DOI: https://doi.org/10.37162/2618-9631-2025-3-8-31

Wind gust nowcasting using numerical forecasts, radar data and machine learning: definitions and terms, observational tools and models / Muravev A.V., Kiktev D.B., Smirnov A.V. // Hydrometeorological Research and Forecasting, 2025, no. 3 (397), pp. 8-31.

A brief overview of modern tools and methods for nowcasting of surface wind gusts using the output of numerical weather prediction, radar observations, and machine learning techniques is presented. The relevant definitions and terms are given, observational tools and methods for processing observations are described, wind gust models and their nowcasting systems are discussed. The overview is compiled taking into account the domestic operational technologies involved in the tests of a new gust nowcasting version conducted in 2024.

Keywords: wind gust nowcasting, numerical weather prediction, radar observations, machine learning

Ref. 80.

DOI: https://doi.org/10.37162/2618-9631-2025-3-32-48

Extratropical tropopause features in the Southern Hemisphere based on the upper-air sounding data / Sokolova U.O., Ivanova A.R., Skriptunova E.N. // Hydrometeorological Research and Forecasting, 2025, no. 3 (397), pp. 32-48.

The seasonal and interannual variability of the tropopause height and temperature was studied using the information from 41 upper-air sounding stations located south of 30° during 2015–2024. Average values and the distribution of the tropopause characteristics were obtained, and the influence of the Antarctic continent on the tropopause location was discussed. A search for trends in the tropopause height in the Southern Hemisphere over the past decade was carried out.

Keywords: tropopause, Southern Hemisphere, upper-air sounding

Tab. 3. Fig. 8. Ref. 14.

DOI: https://doi.org/10.37162/2618-9631-2025-3-49-63

Inclusion of ecRad parameterization in the SL-AV atmosphere model and its effect on atmospheric circulation at annual and seasonal timescales / Fadeev R.Yu., Tolstykh M.A., Biryucheva E.O., Goyman G.S. // Hydrometeorological Research and Forecasting, 2025, no. 3 (397), pp. 49-63.

The results of replacement of shortwave and longwave radiation parameterizations with freely distributed ecRad parametrization in the SL-AV atmosphere model are presented. The effect of this change is evaluated at seasonal and annual time scale. It is shown that the improved and adjusted model reproduces annual mean and seasonal mean precipitation field more accurately, both in integral characteristics and geographical distribution. The errors in the seasonally averaged tropical atmosphere circulation near the surface are reduced. Implementation of ecRad with ecCKD algorithm allows accelerating computations of SL-AV model seasonal forecasts by 17%.

Keywords: atmosphere general circulation model, radiation heat fluxes in the atmosphere, long-range weather forecast

Tab. 1. Fig. 2. Ref. 25.

DOI: https://doi.org/10.37162/2618-9631-2025-3-64-76

Extreme frost forecasting in Krasnoyarsk using the WRF-ARW regional model / Bykov A.B., Vetrov A.L., Kalinin N.A. // Hydrometeorological Research and Forecasting, 2025, no. 3 (397), pp. 64-76.

The reasons for the occurrence of severe frost in Krasnoyarsk are studied, and the accuracy of its forecasting with the WRF-ARW regional model is assessed. Four episodes of cold weather events in 2019, 2020 and 2023 are analyzed. All the cases are associated with the formation of a strong anticyclone over the West Siberian Plain and advection of very cold Arctic air in front of the high-altitude ridge accompanied by the clear-sky weather. The formation environments of an urban heat island were studied, its intensity was found to vary from 4.0 to 8.0°C, with an average of 6.4 °C. The zones of maximum temperature are situated on the both Yenisei banks in the areas of the densest building. During the daytime, the urban heat island effect is less pronounced than at night. The WRF-ARW model was found to simulate the urban heat island on the second forecast day, although it overestimated predicted air temperatures, especially in the daytime. An absolute error in air temperature predictions for the time moments close to the time of daily minimum temperatures was 2,6 °C and 3.9°C (24 and 48 hours of model time, respectively).

Keywords: numerical prediction of temperature, frost, WRF-ARW model, urban heat island, Krasnoyarsk

Tab. 5. Fig. 4. Ref. 14.

DOI: https://doi.org/10.37162/2618-9631-2025-3-77-91

Application of atmospheric electric field strength measurements and machine learning methods in predicting daily precipitation in the summer months: A case study for the city of Nalchik / Bekkiev A.M., Mashukov I.Kh., Shapovalov V.A. // Hydrometeorological Research and Forecasting, 2025, no. 3 (397), pp. 77-91.

The paper considers a relevant problem of short-term forecasting of daily precipitation using meteorological information and data obtained from measurements of the electric field strength of the atmosphere, but without involving data on past precipitation values. The studies showed high efficiency of applying artificial intelligence in solving the problem, in particular, machine learning methods such as gradient boosting models, decision trees, and neural networks. The data for the study over the period from 2020 to 2025 were obtained from the Nalchik weather station (Russia, WMO ID 37212) and the EFM-100 electric field strength meter installed on the roof of the High-Mountain Geophysical Institute building.

Keywords: precipitation forecast, machine learning, gradient boosting, decision trees, neural networks, time series, meteorological data, spectral analysis, wavelet analysis

Tab. 2. Fig. 2. Ref. 21.

DOI: https://doi.org/10.37162/2618-9631-2025-3-92-100

Verification of numerical forecasts of sea ice thickness for the Caspian Sea and the Sea of Okhotsk in the 2023/2024 winter / Nesterov E.S., Zhupanov V.D., Maksimov A.A., Fedorenko A.V. // Hydrometeorological Research and Forecasting, 2025, no. 3 (397), pp. 92-100.

The 16-day forecast of sea ice thickness for the Caspian Sea and the Sea of Okhotsk was implemented on the basis of the CICE viscoplastic sea ice model using three-hour forecast fields of surface temperature, humidity, wind speed, precipitation, and incoming solar radiation from the WRF-ARW nonhydrostatic atmosphere model as forcing. The forecast is computed at the points of the 0.25° regular latitude-longitude grid. The values of sea ice thickness on the 7th and 14th forecast days were compared with the measured sea ice thickness from the Bol'shoi Peshnoi marine coastal station in the Caspian Sea and five stations in the Sea of Okhotsk, as well as with the data of the GDAS analysis (NCEP), Sigrid-3 maps (RSC Planeta), and sea ice maps (Hydrometcentre of Russia) for the entire Sea of Okhotsk. The comparison of the simulation results with observational data showed that the model satisfactorily reproduces the growth and melting of sea ice.

Keywords: Caspian Sea, Sea of Okhotsk, CICE model, sea ice thickness

Tab. 2. Fig. 2. Ref. 16.

DOI: https://doi.org/10.37162/2618-9631-2025-3-101-120

Variability of total currents in the Kara, Laptev, East-Siberian, and Chukchi seas as a result of mooring data analysis / Ipatov A.Yu., Kuzmin S.B.// Hydrometeorological Research and Forecasting, 2025, no. 3 (397), pp. 101-120.

The results of the statistical analysis of data on the parameters of near-surface currents performed at 690 autonomous and submerged buoy stations in 1956–2015 during the expeditions of the Arctic and Antarctic research Institute in the Arctic seas are presented. The variability of currents was analyzed separately in open water areas and straits. The statistical method of vector-algebraic analysis was applied for the data analysis. Simple statistical characteristics of the variability of currents were calculated: the mean, the median, and, in some cases, the maximum, the minimum, skewness, and kurtosis. Quantitative estimates of the variance of total (measured) currents, their spatial homogeneity, and the direction of variability were obtained. Unevenness of the parameters of currents in different layers from the surface to the depth of 25 m was established: an increase in the variability of the velocity of currents from the surface to the 10–20 m layer followed by a decrease with depth. The linear connectivity of currents decreases from the horizons of 10(12)–25 m. A decrease in the variability of the velocity of currents with depth is accompanied by an increase in their spatial orderliness expressed in a decrease in the anisotropy of variance (in the compression of the variance ellipse). An increase in the variability of currents with depth is characteristic of measurements performed under ice. The relationship with bottom terrain and the areas of distribution of river water in summer is shown. The results of the study are compared with the results for other seas (the Black, Mediterranean, and Caspian seas).

Keywords: vector-algebraic analysis, buoy stations, variability of total currents, static characteristics, variance tensor

Tab. 5. Fig. 3. Ref. 24.

Group structure of waves during the Black Sea storm on November 25-26, 2023 / Garmashov A.V., Zapevalov A.S. // Hydrometeorological Research and Forecasting, 2025, no. 3 (397), pp. 121-131.

The paper analyzes changes in the characteristics of the group structure of surface waves during the extreme storm in the Black Sea on November 25-26, 2023. The analysis uses wave measurement data from a stationary oceanographic platform located near the southern coast of Crimea. The group structure characteristics are calculated using two procedures based on the Hilbert transform and the SIWEH function. The temporal variations in the group factor and the number of waves in a group are constructed. The temporal variations in the group structure parameters calculated within the two procedures are similar. At the storm development stage, the group factor and the number of waves in a group changed insignificantly. At the storm weakening stage, the values of the parameters decreased. During the storm, there was a significant increase in the periods of dominant waves, which led to an increase in the group length.

Keywords: sea surface, waves, group structure, storm, Black Sea

Fig. 3. Ref. 23.

DOI: https://doi.org/10.37162/2618-9631-2025-3-121-131

Estimation of average regional expected winter wheat yield using a fully connected neural network / Kleshchenko A.D., Savitskaya O.V., Vdovina Ya.A. // Hydrometeorological Research and Forecasting, 2025, no. 3 (397), pp. 132-145.

A possibility of using deep neural networks to estimate the average district-level expected winter wheat yield for the territory of the North Caucasus Administration for Hydrometeorology and Environmental Monitoring is shown. The neural network was trained on a dataset that included satellite indices, meteorological data, and historical series of average regional yields for the period from 2012 to 2023. An experimental search for optimal neural network hyperparameters was carried out and made it possible to achieve the balance between the model's accuracy and generalizability. A comparative analysis of the accuracy of calculating the expected yield was performed using neural networks, statistical regression models, and machine learning algorithms (decision tree, random forest, linear regression). The results of the analysis showed that the maximum convergence between actual and calculated winter wheat yields is achieved when using the neural network. The results demonstrate the potential of the neural network approach for assessing the expected yield of winter wheat based on the integration of ground-based and satellite data.

Keywords: crop yield, meteorological information, NDVI, VCI, VCNI, regression, neural network

Tab. 2. Fig. 5. Ref. 15.

DOI: https://doi.org/10.37162/2618-9631-2025-3-132-145

DOI: https://doi.org/10.37162/2618-9631-2025-3-146-162

Overview of agrometeorological conditions during the 2024 growing season / Tarasova L.L., Klang P.S., Pavlova A.V., Sumerova K.A. // Hydrometeorological Research and Forecasting, 2025, no. 3 (397), pp. 146-162.

The paper investigates main weather anomalies of the 2023/2024 winter and the 2024 summer. It was found that crop formation conditions during this period were significantly worse than in the recent decade. Due to these anomalies, the yield did not meet expectations.

Keywords: drought, waterlogging of soil, light frosts

Tab. 3. Fig. 6. Ref. 11.

DOI: https://doi.org/10.37162/2618-9631-2025-3-146-162