ISARD-2025-climate009

Accounting for uncertainty in cloud-radiation characteristics and parameters of subgrid-scale orographic drag scheme in ensemble forecasting based on the ICON model

Elena D. Astakhova[1] , Anastasia Y. Bundel[1] , Dmitry Y. Alferov[1] , Marina V. Shatunova[1] , Inna A. Rozinkina[1]

[1] Hydrometeorological Research Center of the Russian Federation

elena_ast_hmc@mail.ru

Ensemble methods are widely used in numerical weather forecasts, allowing for an a priori assessment of their quality and providing users with an extended volume of forecast products, including probabilistic ones. An ensemble system should describe forecast uncertainties associated with both the inaccuracy of the initial and boundary data for numerical models, and the imperfection of the models themselves. In this paper, we consider methods accounting for atmospheric model imperfections in ensemble forecasting and assess the impact of perturbing various parameters of the schemes that describe subgrid-scale processes, including cloud-radiation interaction and subgrid-scale orographic drag, on ensemble mean forecasts, the ensemble spread, and probabilistic characteristics of forecasts. Numerical experiments were performed using the ICON-Ru2-EPS regional high-resolution ensemble system [1], based on the ICON model with a grid step of about 2 km, which made it possible to resolve deep convection explicitly. The METplus package [2] was used for verification. The method of random parameter perturbations was applied. The sources of uncertainty in radiation flux calculations and subgrid-scale orographic drag parameterization in the ICON model were analyzed. The effects of parameter perturbations were considered both for individual test cases and for a longer sample. The results showed that the random parameter perturbations were not sufficiently efficient in allowing for model uncertainty in ICON-Ru2-EPS and it is necessary to involve additional methods.

The study was conducted within the framework of the research works of Roshydromet AAAA-A20-120021890120-8 and AAAA-A20-120021490079-3 (topics 1.1.4 and 1.1.3 for 2020-2024) and topic with registration number 125032004255-7 of Project 1.1 for 2025-2030.

1. E.D. Astakhova, A.Yu Bundel, D.Yu. Alferov, I.A. Rozinkina, G.S. Rivin. On the application of ensemble methods in short-term regional forecasts. // // Hydrometeorological research and forecasts. 2025. No. 1 (395). P. 6-36. DOI: https://doi.org/10.37162/2618-9631-2025-1-6-36

2. Brown B. et al. The Model Evaluation Tools (MET) More than a Decade of Community-Supported Forecast Verification // Bull. Amer. Meteor. Soc. 2021. Vol. 102. R. E782-E807. DOI: 10.1175/BAMS-D-19-0093.1.