Limited Area Modeling in Slovenia - 2012

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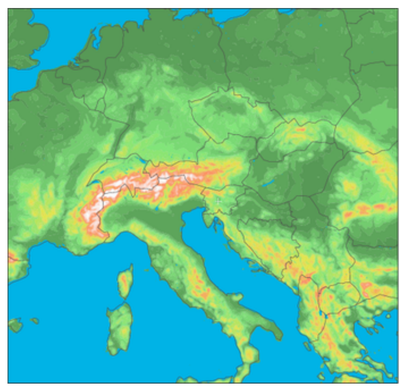
Operational suites

si04da: 4.4 km data assimilation suite

- 4.4 km horizontal grid spacing
- 43 vertical model levels
- linear spectral elliptic truncation
- Lambert projection
- 439x421 points, (with extension zone 450x432), E224x215
- 180 s time-step
- four runs per day till 54 h
- coupling at every 3 hours, LBC from ARPEGE
- data assimilation
- digital filter initialization



Data assimilation cycle features:

- ensemble B matrix (downscaled ARPEGE)
- CANARI surface analysis using surface observations (T and RH at 2 m),
- 3DVAR upper air assimilation
- surface blending step, which merges CANARI surface analysis over land, ARPEGE sea-surface analysis and 3DVAR analysis
- 6-h forecasts as first guess (long cut-off LBC from ARPEGE)
- digital filter initialization
- observations: OPLACE data and local observations (SYNOP)

si09 and si09ec: 9.5 km dynamical adaptation suites

- 9.5 km horizontal grid spacing
- 258x244 points, (with extension zone 270x256), E134x127
- 400 s time-step
- IC and LBC from ARPEGE or ECMWF
- four runs per day till 72 h (60 h)

Applications using ALADIN fields

ALADIN results serve as meteorological input to:

- INCA analysis and nowcasting system
- BOBER hydrological forecast for Sava, Soča and Mura river catchments
- NAPOM (North Adriatic POM) 3D sigma-coordinate ocean model set up in Northern Adriatic
- CAMx photochemical dispersion model

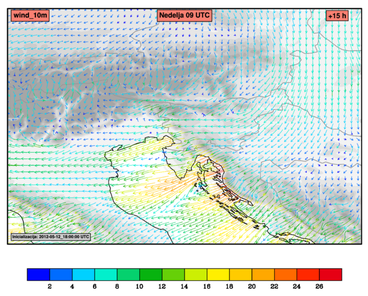
WRF model at University of Ljubljana

Real-time weather and pollution forecasting system using WRF and WRF-Chem models http://meteo.fmf.uni-lj.si/?q=vreme

- WRF-ARW 3.2
- integration once per day 18 UTC (48 h),
- horizontal grid spacing 3.335 km, 300x200 points,
- 42 vertical model levels,
- IC and LBC from ALADIN/SI (9.5 km),
- time-step 18 s,
- LBC coupling every 3 hours.

Ozone forecast:

- three nested domains with horizontal grid spacing (grid points) 33.35 km (105x74), 11.12 km (151x100) and 3.7 km (181x145)
- IC and LBC from GFS

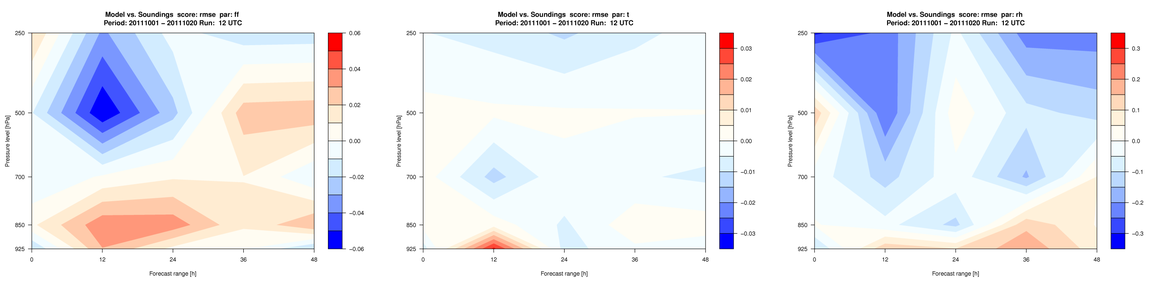


Forecast of 10 m wind (m/s) for 13 May 2012 at 9 UTC.

Data assimilation of IASI radiances

The impact of IASI data (about 100 channels all from 8.26-15.50 micron band) on the analysis and forecasts was investigated over a period of 3 weeks. Assimilation of IASI data demonstrates promising results particularly in the direction of improving relative humidity in mid- and high-troposphere:

- 00 UTC forecasts display mostly neutral and even slightly degrading impact on the forecasts. This is a predictable outcome, as IASI data are generally not available at 00 UTC over our domain.
- 12 UTC forecasts displays mostly neutral impact on temperature and a minor degradation near the surface in the first hours of the forecastere. There is a positive impact on relative humidity in the mid- and high-troposphere for the entire forecast range and a slightly worsening impact near the surface.



Figures display RMSE evaluation of the IASI and the non-IASI experiments. RMSE scores for the non-IASI experiment are subtracted from RMSE scores for the IASI experiment. Hence, negative values (shown in blue) imply a beneficial impact on the forecasts when IASI is assimilated; the opposite is true for positive values shown in red.

Computer system

Technical characteristics (SGI ALTIX ICE 8200):

- 45 compute nodes installed in a single rack, every compute node has a 16 GB of memory and 2 Quad core Intel Xeon 5355 processors (360 cores)
- additional 7 service nodes are used for login, management, control and IO operations
- 52 nodes, 388 cores all together
- two Infiniband DDR networks, one for IO and the other for MPI communication
- a dedicated NAS IO node is installed with 48 TB FC disk array
- 2.2 TB lustre scratch file system

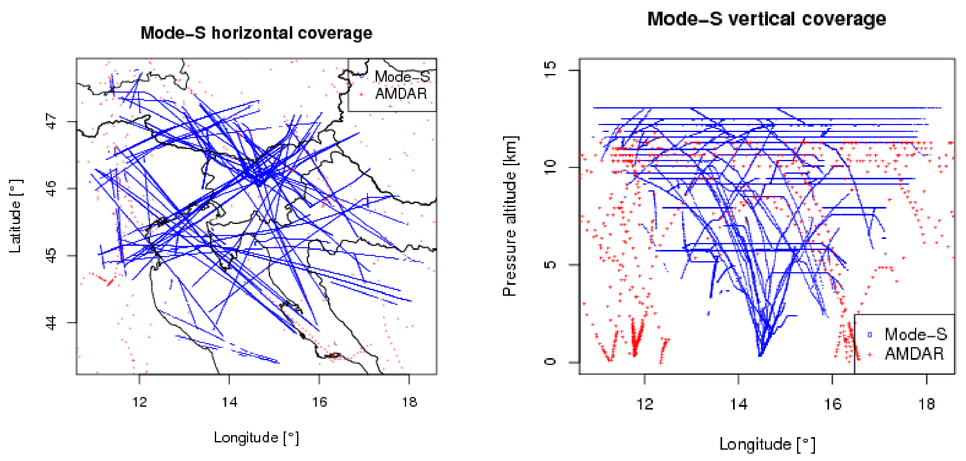
Programs:

- OS: SGI ProPack on top of SLES 10 SP3
- MPI: OpenMPI
- queuing system: Altair PBS Pro 9.2
- Tempo 1.10 cluster management system
- Intel 10.1. & 12.0 Fortran compiler
- TotalView 8.9 with License for 4 process tokens

Validation of Mode-S aircraft observations

Additional upper-air information is available through Mode-S air traffic control system composed of ground radar and transponders on board the aircraft. Mode-S tracking and ranging radars can be configured to interrogate Meteorological Routine Air Report (MRAR) data register which provides direct measurements of temperature and wind. Such observations from Ljubljana Airport have been evaluated over the period of more than 9 months. A collocation study AMDAR and high-resolution radiosonde observations has been carried out. The main conclusions of this study:

- Mode-S observations are of comparable quality to AMDAR: mean standard deviation differences are 0.35 °C for temperature, 0.8 m/s for wind speed and below 10 degrees for wind direction at maximal horizontal separation of 5 km (100 m in vertical).
- mean std. differences with respect to radiosondes are 1.7 °C, 3 m/s and 25 degrees for temperature, wind speed and wind direction, respectively. The horizonal separation is here extended to 25 km.
- roughly 5% of all aircraft return meteorological data, which means approximately 20.000 observations per day over Slovenia. There are slightly more temperature than wind observations.
- data frequecy is 4 s: the quality of raw data is good, the temporal smoothing over few observations (few tens of seconds) has no significant effect on the quality.

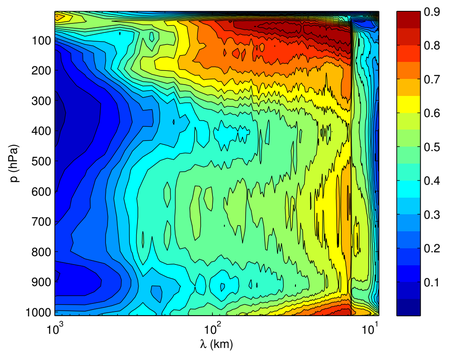


Horizontal and vertical coverage of Mode-S in comparison with AMDAR.

Strajnar B.: Validation of Mode-S Meteorological Routine Air Report aircraft observations. Submitted to JGR-Atmospheres.

Divergent kinetic energy spectra in ALADIN

The aim of this research is to quantify the divergent energy contribution to the total kinetic energy.
The distribution of energy between the balanced (quasi-geostrophic) and unbalanced (inertio-gravity) motions as a function of scale is not well understood and is a subject of active research.
Divergence represents unbalanced or inertio-gravity motions while the balanced motions are mainly represented by vorticity.
Through the use of model spectra of these two variables we show the ratio between the divergent component and the total kinetic energy as a function of horizontal scale and vertical model level.
In this study we used one month average spectra of ALADIN/SI 6-hour forecasts with 4.4 km grid space.



Divergent energy contribution to the total kinetic energy as a function of horizontal scale and altitude. Divergent energy is expressed as the fraction of the total kinetic energy at each model level separately. The contour interval is 0.05 (or 5%).

The divergent energy contribution increases towards smaller scales and reaches maximum values (on average more than 70%) at $3\Delta x$, which is the orography cut-off frequency. The vertical structure is more complex: there are two maxima, one related to friction and energy dissipation at the surface while the reasons for the other are not so clear and are a subject of ongoing research.

Blažica et al., Rotational and divergent kinetic energy spectra in the mesoscale model ALADIN . Submitted to Tellus A