EuMetChem STSM overview

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6. **Eigil Kaas, UoC, Denmark => EMPA, Switzerland [kaas@nbi.ku.dk];**
7. **Velle Toll , UoT, Estonia => DMI, Denmark [velle.toll@ut.ee];**
8. **Hristina Kirova, MetInst, Bulgaria => TUM, Spain, hristina.kirova@meteo.bg;**
9. **Joana Ferreira, UoA, Portugal => EMPA, Switzerland [jferreira@ua.pt]**
10. **Isabel Ribeiro, UoA, Prtugal => UH MI, Germany**
11. **Alexander Baklanov, DMI/WMO, Denmark => CPTEC/INPE, Brazil**

PhD student Velle Toll (University of Tartu) STSM in DMI

Direct radiative effect of summer 2010 wildfires in Russia was simulated with NWP model HARMONIE using external aerosol data from MACC-IFS

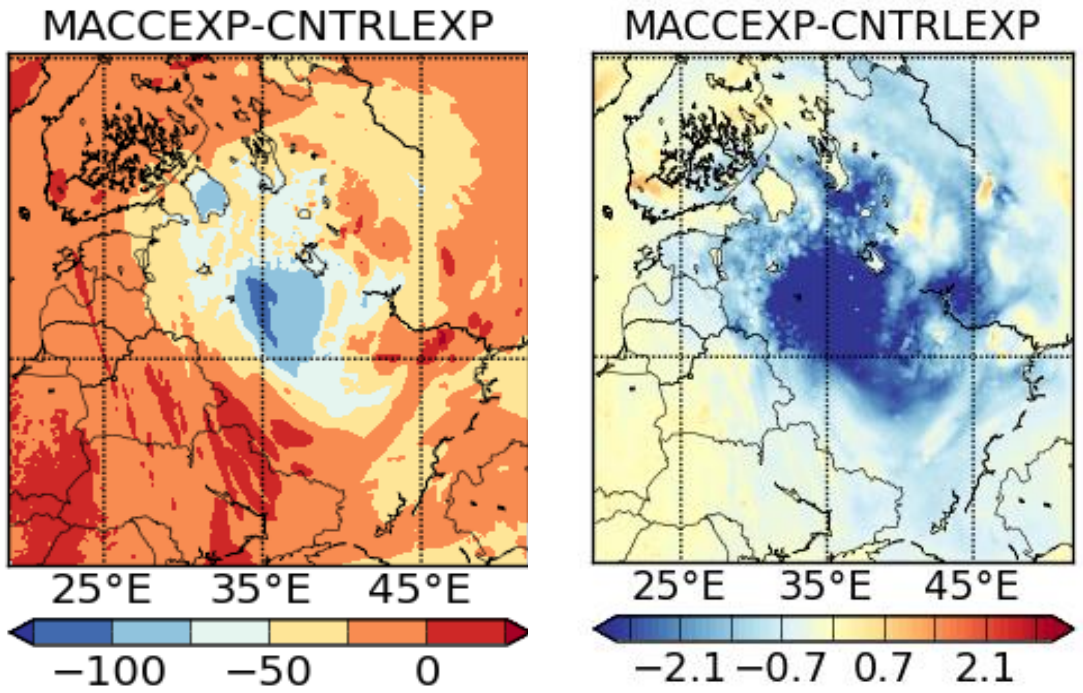


Figure A. Change in downwelling shortwave radiation (W/m^2) at the surface and change in 2m temperature (°C) at 12 UTC 08.08.2010 resulting from aerosol direct radiative effect.

Influence of aerosol vertical profile was tested (climatological profile vs. more realistic profile from MACC-IFS), moderate sensitivity to the vertical profile was found for the studied case.

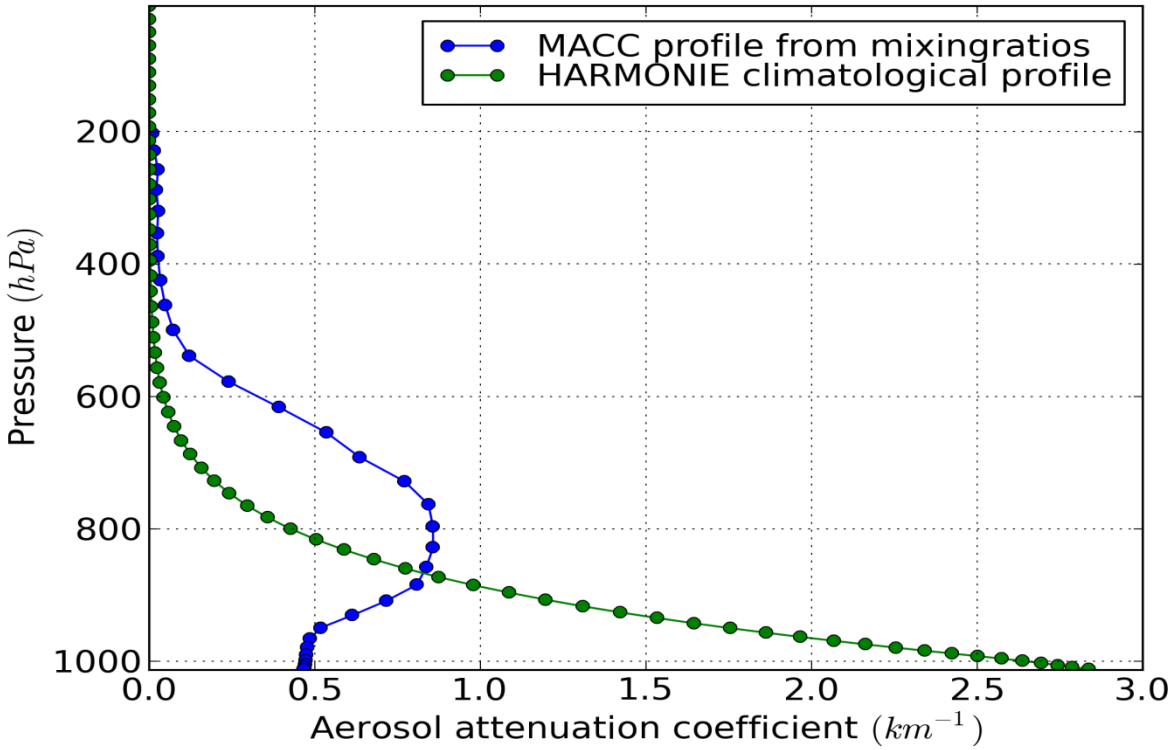


Figure B. Vertical profile of aerosol attenuation coefficient: climatological vertical profile vs profile calculated from MACC-IFS aerosol mixing ratios.

Short Term Scientific Mission 2 (COST Action ES1004):

Beneficiary: Xin Kong

Host institution: Karlsruhe Institute of Technology

Period: 27/11/2013 to 07/12/2013

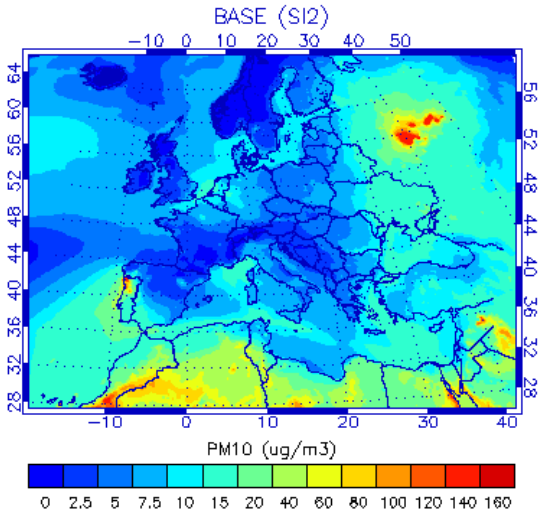
Reference code: COST-STSM-ECOST-STSM-ES1004-271113-036654

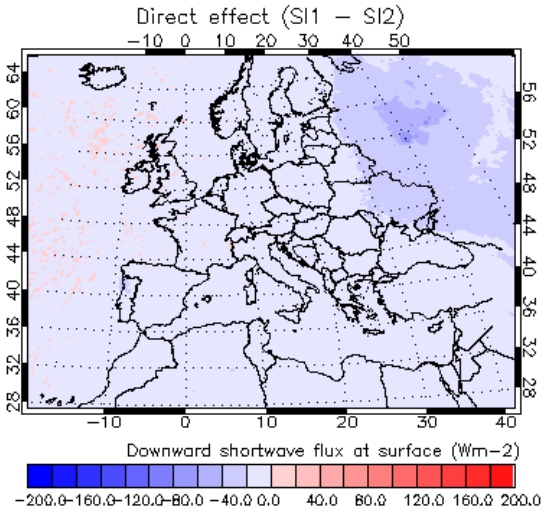
Amount up to: EUR 2200

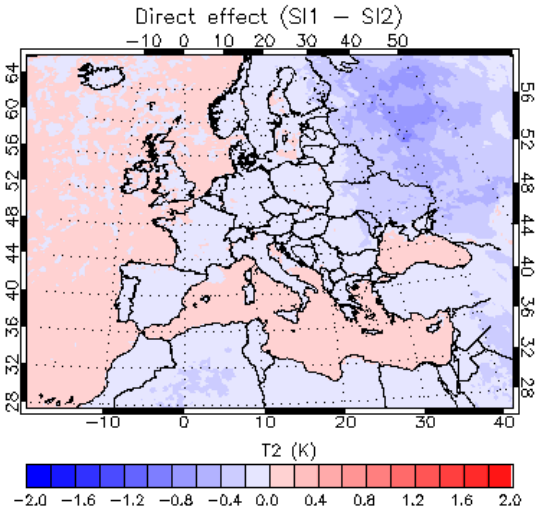
Description of the work carried out during the STSM: A case study for Russian forest fires episode was set up using fully online coupled WRF-Chem model. Simulations for three model sensitivity runs were carried out (including baseline without any feedback, aerosol direct effect only and both direct/indirect effects).

Outcome : the results from this STSM has been published in AE journal (Kong et al., 2014). As an early-stage researcher, the beneficiary has learned more modelling skills and collaborated well with other scientists in the COST action.

Chains of aerosol direct effects on meteorology during the fire-period

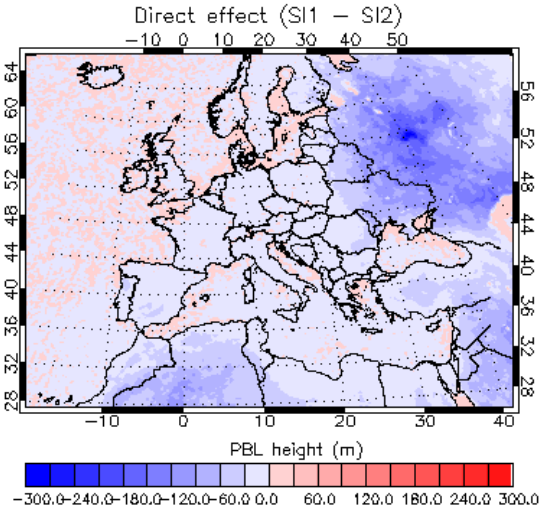


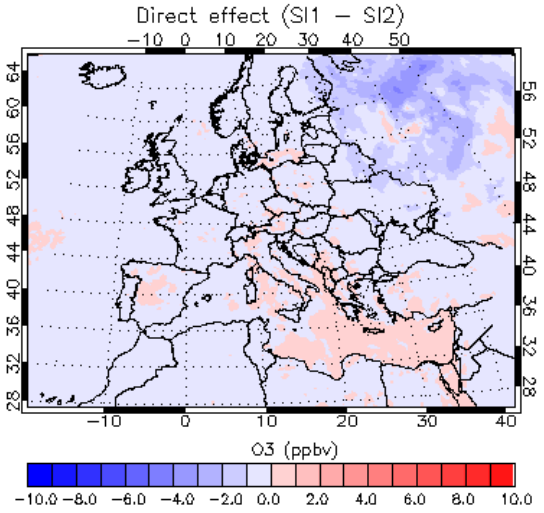




High aerosol loading → Downward shortwave radiation decreased → T2 decreased

→PBL height decreased ozone photolysis rate decreased ↓





Chemical Data Assimilation for EnviroHIRLAM atmospheric chemistry mechanism STSM outcomes

- A variant of CBM-IV atmospheric chemistry mechanism has been implemented to a discrete-analytical scheme (its basic case is known as QSSA) and validated against 0-D part of EnviroHIRLAM atmospheric chemistry model.
- Transport-phase data assimilation algorithm with the chemical model included has been tested on the model cases for different meteorological conditions in the scenario with ‘’unknown” source.
- In the case of ”Calm” wind scenario the chemistry model impact has been the most influential. In this case we can see the shift of solutions that can be seen with big relative errors with respect to tracer-only models. In these cases chemical data assimilation were able to improve the situation. In the case of ”Strong” wind the impact of the chemical model inclusion was also important but data assimilation has relatively small influence.

Data assimilation and chemistry model impact estimation

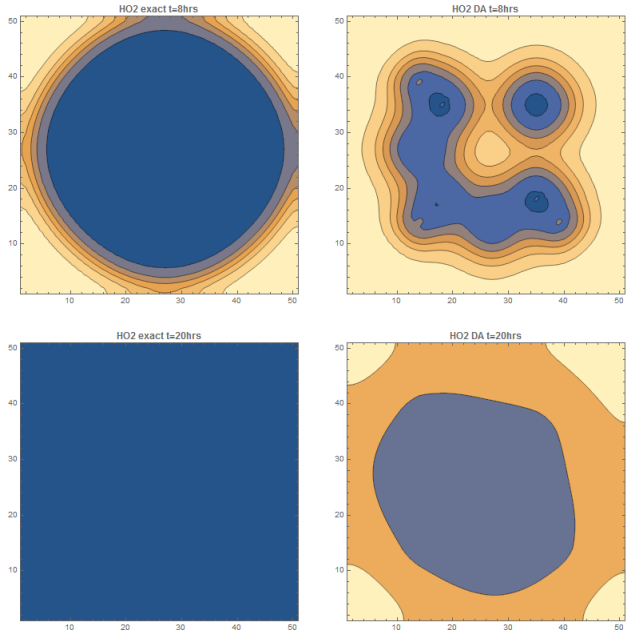


Figure 1. ”Calm” meteorological scenario. Data assimilation result for a substance that is neither measured nor emitted for two time moments from top to bottom. ”Exact” solution is on the left column, data assimilation result is on the right column.

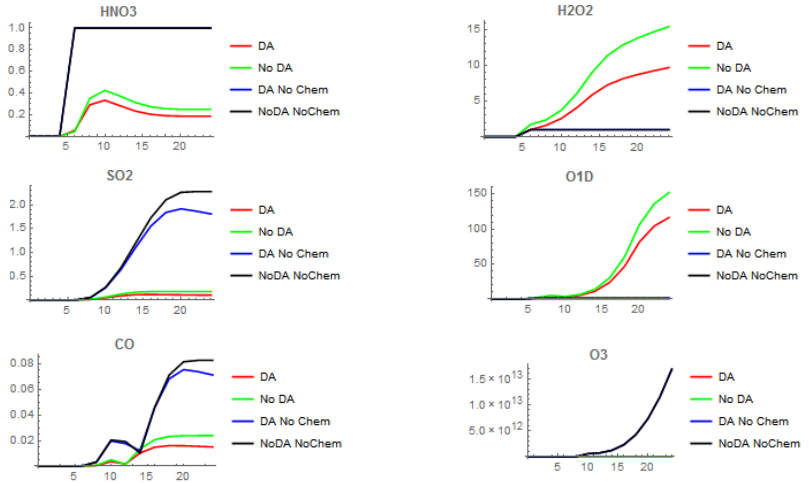
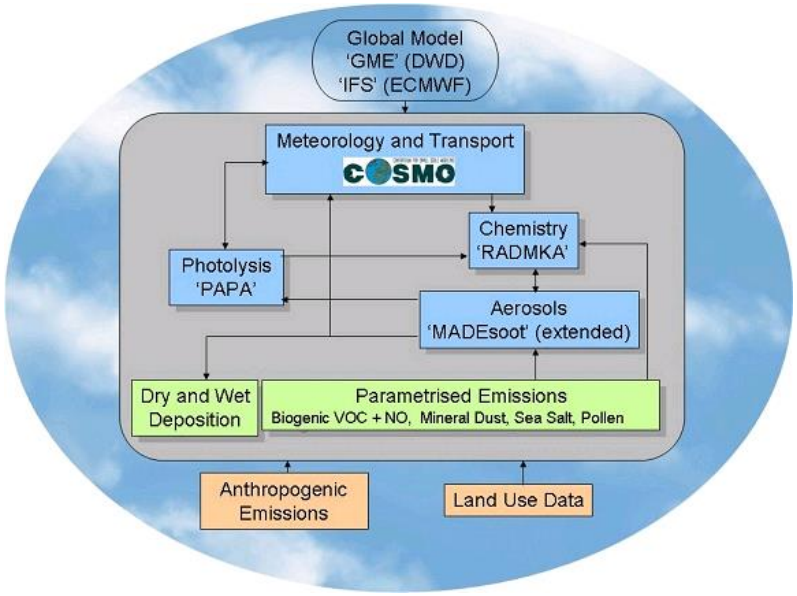


Figure 2. ”Calm” meteorological scenario. Relative error with respect to time. Initial error growth is due to the beginning of photochemical processes (4-5’o clock am). In the legend: DA stands for Convection-diffusion-reaction model with Data assimilation (red), No DA stands for Convection-diffusion-reaction model without Data assimilation (green), DA No chem stands for Convection-diffusion model with Data assimilation (blue), No DA No Chem stands for Convection-diffusion model without Data assimilation (black)

STSM at EMPA

Materials Science & Technology



Host: Dr. Dominik Brunner

Dates: 6th to 13th June 2014

Goal:

- preparation of the COSMO-ART exercise for the Aveiro summer school, held in July 2014
- training to be help the students during the summer school.

Achievements:

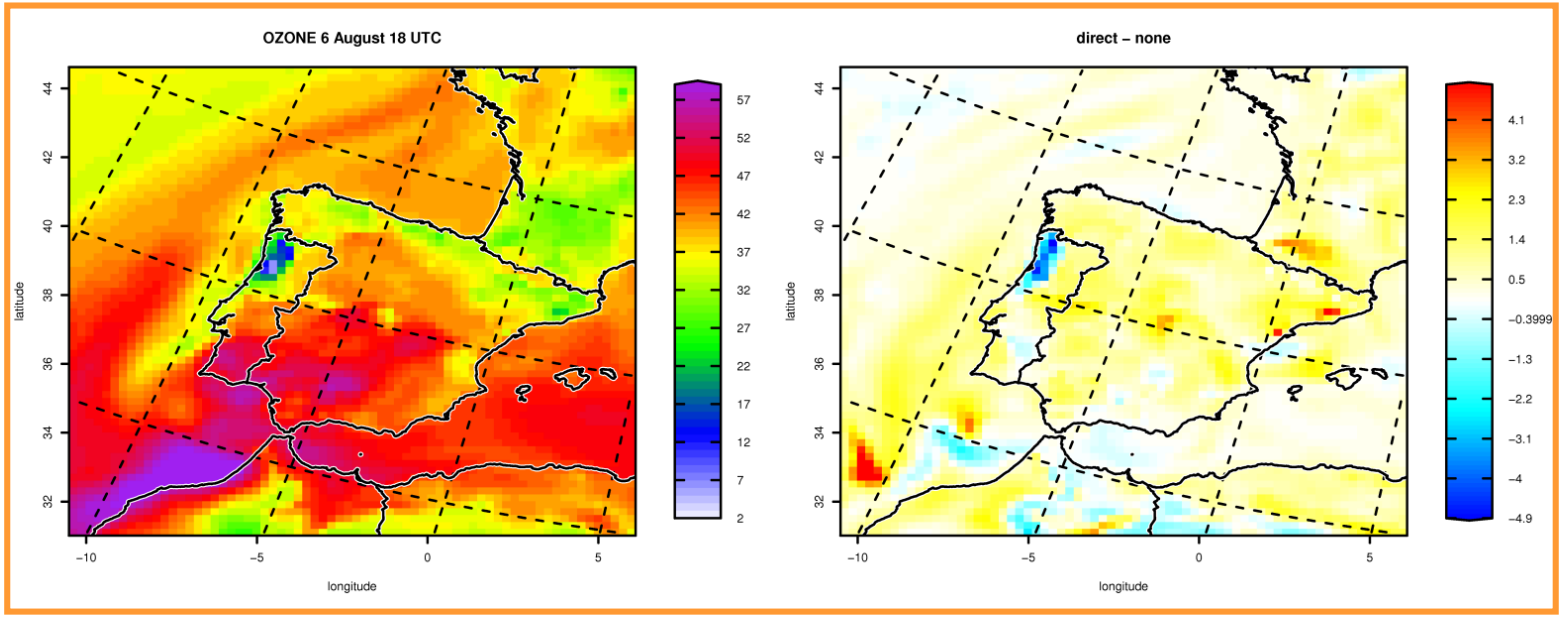
- familiarization with the COSMO-ART model, its principles, operation and outputs
- schedule and plan for the summer school practical session on COSMO-ART, including the list of exercises to be performed with the students
- Preparation of supporting material for the school,

Case study

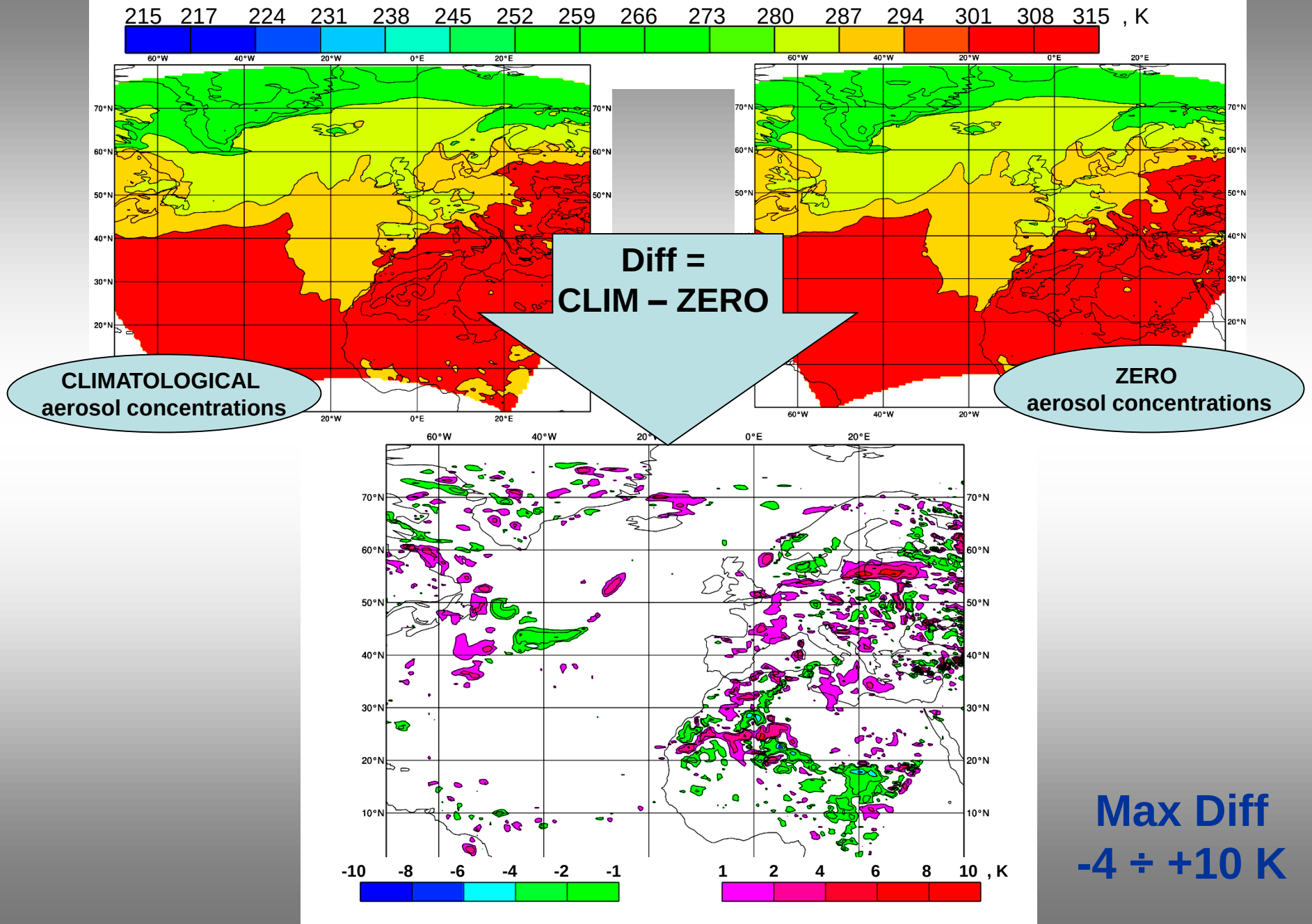
The effects of biomass burning aerosols from forest fires in Portugal

- **Analyze the effect of biomass burning aerosol in Europe/Portugal on**
  - Aerosol optical depth
  - Radiation
  - Cloud cover
  - Temperature

- **4 simulations, August 5 and 6 2010**
  - No feedback between aerosol and radiation
  - Direct feedback
  - Indirect feedback
  - Direct and indirect feedback



Temperature forecast, t = 120 h, h ≈ 100 m

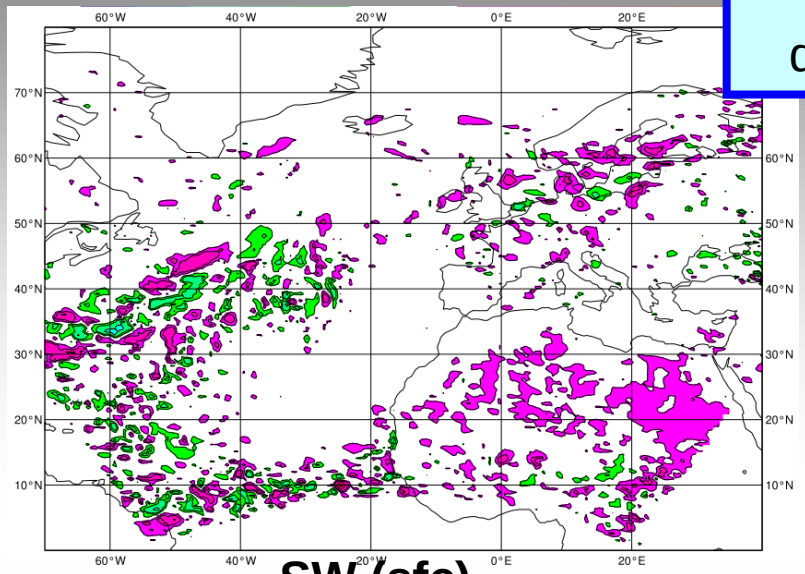


Max Diff
-4 ÷ +10 K

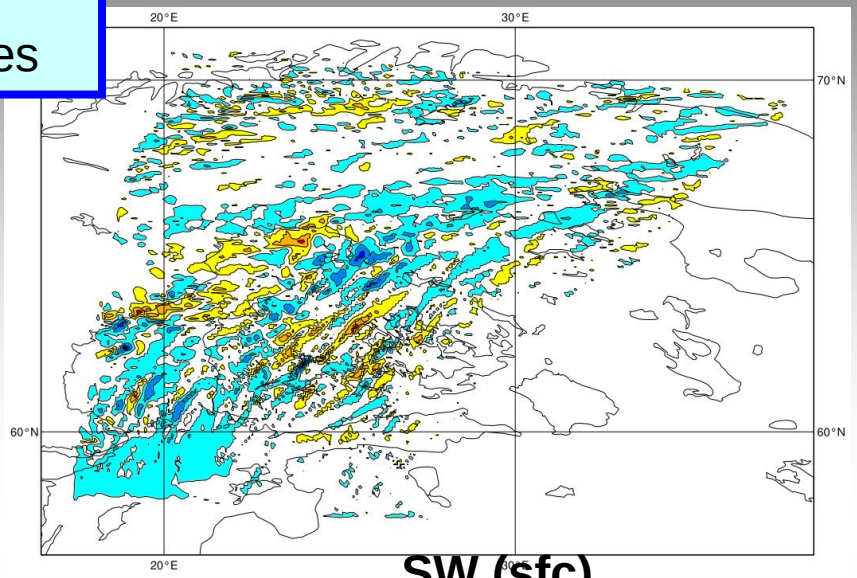
Atlantic domain
diff = clim-zero
SW (TOA)

Net
Short Wave
radiation
fluxes
differences

Finland domain
diff = clim-soot
SW (TOA)



SW (sfc)



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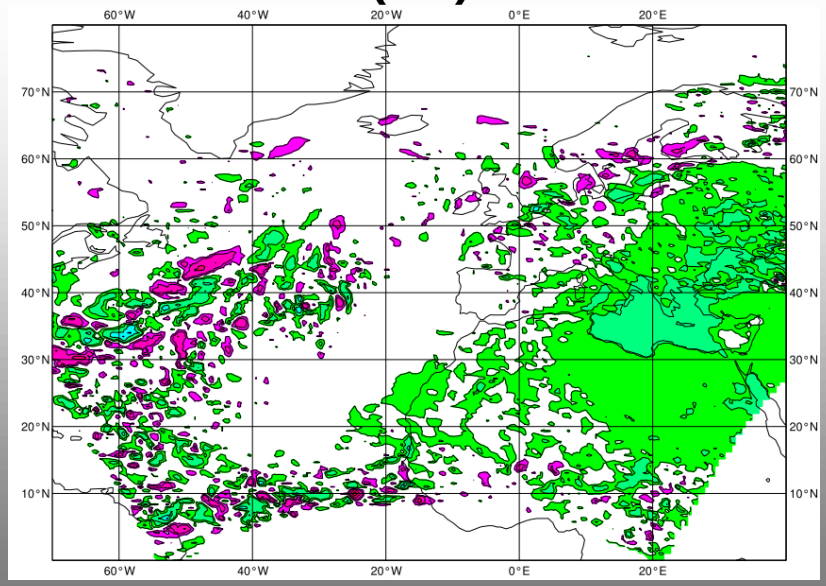
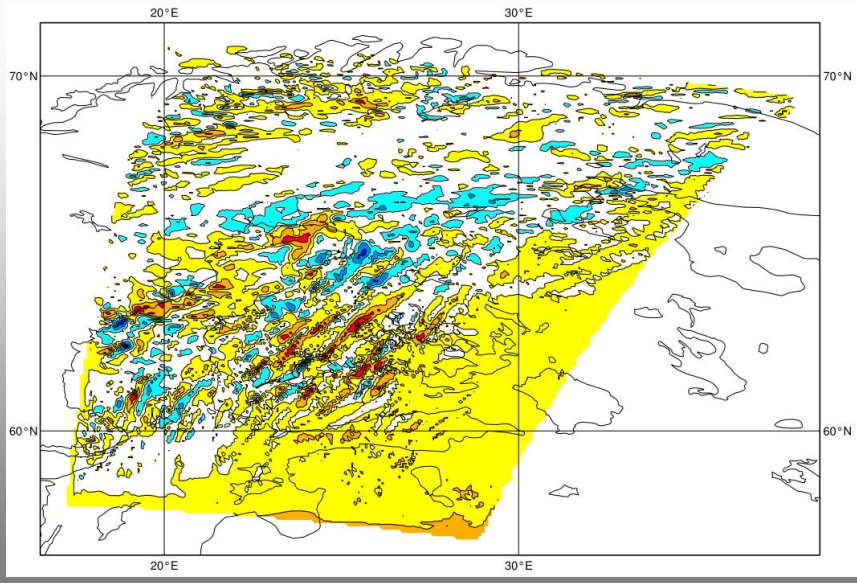


-500 -400 -300 -200 -100 -50 50 100 200 300 400 500, (W/m^2) x 10^5



-55 -45 -35 -25 -15 -5 5 15 25 35 45 55, (W/m^2) x 10^5

CONCLUSIONS

• Aerosol impact occurs in a form of **meso-scale cells with opposite signs**, even a concentration is changed homogeneously over both domains

• For air **temperature and specific humidity**, largest differences are observed at within layer of 500-1500 m with a maximum **near the top of PBL**

• **Specific humidity**, cloud cover and rain water also sensitive to aerosols **in frontal zones**

• **TKE** showed differences **only** within the **surface layer**; sensitivity is increased in presence of soot

• **Short-wave radiation** is increased at the top of the model atmosphere **TOA** (by extra 100 W/m2), while decreased near the **surface** (by extra 200 W/m2)

• **Long-wave radiation** is less sensitive to aerosol, except **in frontal zones and cloudy areas**. However, the sensitivity significantly increases in the presence of soot

• Thus, **aerosol influence** on the physical weather works as a **trigger-link in** a chain of interactions of physical processes

COST STSM Reference Number: COST-STSM-ES1004-13680

STSM Topic: WRF/CHEM configuration study for Sofia and high Artic

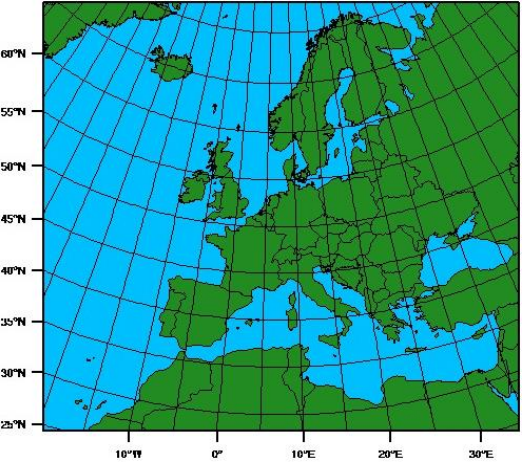
STSM Applicant: Hristina Kirova – Galabova

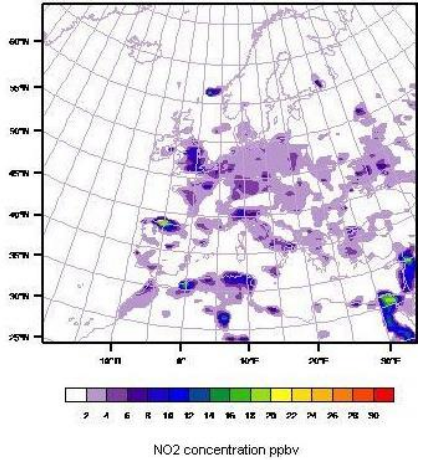
Host: Roberto San Jose, Technical University of Madrid, ESM, Madrid, Spain

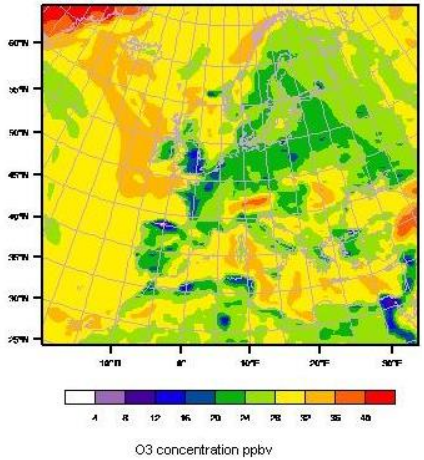
TASK I. *General anthropogenic-emission construction*

TASK II. *Specific WRF/Chem simulations*

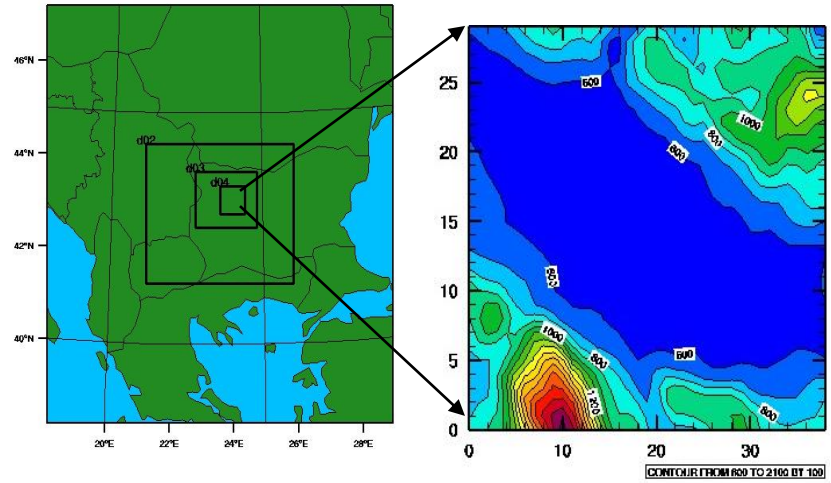
	Europe	Sofia	Sofia 2003, RETRO
Mycrophysics	10= Morrison double-moment scheme	10= Morrison double-moment scheme	10= Morrison double-moment scheme
Longwave radiation	4= RRTMG	1 = RRTM	1 = RRTM
Shortwave radiation	4= RRTMG	2 = Goddard	1=Dudhia
Surface layer	1= MM5 similarity	2=Eta similarity	2=Eta similarity
Land surface	2= Noah LSM	2= Noah LSM	1= 5-layer thermal diffusion
ABL	1= Yonsei University scheme	2 = Mellor-Yamada-Janjic	2= Mellor-Yamada-Janjic
Cumulus parameterisation	3= Grell-Devenyi	3= Grell-Devenyi	5= Grell 3D
Cu_rad_feedback	On	On	On
Chemical mechanism/ gas-phase/aerosol chemistry	9=CBMZ chemical mechanism and MOSAIC using 4 sectional aerosol bins including some aqueous reactions	9=CBMZ chemical mechanism and MOSAIC using 4 sectional aerosol bins including some aqueous reactions	301=GOCART coupled with RACM-KPP
Photolysis	2= use Fast-J photolysis	2= use Fast-J photolysis	2= use Fast-J photolysis
Biogenic emissions	calculates biogenic emissions online using the Gunther scheme	calculates biogenic emissions online using the Gunther scheme	calculates biogenic emissions online using the Gunther scheme

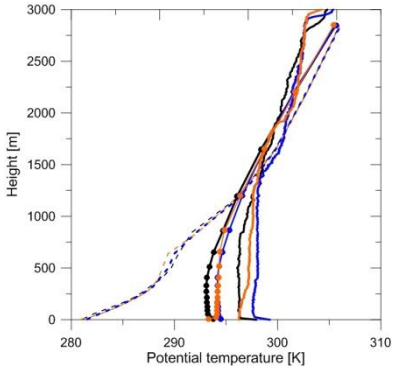


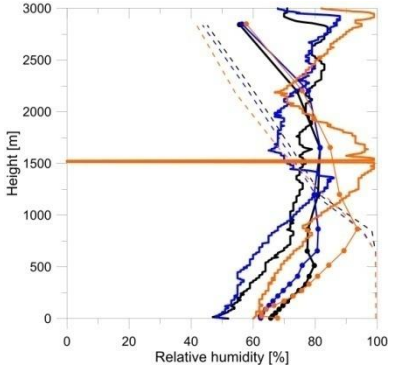


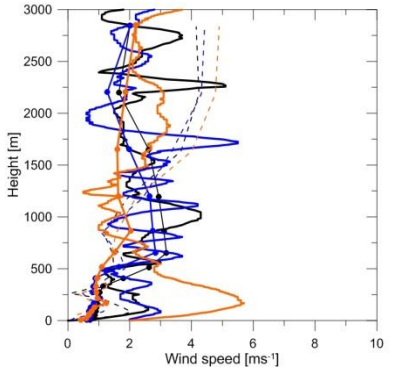


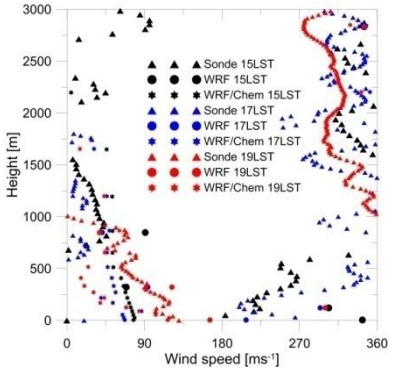
TASK III. General anthropogenic-emission construction using WRF/ Chem tools

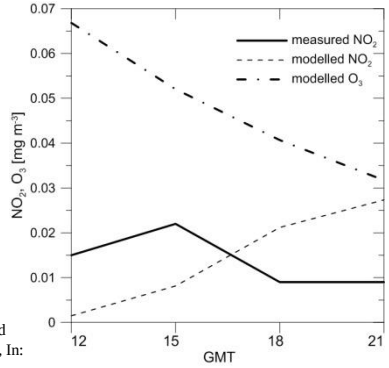


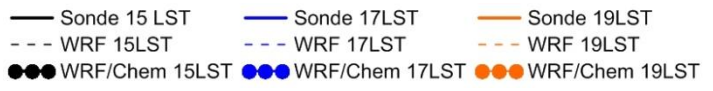












The last task is focused on influence of interaction between chemical and atmospheric processes. Both WRF and WRF/Chem underestimate Theta and overestimate RH below1500 m. The results of WRF/Chem are closer to measurements. The variablity of the wind speed and direction is better represented by the WRF/Chem.

In conclusion, direct comparison between modelled and measured vertical profiles (during Sofia 2003 Experiment, Batchvarova et al, 2006) reveals significant improvements in all studied parameters when these interactions are considered.

Batchvarova, E, Gryning, S.-E., Rotach, M.W and Christen, A., 2006, Comparison of modelled aggregated turbulent fluxes and measured turbulent fluxes at different heights in an urban area, In: Air pollution modeling and its application, XVII, Borrego, C. and Norman A. (Eds.), (Kluwer Academic/Plenum Publishers) (NATO Challenges of Modern Society series), 363-370

Overall structure of Enviro-HIRLAM pollen version

INPUT DATA

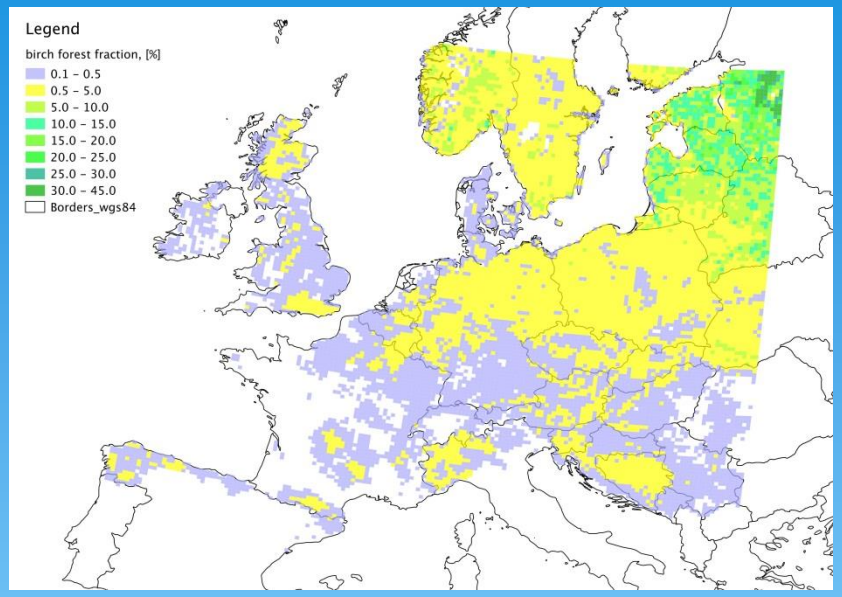
- Phenological data
- Birch forest map
- Met. IC/BC (ECMWF-IFS)

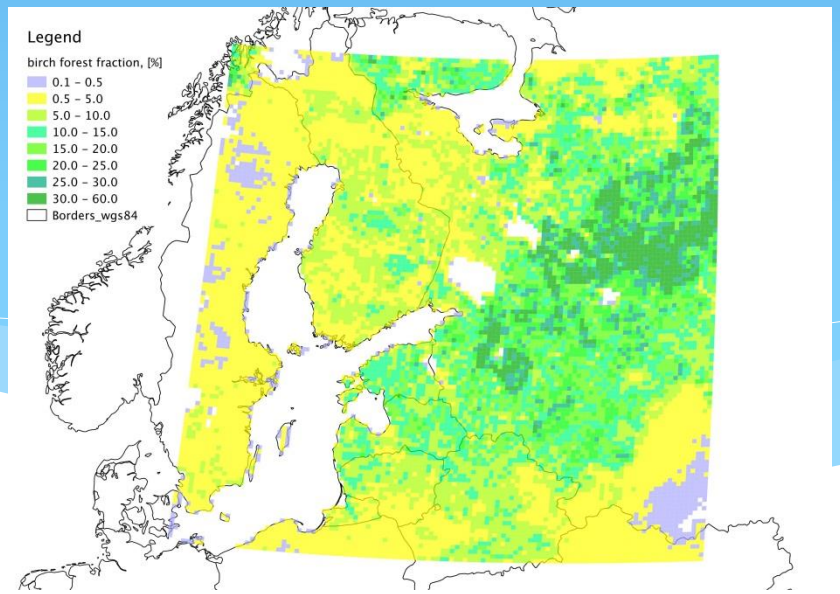
Enviro-HIRLAM

- Meteorology
- Emissions
- Transport
- Diffusion
- Dry deposition
- Scavenging

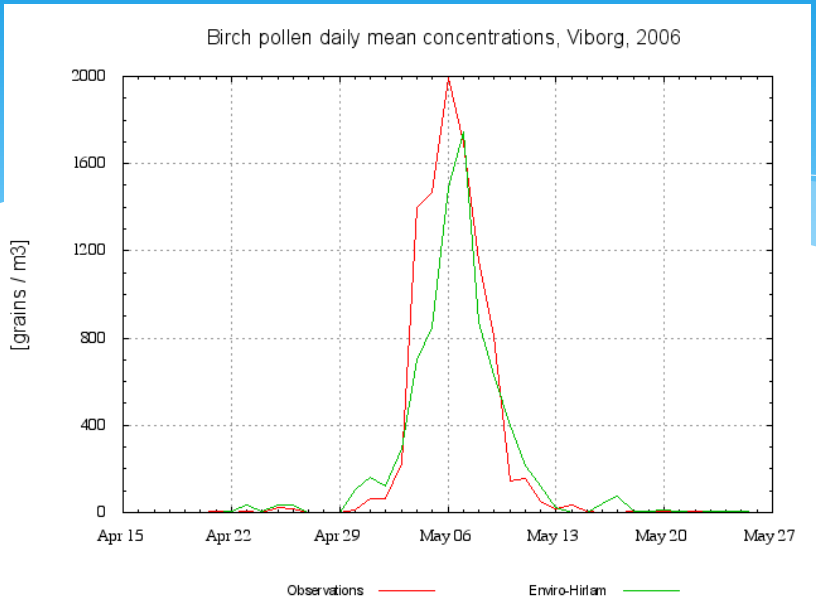
OUTPUT

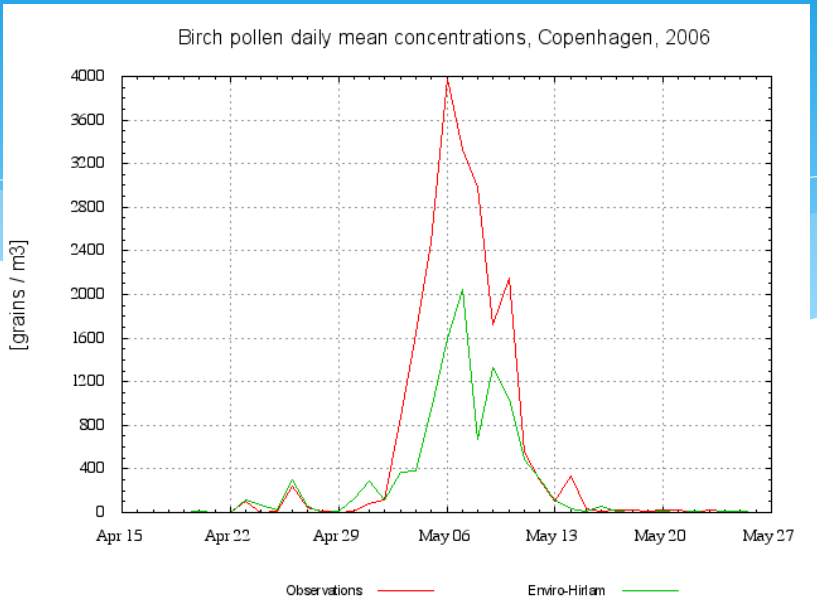
- Birch pollen concentration fields

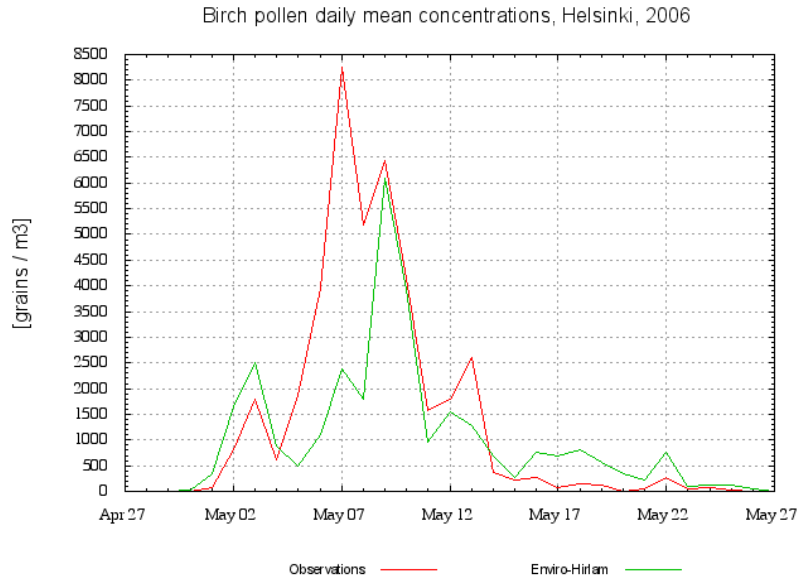


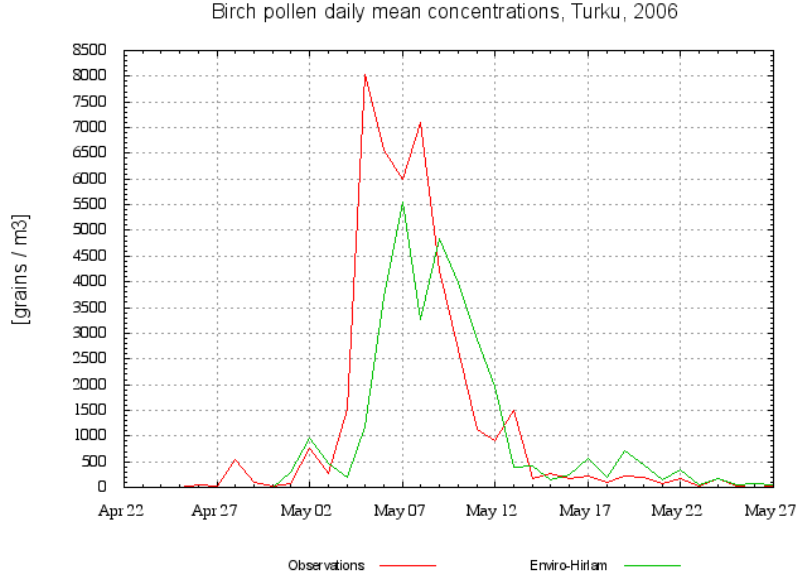


Model vs. Observations









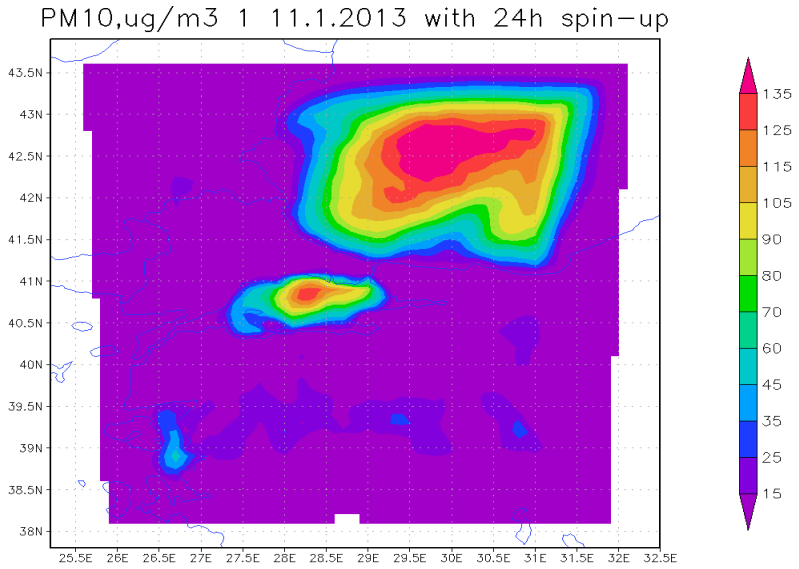
Period of STSM: 5th May – 18th May 2014
STSM Applicant: **Dr Mostamandy Suleiman**, Russian State Hydrometeorological University (RSHU), St. Petersburg, Russia , Suleiman.mostamandy@gmail.com

STSM Topic: Modelling of emission distributions near the coastal region with Enviro-HIRLAM and WRF-CHEM models

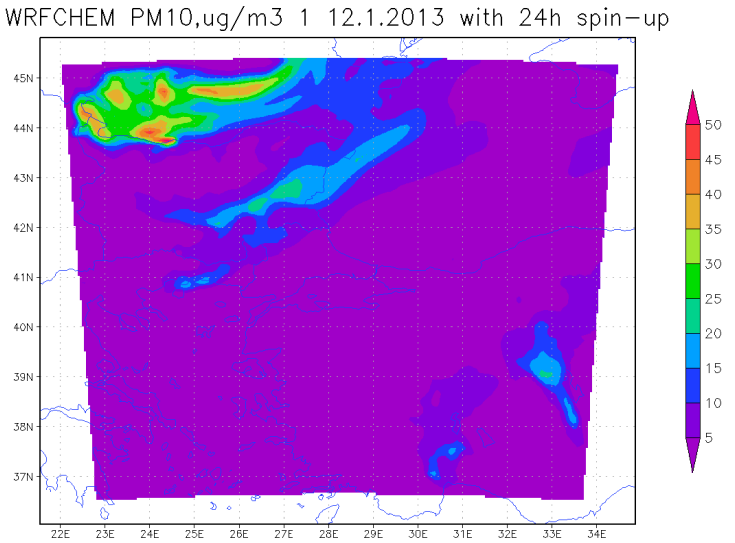
Host: Dr Huseyin Toros,Istanbul Technical University, Istanbul(TR), toros@itu.edu.tr

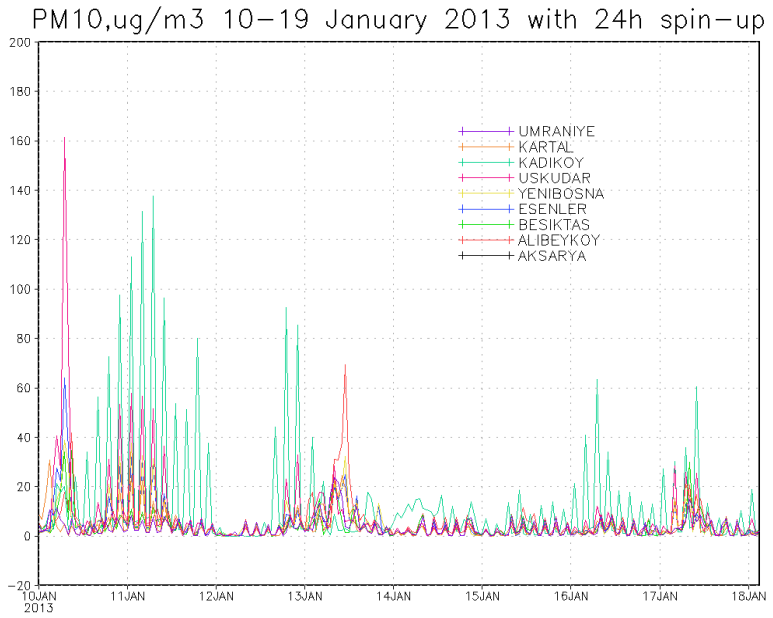
The focus has been mostly on modelling of emission distribution near the coastal area and conducting interdisciplinary research.

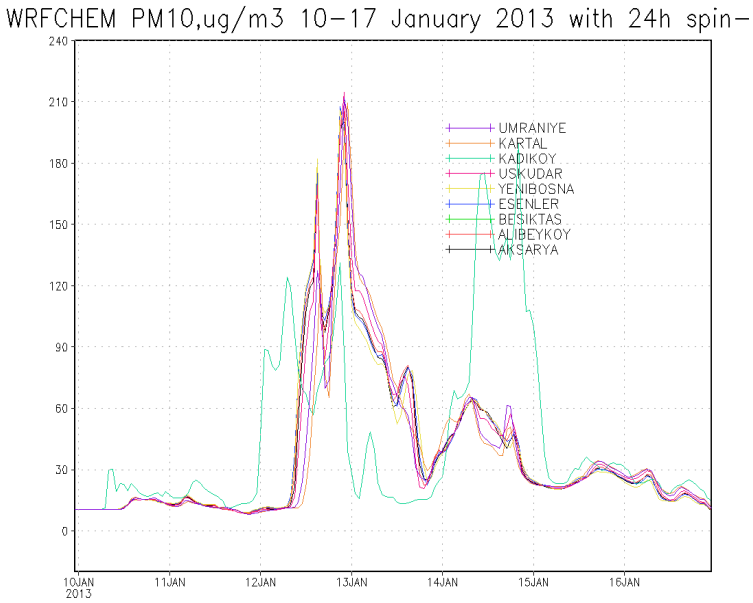
Enviro-HIRLAM



WRF-CHEM




PM10,ug/m3 10-19 January 2013 with 24h spin-up
UMRANIYE
KARTAL
KADIKOY
USKUDAR
YENIBOSNA
ESENLER
BESIKTAS
ALIBEYKOY
AKSARYA
10JAN 2013
11JAN
12JAN
13JAN
14JAN
15JAN
16JAN
17JAN
18JAN
GrADS: COLA/IGES
2014-05-15-10:29


WRFCHEM PM10,ug/m3 10-17 January 2013 with 24h spin-
UMRANIYE
KARTAL
KADIKOY
USKUDAR
YENIBOSNA
ESENLER
BESIKTAS
ALIBEYKOY
AKSARYA
10JAN 2013
11JAN
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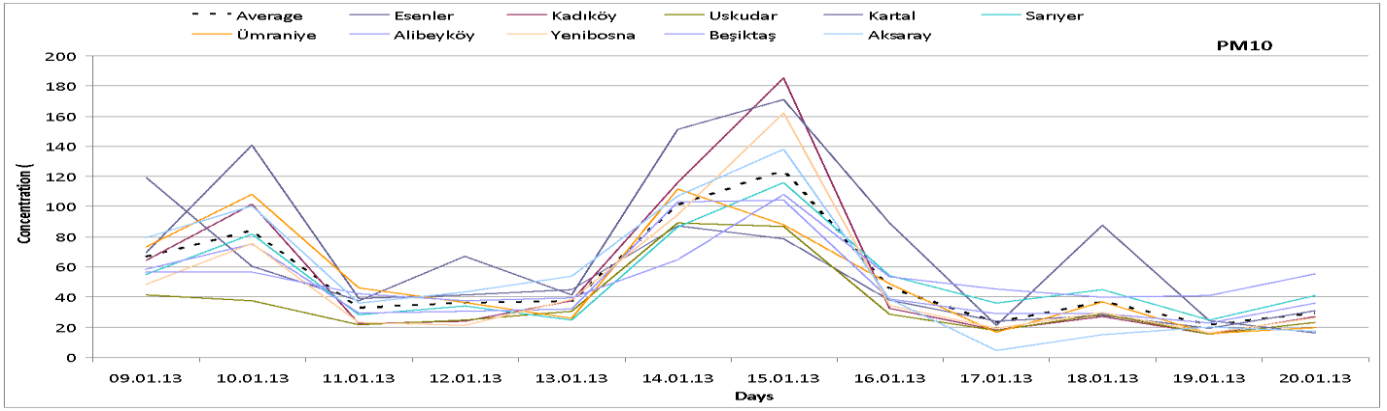
GrADS: COLA/IGES
2014-05-21-11:21


Average
Esenler
Kadıköy
Uskudar
Kartal
Sarıyer
Ümraniye
Alibeyköy
Yenibosna
Beşiktaş
Aksaray
PM10
Concentration (
09.01.13
10.01.13
11.01.13
12.01.13
13.01.13
14.01.13
15.01.13
16.01.13
17.01.13
18.01.13
19.01.13
20.01.13
Days

COST-ES1004
Eigil Kaas STSM to Empa, Switzerland

Host: Dr. Dominik Brunner, Empa, Swiss Federal Laboratories for Materials Science and Technology, Dübendorf (Switzerland), dominik.brunner@empa.ch

Visitor: Prof. Eigil Kaas, Niels Bohr Institute, University of Copenhagen, 2100 Copenhagen(DK), kaas@gfy.ku.dk

Topic: Implementation of a Locally Mass Conserving Semi-Lagrangian advection scheme, originally developed by Eigil Kaas (EK), into the tracer-enabled version of the numerical weather prediction model COSMO (Baldauf et al., 2011) and finally in the online-coupled chemistry transport model COSMO-ART.

Achievements:

- The COSMO code was analysed and a strategy was identified.
- Several subroutines in the tracer version of COSMO were modified to enable implementation of the LMCSL, and two new subroutines were coded.
- The order of the fundamental loops related to tracer transport were reversed
- A new weighting variable needed for the partition of unity principle was set up.
- Parallelization and synchronization issues related to the new weighting variable were investigated.
- Throughout the development a number of short validation simulations were performed to ensure reproducibility of results with the standard version of the semi-Lagrangian scheme.

- A number of meetings with relevant persons at Meteo Swiss and EMPA were held.
- A lecture “Tropical Cyclones in a warmer climate” was given at an extraordinary seminar on Monday 11 November at ETHZ in Zürich. Following this an informal discussion of the COSMO work was carried out at ETHZ with Prof. Christoph Schär, Dominik Brunner and others.

Conclusions and future work

- There is still a lot of work to be done!
- Dominik Brunner has successfully applied for Swiss funding of the continuation the project. However, due to sudden and severe illness the person supposed to do the work under supervision of Eigil Kaas and Dominik Brunner had to leave Empa. At this point it is uncertain if we can find another qualified person who can do the work.
- However, this one week stay at EMPA and the visits at ETH and Meteo Swiss was really constructive and will likely form the basis for further collaboration not only related to the LMCSL implementation into COSMO-art/tracer, but also in a longer perspective.

Date of the visit: 2014-05-23 to 2014-05-29
STSM Applicant: Alexander Baklanov, World Meteorological Organization / Danish Meteorological Institute, Denmark, alb@dmi.dk
STSM Topic: Joint work with WMO WGNE expert team for aerosol effects on NWP
Host: Dr. Saulo Freitas, Centro de Previsao de Tempo e Estudos Climaticos – CPTEC/INPE, Cachoeira Paulista (BR), saulo.freitas@cptec.inpe.br

Purpose of the visit STSM

The main purpose of this STSM and the visit to CPTEC/INPE was to activate a collaboration and joint work of the COST ES1004 EuMetChem community (eumetchem.info) and WMO WGNE expert team for aerosol effects on NWP.

The plan included the aim to build this collaboration and to link the EuMetChem activities with the WMO programmes and to elaborate the common vision and plans.

The most important issues are the following:

1. Joint vision for our plans, e.g. joint analysis of different case studies of aerosol effects on NWP;
2. Planning the Conference at WMO on 9-11 February 2015;
3. Planning the joint ACP Special Issue;
4. Joint publications, web-site and dissemination.

New STSM applications (7 planned)

1. Julia Palamarchuck, OSENU, Ukraine => UoC, DK, January 2015 (approved)
2. Alexej Penenko, INMMG, Russia => DMI, DK, November 2014 (approved)
3. John Douros, AUTH <– >Saulo's group of WGNE ???
4. John Douros, AUTH <– >Saulo's group of WGNE??
5. Meteo-France ⇔ HIRLAM ?