Using METplus for verification of COSMO-Ru/ICON modelling system

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METplus is a forecast verification system [McCabe, G. et al. 2022] with MET (Model Evaluation Tools) [Newman et al. 2022] as a core developed and supported to community via the Developmental Testbed Center (DTC) (https://dtcenter.org/community-code/metplus). It was decided to implement METplus at the Hydrometcentre of Russia because of its flexibility, availability of most necessary methods in one package, and a good support by developers via the forum. METplus with the tools for visualization of the forecast scores has been installed at the Hydrometcentre of Russia and applied to verify mesoscale high-resolution forecasts by the COSMO-Ru system [Rivin et al., 2015]. Figure 1 shows the operational COSMO-Ru model domains, for which the scores are calculated at present. The scores are also calculated in the experimental mode for ICON-Ru system. The plots are prepared in the METviewer package. It proved to be a convenient visualization tool. The synoptic station data are used as a reference.

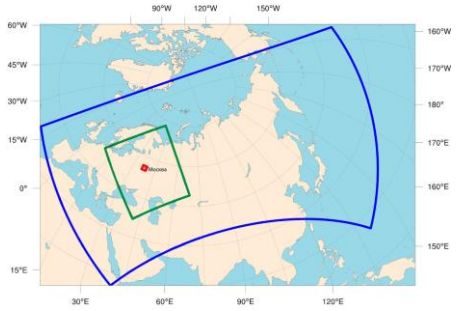

Figure 1. Configuration of the operational COSMO-Ru system [Rivin et al. 2015]. Blue is COSMO-Ru6ENA domain (grid step in horizontal 6.6 km), green is COSMO-Ru2By domain (grid step in horizontal 2.2 km), red is COSMO-Ru1Mr (grid step in horizontal 1 km)

Figure 2 shows how the diurnal cycle of the 2m temperature (T2m) mean error (ME) changes depending on the start time of the COSMO-Ru2By model with a 2.2 km grid step (green contour in Fig. 1). The score is aggregated over European Russia (the whole model domain) and over all lead times up to 24 h. Figure 2 demonstrates that the diurnal amplitude of the T2m changes is underestimated except for 18 UTC run, which overestimates T2m during almost the whole day. The 00 UTC runs have the smallest bias except for the evening hours.

Figure 3 shows the box plots of the wind gusts in COSMO-Ru2By and observations together with the ME and MAE of the wind gusts. It is a useful approach for comparing the distribution of the variable values and the errors. The model and observed values of wind gusts are in good agreement, and the ME is close to zero, although there are some outliers.

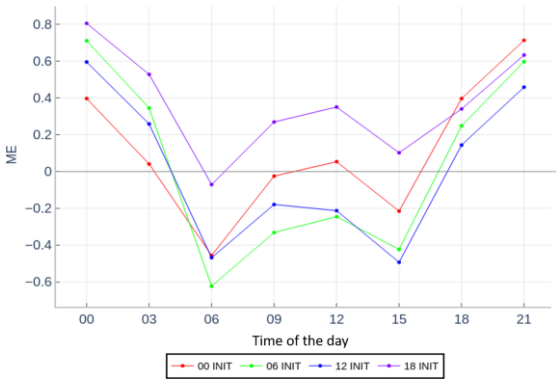

Figure 2. The mean error ME of the air temperature at 2 m (°C) for 00, 06, 12, and 18 UTC runs, COSMO-Ru2By, European Russia, spring 2023.

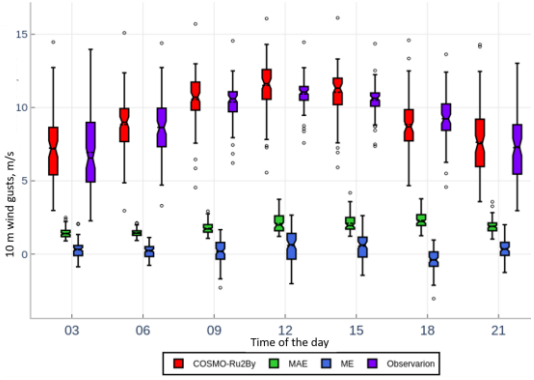

Figure 3. Forecast and observed wind gusts at 10 m (m/s), COSMO-Ru2By, European Russia, MAM 2023, 00 UTC run.

In Figure 4, precipitation performance diagrams are shown for summer 2022 (Fig. 4a) and spring 2023 (Fig. 4b). In summer 2022, COSMO-Ru6ENA overestimated precipitation exceeding low thresholds (0.1 and 1 mm/12h) and underestimated intense precipitation. Overall, the intense precipitation is forecasted worse than precipitation exceeding lower thresholds. There are similar conclusions for COSMO-Ru2By, spring 2023, but the precipitation scores are better compared to COSMO-Ru6ENA, summer 2022.

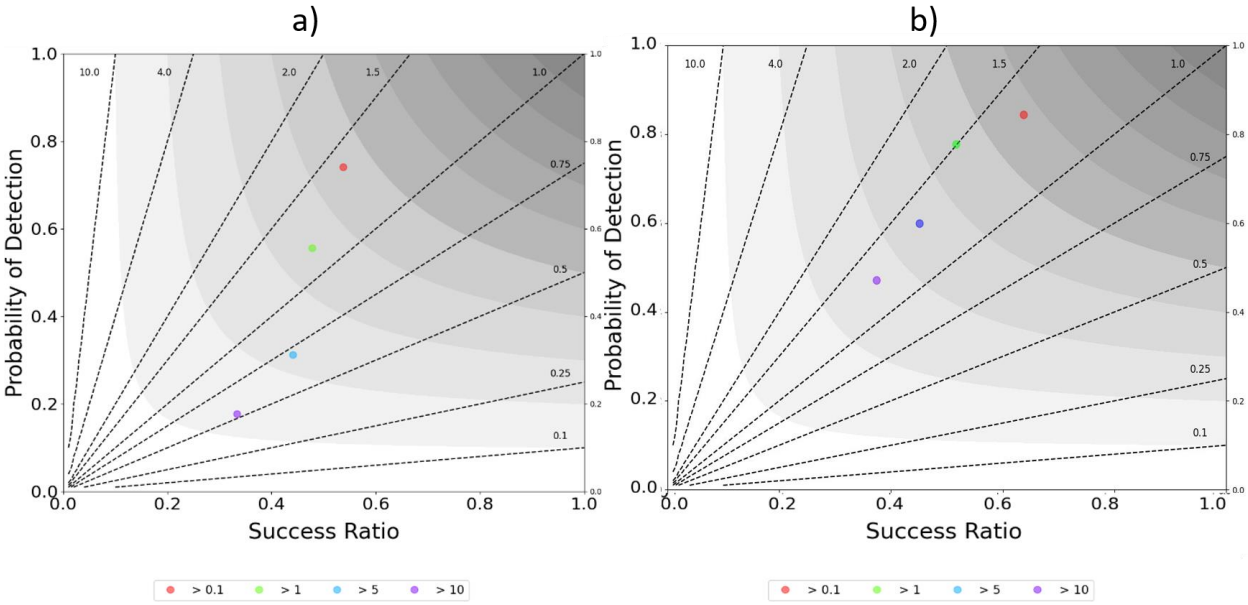

Figure 4. Performance diagrams of 12h precipitation accumulations exceeding different thresholds (0.1, 1, 5, and 10 mm/12h), Central Russia, 15 h lead time, 00 UTC run, (a) COSMO-Ru6ENA, JJA 2022 and (b) COSMO-Ru2By, MAM 2023

METplus is run to verify the test regional ensemble ICON-Ru2-EPS forecast based on the ICON-LAM model (2.2 km horizontal grid step) [Astakhova et al. 2021]. We also use METplus for neighborhood methods, object-based MODE method [Bundel et al. 2022], and for verifying the microphysical fields, such as the liquid water path using the MODIS satellite product as reference.

Conclusions: METplus was chosen as a basic verification tool for the COSMO-Ru system at the Hydrometcenter of Russia. It proved to be a convenient and versatile tool and helped to identify several model flaws. We plan to further expand the range of verification methods in operation, including the spatial ones applied to high-resolution ensembles. The research applications explore using the non-standard fields for both model and observations.

References

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