SLOVENIAN ENVIRONMENT AGENCY

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Limited Area Modeling in Slovenia - 2011

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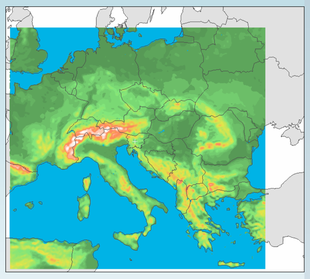
OPERATIONAL SUITES

si09: 9.5 km dynamical adaptation suite

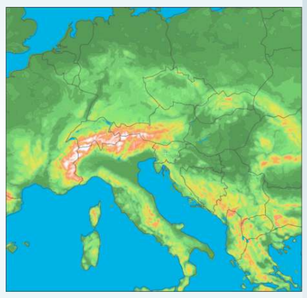
Characteristics:
- model version: AL35T1 using ALARO with 3MT physics
- integration four times per day: 00 UTC (72 h), 06 UTC (72 h), 12 UTC (72 h), 18 UTC (60 h),
- 9.5 km horizontal grid spacing,
- 43 vertical model levels,
- linear spectral elliptic truncation (E134x127,258*244 points, with extension zone 270*256),
- Lambert projection,
- 400 s time-step,
- initial and lateral boundary conditions from ARPEGE,
- LBC coupling every 3 hours,
- digital filter initialization.



Operational ALADIN/SI domain9.5km

si09ec: 9.5 km dynamical adaptation suite

same as si09 except for:
- integration four times per day: 00 UTC (72 h),06 UTC (72 h), 12 UTC (72 h), 18 UTC (72 h),
- initial and lateral boundary conditions from ECMWF.



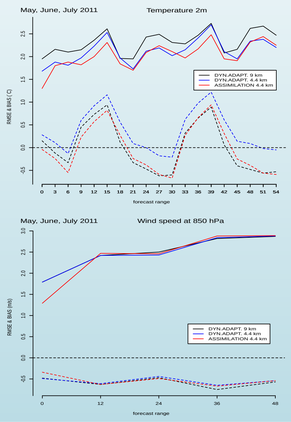
ALADIN 4.4 km domain 439*421 points

si04da: 4.4 km data assimilation suite

same as si09 except for:
- integration two times per day: 00 UTC (54 h), 12 UTC (54 h),
- 4.4 km horizontal grid spacing,
- linear spectral elliptic truncation (E224x215, 439*421 points, with extension zone 450*432),
- 180 s time-step,
- data assimilation.

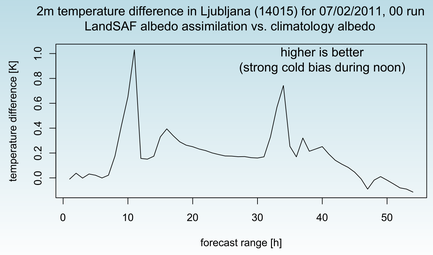
4.4 km Data assimilation
- B matrix (downscaled ARPEGE),
- CANARI surface analysis using 2 m temperature and 2 m relative humidity observations,
- 3DVAR upper air assimilation,
- surface blending step, which merges CANARI surface analysis over land, ARPEGE sea-surface analysis and 3DVAR analysis,
- cycling of microphysical and 3MT prognostic fields (initialization from first guess)
- first guess step using long cut-off ARPEGE lateral boundary conditions, digital filter initialization (DFI).

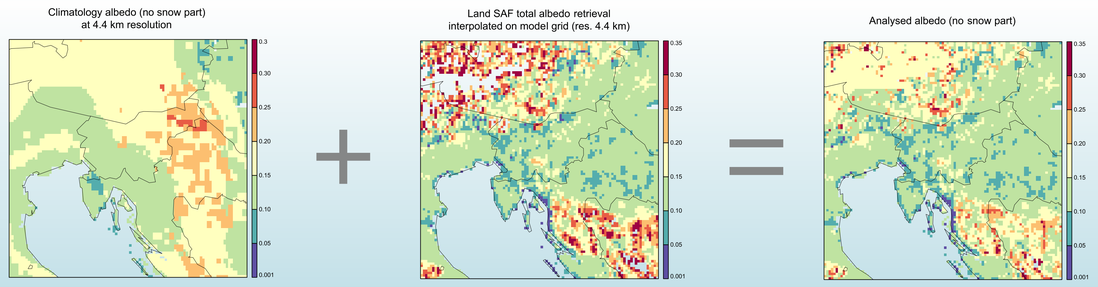
Observations usage:
- OPLACE pre-processed data: SYNOP (ps,T,q), AMDAR/AIREP aircraft data (T,u), METEOSAT SATOB cloud drifts (u), TEMP (T,u,q), WINDPROFILER (u), NOAA AMSU-A,AMSU-B (Tb), METEOSAT SEVIRI (Tb),
- local non-GTS data on surface level,
- web-based observation monitoring system developed by LACE.



Implementation of LandSAF albedo assimilation

A simple one-dimensional Kalman filter algorithm is used to obtain the best estimate of albedo (only snow free).
The analysis is performed once per day, at 06 UTC.
On the average, the analysed albedo is lower therefore the 2 m temperature is a few tenths of a degree higher; in particular cases, the impact can be much higher.



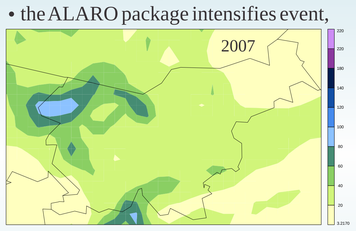


Model climatology and Land SAF retrieval are used as input. Land SAF retrieval has greater spatial variability and more weight is set on it.

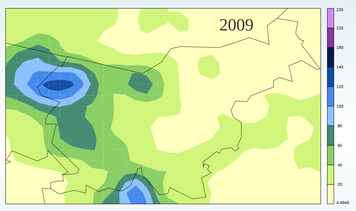
Progress of operational precipitation forecast

- the flash flood on 18 September 2007 was one of the most severe weather events in recent history, 6 casualties,
- there was more than 300 mm of rain localy in less than 12 hours due to quasy stationary convection,
- though the warning was issued the severity of the event was not anticipated.

The recent model development has been verified by running different operational versions of the model for this particular event:
- the ALARO package intensifies event,

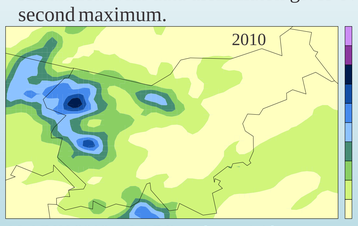


ALADIN 2007: 9.5 km

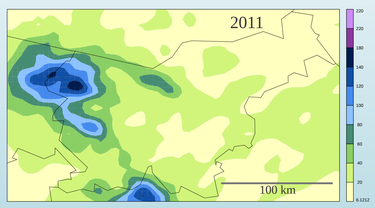


ALADIN 2009: ALARO package,9.5 km

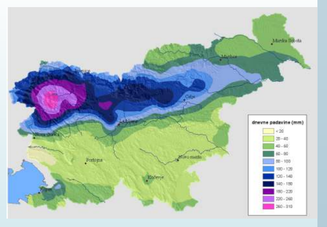
- higher resolution (4.4 km) improves the spatial pattern of precipitation, while spatial average of precipitation remains similar,
- simulation with data assimilaton gives even higher maximum amounts, but weakly reduces the second maximum.



ALADIN 2010: ALARO package, 4.4 km



ALADIN 2011: ALARO package, 4.4 km, Data assimilation



24 hour precipitation accumulation from 18 Sep 6 UTC till 19 Sep 2007 6 UTC based on measurements.

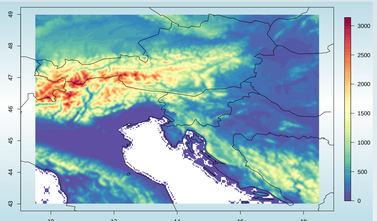
The computer system SGI Altix ICE 8200

Technical characteristics:
- 45 compute nodes in a single rack (360 cores)
- 16 GB of memory and 2 Quad core Intel Xeon 5355 processors per node,
- two Infiniband DDR networks, one for IO and the other for MPI communication,
- additional 7 service nodes for login, management, control and IO operations (388 cores all together),
- a dedicated NAS IO node with 48 TB FC disk array,
- 2.2 TB lustre scratch file system (on 4 IO nodes).

System software:
- OS: SGI ProPack on top of SLES 10 SP3,
- MPI: OpenMPI, SGI MPI,
- queuing system: Altair PBSPro queuing system,
- Intel 10.1. - 12.0 Fortran compiler,
- Totalview 8.9 with License for 4 process tokens.

WRF model at University of Ljubljana, Chair for meteorology

- WRF-ARW 3.2 (testing 3.3.1),
- integration once per day 18 UTC (48 h),
- horizontal grid spacing 3.335 km, 300 * 200 points,
- 42 vertical model levels,
- time step 18 s,
- initial and lateral boundary condition from ALADIN/SI (9.5 km),
- LBC coupling every 3 hours.



Usage of ALADIN results in various applications

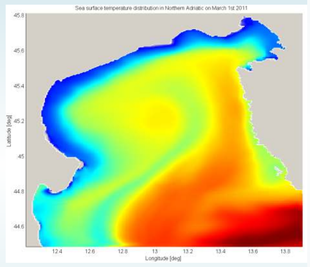
- **INCA** analysis and nowcasting system (status: operational).

- BOBER hydrological forecast for Sava, Soča and Mura river catchments (status: pre-operational).

- **NAPOM (North Adriatic POM)** is a 3D sigma-coordinate ocean model set up in the Northern Adriatic by Marine Biology Station of National institute of biology and EARS.

  - ocean boundary and initial conditions from the Adriatic Forecasting System,
  - surface winds, heat fluxes and precipitation from ALADIN,
  - main products are ocean circulation and 3D temperature and salinity distributions.

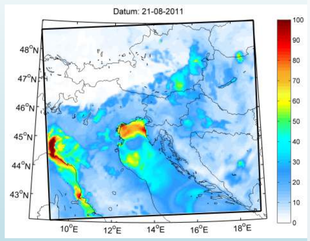
  Status: regular daily simulations, validation is ongoing.



- **CAMx (the Comprehensive Air quality Model with extensions)** is an Eulerian photochemical dispersion model.

  - selected ALADIN fields as meteological input,
  - chemical boundary conditions (MACC), gridded and point emissions (locally provided and MACC),
  - main product is a simulation of air quality (ozone, particulate matters and other chemical species).

  Status: setup and flow of input data is prepared, validation has started.
  Plan: daily simulation of concentrations over Slovenia.

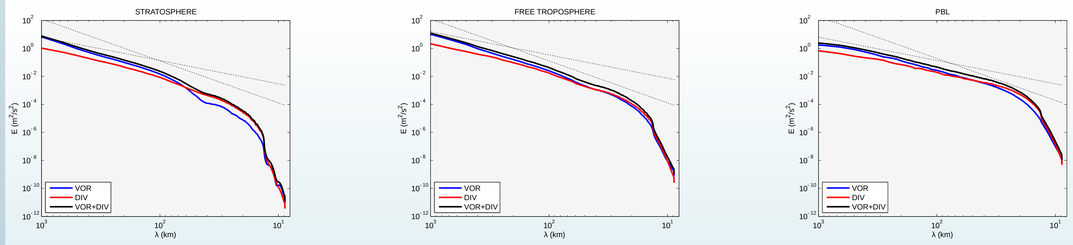


Hourly concentration of PM10 [μg/m³].

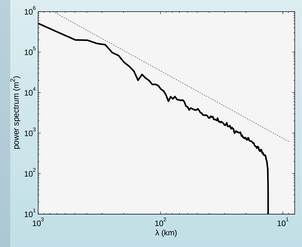
Research: Analysis of energy spectra in ALADIN/SI of vorticity and divergence

The aims of the research:
- To study the energy distribution in terms of the divergent versus vortical energy as a function of the horizontal scale and altitude for the ALADIN/SI model with 4.4 km grid spacing.
- To investigate the differences in the spin-up process of the vorticity and divergence fields.

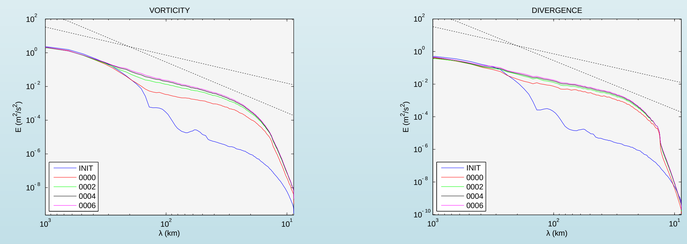
The summary of the main results:
- The slope of the divergent energy spectra is at all scales shallower compared to the vortical energy. The slope of the spectra of both variables decreases closer to the surface; it shifts from k^{-3} in the stratosphere to almost $k^{-5/3}$ in the PBL. The spectrum of the model orography also follows the $k^{-5/3}$.
- Below the scales of about 100 km, both the variables represent about 50% of the total energy in the free troposphere while this percentage shifts in favour of the divergent energy in the stratosphere and in the PBL.
- The largest differences in the spin-up process appear in the stratosphere and in the PBL.
- In the stratosphere, little vorticity is added by the spin-up process and the impact is limited to scales between 40 and 200 km. The divergence is almost doubled at scales between 20 and 300 km, suggesting that the stratospheric divergence may not be well represented in the driving global model.
- In PBL, the increment of energy is the largest and most of it builds up already during the initialization step. The DFI adds energy even at the smallest resolved scales. The building up of the divergent energy after the DFI step is more gradual and smaller compared to the vortical energy.



Monthly averaged spectra of vortical (blue), divergent (red) and thetotal kinetic energy (black). Results are vertically averaged over modellevels in the stratosphere (left), free troposphere (middle) and PBL(right). The reference lines are k^{-3} and $k^{-5/3}$.



Spectrum of the model orography. The reference line is $k^{-5/3}$.



The spin-up process in the PBL in the first 6 hours of integrationfor the vorticity (left) and divergence fields (right). The INIT spectrum is the downscaled initial field of the ECMWF model and the 0000 is the spectrum after the DFI.