Supercomputing at Croatian Hydrological and Meteorological Service

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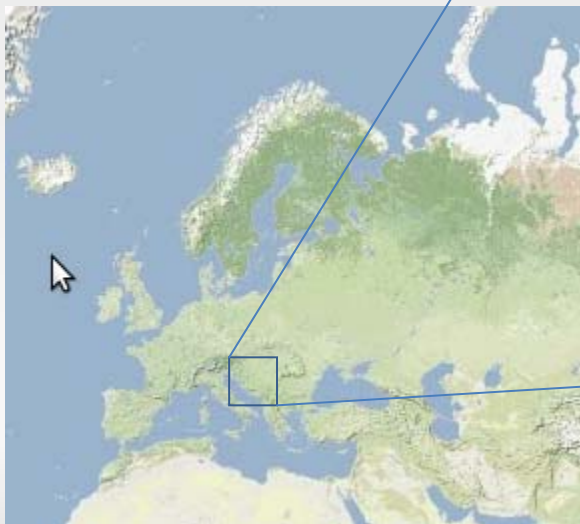
DHMZ

Outline

- General information

- Croatia supercomputers

- Usage of DHMZ supercomputer Viking

- OU – DHMZ collaboration

Croatia

- 56,542km^2
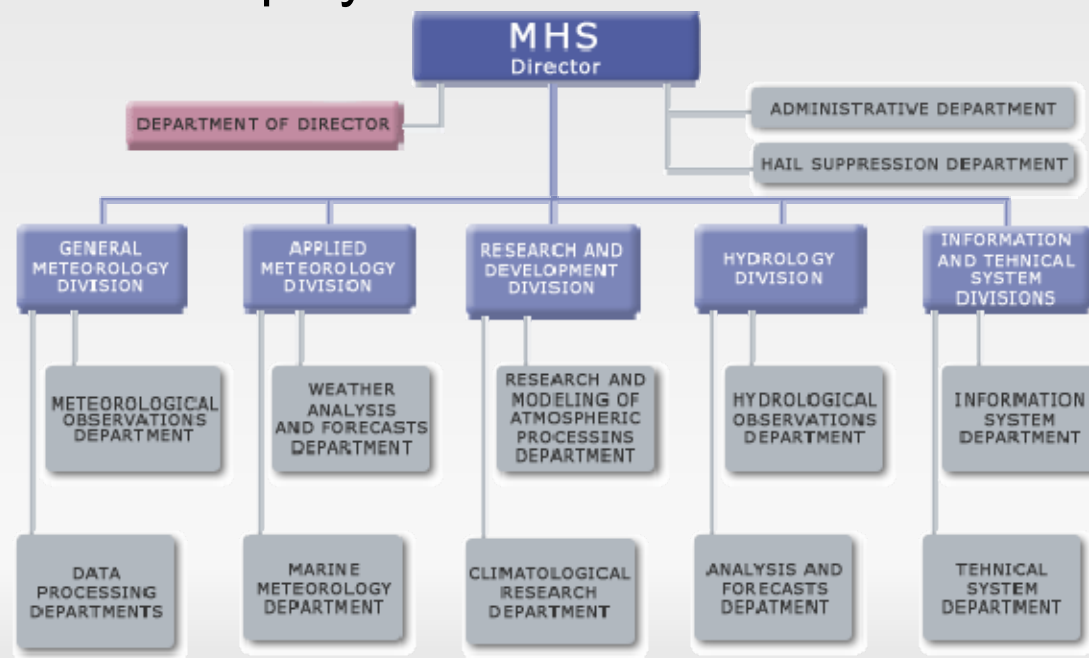
- 4,5 million inhabitants

Croatia

DHMZ

- DHMZ – Croatian Hydrological and Meteorologica Service
  - fundamental institution for meteorology and hydrology in Croatia
  - founded by decree of Government of People's Republic of Croatia (NRH) on 27th of August 1947
  - the number of employees increased to reach a stuff of more than 440

Croatia - supercomputers

- Isabella – located at University Computing Centre (SRCE)

  - 100+2 servers

  - 352 CPU cores on compute nodes

  - 544 GB RAM memory

  - 8 TB local disk space

  - additional disk space at main SRCE's disk space (SAN - Storage Area Network) with total capacity up to 40 TB

Croatia - supercomputers

- Viking – located at DHMZ
  - SGI Altix LSB-3700 BX2 Server
  - 48 Intel Itanium2 1.6GHz/6MB
  - 96 GB standard system memory, 2x146 GB/10Krpm SCSI disk drive
  - OS SUSE Linux Enterprise Server 9 for IPF with SGI Package
  - Intel Fortran & C++ compilers version 9.0.031
  - Queuing system (PBS Pro)
  - 7 TB of storage place available and ongoing implementation of 30 TB of disk space

Supercomputing at DHMZ

- Operational 72h forecast

- Research activities:

  - Data assimilation

  - Case studies

  - Climate model

  - Chemical transport model

  - Downscaling of ECMWF reanalysis

General information - NWP in Europe

- At the moment there are 5+1 NWP Consortia in Europe:

  - ALADIN- **A**ire **L**imitée **A**daptation dynamique **D**éveloppement **I**nter**N**ational (Algeria, Belgium, Bulgaria France, Morocco, Poland, Portugal, Tunisia, Turkey)

  - COSMO- **CO**nsortium for **S**mall-scale **M**odeling (Germany, Switzerland, Italy, Greece, Poland, Romania)

  - HIRLAM- **HI**gh **R**esolution **L**imited **A**rea **M**odel (Denmark, Estonia, Finland, Iceland, Ireland, The Netherlands, Norway, Spain, Sweden)

  - UK Met Office

  - ECMWF- European Consortium for global model

  - RC-LACE- **R**egional **C**ooperation for **L**imited **A**rea modeling in **C**entral **E**urope (Austria, Croatia, Czech Republic, Hungary, Slovakia, Slovenia, Romania) => DHMZ (Croatia) is member of ALADIN and RC-LACE Consortiums

About models in ALADIN World

- **ARPEGE** – global spectral model

- **ALADIN** – NH/H regional NWP model developed for scale ~ 10 km

- **Mezo-NH** – NH mesoscale atmospheric model of the French research community

- **AROME** – NH mesoscale NWP model with advanced physics for nowcasting and very short range forecasting. Dynamical kernel – NH ALADIN and physical parameterization package of the Meso-NH for ~2 km resolution

- **ALARO** (is not a model) – improved version of ALADIN: new radiation scheme, horizontal diffusion, microphysics, TKE; mostly developed by RC-LACE

Operational forecast

- LBC – ARPEGE (global model); runs at Meteo-France

- ALARO – regional model
  - 8km horizontal resolution
  - hydrostatic
  - 37 levels
  - (229x205) 240x216 grid points
  - 72 hour forecast;1-3 hourly output

- DADA – dynamical adaptation
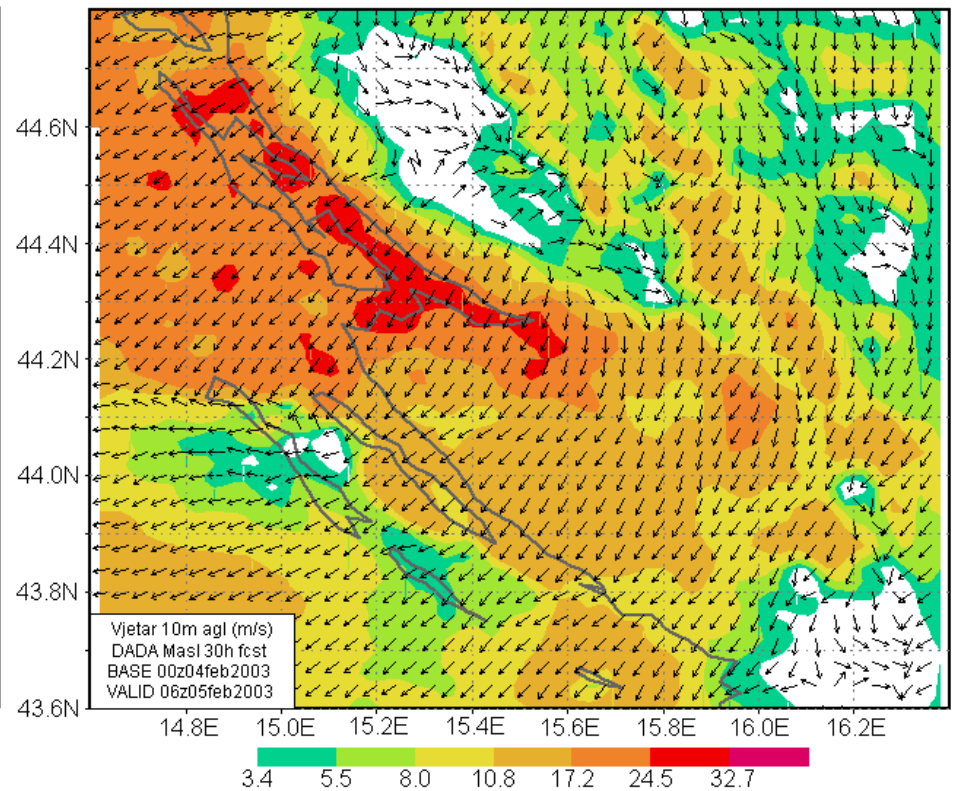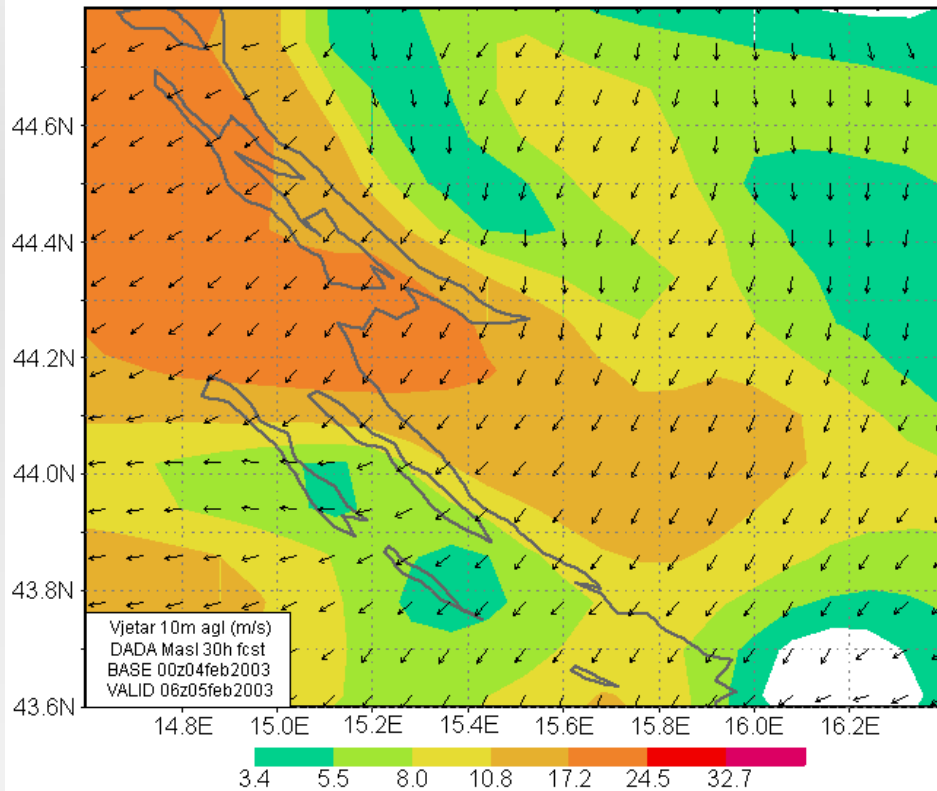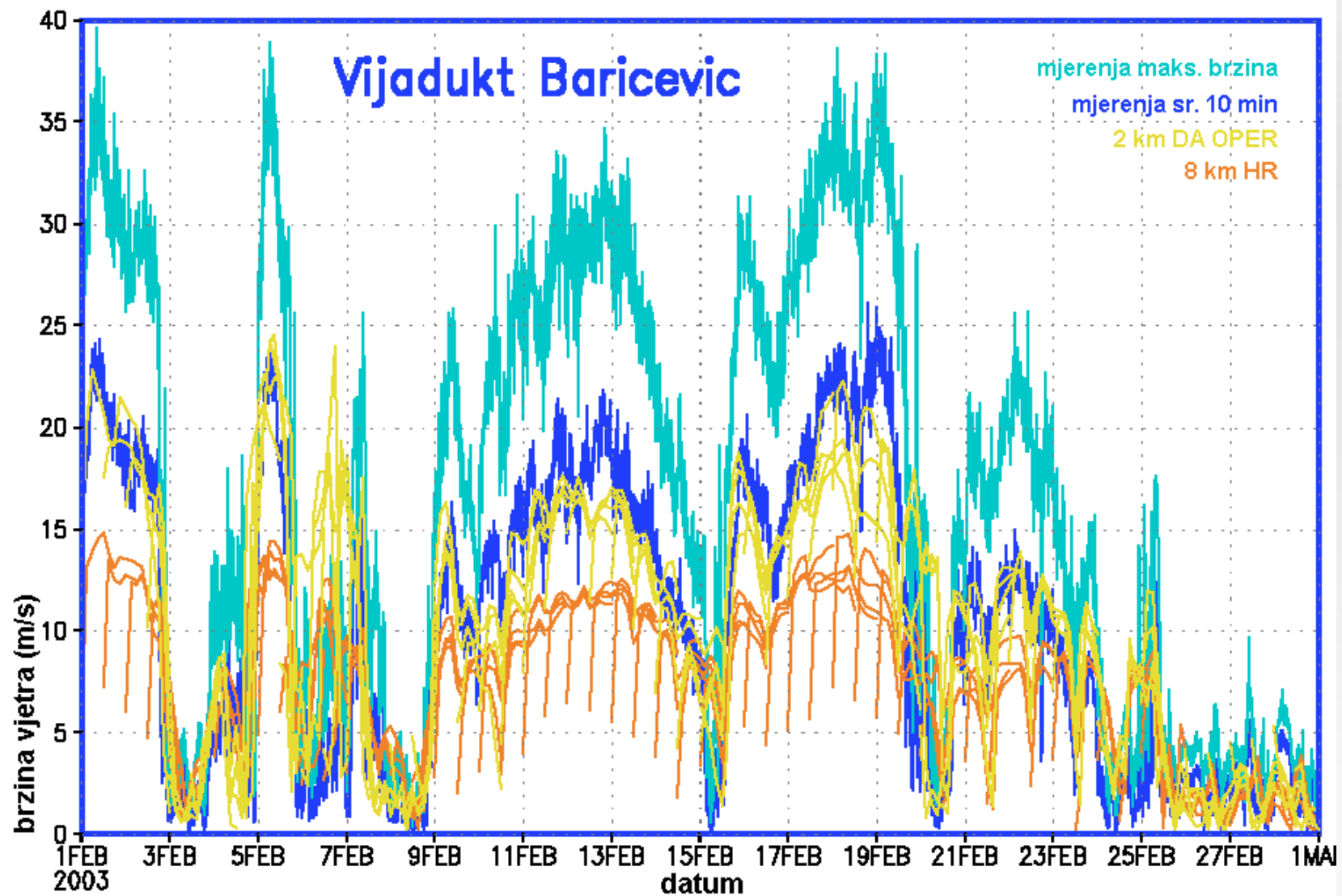 - 10m wind forecast, 450x450gp, 15 levels (lowest 17m) below 1km
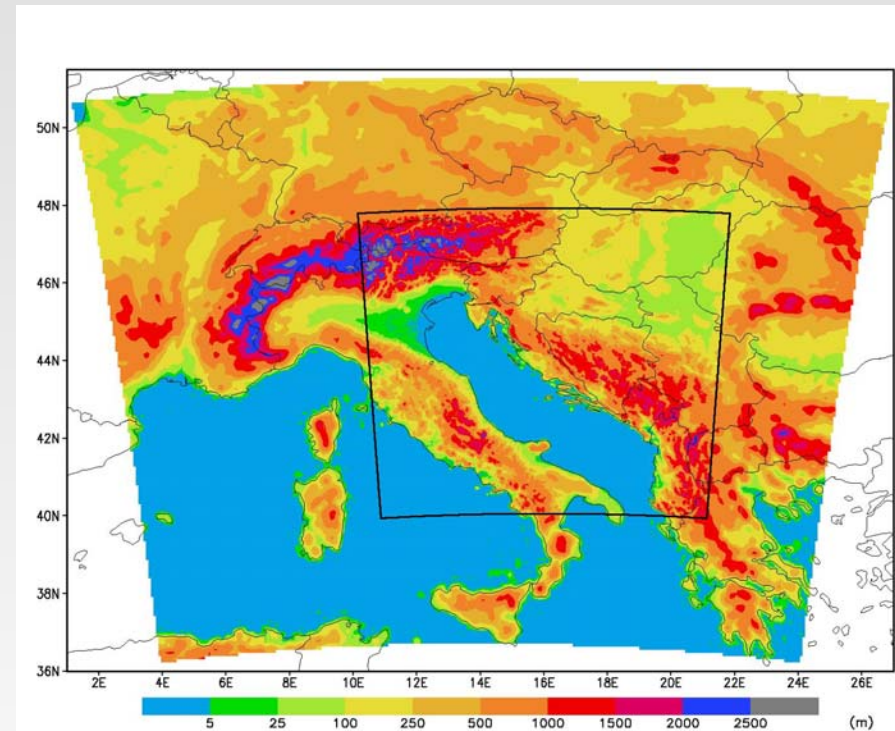
DADA
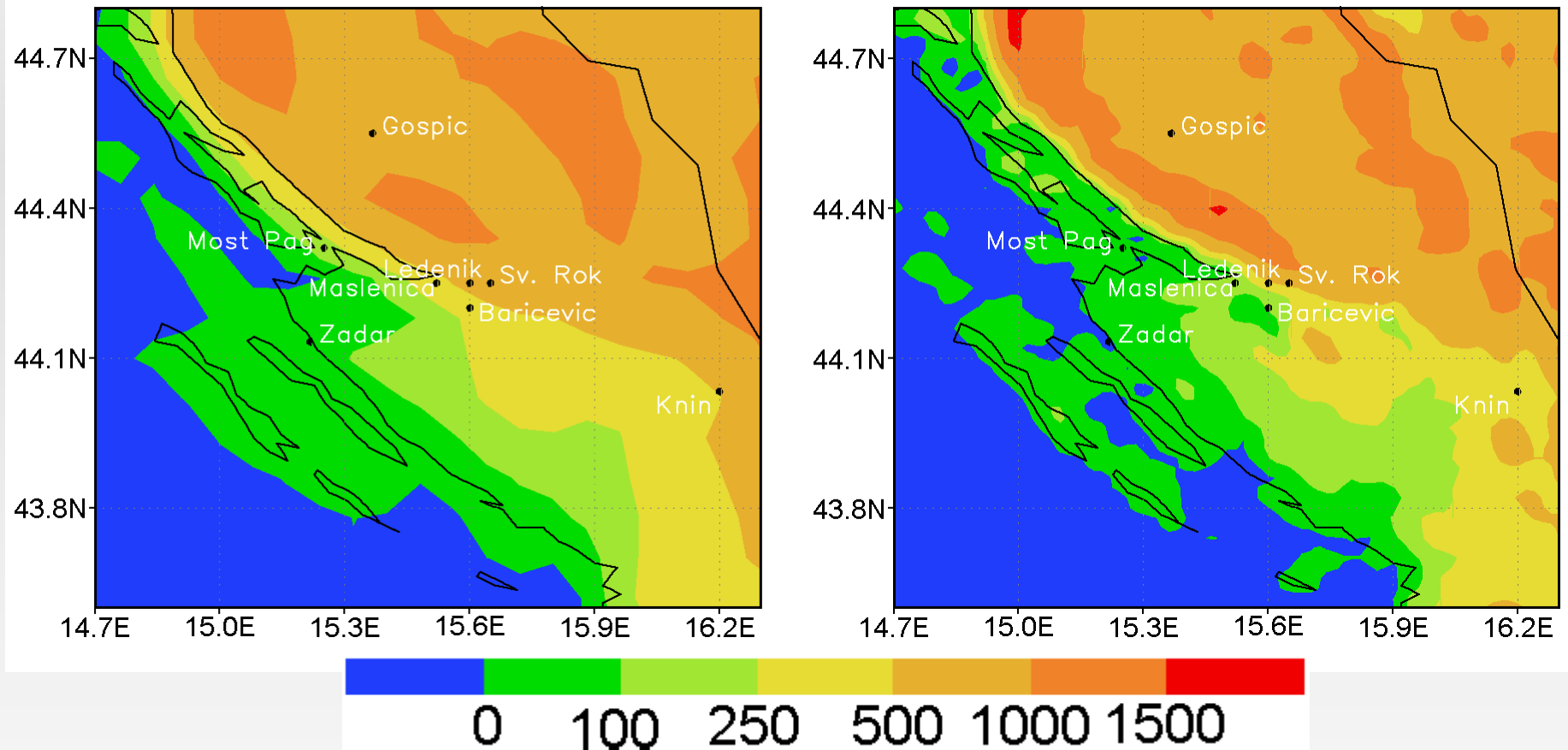
- To make integration with smaller number of levels and only part of physical parameterizations (vertical diffusion and influence of gravity waves) to adjust flow to better orography until quasi stationary state

DADA

- More details in flow (stronger flow behind mountain Velebit)

DADA

- Comparison with measurements

.Bura

Operational forecast

- Operational production (00 and 12 UTC):

    - Downloading of LBC files (ARPEGE)

    - Interpolation of fields to finer resolution

    - ALARO Integration

    - Visualization of meteorological fields: surface charts, pressure levels charts and vertical cross-sections (in time and space)

    - Change of the resolution 8 to 2 km

    - DADA - Adaptation of the wind field (Integration) at 2 km

    - Visualization of the 2 km resolution wind field forecast

Operational forecast

- Top time consuming applications on supercomputer Viking
  - Downloading of the LBC files ~ 30 minutes (done at 03:25 and 15:00 UTC)
  - Integration at 8 km (20 processors) ~ 40 minutes (done at 03:40 and 15:20 UTC),
  - Dynamical Adaptation of the wind field (Integration) at 2 km with 3 hrs time resolution (20 processors) (done at 04:25 and 16:00 UTC)
  - Continuation of the Dynamical adaptation for 1 hr time resolution (extra 1 hour done at 05:25 or 17:00)
  - For operational usage most of the time less than 5 hours per day is sufficient.

ALARO

- Most important public users
    - Air traffic control – HKZP
    - Military – MORH
    - National Protection and Rescue Directorate -112- DUZS
    - Forecast department in DHMZ
    - Hail protection department in DHMZ
    - Forest fire forecast for DHMZ
    - Road authorities- HC wind fcst
    - Electrical company- HEP
    - Nuclear Safety Agency- DZNS
    - TV's- public & private
    - Mobile phone providers
    - Internet- free public forecasts
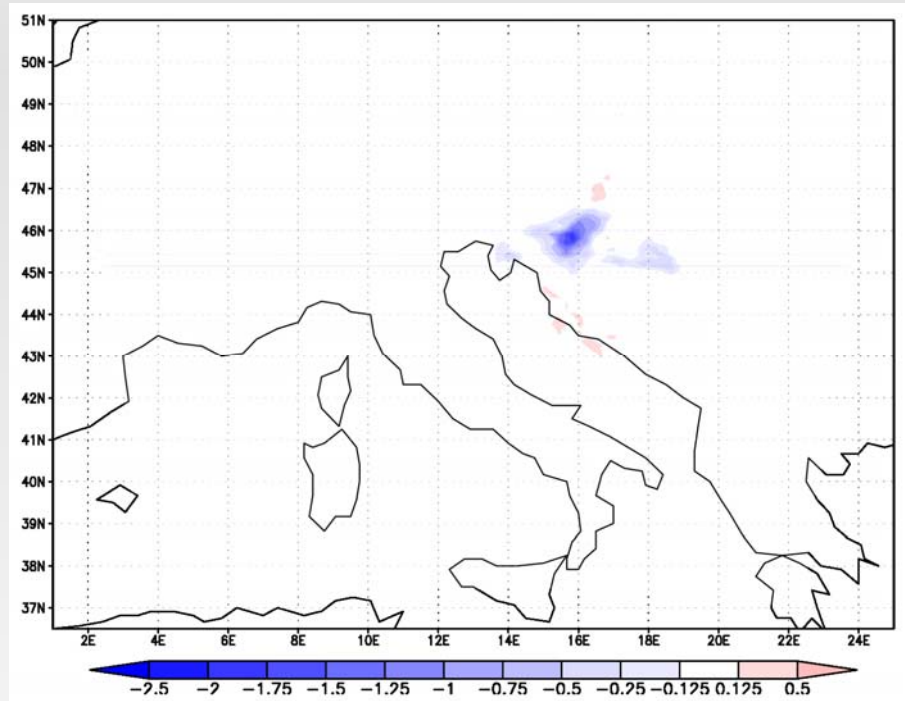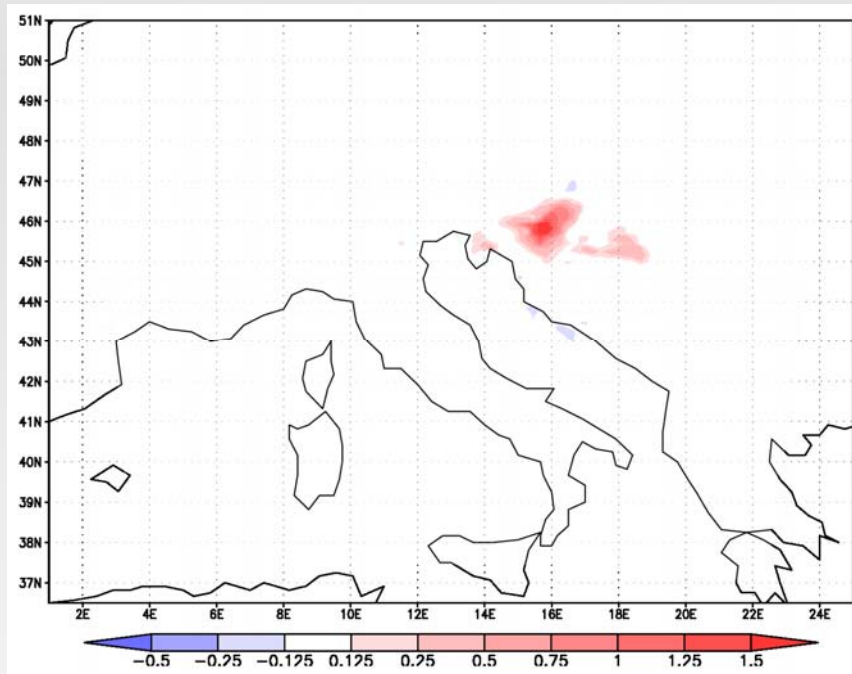
Research: EMEP4HR

- The Unified EMEP model is coupled to ALARO meteorological output and run on 10km resolution.

- This model setup called EMEP4HR is used for air quality studies in DHMZ
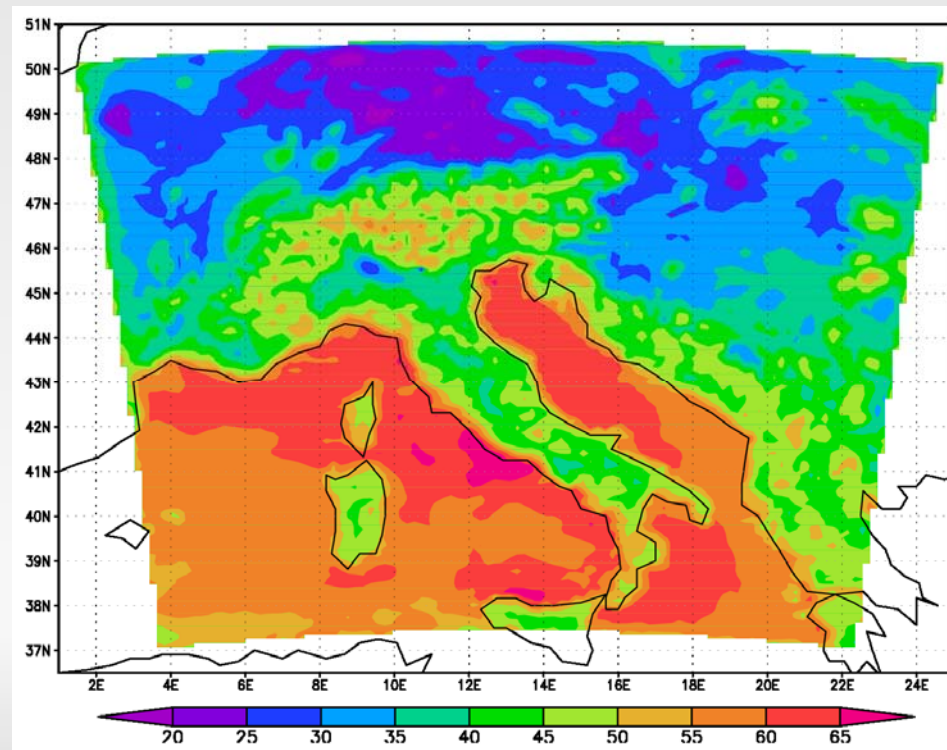
Monthly maximum surface ozone fields (in PPBV) for May

EMEP4HR

- Example: Part of a study made to determine the influence of industrial and traffic emissions on ozone

Relative effects of 15% increase(left) and 15% decrease(right) of traffic based NOx and VOC emissions.

- In the first case maximum ozone is increased while in the other it is decreased by approximately 1% in the area with very high traffic emissions. This study is made for the purposes of the Ministry of construction and environment of Croatia.

Research: Data assimilation

- 3DVar data assimilation for upper air fields and OI for surface fields in ALARO model

  - Observations used: Synop, Temp, Aircraft, AMV, Wind profiler, Satellite (ATOVS AMSU-A,B,HIRS(NOAA), SEVIRI)

  - External observation preprocessing - Hungary

  - Local set up of assimilation cycling and production

Research: Data assimilation

- Statistics for operational (oper) and production from 3dvar (3dvar) calculated against synop and temp observations (2m fields)
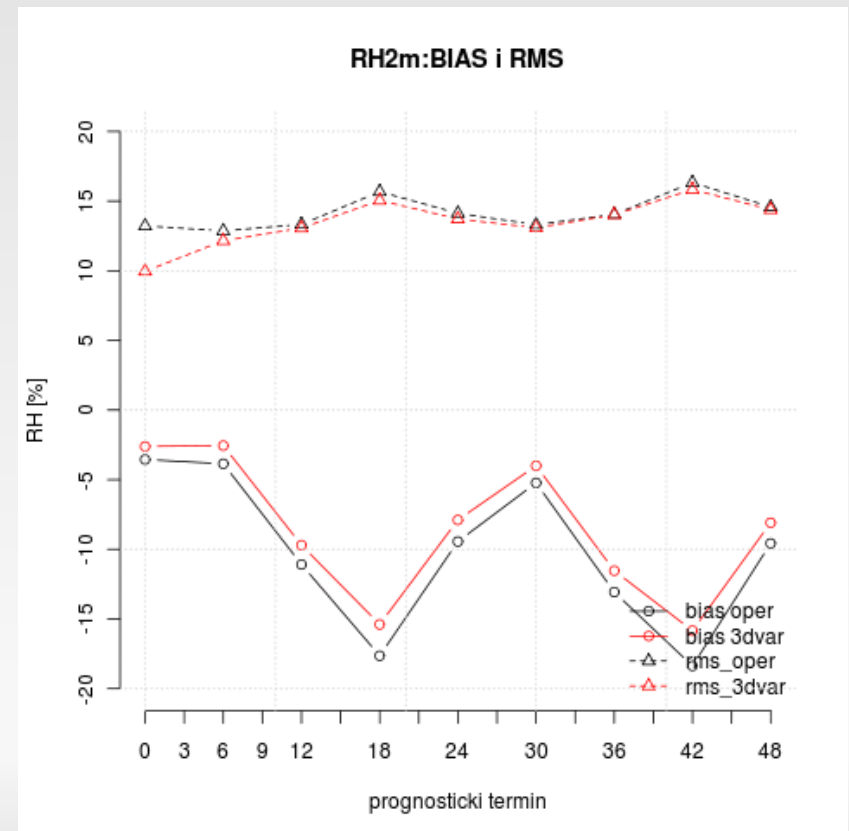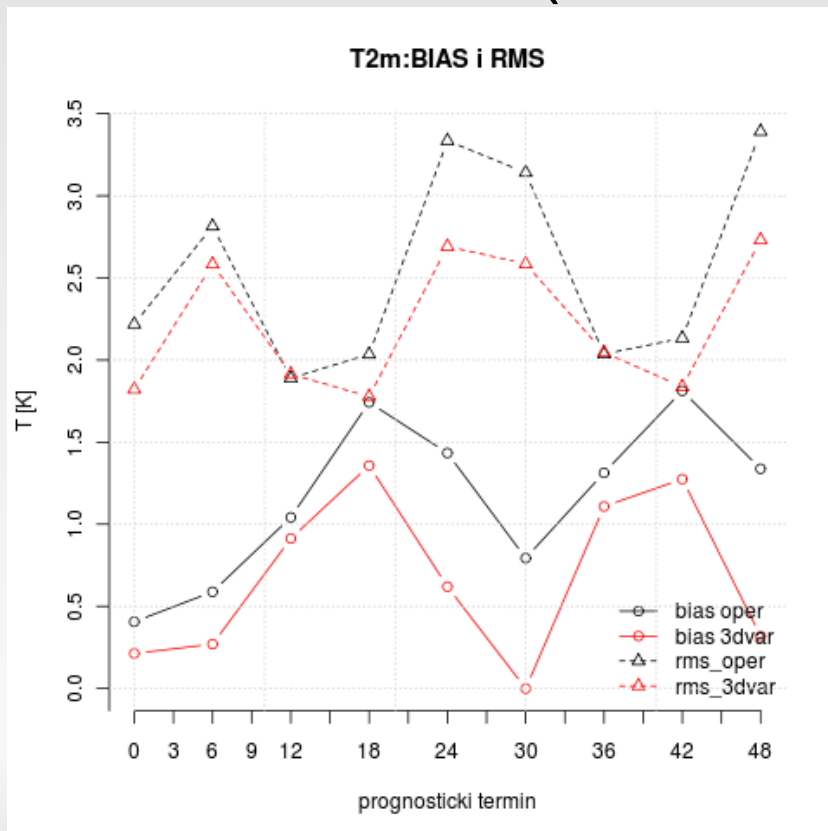
Plans and needs

- Plans (Research and Development Division):
    - Turn on more sophisticated physical package already available for ALARO
    - Operational assimilation
    - Increase number of vertical levels
    - Increase horizontal resolution
    - Assimilate more data
- Needs:
    - More CPU power
    - More storage place

OU - DHMZ collaboration

- Contract between University of Oklahoma (OU) and Meteorological and Hydrological Service of Croatia (DHMZ) on *Feasibility Study for the Meteorological and Hydrological Service Modernization Project in the Republic of Croatia*

- Optimize the overall HydroMet system modernization plan in Croatia

- Study Team:
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OU - DHMZ collaboration

- Some recommendations from Study Team:
  - Establish DHMZ headquarters of weather and water research and operations in a modern, high-technology facility
  - Significantly enhance the DHMZ IT infrastructure
  - Modernize and expand the DHMZ network of Doppler radars
  - Establish an integrated surface observing network for weather, water, and climate observing that provides high-quality data in real-time
  - Establish a verification unit to demonstrate the ski(of modernized operations and to identify new opportunities for research and development
  - Invest in the workforce to operate and thrive in a modernized DHMZ by providing positions for highly educated professionals, a salary structure appropriate for a highly educated and technology-driven workforce, and intensive instructional programs to re-educate the workforce