/upperair/sounding.html
- Other sources …

SSRPs

General information on presentation

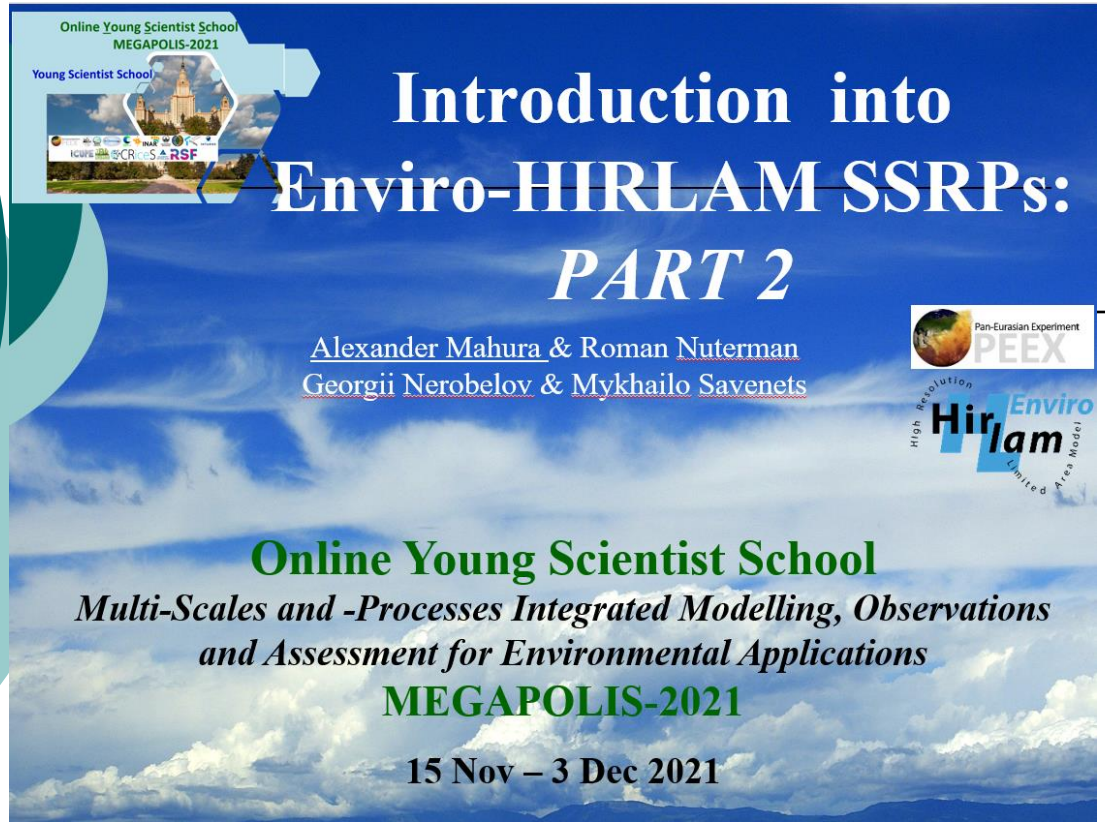
EXPECTED STRUCTURE/ CONTENT

- Title of your SSRP
- List of co-authors with list of corresponding affiliations & logos of organizations
- Main aim, specific objectives, tasks, area of interest/study
- Methodology (model, methods, approaches, etc.)
- Model setup (modelling domain(s), boundary conditions, etc.) & model runs to be analyzed <– ***info from teachers of SSRPs on next zoom***
- Case study/ episode – description of meteorological situation
- Obtained results, their visualization and analysis, discussions with illustrative examples
- Findings and conclusions
- Acknowledgements/ thanks

List-To-Do before the next zoom-meet on 23rd November 2021, Tuesday

- **Install software/ tools** for visualization and analysis of Enviro-HIRAM model output (see slides above) & **help** each-other in case problems will appear with installations/visualizations
- **Download** from google-folder (**example of Enviro-HIRLAM model output** files) **& learn & practice** on how to convert between formats, visualize and interpret/analyze various meteo. & aerosol related parameters
- **Initiate discussions** in your groups on SSRPs (following slide #5), based on model output, which questions/problems/tasks might be of interests, which parameters will be of interest to analyze, etc.
- **Think** about your **possible expected outcomes** in your group SSRP
- **Think outline/content** of your group **future presentation** on SSRP (& you may prepare a few slides if you want to share your ideas with the other groups)

Science Education: Small-Scale Research Projects (SSRPs) to be continued



See you soon on the next zoom-meeting
23 November 2021
Tuesday
16 pm of Helsinki time

://www.helsinki.fi/en/inar-institute-for-atmospheric-and-earth-system-research

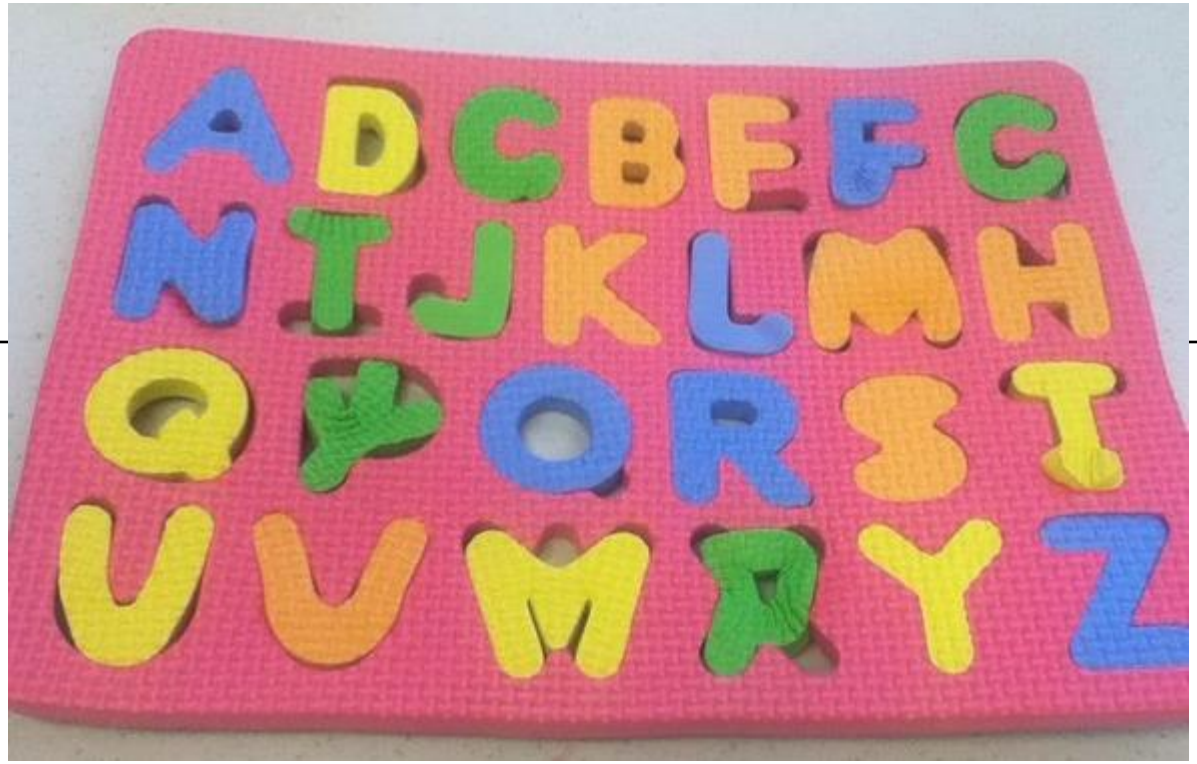
Thank you!

https://www.atm.helsinki.fi/peex

Pan-Eurasian Experiment
PEEX

High Resolution Limited Area Model
HIRLAM Enviro

SSRPs



Energy = milk · c²offee

Good Luck

☺