Limited Area Modeling in Slovenia - 2013

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Computer system NEW

Technical characteristics (SGI ICE X):

- 62 compute nodes installed in two racks, every compute with 4 Intel Sandy Bridge (E5-2670) processors (992 compute cores altogether) with 1984 GB of memory,
- additional 5 service nodes are used for login, management, control and IO operations,
- two Infiniband FDR networks,
- two NFS storage servers in HA mode with 120 TB of storage space.

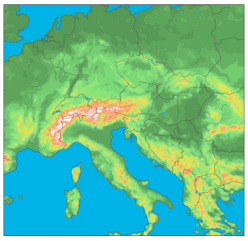
Programs:

- OS: SGI ProPack on top of Suse Entreprise Server,
- SGI MPI,
- Intel Fortran compiler,
- Altair PBS job queueing system,
- SGI Cluster Managing System,
- TotalView debugger.

Operational suites

si04da: 4.4 km data assimilation suite

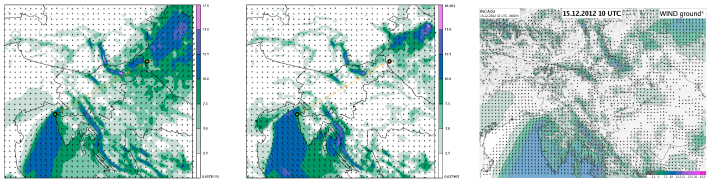
- 4.4 km horizontal grid spacing,
- 43 vertical model levels,
- linear spectral elliptic truncation,
- Lambert projection,
- 439x421 points, (with extension zone 450x432), E224x215
- 180 s time-step,
- four runs per day till 54 h,
- coupling at every 3 hours, LBC from ARPEGE,
- data assimilation,
- digital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



Testing options in turbulence scheme

Influence of mixing length on quality of wind forecast was tested:

- predicted SW wind in NE of Slovenia in situations with stable stratification near the surface is often too strong,
- the usage of mixing length based on TKE qualitatively improves the forecast (wind speed reduced),
- the TKE based mixing length produces less mixing (than the current scheme) near the surface, The problem originates in diagnostic of PBL height which depends on Richardson number and is very inaccurate, leading to erroneous vertical profiles of mixing length. Too strong mixing causes too strong downward transport of momentum.

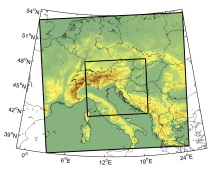


Wind forecast for 14.12.2012 00:00 + 34h with current computation of mixing length (left), and TKE-based mixing length (middle). Reference INCA 10 m wind analysis for 15.12.2913 at 10 UTC (right).

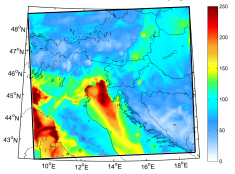
Modelling system ALADIN-CAMx

Photochemical dispersion model CAMx (version 5.40) coupled offline with ALADIN is used for air pollution simulations:

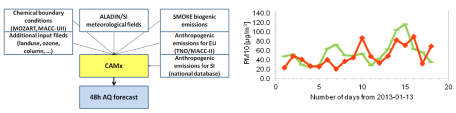
- Lambert projection,
- coarse grid: 145x135 points, 13.2 km horizontal grid spacing,
- fine grid: 185x167 points, 4.4 km horizontal grid spacing,
- 34 vertical levels up to 14 km in the troposphere,
- initial chemical conditions from the previous model run,
- chemical boundary conditions from global 3h MOZART forecast (MACC-II project),
- emissions: highly resolved emission database for Slovenia region,
  emission database (MACC-II project) for the areas outside of Slovenia,
  biogenic emission using emission model SMOKE.



Modelling domains used in operational ALADIN-CAMx model configurations



Hourly ozone concentrations (in μgm^{-3}) at lowest model level as simulated by ALADIN-CAMx for August 22, 2011, at 14 UTC. Shown are concentrations in the inner domain.

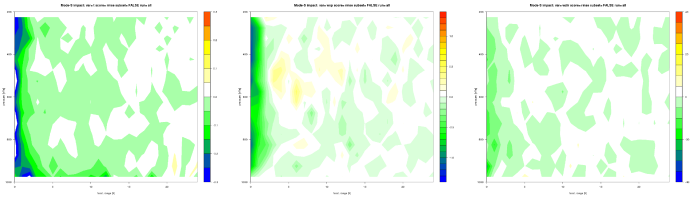


Model setup and hourly ozone concentrations (in μgm^{-3}) at lowest model level as simulated by ALADIN-CAMx for August 22, 2011, at 14 UTC. Shown are concentrations in the inner domain.

Assimilation of Mode-S MRAR observations in ALADIN

Locally received Mode-S MRAR (Meteorological Routine Air Report) wind and temperature observations were evaluated within the operational data assimilation cycle with ALADIN, 3-hourly RUC, from 2 August 2012 till 29 September 2012:

- the observational coverage in lower atmosphere locally significantly improved,
- systematically positive impact on wind forecasts till around T+3 hours of the forecast, later on neutral/mixed impact
- systematic improvements of temperature analysis and forecasts up to T+4 hours in the free atmosphere and up to T+12 hours near the surface, no significant degradations,
- conclusion: local Mode-S MRAR very useful for nowcasting.

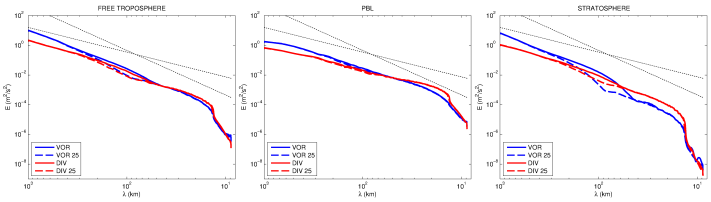


Temperature(left), wind speed (middle) and wind direction (right) RMSE reduction due to assimilated Mode-S wind and temperatures. Verification is against all Mode-S MRAR observations. Green and blue colors indicate improvements.

The impact of extension zone size on kinetic energy spectra

This sensitivity study addresses the question whether changing the width of the extension zone impacts the shape of the ALADIN kinetic energy spectra:

- regular size extension zone (11 points) was compared to an experiment where the extension zone was larger (25 points), the size of the outer domain remained unchanged for both sets; a wider extension zone was achieved by reducing the number of points in the inner (physical) part of the domain,
- one month average spectra of 6-hour forecasts with 4.4 km grid space were used for this study,
- the impact is present at scales that are about the width of the extension zone and larger; the biggest impact on the spectra is in the stratosphere,
- increasing the width of the extension zone shifts the location of the bump in the stratospheric rotational kinetic energy spectra to larger scales, proportionally to the extension zone width,
- a similar feature, but to a smaller extent, can be observed in the divergent kinetic energy spectrum and in lower atmospheric layers. The smaller impact is most likely related to the larger values of energy in physical space.

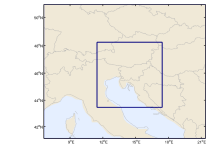


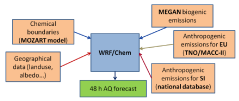
A comparison of rotational and divergent kinetic energy spectra for the experiments with the 25-point extension zone and with the 11-point extension zone. Averaged over model levels in the free troposphere (left), PBL (center) and in the stratosphere (right).

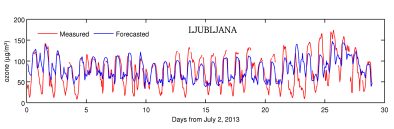
WRF real-time weather and pollution forecasting system

Within the Centre of Excellence SPACE-SI (www.space.si) meteorology group at the University of Ljubljana (meteo.fmf.uni-lj.si) a real-time forecasting system using WRF (http://meteo.fmf.uni-lj.si/vreme) and WRF/Chem (http://meteo.fmf.uni-lj.si/onesnazenje) has been developed:

- WRF-ARW 3.4.1,
- two nested domains with horizontal grid spacing (grid points) 11.12 km (151x100) and 3.7 km (181x145),
- meteorological IC and LBC from GFS,
- 42 vertical model levels,
- integration once per day 18 UTC (WRF) and 00 UTC (WRF-Chem),
- integration time 48h.







Evaluation of WRF/Chem hourly ozone forecast for July 2013. WRF/Chem model has a tendency to underestimate daily maxima and overestimate nighttime ozone levels, where correlation coefficient between forecasted and measured ozone hourly values varies from 0.41 to 0.73 for different monitoring sites (0.63 for Ljubljana)