NWP at Croatian Meteorological and Hydrological Service, 2023

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Operational suite

- The new operational model configurations (from 6. 2. 2023.):
  - **ALADIN-HR40**: Δx=4 km; 480x432x73; CY43T2; HYD dyn.; Δt=150 s; ALARO-1 phy.; IC: CANARI + 3DVar (3h-cycle, ENS B); 72h fcst.; LBC: IFS-3h (6-h lagged), 4 runs per day
  - **ALADIN-HR20**: Δx=2 km; 450x450x87; CY43T2; NH dyn.; DFI ini.; Δt=60 s; ALARO-1 phy.; 72h fcst.; IC: ALADIN-HR40; LBC: IFS 1-h (6-h lagged); 4 runs per day
  - **Analog-based method** (**HRAN**): a statistical post-processing method that finds analogous situations in the previous (training) period and using a similarity metric predicts values that are observed under a "very similar" forecast; predictor weight optimization and statistical correction for rare events are used
- Both previous model configurations (4 km **HR44** and 2 km **HRDA**) are upgraded to cy43T2 and ported to new HPC.
- **HRDA** is upgraded to full NH model run (from dynamical adaptation mode).
- Model domains remained the same (**Fig. 1**).
- More vertical levels are added for 2 km model configuration (32 → 87).

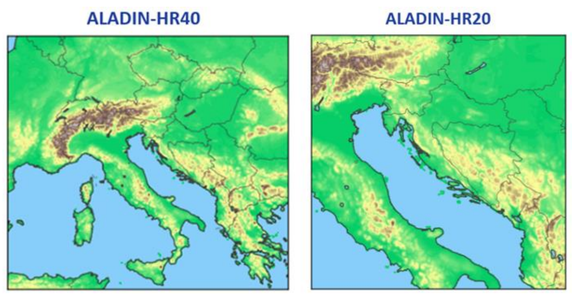

Fig. 1. The model domain for ALADIN-**HR40** (left) and ALADIN-**HR20** (right).

Verification of new operational configurations

Temperature – ALADIN HR40

- Results show that the RMSE and systematic errors for temperature NWPs are the highest during winter due to negative bias of the mean, especially for **HR44** (**Fig. 2**).
- Overall, **HR40** predictions outperform **HR44**, measured by categorical scores such as ETS and EDI. Measured by RMSE, **HR40** outperforms for temperature predictions whereas predictions of other variables yield mixed results.

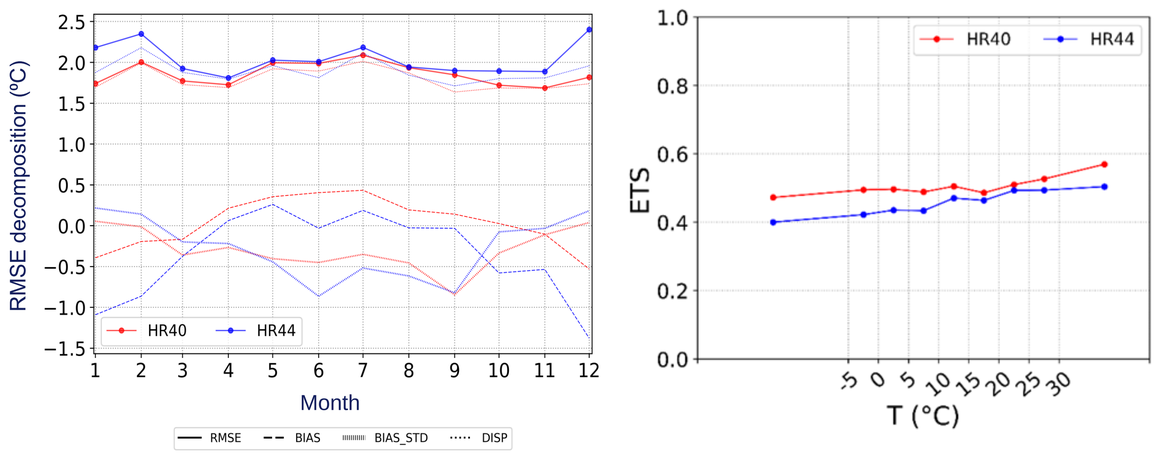

Fig. 2. RMSE decomposition (left) and ETS (right) for **HR40** and **HR44** temperature (2 m) predictions within the period 1. 1. 2021 - 31. 12. 2021. for 48 Croatian stations.

Wind – ALADIN HR20 and HRAN

- Dispersion error is dominant source of RMSE throughout the year. Overall, the **HR20** outperforms **HRDA**, and error can be further reduced by post-processing (**Fig. 3**), for different terrain types in Croatia.
- The differences between **HRDA** and **HR20** are the most pronounced at coastal stations, including reduction of bias of the mean and dispersion error in favour of **HR20**.
- Using ETS, categorical verification shows that **HR20** outperforms **HRDA** for all common wind events, and the improvement is even more pronounced after post-processing, whereas the results for rare wind speed events are mixed.
- The large errors (e.g., MAE > 15 m/s) mostly occur due to small time or space shift during bora events, when **HR20** and **HRAN** usually outperform **HRDA**.

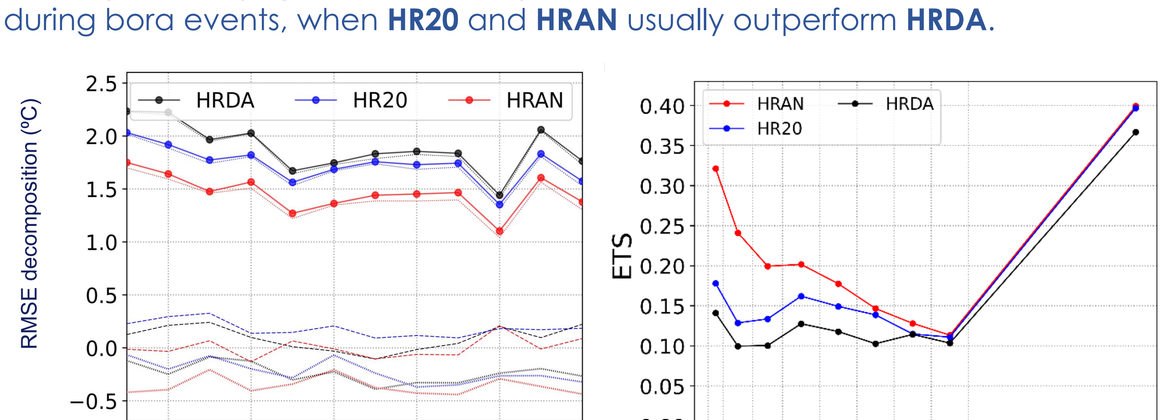

Fig. 3. RMSE decomposition (left) and ETS (right) for **HRDA**, **HR20** and **HRAN** wind speed predictions within the period 1. 1. 2022 - 31. 12. 2022. for 48 Croatian stations.

Temporal and spatial quality control

- A quality assurance method (**QAM**) is a user-friendly tool developed for the subjective and objective assessment of data quality, based on pre-defined procedures that flag the suspicious data.
- The **QAM** automatic procedures include examining the data through plausible range checks based on the physical, climatological limits, or specified limits of the measurement device; performing temporal control procedures to identify abnormally low or high variations; checking the data in the spatial domain by utilizing the Titanlib library which provides a wide variety of spatial checks; inspecting the 15-day moving averages and variances of time series data between nearby stations.
- The **QAM** is tested using automatic weather stations measurements of temperature, wind speed, mean sea level pressure, and relative humidity.
- Successful recognition of rough errors by the implemented **QAM** procedures is achieved (**Figs. 4-5**). Results show that most of the flagged suspicious data originated from non-physical entries.

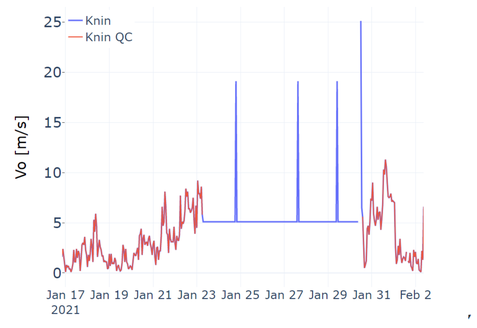

Fig. 4. The wind speed measured at the AWS Knin - an example of flagged unnatural steadiness of the wind with peaks (blue).

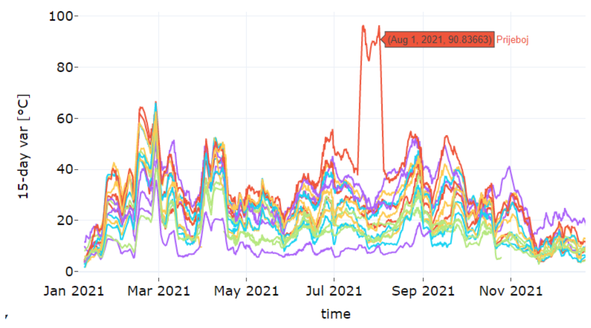

Fig. 5. A temperature variance for continental AWS, where a significant increase in variance at the AWS Prijeboj is flagged (red).

Destination Earth (DestinE)

- **DestinE** is an initiative of the European Commission to develop a digital model of the Earth on a global scale, and DHMZ is collaborator on several workpackages (WPs).
- Within WP4, which is focused on post-processing, a benchmark method to generate ensemble of forecast and/or to provide uncertainty (**Fig. 6**) for the deterministic model is implemented.
  - The ensemble is generated from the multiple neighbouring model points to the location of interest and thus no additional NWP or training dana is required. Neighbouring points can be filtered with respect to the orography or land-sea mask. Different shapes are also supported.

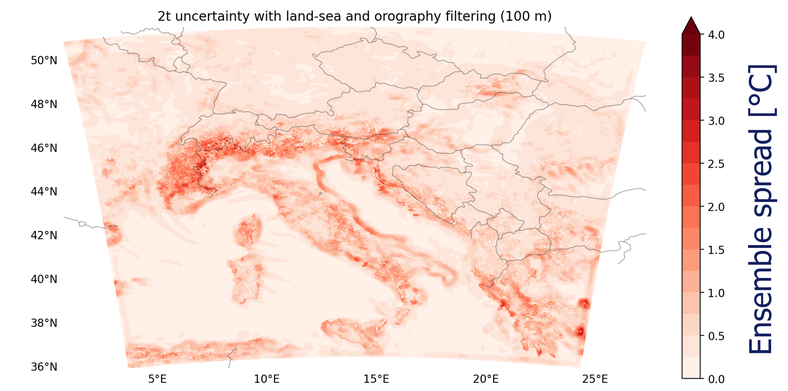

Fig. 6. Deterministic model uncertainty from the neighbourhood ensemble.

- Within WP8, which is focused on energy sector, wind speed data for unknown location are gathered from investors, containing the data from meteorological mast and wind measured at 16 wind turbines. Quality control is currently in process.
- In the first five months of 2021, the most dominant wind at the location of the meteorological mast is between 5 and 7.5 m/s at rotor height (80 m), and strong wind is blowing from NE and NNE (bora; **Fig. 7**).
- As expected, turbines' wind data show a higher correlation with measured at closest turbines (**Fig. 8**).

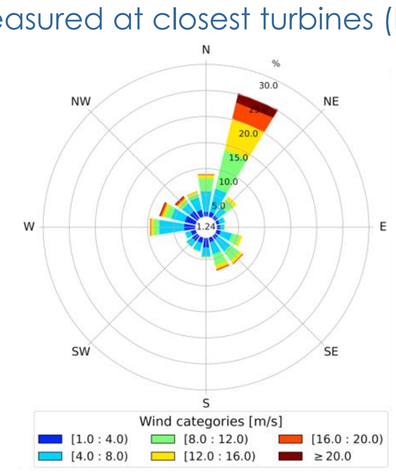

Fig. 7. The wind rose - measured at wind farm location (80 m; 5-month period).

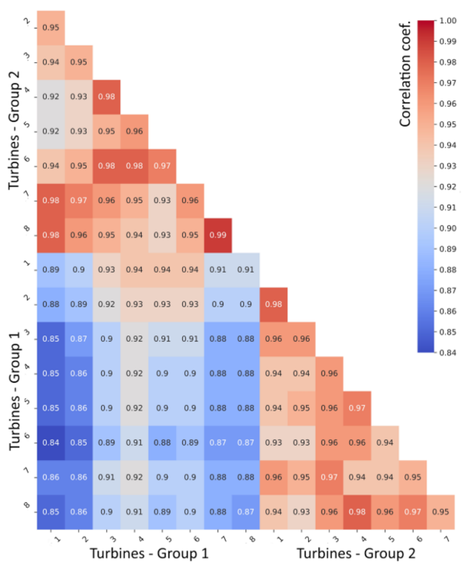

Fig. 8. Correlation between wind speed at turbines.