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THE CALCULATION OF THE FRONTOGENETIC FUNCTION

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Abstract The development of methods of diagnosis and forecasting of atmospheric fronts is one of priority problems of atmospheric dynamics. It is known that in overwhelming majority of cases the diagnosis of fronts is determined by the synoptic analysis. In this paper we develop some quantitative methods of diagnosis of fronts.

Development of methods of the diagnosis and the forecast of atmospheric fronts is one of prioritary problems of atmospheric dynamics. It is known, that in overwhelming majority of cases the diagnostics of fronts is determined by the synoptic analysis. In the present work we develop quantitative methods of the diagnosis of fronts. One parameter on which it is possible to judge the presence of the atmospheric front is the frontogenetic function, representing the total derivative with respect to time from a horizontal gradient of temperature. Using the thermodynamics equation, the frontogenetic function can be written as

F = $\frac{d}{dt}\,|\nabla\theta|$ = Convergence + deformation + a bend + inflows of heat

where convergence = - $\frac{1}{2|\nabla\theta|}(\theta_x^2+\theta_y^2)(U_x+V_y)$

deformation = - $-\frac{1}{2|\nabla\theta|}[(\theta_x^2-\theta_y^2)(U_x-V_y)\ +\ 2\theta_x\,\theta_y(U_y+V_x)]$

bend = - $\frac{\theta_z}{|\nabla\theta|}(\theta_x\,W_x+\theta_y\,W_y)$, Inflows of heat = $\frac{1}{|\nabla\theta|}\nabla\theta\nabla H$

where ∇ −horizontal gradient, H - inflows of heat owing to evaporation and condensation, θ - temperature, u, v, w - components of speed of a wind.

To positive values F the process of amplification of horizontal gradients of temperature, i.e. frontogenesis, while to negative values, a negative - frontolise correspond.

As at calculation of the frontogenetic function it is necessary to calculate derivatives from nonlinear terms, vertical speeds, sources and drains high smoothness requirements on the initial data must be imposed. Indeed, a series of calculations which have been carried out on GARP data, has shown high sensitivity of the frontogenetic function on the possible noise in given measurements (fig. 1a,b). In addition the noise level quite often appears to be equal in intensity to the level of a useful signal. In order to suppress the noise the median filtration, which is one of methods of nonlinear processing signal

as used. Median filtration keeps sharp differences in fields whereas the usual linear filter smoothes these differences.

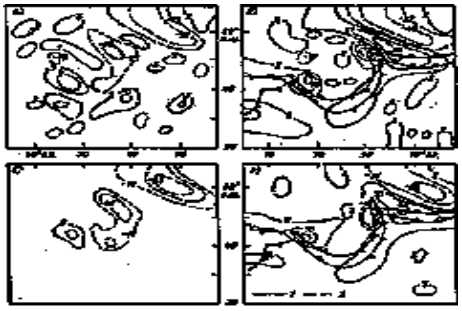

Fig. 1 Frontogenetic function without using median filter (a,b). Below after filtration. GARP dataset H500 and H1000 for 00h. 5 January 1979. --- for $F > 0$, —- $F < 0$. Fronts position were obtained by using the synoptic analysis.

A series of experiments with GARP data by using the median filter has shown that the best results are obtained with the filter with the aperture 5x5, in case when the field of temperature is exposed to a filtration only. Median filter substantially suppresses noise, allocates a useful signal, leaving constant its site.

Position of areas of positive values of F and change of their intensity can be connected with certain sites of fronts rather easily. The greatest positive values of F are marked along a zone of the Arctic front while at the top of an internal wave begun the occlusion of the cyclone. Concurrence of maxima of positive values of F to the position of frontal sections and tops of waves on them on 12 has forecasts value. Areas of negative values F coincide either with areas of divergence of anticyclones on a surface 500GPa, or with the position of the anticyclones crosspieces - saddles on the ground.

In order to study the structure of the front, the vertical cuts of an atmosphere along two parallels $42{,}5^0$ and $47{,}5^0$n.l., for 00h. January 5, 1979, GARP data were executed. They cross the cold fronts under an ungle of almost 90^0, but on different distances from the top of a wave. On vertical cuts the following parameters were analyzed: temperature, horizontal speed of the wind, relative humidity, vertical speed, convergence, deformation, a bend and total frontogenetic function.

Making separate comparison on the frontogenetic function shows that a bend isentropic surface is sometimes more than its other components. The contribution of heat inflows of in the total frontogenetic function appeared insignificant.