THE NWP ACTIVITIES AT CROATIAN METEOROLOGICAL AND HYDROLOGICAL SERVICE IN SPRING 2023

Antonio Stanešić (stanesic@cirus.dhz.hr), Kristian Horvath, Mario Hrastinski, Endi Keresturi, Ena Kožul, Ines Muić, Iris Odak Plenković, Suzana Panežić, Ana Šljivić, Ivan Vujec, Anamarija Zajec

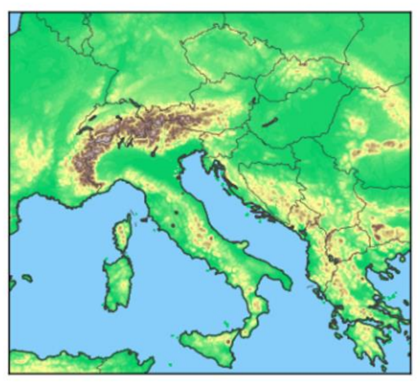
New operational configurations

The new operational model configurations (from 06.02.2023.)

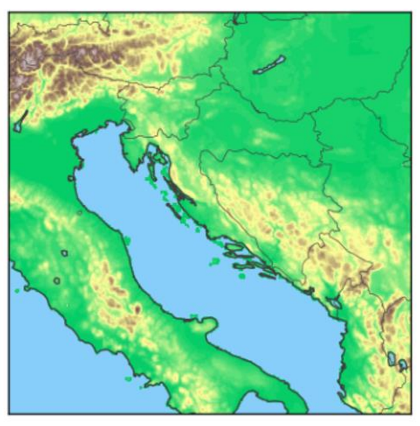
- **ALADIN-HR40**: Δx=4 km; 480x432x73; **CY43T2**; HYD dyn.; **Δt=150 s**; **ALARO-1 phy.**; IC: CANARI + 3DVar (3h-cycle, ENS B); 72h fcst.; LBC: IFS-3h (6-h lagged), 4 runs per day
- **ALADIN-HR20**: Δx = 2km; 450x450x87; **CY43T2**; **NH dyn.**; **DFI ini.**; Δt=60 s; **ALARO-1 phy.**; 72h fcst.; IC: **ALADIN-HR40**; LBC: **IFS 1-h** (6-h lagged); 4 runs per day

- both previous model configurations (4km and 2km) were upgraded to cy43T2 and ported to new HPC
- 2km model configuration was upgraded to full NH model run (from dynamical adaptation mode)
- model domains remained the same; more vertical levels for 2km model configuration

ALADIN-HR40



ALADIN-HR20



Verification of new operational configurations

Verification was performed using one-year-long dataset (2021.) Measures such as RMSE, bias, standard deviation, Pearson correlation coefficient are used when the surface meteorological variables are considered as continuous predictand, and measures such as equitable threat score (ETS) and extremal dependency index (EDI) are used when they are considered categorically, where the relative frequency for different events is also taken into account. Besides by lead-time and pre-defined categories, the results are analysed in more detail by month or season, as well as by region defined by terrain type or exact location.

ALADIN-HR20

- primary aimed to replace HRDA – dynamical adaptation configuration that was used for enhancing wind forecast
- results show improved wind and wind gusts forecast of ALADIN-HR20 compared to previous dynamical adaptation configuration; RMSE decomposition and EDI shown only for wind gusts (Fig. 1)

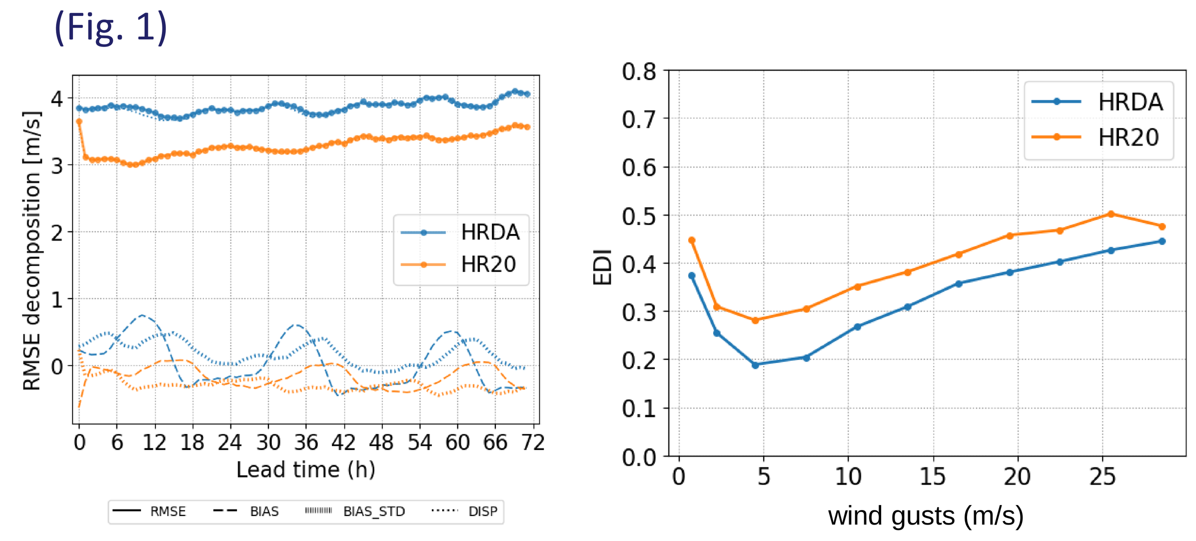


Fig. 1 RMSE decomposition (left) and EDI (right) for wind gusts within the period 1.1.2021-31.12.2021. for Croatian stations (blue – dynamical adaptation, orange – tuned CY43-based ALADIN-HR20 configuration)

ALADIN-HR40

- new tuned model configuration ALADIN-HR40 (cy43) was compared with previous operational configuration ALADIN-HR44 (cy38) using temperature, precipitation, wind speed and gusts predictions and available measurements after a quality assurance method is applied
- 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.

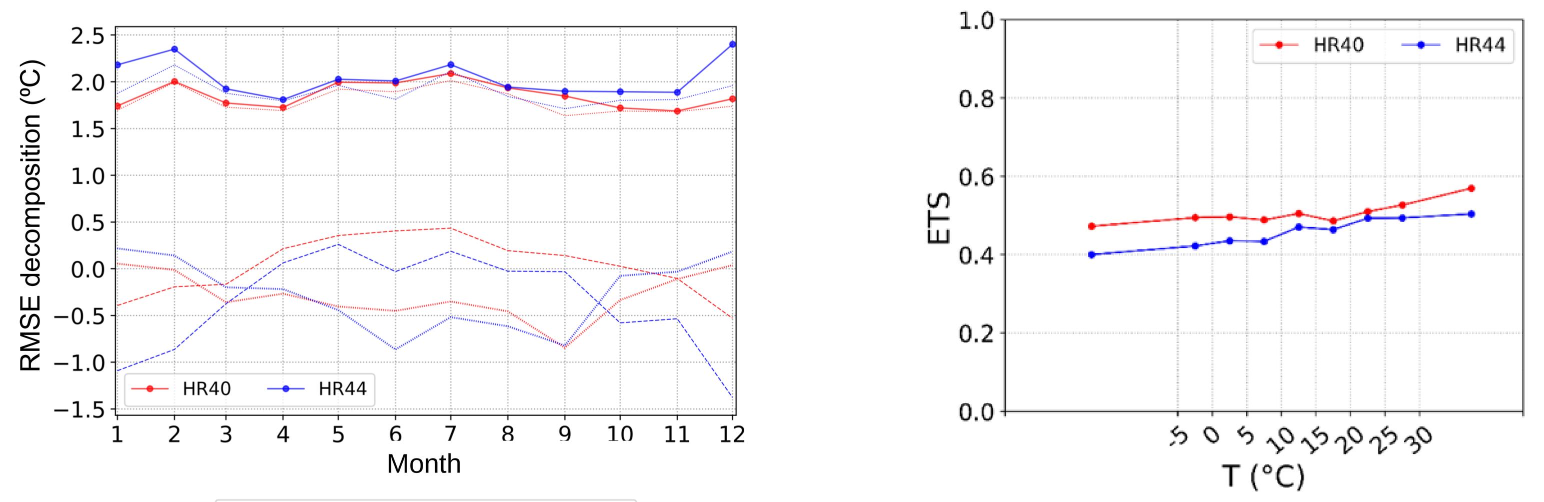


Fig. 2 RMSE decomposition (left) and ETS (right) for HR40 and HR44 temperature (2 m) predictions within the period 1.1.2021-31.12.2021. for 48 Croatian stations

Problem with forecast jumpiness

- during the summer 2022 in Croatia, jumpiness of forecast was noticed – e.g. sometimes 06 UTC run had maximum temperatures several degrees lower than 12 UTC run (Fig. 3)
- the problem was attributed to surface data assimilation and intensive moistening/drying of soil
- investigation revealed that also yearly cycle of soil moisture had an „unrealistic" pattern (Fig. 4)
- several soil analysis parameters were tuned and new settings were obtained taking into account verification results for winter and summer months: spatial smoothing is applied, ANEBUL=0.45, SPRECIP=5, V10MX=10., ISBA poly. v6, SODELX(0)=1; SODELX(1)=2, RCLIMCA=0.015
- with new surface DA settings (EXP10) jumpiness of forecast was reduced during summer (Fig. 3) compared to reference (HR40)

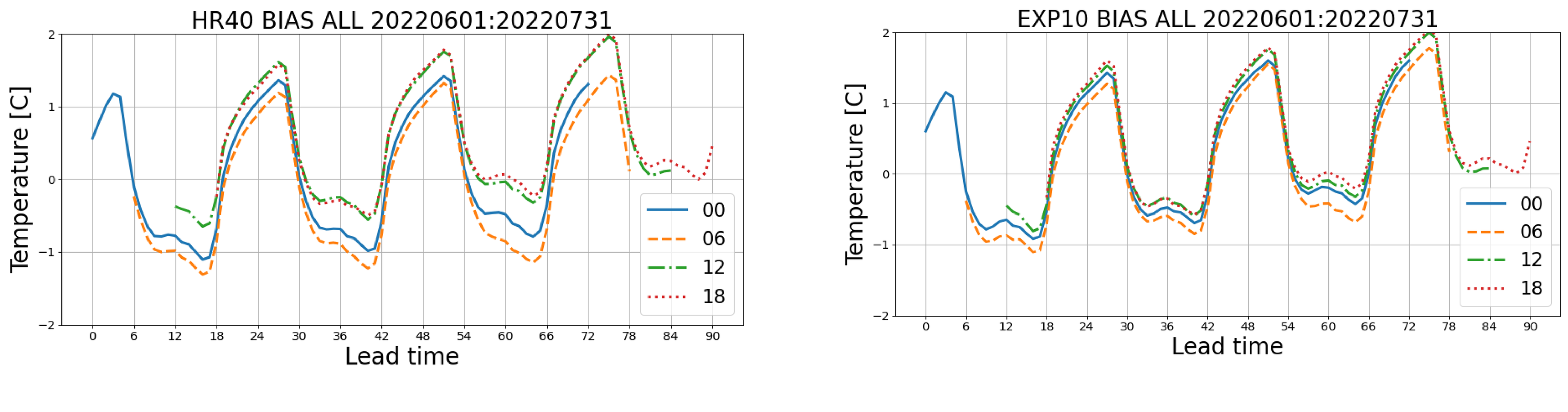


Fig. 3 BIAS of T2m calculated comparing 72-h forecast with measurements from Croatian stations for each of 4 model runs for: reference – HR40 (left) and forecast calculated from initial conditions from assimilation cycle with tuned surface assimilation – EXP10 (right).

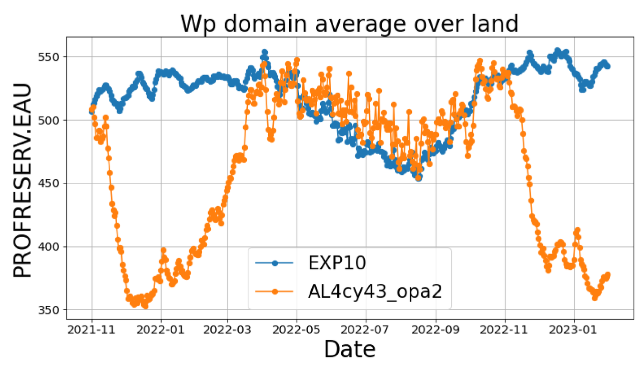


Fig. 4 Domain average of deep soil reservoir water content for period 20211101-20230129 from reference-HR40 (orange) and EXP10 (blue).

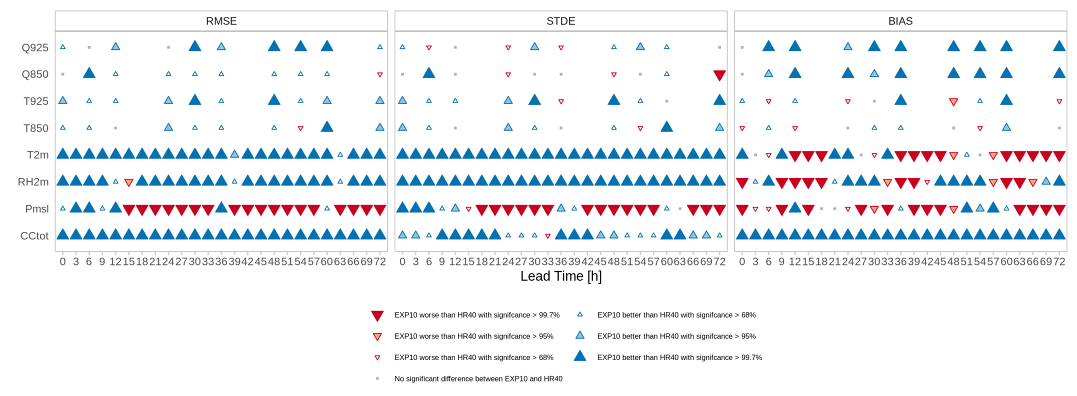


Fig. 5 Scorecard calculated against surface stations inside model domain for period 20211101-20220228 for reference-HR40 and EXP10. Better scores for EXP10 are marked with blue.

- with new surface DA settings yearly soil moisture cycle has more realistic behaviour (Fig. 4)
- verification for period when differences in average soil moisture were most pronounced (202112-202202) showed (Fig. 5) :
  - slightly increased BIAS for some lead times for T2m, RH2m while RMSE and STD were decreased; degradation of MSLP forecast
  - improvement in total cloudiness and small improvement for T and Q on lowest model levels

Post-processing

The verification was performed to determine the quality of the analog wind speed and gusts forecasts generated by the newly implemented HR20 ALADIN configuration in comparison to the HR40 configuration.

- the RMSE decomposition for wind speed (Fig. 6, left) shows better overall results for the analog forecast AN20 (generated by the HR20) for majority of lead times, although the better relative improvement upon the starting NWP forecast shows the forecast AN40 (generated by the HR40 NWP).
- the AN20 forecast outperforms AN40 for almost all categories (Fig. 6, middle and right) . Additionally, one should be careful with the interpretation of the most extreme categories as they contain a relatively small number of events.

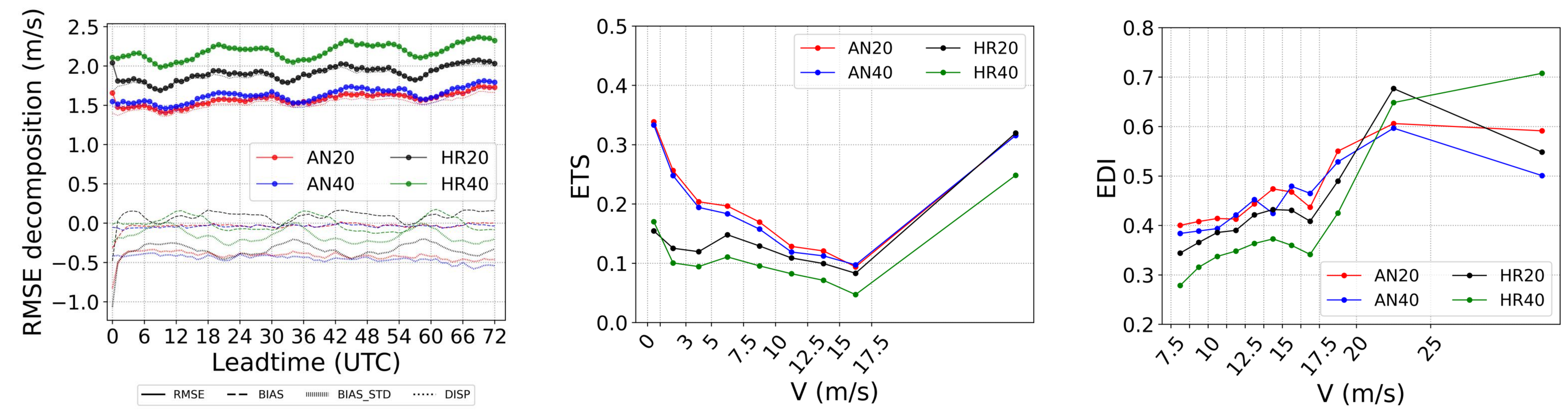


Fig. 6 RMSE decomposition (left), ETS (middle), and EDI (right) measures for the NWP forecasts (ALADIN configurations with 2km (HR20) and 4km (HR40) grid-step) and analog-based forecasts generated by the 2km (AN20) and 4km (AN40) configurations of the NWP model. The verification period is 1.1.2022.-29.9.2022., and the measurements are collected from 57 locations across the Republic of Croatia.

Temporal and spatial quality control

- a quality assurance method (QAM) is a user-friendly tool developed for the subjective assessment of data quality, based on pre-defined procedures that flag the suspicious data
- the main QAM goal is the identification of rough errors and the detection of possible systematic errors --> efficiently and quickly ensures the quality of data used for postprocessing, verification, and research studies
- 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 the ALHRDB database of 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, as in Figures 7-9. Results show that a majority of the flagged suspicious data originated from non-physical entries.

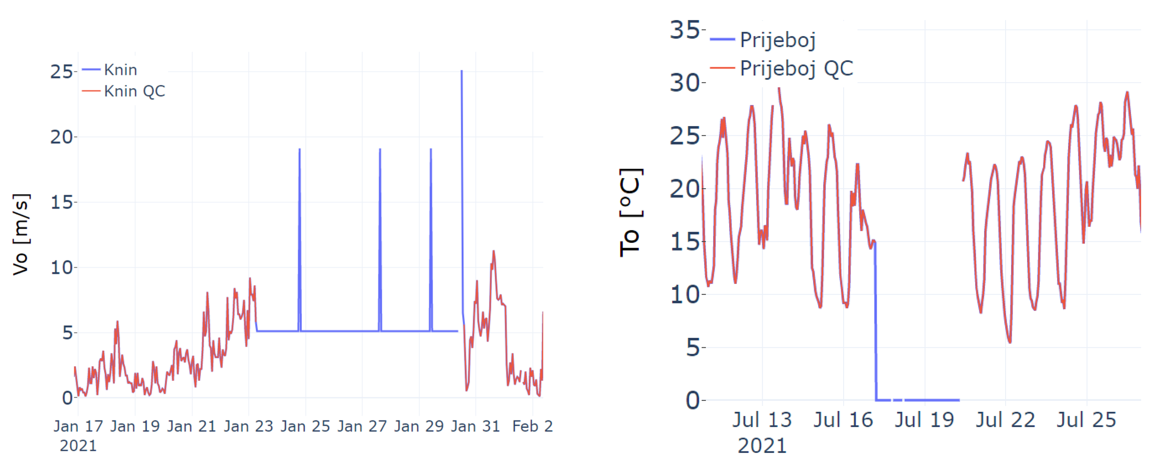


Fig. 7 The wind speed at 10 meters at the AWS Knin (left) and Prijeboj (right). The blue line represents the raw data, and the red line represents the data after quality control. For AWS Knin an unnatural steadiness of the wind with peaks during one measurement period was recorded, and that part of the data has been flagged as suspicious. At the AWS Prijeboj during July, the temperature dropped abruptly to zero and remained at that value for several days, which the quality control procedures successfully identified.

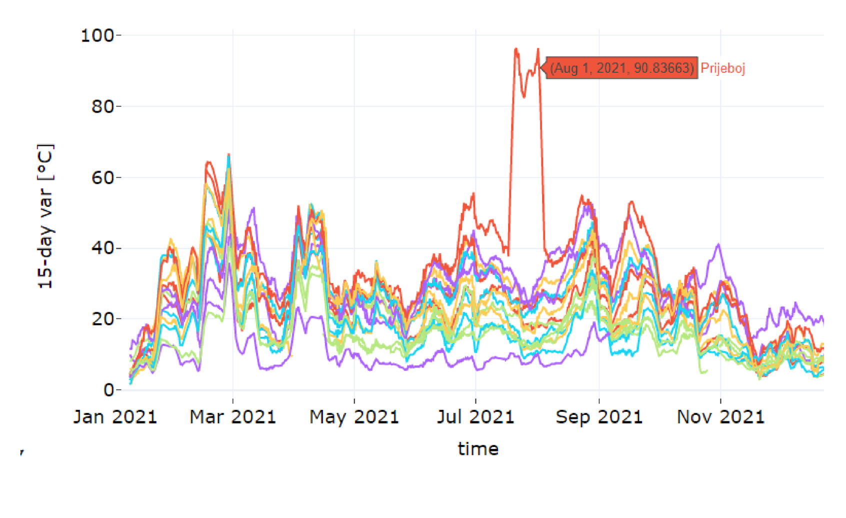


Fig. 8 15-day temperature variance for continental AWS. A significant increase in variance at the AWS Prijeboj indicates an error, which is shown in Fig. 7. Subjective assessment of such situations and removal of suspicious data is necessary.

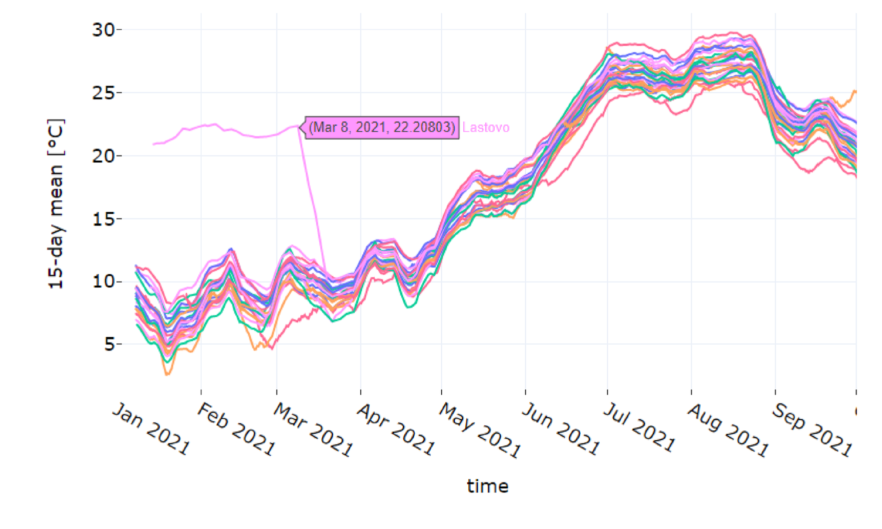


Fig. 9 Fifteen-day mean temperature for coastal AWS. A significant increase in the deviation of the mean at the AWS Lastovo indicates an error. Subjective assessment of such situations and removal of suspicious data is necessary.