

# Limited Area Modelling in Slovenia - 2016

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## HPC system

Technical characteristics (SGI ICE X):

- 62 compute nodes installed in two racks, every compute node has 32 GB of memory and 2 eight core Sandy Bridge processors(E5-2670 @ 2.6 GHz) (992 cores),
- two Infiniband FDR networks,
- 150 TB of disk space (HA NFS).

Software:

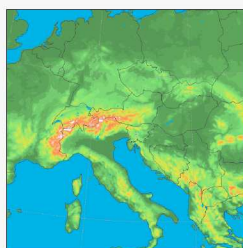
- OS: SGI ProPack on top of Suse Enterprise Server,
- Intel Fortran compiler, SGI mpt,
- Altair PBS job queueing system,
- TotalView debugger.



## Operational suite

Model characteristics:

- CY38T1, ALARO-0 baseline,
- 4.4 km horizontal grid spacing, 87 model levels,
- linear spectral elliptic truncation,
- Lambert projection,
- 421x421 points, (with extension zone 432x432), E215x215,
- 180 s time-step,
- four production runs per day: 00, 06, 12, 18, forecast up to 72 hours, additionally four runs 03, 09, 15, 21 up to 36 hours,
- coupling at every 3 hours, LBC from ECMWF Boundary Conditions Optional project (time lagged coupling).



ALADIN-Slovenia model domain.

Assimilation cycle:

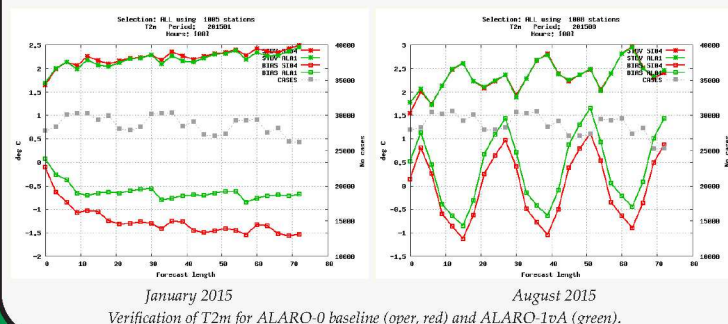
- 3-hourly 3D-Var assimilation cycle (RUC),
- B-matrix sampled from downscaled ECMWF ensemble members,
- CANARI surface analysis using surface observations (T and RH at 2 m),
- coupling frequency 1 hour,
- space consistent coupling, no digital filter initialization,
- observations: OPLACE data and local observations (SYNOP, Mode-S MRAR).

## ALARO-1 evaluation

An evaluation of ALARO-1vA physics was carried out over summer and winter seasons.

- winter bias of 2 m temperature is reduced, summer maximum 2 m temperature forecasts are still underestimated,
- while impact is clearly seen in temperature biases, it is hardly visible in standard deviation of forecast error,
- 2 m humidity bias improved in 0 UTC (night) runs and degraded in 12 UTC (day time) runs,
- neutral impact on upper-air fields.

Our plan is to use ALARO-1vA in the operational suite and to re-compute forecasts for the period of few years. Background error covariances are recomputed, some differences (probably due to more advanced model physics) in multivariate couplings are noticed.

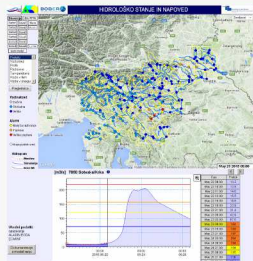


January 2015  
Verification of T2m for ALARO-0 baseline (oper, red) and ALARO-1vA (green).

## Applications using ALADIN forecast

ALADIN results serve as meteorological input to:

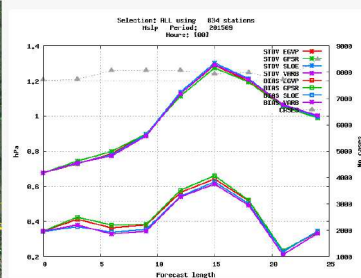
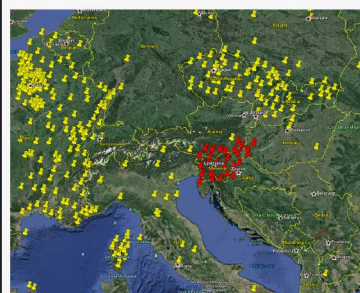
- INCA analysis and nowcasting system,
- BOBER hydrological forecast for 241 river catchments in Slovenia,
- Ocean circulation models, wave models and storm surge models,
- CAMx photochemical dispersion model.



Simulation of river discharge on 25 May 2015

## Data assimilation of GPS ZTD observations

Evaluation of GPS Zenith Total Delay (ZTD) impact was tested in ALADIN. The GPS data sets included test NRT E-GVAP data and data from Slovenian Geodetic Institute (SIGNAL network).



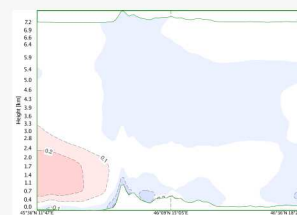
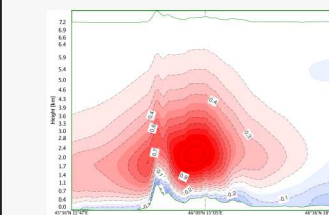
Evaluated test E-GVAP (yellow) and Slovenian SIGNAL (red) GPS networks.

Impact of various experiments on mean sea level pressure forecasts: reference without GPS observations (green) experiment with E-GVAP and static bias correction (red), experiment with E-GVAP+SIGNAL and static bias correction (blue) and experiment using E-GVAP+SIGNAL and variational bias correction (purple).

Several assimilation experiments were carried out to evaluate impact and performance of bias correction schemes:

- a moderate positive impact of E-GVAP on mslp, RH2m and cloudiness was observed both in the case of static and variational BC, neutral impact on other variables,
- a detrimental impact on T2m and RH2m found over Slovenia for SIGNAL data, especially in the case of variational bias correction,
- rather large OMG and small OMA departures were observed over Slovenia, resulting in large analysis increments. This possibly indicates improper specification of observation errors.

Data from SIGNAL are already disseminated to ARSO in real time. Further evaluation is needed.



Horizontal cross section of specific humidity analysis increment over Slovenia for (left) experiment using Slovenian GPS ZTD data and (right) reference analysis without using GPS observations.

## Two-way atmosphere-ocean coupling

A coupled atmosphere-ocean modeling system is being developed:

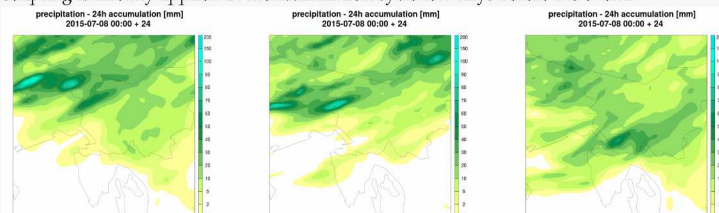
- coupling of ALADIN at 4.4 km with ADRIPOM (Princeton Ocean Model for Adriatic Sea) at 3.6 km using OASIS3-MCT coupler,
- real time two-way coupling for the Adriatic Sea region, quantities are exchanged every model time step (see figure),
- ADRIPOM initializes from MyOcean MFS but is hot-started during the forecast runs,
- ADRIPOM model results: energy-consistent sensible heat fluxes at the air-sea boundary,
- ALADIN model results are being validated: validation is focusing mainly on near-surface temperature, winds and precipitation.



Coupling scheme for one timestep in the 2-way coupled models.

Further plan is to add the ECMWF wave model (WAM) at 1.5 km for a 3-way coupled system. A working atmosphere-wave-ocean two-way coupled system is available.

Importance of two-way coupling in assimilation cycle was investigated for selected heavy precipitation cases. It is preliminary concluded that the best results are obtained if two-way coupling is already applied in the assimilation cycle few days before the event.



Sensitivity of 24-hour precipitation accumulation to implementation of atmosphere-sea coupling: operational uncoupled setup (left), 2-way coupling in production (middle), full 2-way coupling in production and assimilation (right). In the fully-coupled system (right) convection is increased near the coast and precipitation amounts are decreased over southern slopes of the Alps.