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Diagnostic object-oriented verification of very short-range mesoscale precipitation forecasts. Part 1: Methodology and computational algorithms with application to object size / Muravev A.V., Kiktev D.B., Bundel A.Yu., Smirnov A.V., Blinov D.V. // Hydrometeorological research and forecasts. 2026, no. 3 (401), pp. 6-40.

The paper describes object-oriented verification methods used to evaluate very short-range mesoscale precipitation field forecasts generated by the COSMO-Ru2By model (Hydrometeorological Research Centre of the Russian Federation) over European Russia for the period of May–September 2025. The reference fields consist of initial composites from the pySTEPS precipitation nowcasting system derived from data provided by the DMRL-C radar network in the same region. Reference is also made to previously obtained point-based and spatial forecast skill scores based on comparisons with weather station data.

Definitions of “object”, “attributes of the first category”, “attributes of the second category” and their examples are given. The calculation algorithms of the used mathematical packages are discussed. A description of important statistical features of order values and sample quantiles is provided, including their asymptotic properties, and the application of the theory to the most important attribute of an object, namely its size, is explored.

Diagnostic verification of object forecasts for a certain lead time consists of two stages. At the first stage, the individual attributes of all objects in “forecast – observation” pairs of synchronized fields are cross-compared, and a complete matrix of values of the corresponding quality metric is constructed. At the second stage, instead of a complex procedure for “pairing” objects, the following operations are performed. Namely, from each complete matrix, “the best available” values are extracted in an amount equal to the smallest number of objects in any of the synchronized fields, and these values collected over the entire period of the experiment are presented as deciles of the distribution. Object-oriented diagnostics of the model and, in particular, its radar information assimilation system presupposes interpreting the tables of these quantiles for all lead times.

Keywords: object-oriented verification, order values and sample quantiles, diagnostics of a forecast system

Tab. 7. Fig. 5. Ref. 50.

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Global analysis of precipitation based on the SL-AV10 atmospheric model and synoptic observations / Zaripov R.B. // Hydrometeorological research and forecasts. 2026, no. 3 (401), pp. 41-62.

A procedure for analyzing global 6-hour precipitation fields is described. The input data are 0–6-hour lead-time forecasts of the SL-AV10 atmosphere model (serving as the first guess) and precipitation observations from weather stations. The analysis includes three stages, with the first guess being successively refined at each step: 1) mid-latitude biases are corrected; 2) relative differences between observed precipitation and the first guess are analyzed for observation clusters (observations within $\sim 1110 \times 1110$ km domains are aggregated); 3) individual observations are assimilated. The optimal interpolation procedure is used, with parameters selected directly in the process of analysis. Precipitation is processed in order to get distribution closer to normal using a power transformation. A verification of the analysis results against observational data and the GPCP and ERA5 analysis fields demonstrates the success of the developed methodology: the precipitation fields are refined at each stage of analysis. The planned application of the analysis is to improve the initial dataset for SL-AV forecasts and to refine the estimate of available soil moisture.

Keywords: global analysis of precipitation, optimal interpolation, SL-AV global atmosphere model

Tab. 3. Fig. 2. Ref. 49.

DOI: <https://doi.org/10.37162/2618-9631-2026-3-63-81>

Characteristics of the Southern Hemisphere jet streams based on ERA5 data for 2001–2025 / Ivanova A.R., Skriptunova E.N., Komasko N.I., Zavyalova A.A. // Hydrometeorological research and forecasts, 2026, no. 3 (401), pp. 63–81.

A climatology of the Southern Hemisphere jet streams calculated for the first quarter of the 21st century using ERA5 reanalysis data is presented. An occurrence frequency of jet streams in various regions is investigated, and the seasonal and interannual variabilities of maximum wind characteristics (speed, level height, direction, and layer thickness) are analyzed. Climatological data on jet streams at flight levels intended for air navigation planning are provided.

Keywords: jet stream, Southern Hemisphere, reanalysis, climatology, seasonal air navigation
Tab. 4. Fig. 9. Ref. 13

DOI: <https://doi.org/10.37162/2618-9631-2026-3-82-98>

Identification of adverse meteorological conditions for pollutant dispersion using machine learning models / Tatarinovich E.V., Borisov D.V., Kuznetsova I.N. // Г Hydrometeorological research and forecasts. 2026, no. 3 (401), pp. 82–98.

Machine learning methods were used for the first time to identify adverse meteorological conditions (AMC). The Ostankino district of Moscow was selected for the study. The study utilized meteorological measurement data from the Ostankino TV tower in a layer up to a height of 503 m, retrospective ERA5 data on wind at the 925 hPa level, 3-hour precipitation totals, and the height of the atmospheric boundary layer, as well as pollutant concentration measurements for the period of 2020–2025. When constructing the AMC machine learning models, significant predictors were identified, the most informative of which were 3–6-hour moving averages of the temperature difference in the 2–253 m layer and the average wind speed in the 201–305 m layer over the previous 3–6 hours. A local AMC identification model was developed and tested using five machine learning algorithms. It was found for the binary classification of atmospheric conditions that ensemble methods (CatBoost, random forest) provide the best balance between minimizing missed AMC and minimizing false alarms ($F1 = 0.62\text{--}0.64$). Significant predictors of AMC will serve as a basis for improving the statistical methods used for AMC forecasting.

Keywords: adverse meteorological conditions, machine learning methods, local AMC model
Tab. 5. Fig. 1. Ref. 22.

DOI: <https://doi.org/10.37162/2618-9631-2026-3-99-113>

Retrieval of wind vectors from the Arktika-M MSU-GS/VE visible channel data / Bloshchinskiy V.D., Filei A.A., Shamilova Yu.A. // Hydrometeorological research and forecasts. 2026, no. 3 (401), pp. 99-113.

The study addresses a retrieval of wind vector fields from satellite data. An algorithm developed for the 0.7 μm channel of the MSU-GS/VE instrument aboard the Arktika-M series satellites is presented. The method is based on a modified differential optical flow algorithm (the Brox method) optimized for GPU-based computations. To ensure the product reliability, a quality control and filtering system was developed, incorporating tests for image contrast, minimum wind speed, and both vertical and spatial consistency of the vectors. Validation of the results for 2025–2026 demonstrated high agreement with reference data: the root-mean-square vector difference reached 5.22 m/s against radiosonde observations and 5.33 m/s as compared to the GFS model. While accuracy decreases at large satellite zenith angles and in the upper troposphere, the overall performance meets the standards set by the World Meteorological Organization. The resulting products feature high spatial density and are suitable for both the synoptic analysis of the Arctic atmosphere and subsequent assimilation into numerical weather prediction models.

Keywords: wind vectors, visible band, Arktika-M, MSU-GS, optical flow, Brox method

Tab. 3. Fig. 5. Ref. 8

DOI: <https://doi.org/10.37162/2618-9631-2026-3-114-132>

Methods and Results of the Analysis of the Spatial Structure of the Siberian High / Sumnerova K.A. // Hydrometeorological research and forecasts. 2026, no. 3 (401), pp. 114-132.

A methodology has been developed for quantitative assessment of the spatial structure of the Siberian High (SH) based on calculating the center of gravity of the positive sea level pressure anomaly field. On its basis and using ERA5 data, the position of the SH center of gravity, the radius of inertia (a measure of compactness), and the total intensity were calculated for the period of 1950–2025. It is shown that powerful anticyclones are localized within 40–60° N, 80–120° E in 93.8% of cases, whereas the respective value for weak ones is only 30.4%. The method was verified by the air density field (differences in mean positions $\leq 0.5^\circ$). The characteristics of seasonal and interannual variability of the SH have been quantitatively determined. A spectral analysis of the main SH parameters revealed significant periods in the variability: 9.5 years (longitude of the center) and 2.5 years (latitude of the center), which may be associated with the 11-year solar activity cycle and the quasi-biennial oscillation (QBO). The developed methodology allows monitoring the SH parameters and is applicable for diagnosing an expected position and intensity of the anticyclone from model forecast fields.

Keywords: Siberian High, center of gravity, radius of inertia, eccentricity, SHI, spectral analysis, Arctic amplification

Tab. 5. Fig. 7. Ref. 24

DOI: <https://doi.org/10.37162/2618-9631-2026-3-133-153>

Characteristics of Atmospheric Turbulence According to the Perm Rawinsonde Station Data / Fedurin Ye.Yu., Kalinin N.A. // Hydrometeorological research and forecasts. 2026, no. 3 (401), pp. 133-153.

New technical tools allow high-resolution measurements of atmospheric characteristics and create new opportunities for assessing the intensity of turbulent exchange in the atmosphere. The results of applying the Thorpe's method for studying the parameters of atmospheric turbulence in Perm are presented. The Thorpe's method requires initial data with high temporal resolution. The study was based on data of radiosonde observations with a discreteness of 2 s at the Perm aerological station during 2018–2024. The study showed that the analyzed method provides quite accurate quantitative estimates of the turbulent characteristics of the atmosphere. In summer, the size of turbulent eddies in the boundary layer is on average 200–300 m, and the one in the free atmosphere reaches 50–70 m. The energy dissipation rate throughout the atmosphere varies from 10^{-6} to 10^{-1} m^2/s^3 , and the turbulent diffusion coefficient ranges from 10^{-2} to 10^2 m^2/s . During winter, the size of turbulent eddies ranges within 10–20 m, the energy dissipation rate varies from 10^{-6} to 10^{-5} m^2/s^3 , and the turbulent diffusion coefficient ranges from 10^{-2} to 10^{-1} m^2/s .

Keywords: atmospheric instability, turbulence, eddy scale, turbulence dissipation rate, turbulent diffusion coefficient

Tab. 1. Fig. 6. Ref. 40

DOI: <https://doi.org/10.37162/2618-9631-2026-3-154-166>

Estimation of the internal structure of tropospheric waves over the tropical Atlantic according to reanalysis data / Martinez E.N., Balakin V.S., Shipko Yu.V., Kolychev O.V., Semenov M.E. // Hydrometeorological research and forecasts. 2026, no. 3 (401), pp. 154-166.

A subject of research is the eastern tropical mid-tropospheric waves over the Atlantic region, the development of which is accompanied by heavy rains and thunderstorms and sometimes leads to the formation of tropical cyclones. The initial data are the data from the NCEP/DOE AMIP-II reanalysis of atmospheric parameters at the levels of 850 and 700 hPa during the wave activity period (June–October) for 2018–2023. The research methods are the applied statistics approaches: cluster, factor, and discriminant analyses. A factor model for quantitative assessment of synoptic conditions is built. Statistically different groups of circulation objects are identified, for which descriptions are given with examples of typical constant pressure charts. A model is presented for classification of synoptic conditions by types, including those implementing tropical waves.

Keywords: tropical wave, reanalysis, geopotential height, isobaric level, factor, cluster, constant pressure chart

Tab. 1. Fig. 10. Ref. 15

DOI: <https://doi.org/10.37162/2618-9631-2026-3-167-183>

Method for ten-day assessment of the contribution of agrometeorological conditions to expected winter grain crop productivity based on satellite and ground-based information / Kleshchenko A.D., Savitskaya O.V. // Hydrometeorological research and forecasts. 2026, no. 3 (401), pp. 167-183.

The paper presents a developed and tested method for 10-day assessment of the contribution of agrometeorological factors to winter grain crop productivity. The method is based on an integrated analysis of satellite spectral indices and ground-based meteorological data for the North Caucasus, Volga and Central Black Earth regions. Satellite data from MODIS (Terra satellite) and VIIRS (SUOMI NPP satellite) radiometers were used to calculate the NDVI, VCI, and VCNI vegetation indices. Ground-based information includes meteorological and agrometeorological indicators reflecting temperature and humidity conditions. The algorithm and software modules developed within the study allow for automated tracking of 10-day changes in agrometeorological conditions and quantitative ranking of factors based on their contribution to the expected winter grain crop yield, providing an information basis for informed planning of agricultural measures.

Keywords: agrometeorological conditions, 10-day monitoring, crop yield, meteorological information, satellite indices (NDVI, VCI, VCNI), MODIS, VIIRS

Tab. 1. Fig. 13. Ref. 8.