Three-Dimensional Geometry of Atmospheric Fronts. Analysis and Forecast.

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Abstract:
The atmospheric fronts' geometry is evaluated on standard baric levels according to data of the objective analysis (or of the forecast) of basic meteorological fields on global regular latitude-longitude grids. The traditional predictors of the fronts are 1) vertical component of the wind's vorticity; 2) Laplacian of pressure upon a sea level; 3) temperature gradient. We use (instead of the first ones) maximal eigenvalues of the following matrices: a symmetric part of matrix Jacobi horizontal wind and the second horizontal derivatives (matrix Hesse) geopotential (or pressure upon a sea level), correspondingly. Then we search the optimal weight, dependent on the season and the baric level, for these three predictors' combination.

We use high order approximations (fast Fourier transform and compact scheme approaches). Heuristic methods of construction of the frontal thin zones along "crests" in the predictor's 2D field are developed. Also we use some algorithms for a vertical adjustment of the frontal lines.

A validation of the geometry's evaluation is considered, too. We calculate two kinds of correlation functions (CF) for the basic meteorological fields. CF are functions of the distance between to points. Two clusters of points' pair are used: the points are divided by a frontal zone and points not are divided by a frontal zone. Our algorithm (with optimal weights of various predictors) provides significant difference (in the integral norm) between these CF.

Thus, we demonstrate an algorithm, codes and results, base 0.5[U+25CB] NCEP analysis and 12-, 24- or 36-hour forecasts that construct frontal surfaces. Usually we obtain frontal surface that across all troposphere. However, sometimes we observe such surface near Earth only, or, on the contrary, in higher troposphere only. The 3D-geometry of such surfaces is sometimes sophisticate.

Ph.L.Bykov, V.A.Gordin Diagnosis of atmospheric fronts on meteorological fields values on a regular grid. A series of "Mathematical Modelling and modern information technologies", Issue 8 Modern Problems of Mathematical Modeling. Mathematical modeling, numerical methods and program complexes. Rostov-on-Don, publisher of Southern Federal University, 2009. 129 -137 (in Russian).

V.A.Gordin. Mathematical Problems and Methods in Hydrodynamical Weather Forecasting. - Amsterdam etc.: Gordon & Breach Publ. House, 2000.

V.A.Gordin. Mathematics, Computer, Weather Forecasting, and Other Mathmatical Physics' Scenarios. - Moscow, Fizmatlit, 2010 (in Russian).

Ph.L.Bykov, V.A.Gordin. The Objective Analysis of Three-Dimensional Geometry of Atmospheric Fronts. Research Activities in Atmospheric and Oceanic Modeling, 2009 http://collaboration.cmc.ec.gc.ca/science/wgne/BlueBook/submitted- documents/ 02$$Gordin$$Vladimir$$fronts.pdf P.2.11-2.12.