THE NWP ACTIVITIES AT CROATIAN METEOROLOGICAL AND HYDROLOGICAL SERVICE IN SPRING 2022

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Operational setup & NEW HPC

The operational model configurations

- **ALADIN-HR4**: Δx = 4 km, 73 vert. lev.; CANARI+3DVar with 3h cycle (no DFI); 72h fcst. (with DFI), LBCs: IFS (lagged mode), 4 runs per day (00, 06, 12 and 18 UTC); hydrostatic, AL38T1 with ALARO0 physics
- **ALADIN-HRDA**: Δx = 2km, 32 vert. lev., 72h fcst., LBCs: ALADIN-HR4, dynamical adaptation mode; 4 runs per day (00, 06, 12 and 18 UTC); hydrostatic

New HPC

- BullSequana XH2000
- 2 login nodes
- 32 compute blades with 3 compute nodes
- 2 x AMD Epyc Rome (64-core, 2.6GHz, 280W)
- 256GB memory (16x 16GB DDR4 3200MT/s ECC)
- 250 TB Lustre storage
- Red Hat 8.3

Ongoing work - porting of CY43T2_bf10 model configurations at new HPC:

- Compilation: gmkpack 6.6.8; Intel compilers 2020.4.304; Intel MPI 2020.4.304; Intel MKL 2019
- New model configurations HR40 and HR20 (more info below)
- EC FLOW – first setup

New B matrix for HR40 model configuration

The ensemble B matrix was calculated for HR40 model domain in order to replace NMC B used operationally. It was computed in two steps:

1) Calculaton of spinup B (**Bspinup**) – downscaling of IFS ensemble
2) Calculation of ensemble B (**Bens**) – EDA with Bspinup

- For downscaling and EDA 10 members of IFS ensemble for two-week period in winter (20210209-20210223) and two-week period for summer (20210621-20210704) were used.
- For calculation of Bspinup and Bens first 6 days for both periods were left out. Only 00 and 06 UTC (12 and 18 UTC) forecast differences were used in winter (summer) period
- Diagnostic plots indicate shift of energy towards smaller scales (Fig 1.) and generally smaller background standard deviations
- Tuning and validation is ongoing

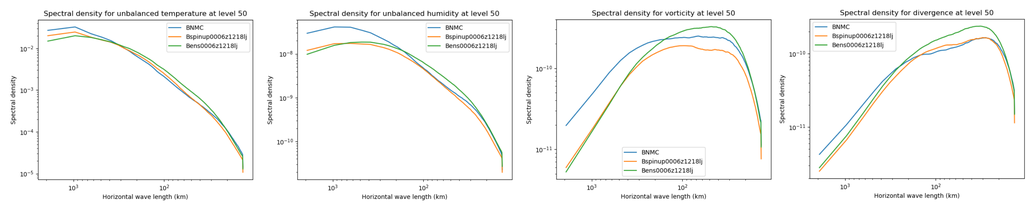

Fig. 1. Horizontal spectral covariance densities for unbalanced temperature, unbalanced humidity, vorticity and divergence at level 50.

Tuning of HR40 and HR20 model configurations

The two new model configurations based on cy43 were set up:

- **HR40** – same geometry as ALADIN-HR4; hydrostatic; ALARO-1 phys. package; tuned surface, deep convection, the cloud microphysics parameterization and additionaly screen level interpolation in stable conditions
- **HR20** – same domain as ALADIN-HRDA, 87 vert. lev., 72 fcst. hours, LBCs: IFS, non-hydrostatic; ALARO-1 phys. package; LESCALE_U=.T.; diagnostic of wind gust modified; modified and tuned calculations of orographic roughness
- HR40 verification results for winter (01-31.12.2020.) and summer period (16.06.-15.07.2020) (Fig 2.):
  - Tuning of the screen level interpolation improved BIAS and STD for T2m (more pronounced in winter) with minor degradation for RH2m
  - The main improvement in summer is for cloudiness BIAS and STD; mainly due to the ALARO0 --> ALARO-1 switch and partly related to the tuning of ALARO-1. Consequently, the temperature profile is improved as well (mostly STD)
  - In winter the improvement is a result of physics switch and its tuning: i) improved cloudiness (BIAS and STD) and ii) upper-air RH and wind (BIAS and STD).

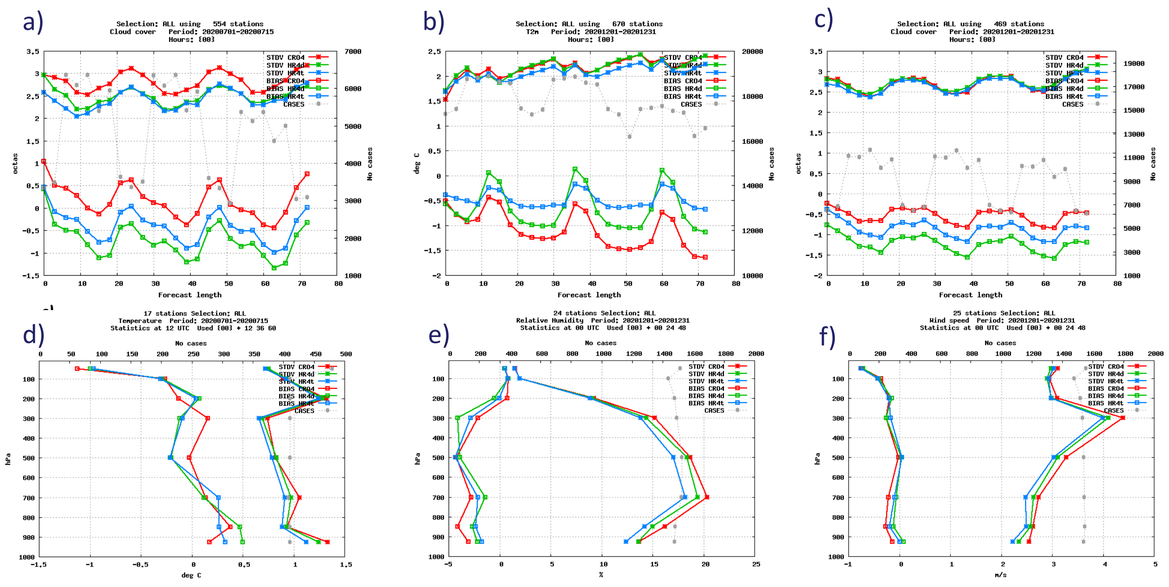

Fig. 2. Verification scores for: a) cloud cover summer b) T2m winter, c) cloud cover winter, d) T summer at 12 UTC, e) RH summer at 00 UTC, f) wind speed winter at 00 UTC. Red line represents currently operational cy38, green line e-suite cy43 (before tuning) and blue line is tuned setup (also cycled in the assimilation).

- The main goal of the HR20 configuration is to replace and improve the wind forecast currently obtained with ALADIN-HRDA
- Verification results show that 10m wind BIAS and STD are smaller for tuned configuration (compared to reference). However, this leads to a decrease in skill for strong winds (Fig 3.). Further tuning is needed.

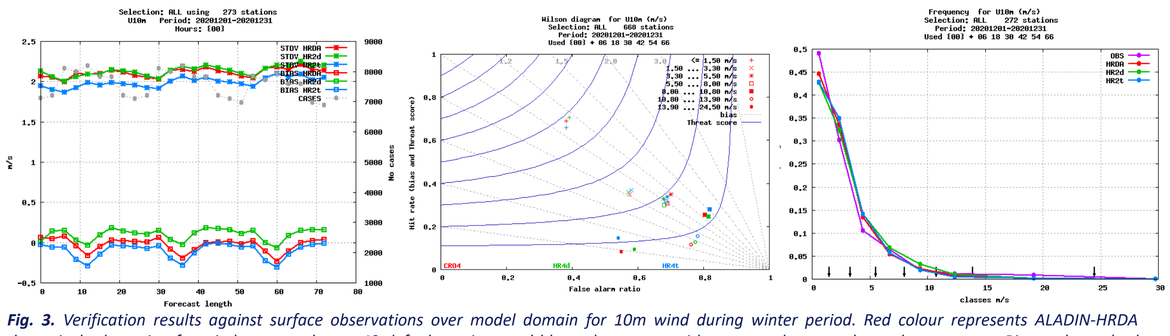

Fig. 3. Verification results against surface observations over model domain for 10m wind during winter period. Red colour represents ALADIN-HRDA dynamical adaptation for wind, green colour cy43 default settings and blue colour setup with new roughness and tuned parameters. Bias and standard deviation against forecast length (left), Wilson diagram (middle), frequency of event (right).

Analog-based method updates

- Prediction-weighting strategy is performed for temperature, wind speed and gusts. The updated weights and statistical correction for the rare events are included into operations.
- A detailed sensitivity test to find the optimal value of the variance ratio *r* for four different post-processing forecasts that use the Kalman filter (KF) for the point-based wind gust predictions is performed (e.g, Fig. 4). Even though the recommended value of 0.01 seems to be an optimal choice for some of these forecasts, for a few a lower value (e.g., 0.001) is recommended.
- The tools needed for using an analog-based method to produce gridded output are successfully developed. Two distinctive approaches are tested, Point-by-Point and Field-wise approach, generating comparable results when using training datasets of the same length. The preliminary results also show that the Field-wise experiment with 2-years-long training seems to produce the best result, since it is comparable to the Point-by-Point experiment with 1-year-long training but is also computationally less demanding (Fig.5).

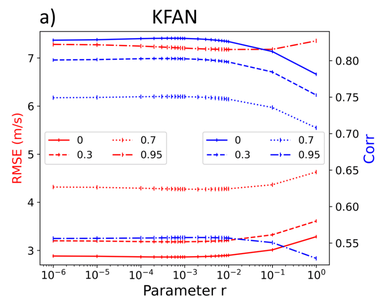

Fig. 4. The RMSE and correlation coefficient for so-called KFAN post-processing approach of 10-m wind gust predictions up to 72-h ahead, depending on the value of parameter r, including only the events for which observed values exceed the value of the percentile noted. The sensitivity tests are performed using operational ALADIN NWPs for the year 2018 and include 61 locations across the Republic of Croatia.

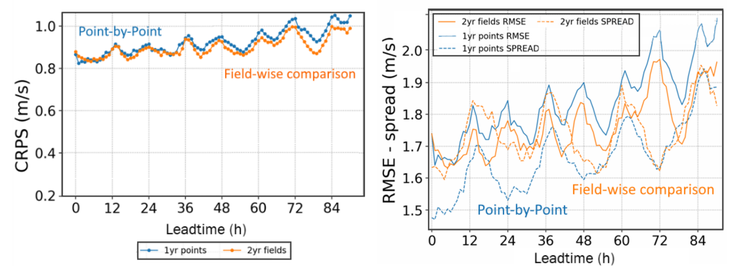

Fig. 5. The CRPS (a) and RMSE-spread (b) for the Point-by-Point analog-based approach (using a 1-year-long training dataset) is compared to the Field-wise approach (using a 2-years-long training dataset) during January 2019. The control member of the ECMWF ensemble forecast is used as a raw forecast and all forecasts are verified using INCA analysis wind speed values on .the domain covering Austria.

Neighborhood post-processing (NPP)

- To address the fact that model grid size is NOT the same as model resolution and acknowledge the rapid predictability loss at small scales, equiprobability between neighbouring model grid points can be used
- Potential solution: treating neighboring points as members of an ensemble valid at point of interest – Neighborhood Post-Processing (NPP) in time or space
- Several operational products were developed as shown on Figs. 6 and 7
- The results show that the NPP ensemble mean has approximately 10% (15%) lower RMSE for wind speed (gusts)
- Using specific percentile (~ 55th-60th) of a NPP ensemble instead of using the closest model grid point produces significantly more accurate precipitation forecast (more hits, less false alarms).
- Combination with an EPS: spread is significantly increased (Fig. 8)

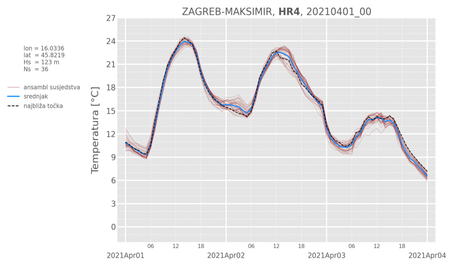

Fig. 6. ALADIN-HR4 T2m forecast with NPP ensemble as plumes (red), up to 72 h ahead, where dashed black line denotes raw nearest point deterministic forecast and ensemble mean is shown in solid blue.

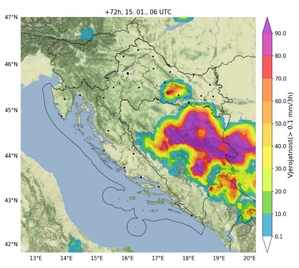

Fig. 7. The ALADIN-HR4 probabilistic precipitation forecast (> 0.1 mm/3h) derived from the NPP ensemble.

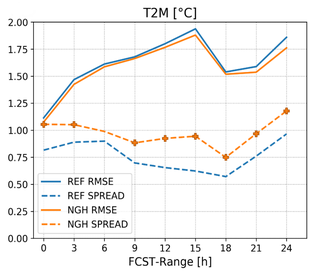

Fig. 8. The RMSE of the ensemble mean and spread for the NPP and the reference experiment. The results include T2m predictions averaged over 62 days and forecast ranges with statistically significant difference are highlighted using markers.

A-LAEF - interactive visualization

- A meso-scale ensemble system A-LAEF, focused on short range probabilistic forecasts, is developed in the frame of RC LACE consortium and profits from the advanced multi-scale ALARO physics
- Its main purpose is to provide a probabilistic forecast for the national weather services of RC LACE partners which could not achieve that with their own HPC resources
- We have designed completely new website (Fig. 9) which provides an interactive user experience for A-LAEF products (e.g., values are shown on mouse hover, features shown in legend can be turned on or off)
- Products such as meteograms and probability plots (Fig. 9) are provided for various thresholds, as well as 2-D plots of ensemble mean and spread
- After a positive feedback that we received, we will continue to use and expand this format (e.g., include other ALADIN products)

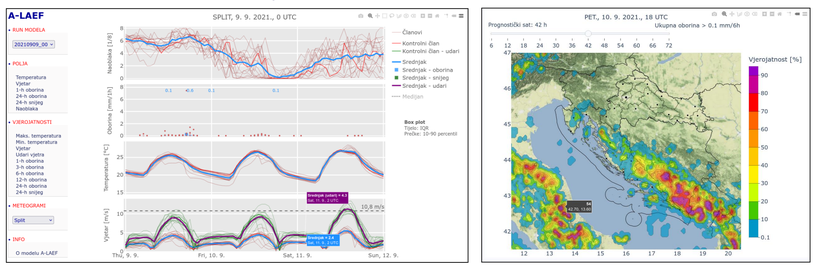

Fig. 9. The A-LAEF homepage and meteogram (left). The probability of 6-h precipitation exceeding 0.1 mm (right).