THE NWP ACTIVITIES AT CROATIAN METEOROLOGICAL AND HYDROLOGICAL SERVICE IN SPRING 2020

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OPERATIONAL SETUP AND PLANS

The operational model version used is AL38T1 with ALARO0 physics for 8, 4 and 2 km resolution forecasts.

Operational configuration settings:

- ALADIN-HR8: Δx = 8 km, 37 vert. lev.; CANARI+3DVar with 6h cycle (no DFI); 72h fcst. (with DFI), LBCs: IFS (lagged mode), 4 runs per day (00, 06, 12 and 18 UTC); hydrostatic
- 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
- ALADIN-HR2: Δx = 2km, 37 vert. lev., SSDFI, 24h fcst. hours, LBCs: ALADIN-HR8, 1 run per day (06 UTC); non-hydrostatic
- ALADIN-DA2: Δx = 2km, 15 vert. lev., 72h fcst., LBCs: ALADIN-HR8, dynamical adaptation mode; 4 runs per day (00, 06, 12 and 18 UTC); hydrostatic

Ongoing work: switching-off ALADIN-HR8 (coupling ALADIN-DA2 and ALADIN-HR2 to ALADIN-HR4), testing CY43T2, moving plotting and applications to Python-based system and development of statistical (analog-based) post-processing.

PYTHON-BASED PLOTTING SYSTEM

Complex system of GrADS scripts for plot generation has been replaced with a new Python based system, using EPyGrAM for reading/writing data directly from/to the FA file. It features a number of generalized functions which are controlled by input arguments, making the system more flexible and simple for future changes (e.g. adding a new user with specific needs). New system is also adapted for interactive use and parallelized calculation. Meteograms and other point-based post-processed outputs are produced from .json file containing the data extracted from FA by EPyGrAM. An example of the new 2D plot and meteogram are shown on Figures 3-4.

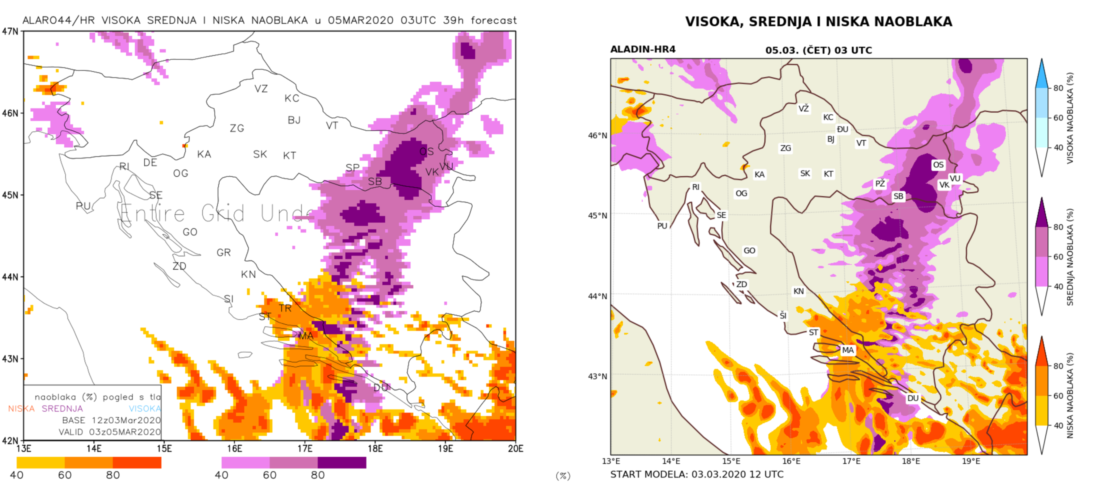

Figure 3. An example of old (left panel) and new (right panel) spatial plot of high, middle and low cloudiness.

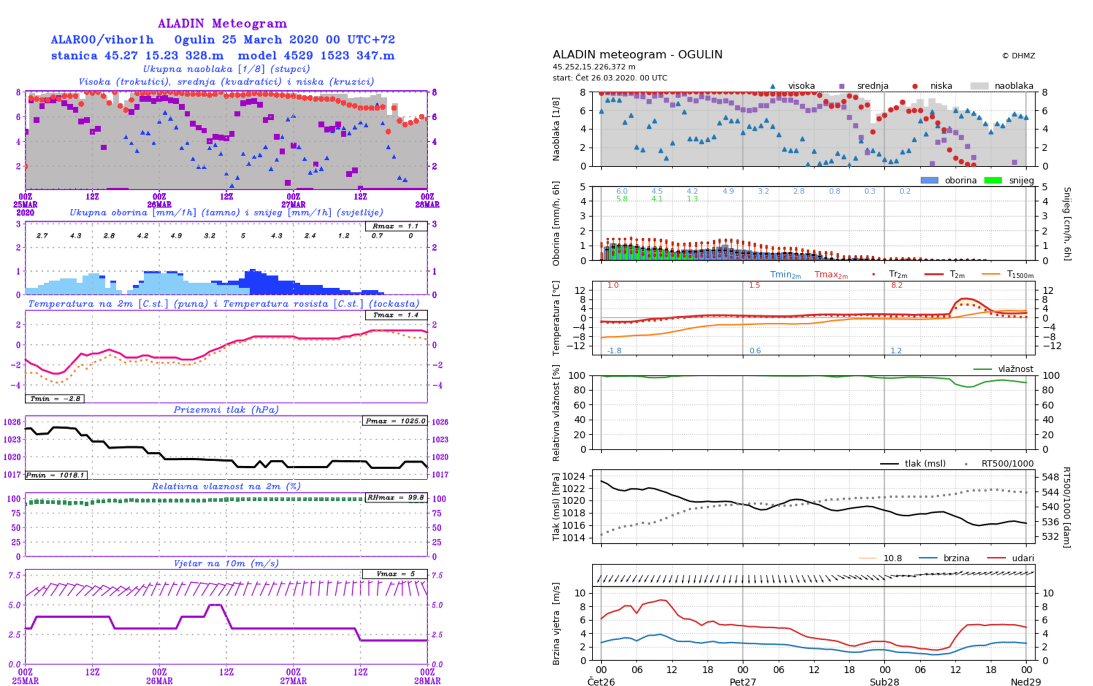

Figure 4. An example of old (left panel) and new (right panel) meteogram.

PROBABILISTIC PRECIPITATION

In the new meteograms, model precipitation is post-processed using spatio-temporal neighborhood as can be seen on Figure 4. During the first 36h, the size of the spatial neighborhood is 7x7 grid-points for the current time and 5x5 grid-points for a +/-1 h shift in time (99 grid-points in total). After 36h, additional neighborhood of 3x3 grid-points, shifted +/-2h in time, is added (117 grid-points in total). Median of this distribution (black bar on Figure 4.; right panel) is up to 25% more accurate (as measured by MAE) then a point-based deterministic forecast (Figure 9.).

In addition, we explored this technique for other parameters, such as forecast of minimum and maximum temperature. In this case, the improvement in forecast accuracy was around 20% percent.

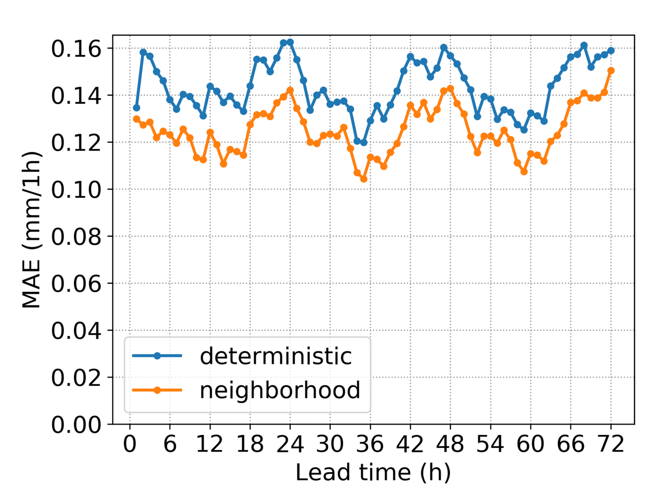

Figure 9. Mean Absolute Error (MAE) of precipitation for: deterministic forecast (blue) and median of spatio-temporal neighborhood (orange) for the year 2017 and 00 UTC run.

EARTHQUAKE IN ZAGREB

Series of earthquakes hit wider area of Zagreb during Sunday, March 22nd 2020. The strongest two were of the 5.4 and 5.0 magnitude according to the ML scale.

The DHMZ building is severely damaged and it is not suitable for further use. Our HPC system and other servers are currently not physically available as entrance to the building is forbidden until the surface settles down. There is an ongoing work on moving basic operations to ECMWF HPC system.

Figure 1. The impact of earthquake in Zagreb on DHMZ building

PRECIPITATION ANALYSIS

The lack of radar and real-time precipitation data over Croatia creates a problem when reliable spatial precipitation analysis field is required. To prepare for ALADIN CY43 verification and tuning, a new product has been set up. INCA (Integrated Nowcasting through Comprehensive Analysis) algorithm has been modified to correct radar rain rate data (accumulated over 24h) with daily precipitation data which passed a quality control (3 months delay). The product is then interpolated to the ALADIN-HR4 domain for easier verification. With the number of climatological stations (06-06 UTC precipitation data) over the Croatian domain reaching more than 300, the algorithm gives reliable spatial analysis field, as shown in Figure 2.

This product should reach its full potential by the end of 2021 when it's expected for 6 new radars to be set up (3 old ones replaced and 3 new ones along the coast), covering up the whole Croatian domain.

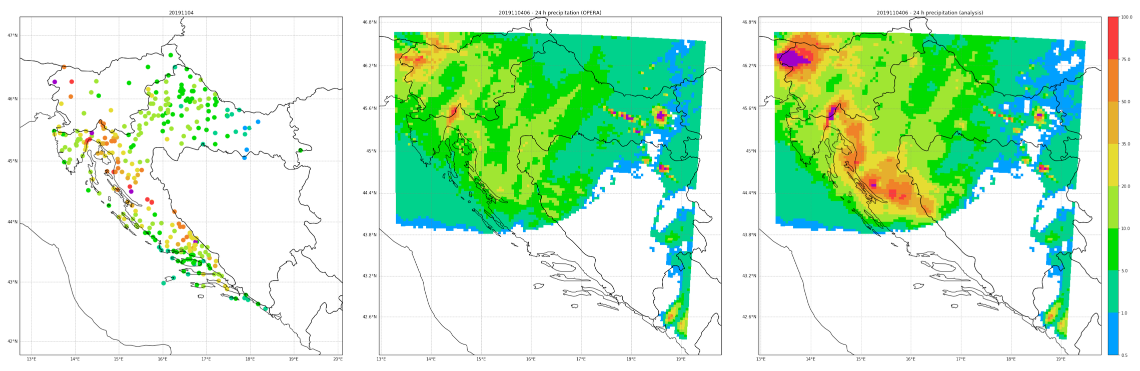

Figure 2. Precipitation analysis: observations (left), 24-hours accumulated radar data (middle) and 24-hours accumulated data corrected with observations(right).

THE NEW ALADIN-DA2 CONFIGURATION

In order to switch-off ALADIN-HR8 configuration and continue the upgrade of our prognostic system, we needed to couple ALADIN-HR2 and ALADIN-DA2 configurations to ALADIN-HR4. While the first one is still a work in progress, the latter one is ready to enter operations from April 1st 2020.

During the coupling procedure we lowered the first model level of the ALADIN-DA2 to ~10m in order to reduce the effect of vertical interpolations on near-surface winds. We also created several sub-configurations with different number and distribution of vertical levels which follow the levels of the ALADIN-HR4 up to certain height. Based on verification scores (Figure 5.; left panel) and time needed for its running we have chosen the configuration with 32 vertical levels (follows the ALADIN-HR4 up to ~1500m) for further testing.

After this, new climate files (with orography from GMTED2010 database) were introduced (Figure 5.; right panel). In parallel, we also performed the tuning of wind gusts on several bora cases (Figure 6.). Final configuration with 32 vertical levels, new climate files and FACRAF=10 was chosen for pre-operational testing. The results of 6-months simulations (1.10.2018.-31.3.2019.) are shown on Figures 7-8. An improvement over old configuration is relatively small, but significant on the 95% level (Figure 7.) and for strong wind (Figure 8.).

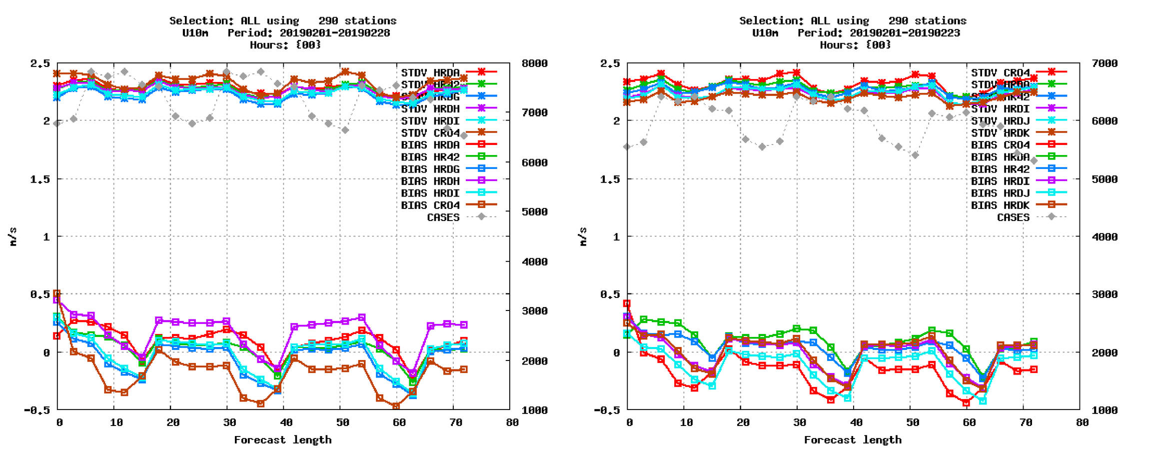

Figure 5. BIAS and STDEV for new ALADIN-DA2 configuration with: different number of model levels (left) and different climate files and resolutions (right) during the period 1.2.-28.2.2019.

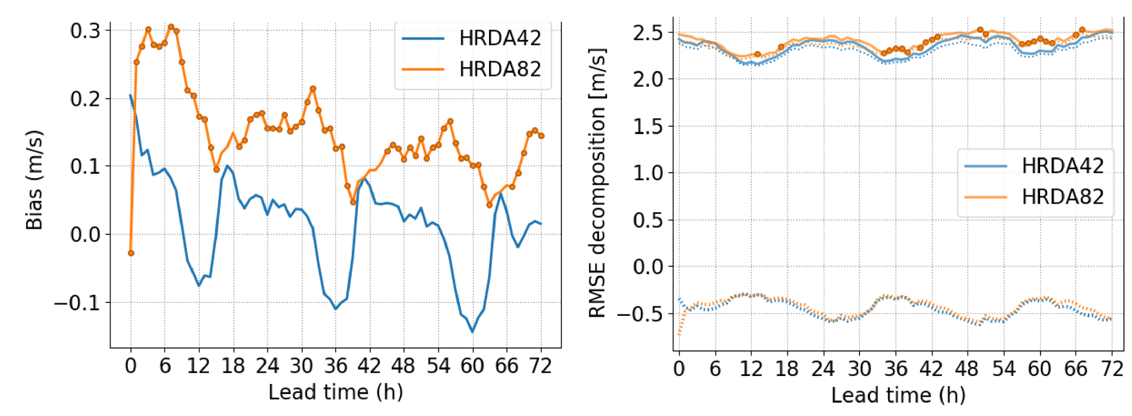

Figure 7. BIAS (left panel) and RMSE decomposition (right panel) for old (HRDA82; coupled to ALADIN-HR8) and new (HRDA42; coupled to ALADIN-HR4) ALADIN-DA2 configuration during the period 1.10.2018.-31.3.2019.

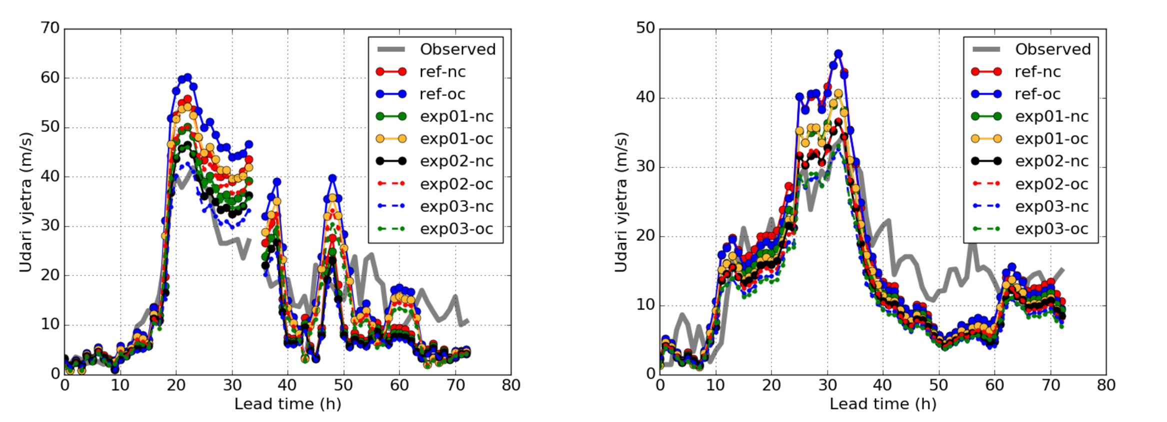

Figure 6. Time series of 10m wind gusts from the new ALADIN-DA2 configuration for several values of FACRAF coefficient ($u_{gst} = u_{mean} + FACRAF * \sqrt{TKE}$) during bora case (starting from 00 UTC 22.02.2019.) at Maslenica bridge (left) and Šibenik (right). FACRAF=15, 12, 10 and 8 sequentially, while öcänd nc"denote old and new climate files.

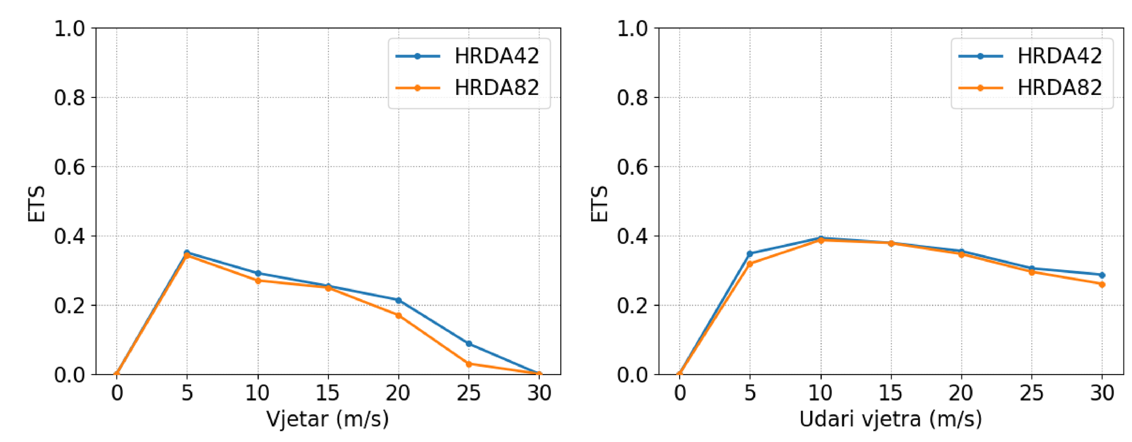

Figure 8. Equitable Threat Score (ETS) of old (HRDA82; coupled to ALADIN-HR8) and new (HRDA42; coupled to ALADIN-HR4) ALADIN-DA2 configuration for mean wind (left panel) and wind gusts (right panel) during the period 1.10.2018.-31.3.2019.

ANALOG-BASED METHOD

Analog-Based Method (ABM) is built on finding the most similar past numerical weather predictions (analogs) over several variables (predictors) and forming an analog ensemble (AnEn) out of the corresponding observations. Data includes the measurements (temperature, wind speed, and gusts) and ALADIN-HR4 00 UTC forecasts at approximately 50 stations.

The temperature ABM forecasting is very easily over-fitted so only 4 predictors are used, while 10 predictors are used for the wind forecasting. ABM setup includes 15 members of wind speed, wind gusts and temperature ensemble predictions with the hourly resolution, up to 72 h ahead (Figure 10.). It is implemented as a part of the forecasting system in operational test mode from August 2019. For both wind speed (Figure 11; left panel) and gusts ABM forecast is more accurate at nearly-flat continental terrain situated more inland than at coastal and mountain complex area, as expected. The best results for the temperature forecast are at coastal maritime region, while the mountain complex area seems to be the least predictable one, resulting in the lowest CRPS (Figure 11.; right panel). More information can be found in 14th ALADIN HIRLAM Newsletter.

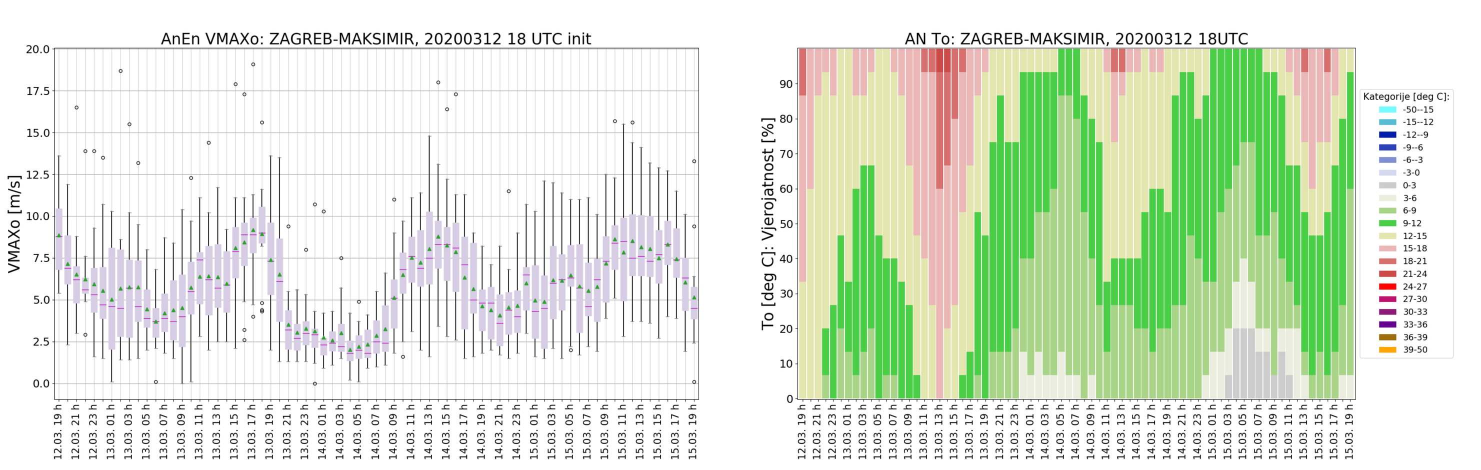

Figure 10. The analog-based ensemble forecast output of the 10m wind gusts (left panel) and probabilistic forecast of the 2m temperature (right panel).

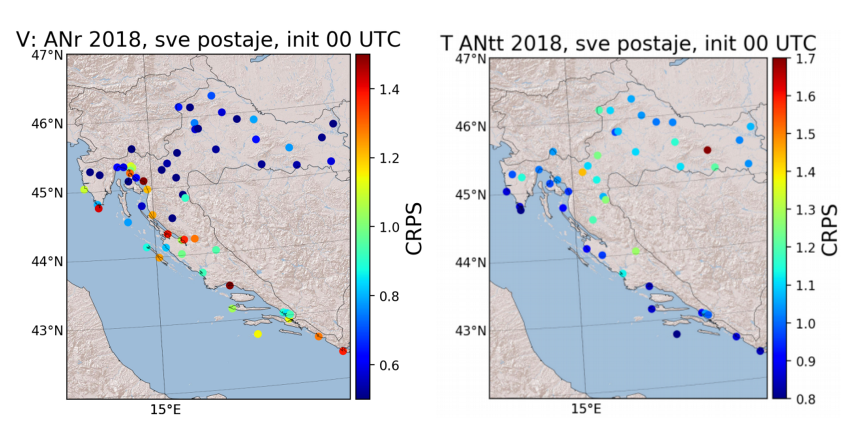

Figure 11: Continuous Rank Probability Score (CRPS) for wind speed (left panel) and temperature (right panel) analog-based forecasting at all locations (yr. 2018).