EMEP4HR – project overview and current development

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Presentation outline

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EMEP what ?

Eulerian chemical transport model developed as a part of EMEP program under the Convention on Long–range Trans–boundary Air Pollution for international co–operation to solve trans–boundary air pollution problems

- Developed at EMEP's Meteorological Synthesizing Center – West (Norwegian Meteorological Institute)
- Officially used for modeling the source–receptor matrices which estimate the contribution of the emissions in any country to the depositions or concentrations of any acidifying or photochemical pollutant in any other country
- Contains 71 chemical species, 22 photochemical reactions and many chemical reactions

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EMEP for what?

For Croatia

- A 4 year international project funded by Norwegian ministry of sciences
- Co–operating Institutes:
  - Norwegian Meteorological Institute (met.no)
  - Croatian Meteorological and Hydrological service
  - Andrija Mohorovičić Geophysical Institute, University of Zagreb
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Project objectives

1. the development of high resolution emission inventories of air pollutants in Croatia and in selected urban areas
2. the implementation and further development of a high–resolution version of the Eulerian EMEP Unified chemical transport model for use in Croatia
3. the development of a new capability for the assessment of urban air quality in main Croatian cities
4. the evaluation and testing of the new modeling capability according to international standards as a pilot project for other countries in the West Balkan area
5. the support to Croatian authorities to meet the requirements from the new EU legislation on air quality.

Organization of work

The work is organized in four different work packages:

Work Package 1: Emission Inventory Compilation

Work Package 2: Mesoscale application of the EMEP model in Croatia

Work Package 3: Assessment of urban air quality

Work Package 4: Validation and Dissemination

Presentation outline

- The work done in WP2, shell be presented here
- The further topic of this presentation shall be technical work mostly
- Current scientific development shell mostly be presented in the next presentation

Necessary preconditions for running EMEP4HR

The following software modules had to be developed:

Meteorological driver: Creates EMEP meteorological input from ALADIN output

Boundary and Initial Conditions tool: Interpolates and reprojects BIC fields from EMEP grid to EMEP4HR grid

Land use tool: Creates land use file, forests file and land–sea mask file

Snow cover tool: Creates snow cover map

Anthropogenic emissions tool Mass conserving interpolation and reprojection of EMEP gridded emission files

Disulphide emissions tool Mass conserving interpolation and reprojection of EMEP natural disulphide emissions

Meteorological driver

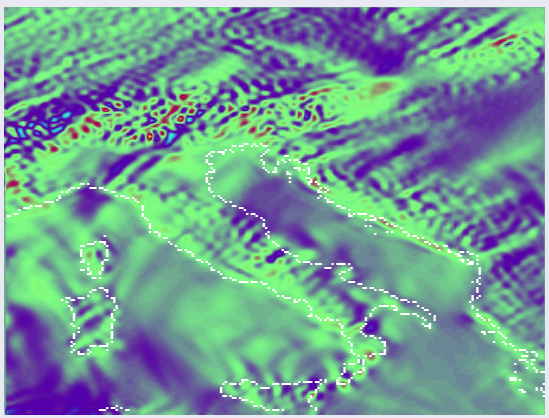
Used for:

- Format conversion between ALADIN format and EMEP readable NetCDF
- Vertical interpolation from ALADIN to EMEP grid
- Reprojection from Lambert conformal to lat–lon
- Mass conservation by recalculation of vertical velocity (ALADIN semi–Lagrangian, semi–implicit advection scheme is not 100% mass conservative)
- Calculation of the derived variables needed for EMEP

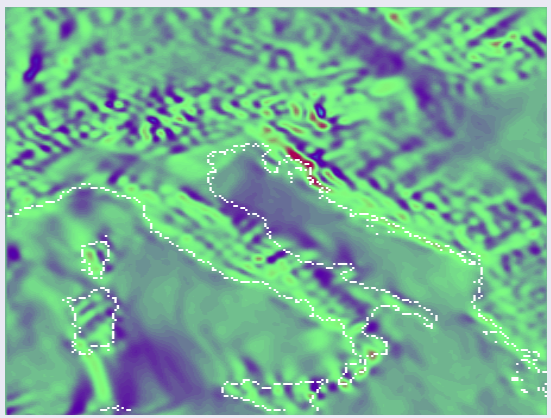
Meteorological driver – continued

- continuity equation is integrated from the bottom to the top
- errors propagate upwards
- bi–directional approach will be tested

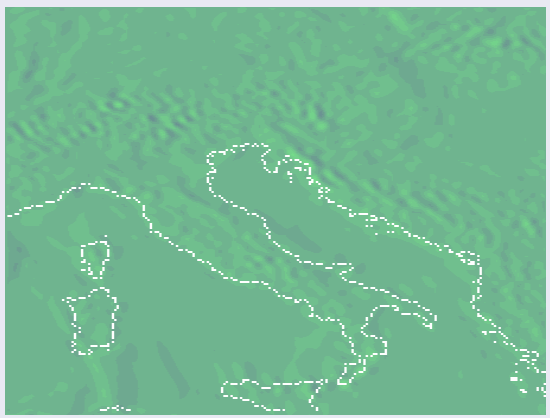
$\sigma = 0.2$



$\sigma = 0.8$



$\sigma = 0.99$

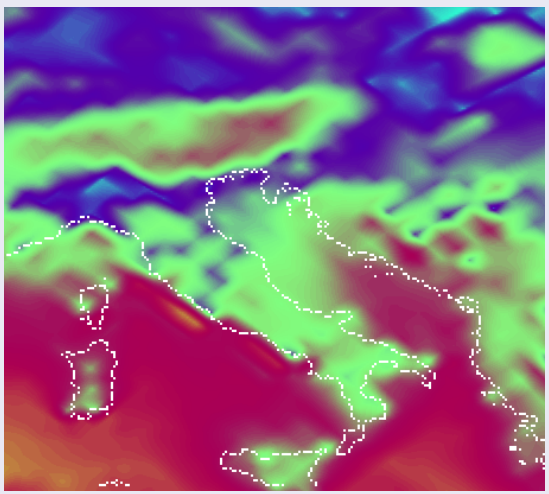


Initial and Boundary Conditions

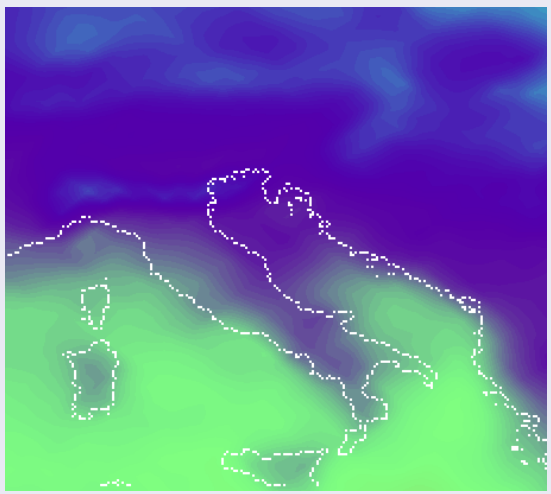
- Initial and boundary concentrations of major long–lived species are required
- Short–lived species do not need IBSs
- For nested runs IBCs will be provided by EMEP model runs
- For non–nested runs IBSs are reprojected and interpolated (bi–linear interpolation) from original EMEP IBCs

Initial and Boundary Conditions – example

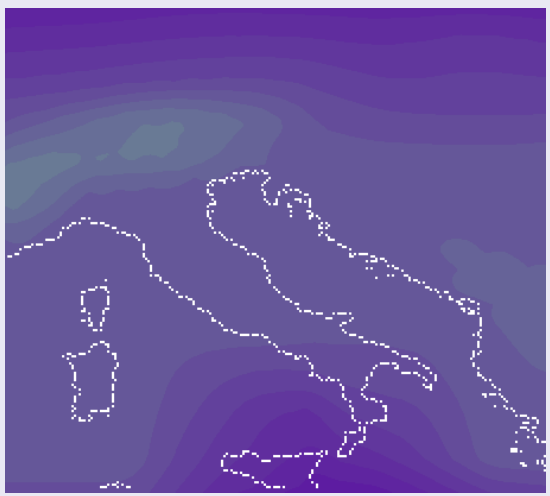
CH_3COO_2, $\sigma = 0.917$



H_2O_2, $\sigma = 0.8815$



O_3logan, $\sigma = 0.839$



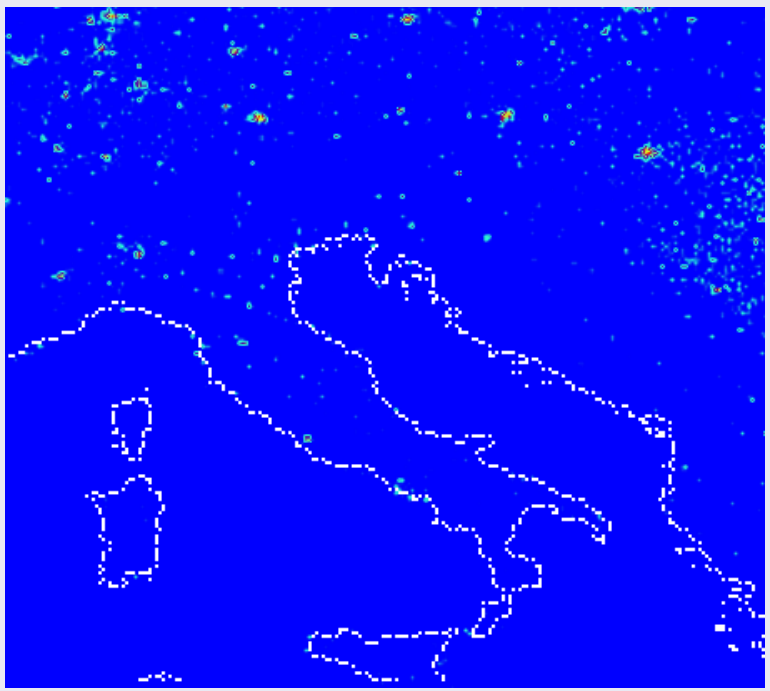
Land use

- Land–use data are required primarily for dry deposition modeling and for estimation of biogenic emissions
- High–resolution good quality land use data is needed
- EMEP uses 16 land–use classes
- Two high resolution land use databases are considered
  1. MM5 Vegetation database (24 classes)
  2. GLC 2000 (23 classes)
- For both databases mapping their classes to EMEP classes is not straightforward (fe. EMEP requires Mediterranean forests)
- GLC 2000 subjectively looks a better choice

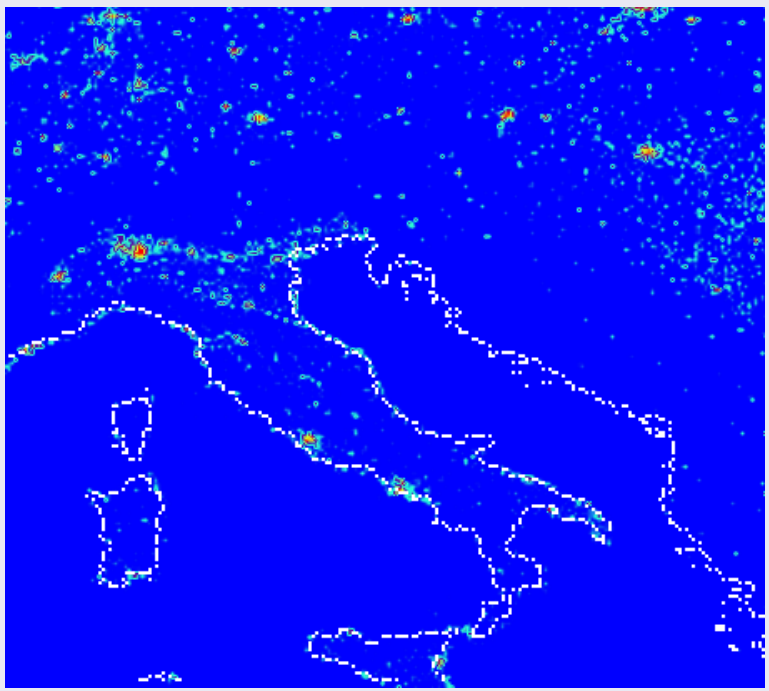
GLC 2000 v.s. MM5 – Urban

- GLC obviously better

MM5



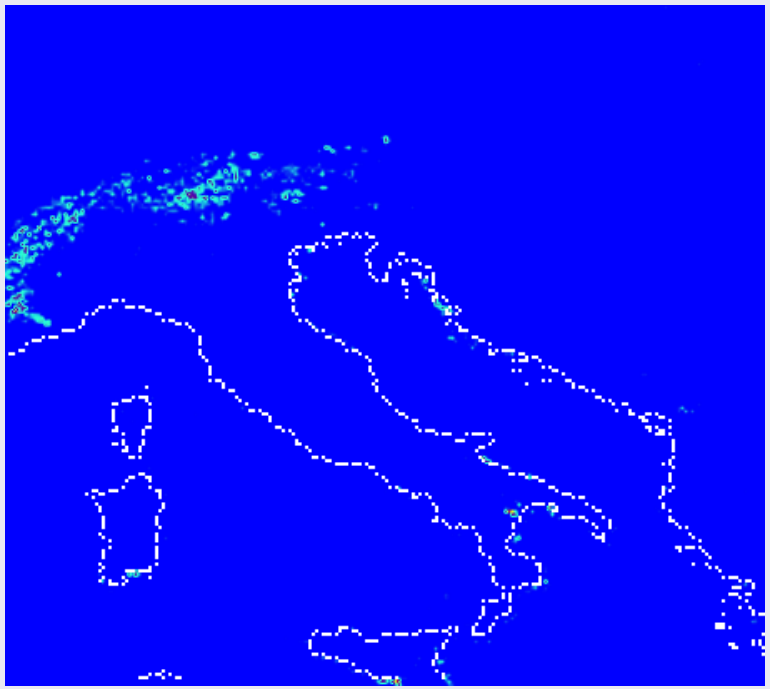
GLC



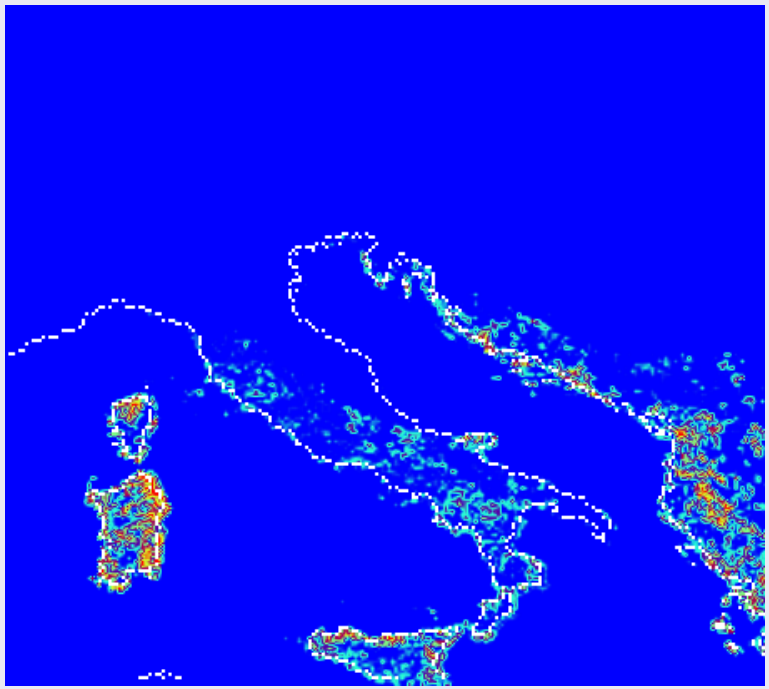
GLC 2000 v.s. MM5 – Shrub

- GLC shows a lot of evergreen shrub

MM5



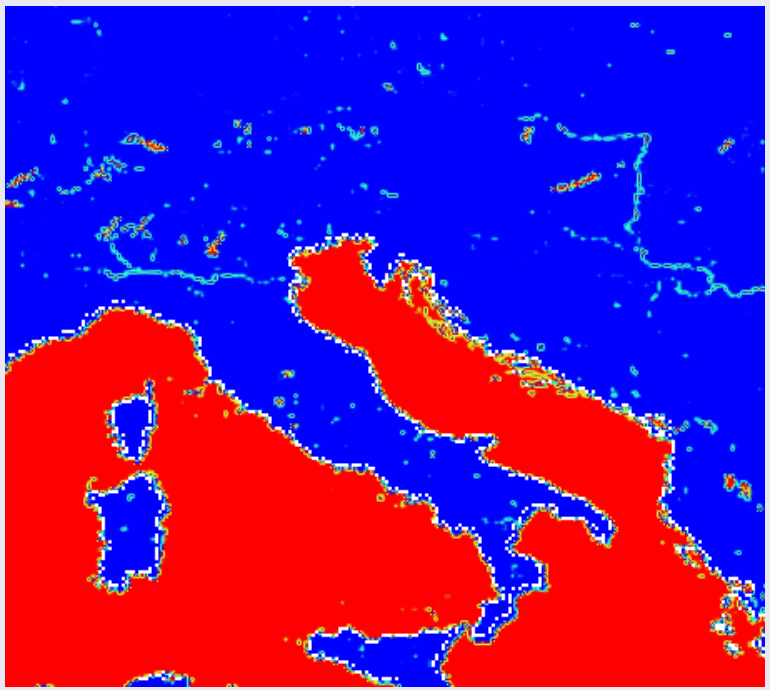
GLC



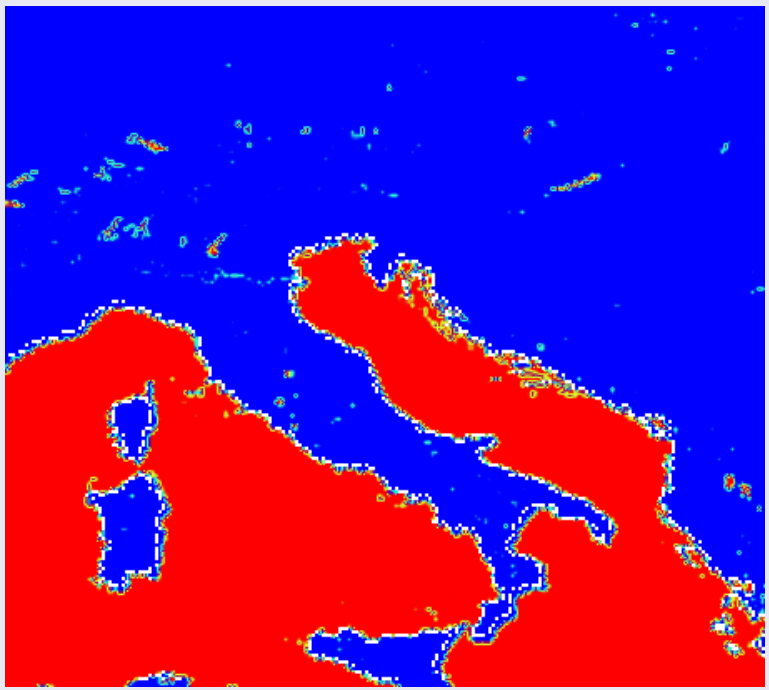
GLC 2000 v.s. MM5 – Water

- MM5 has more water bodies and better rivers

MM5



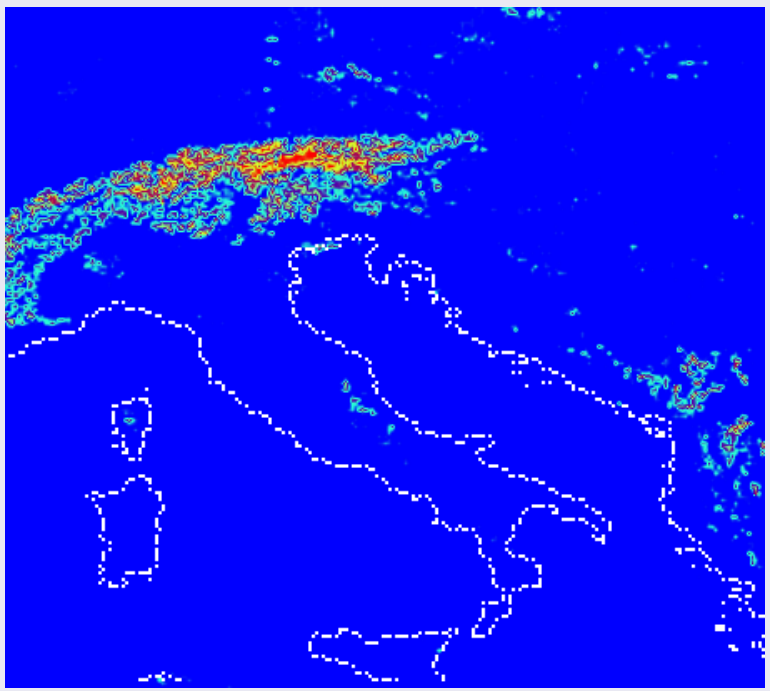
GLC



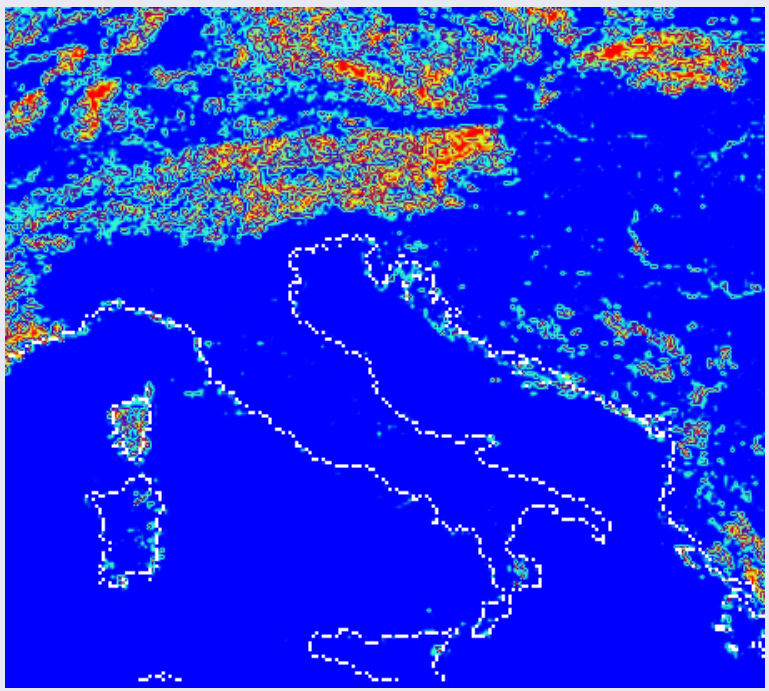
GLC 2000 v.s. MM5 – Needle–leaf evergreen

- GLC shows Mediterranean evergreen forests

MM5



GLC

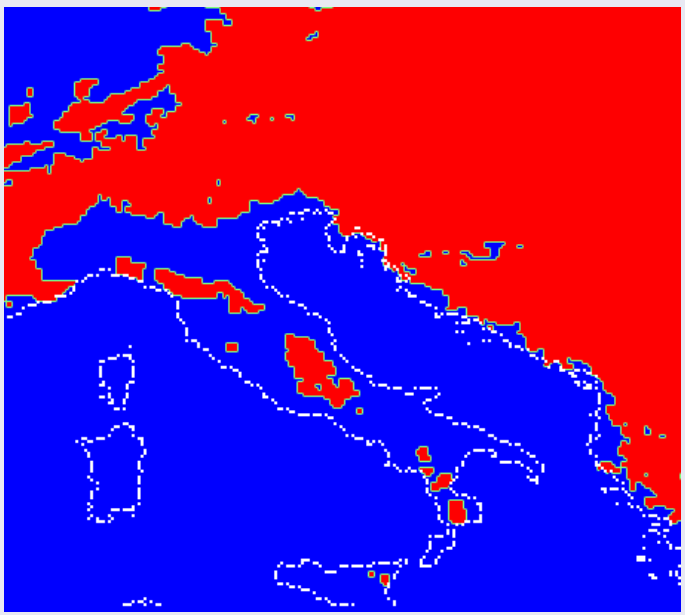


DHMZ

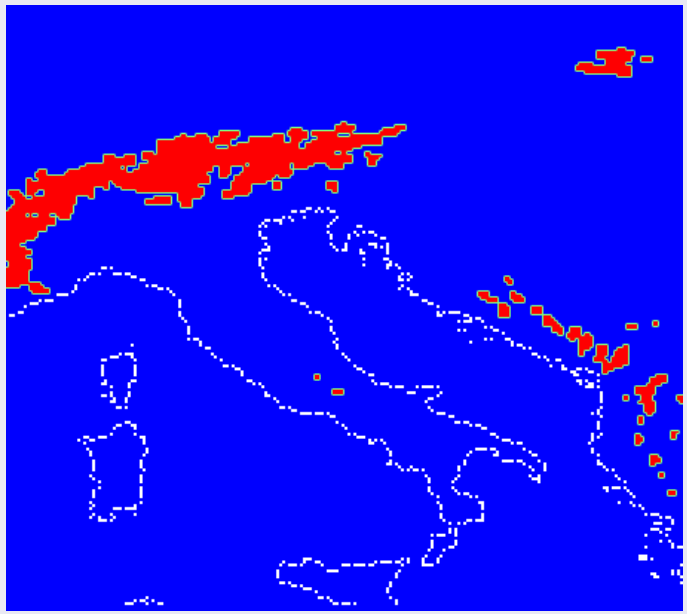
Snow cover

- Derived from ALADIN climatological files (WEASD)
- Look excessive in January, some tuning can be done

January

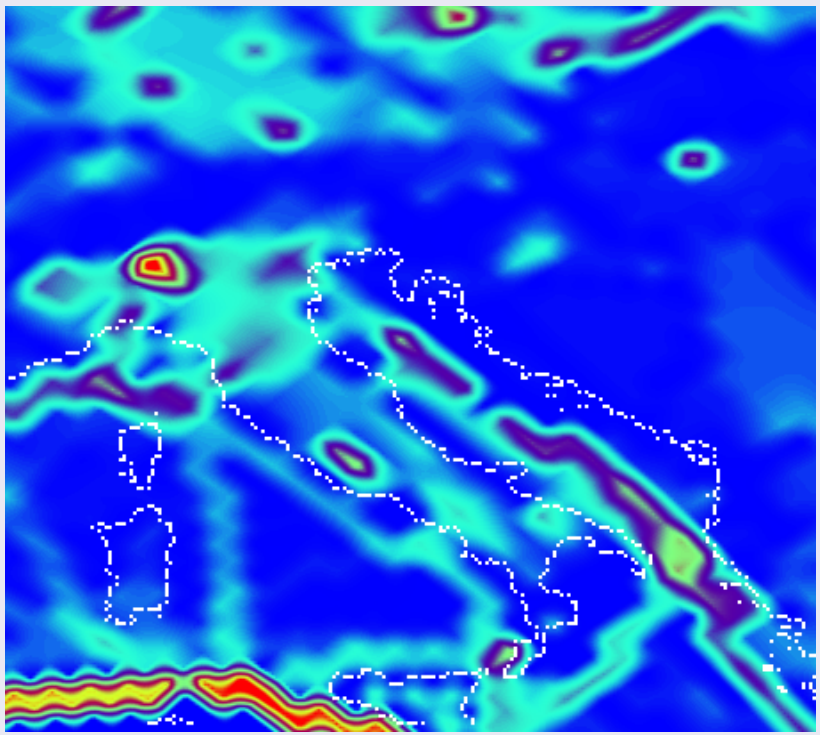


March

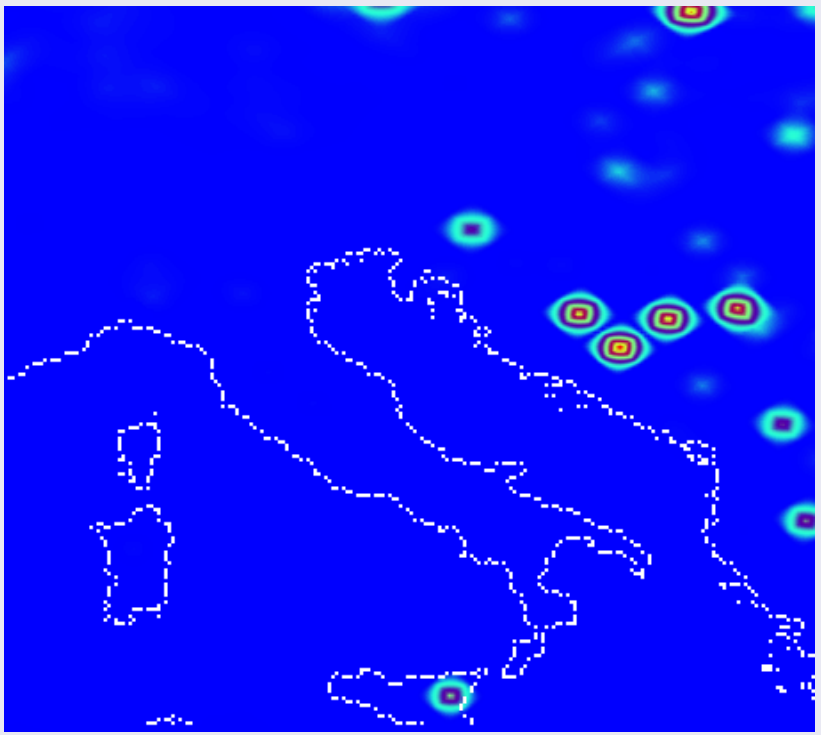


Gridded emissions

NOx sector 8



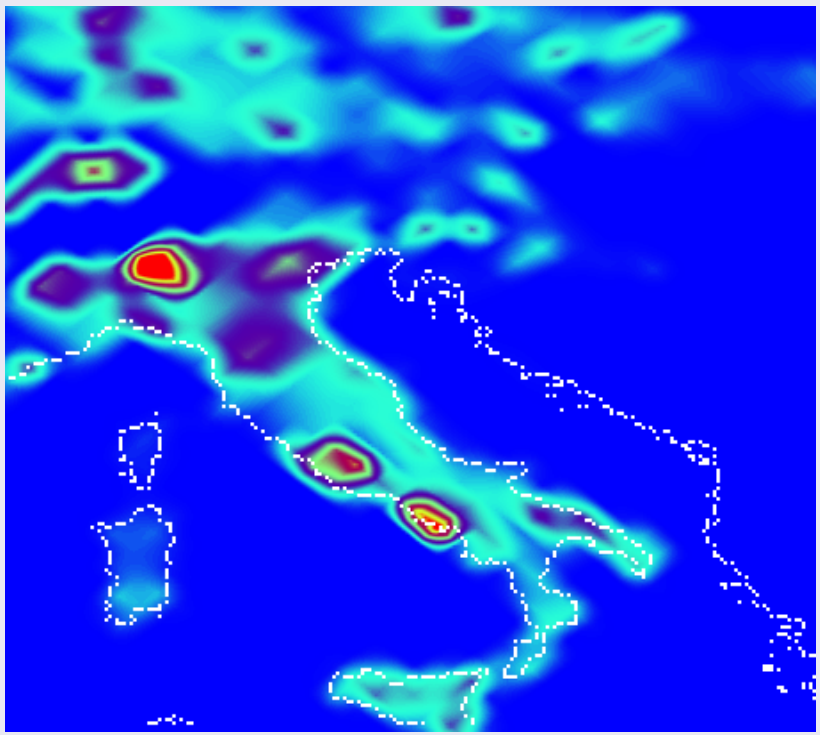
SOx sector 1



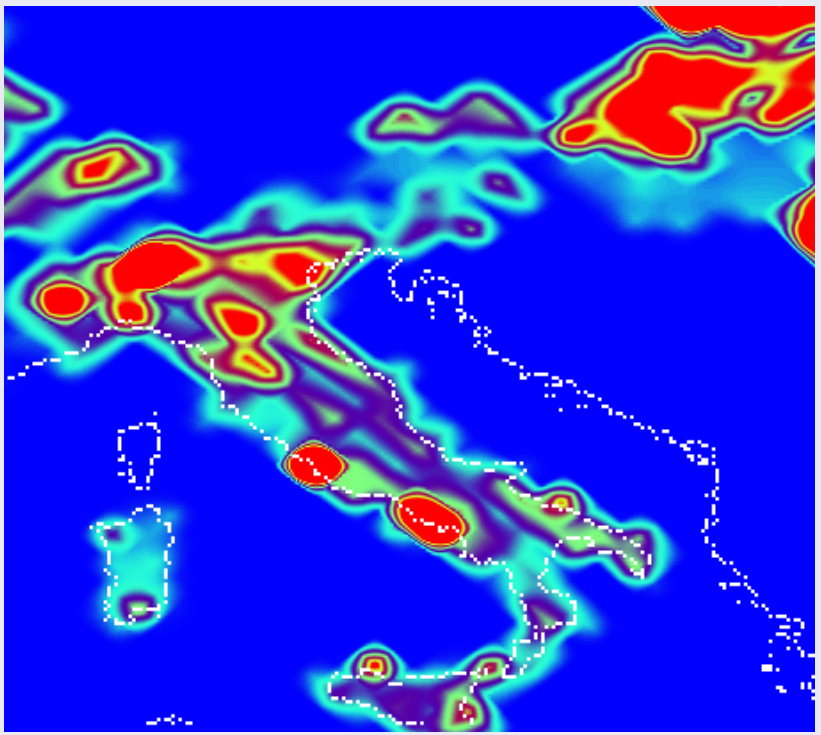
EMEP4HR gridded emissions are created by mass conserving bi–linear interpolation of EMEP emissions. This will probably be changed.

Gridded emissions

NH_3 sector 7



NH_3 sector 9

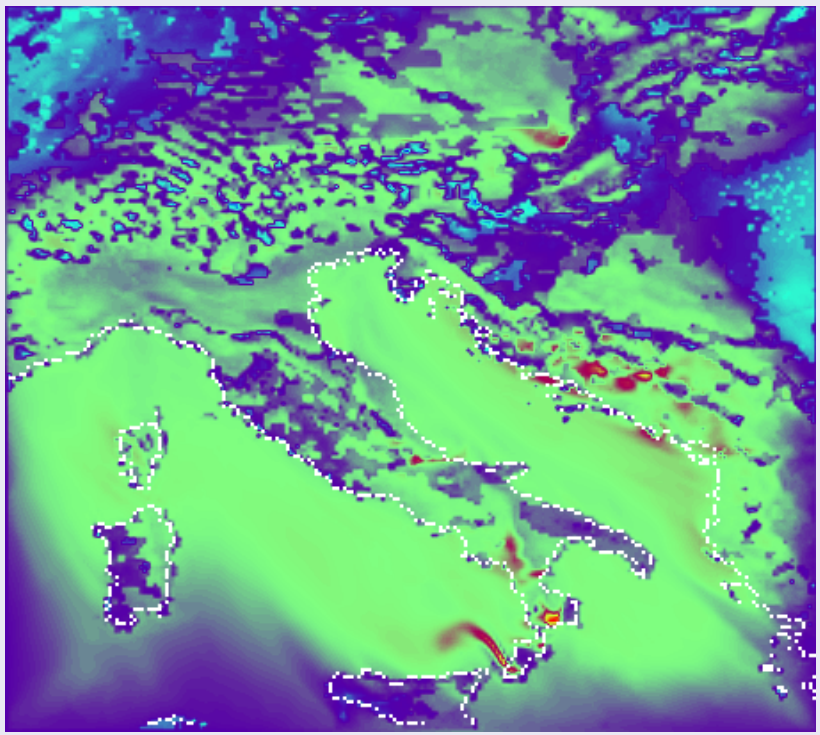


Tentative results

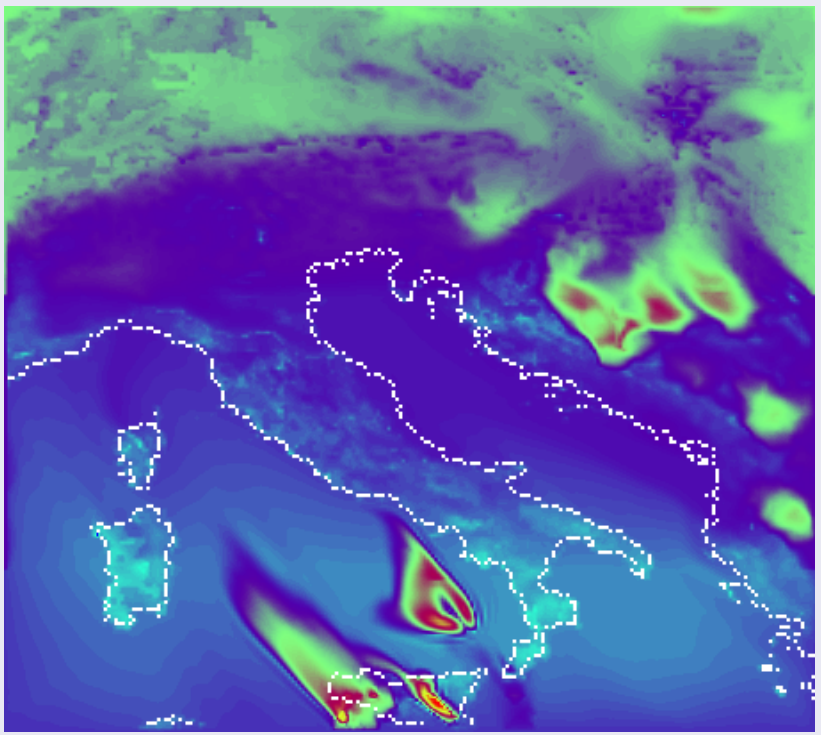
- Model runs without crashing
- The longest run up to now was 2 days long
- Extensive testing needs to be done

Model results – 1

Ozone

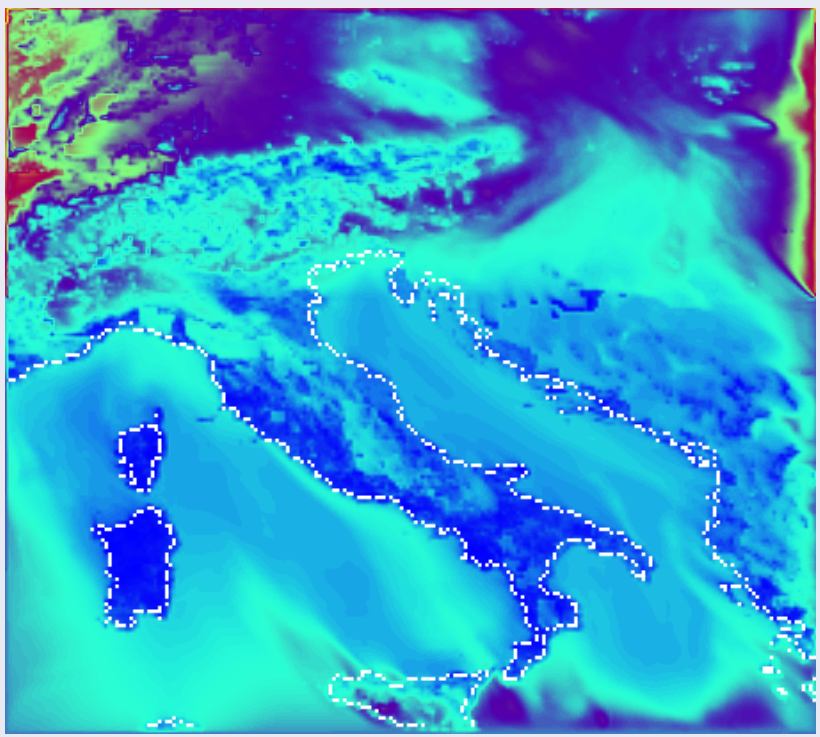


SO_4

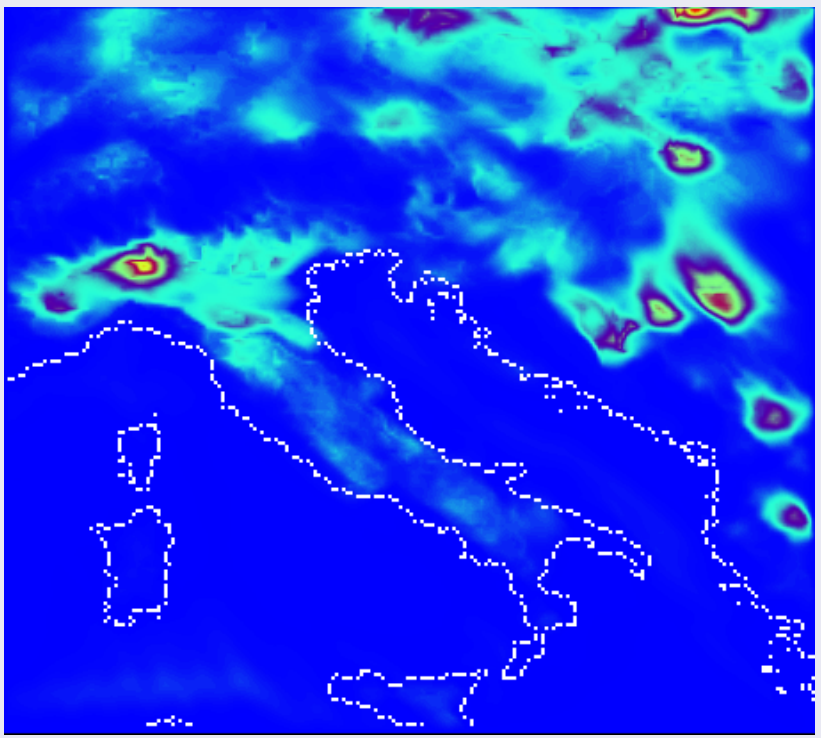


Model results – 2

Primary NO_3



Primary PM25



Presentation outline

Horizontal diffusion

- A horizontal diffusion scheme will be implemented in the EMEP model
- The scheme to be used is based on Mason and Sykes (1982)
- Horizontal stresses are parametrized through Smagorinsky type deformations but also take stability into account
- Buoyancy effects act through modification of the length scale
- No work is done on the implementation of the parametrization, yet

Presentation outline

Conclusion

- The project is well under way
- Most of the technical problems are solved
- Some of the scientific issues are being solved (see next presentation)
- Some of the scientific issues have not been tackled yet (horizontal diffusion)

Thank you !