Bias, Variability, and Hydrostatic Adjustment for 3D Forecast Fields of Geopotential Height, Temperature and Wind[1]

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Forecast meteorological fields are used as first guess (FG) for objective analysis (OA) procedures. Our verification of the fields shows that they are not fulfilled to hydrostatic equation:

$$\frac{dH}{d\xi} = T, \quad \text{where} \quad \xi = -\frac{R}{g} \cdot \ln p \qquad (1)$$

The differential equation can be discretized (by cubic splines) for 16 mandatory levels as

$$\frac{3 \cdot H_{i-1}}{h_{i-1}^2} - \frac{3 \cdot H_i}{h_{i-1}^2} + \frac{3 \cdot H_i}{h_i^2} - \frac{3 \cdot H_{i+1}}{h_i^2} + \frac{T_{i-1}}{h_{i-1}} + \frac{2 \cdot T_i}{h_{i-1}} + \frac{2 \cdot T_i}{h_i} + \frac{T_{i+1}}{h_i} = 0, \quad i = 2,...,15, \qquad (2)$$

where $h_i = \xi_{i+1} - \xi_i$, $i = 1,...,15$. To damp the residuals of the hydrostatic equation we make a projection (see [3]) of any twin vertical profile of the 32D-field $\left\langle \{H_j\}_{j=1}^{j=16}, \{T_j\}_{j=1}^{j=16} \right\rangle$ onto the 18 dimensional subspace composed from all vectors that satisfy to (2).

Evaluations over four years of three-dimensional fields of bias and variability of the difference between some observed upper-air values and forecast fields (Bracknell's) are shown on **Fig.1-5.** The variability here i) is smaller the climatic one, [2]; ii) strongly depends on horizontal coordinates. The mean values of differences are remarkable large. The application of corresponded corrections to the first guess fields during objective analysis procedure leads to improvements of the resulted objective analysis geopotential height fields [1,3].

1. Alduchov O.A., Bagrov A.N., Gordin V.A.: *Statistical characteristics of forecast meteorological fields and their application for objective analysis. Bias and hydrostatic departures*. Submitted to "Meteorology and Hydrology".
2. Alduchov O.A., Gordin V.A : *3-Dimentional Correlation Functions of Basic Upper-Air Parameters.* , 2001, Izvestia of Russian Academy of Sciences. ser. ``The Physics of Atmosphere and Ocean'', 37(1), pp.3-23.
3. Gordin V.A.: *Mathematical Problems and Methods in Hydrodynamic Weather Forecasting.* Gordon & Breach Publ. House, 2000, 842p.

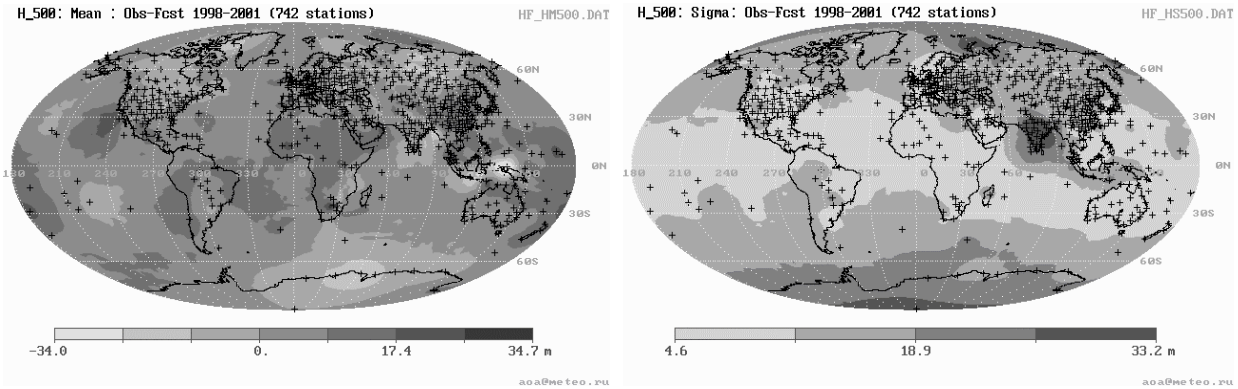

Fig. 1. Mean (left) and variability (right) of differences observations-forecast for geopotential height at level 500 hPa over 1998-2001 years.

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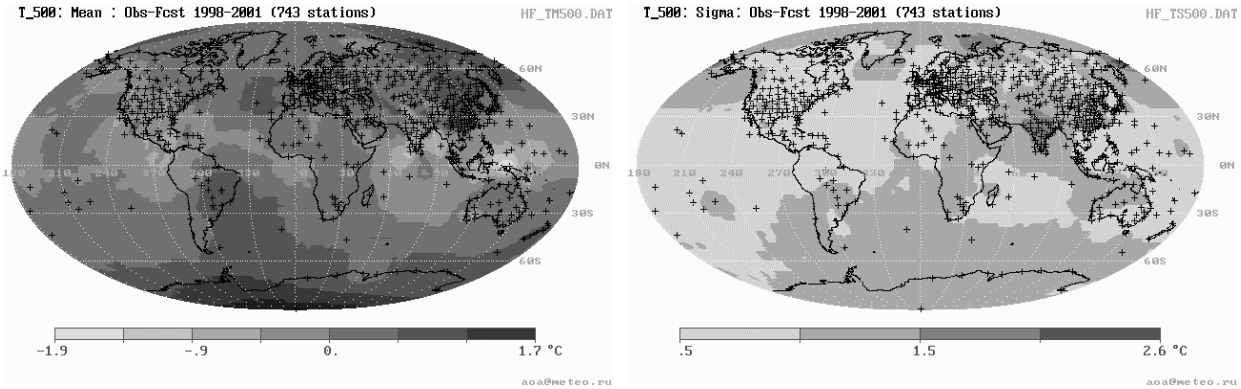

Fig. 2. Mean (left) and variability (right) of differences observations-forecast for temperature at level 500 hPa over 1998-2001 years.

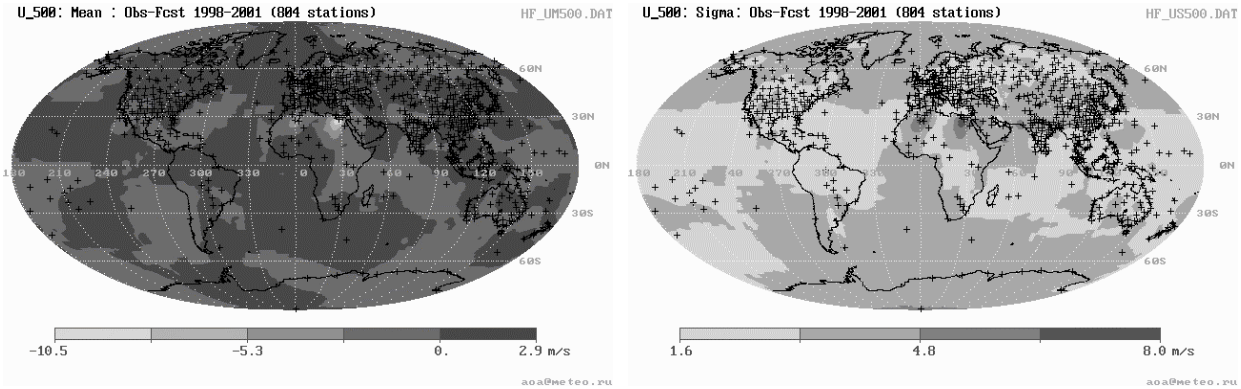

Fig. 3. Mean (left) and variability (right) of differences observations-forecast for zonal wind at level 500 hPa over 1998-2001 years.

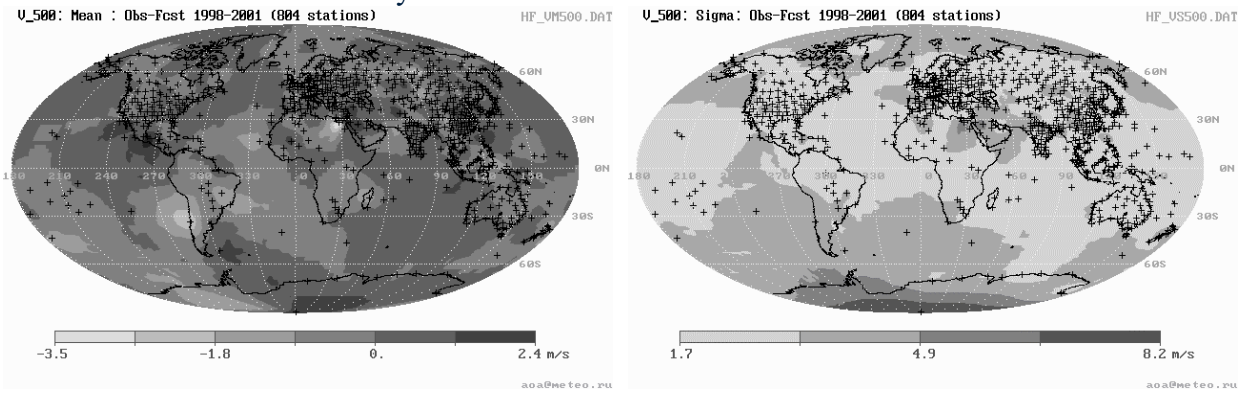

Fig. 4. Mean (left) and variability (right) of differences observations-forecast for meridional wind at level 500 hPa over 1998-2001 years.

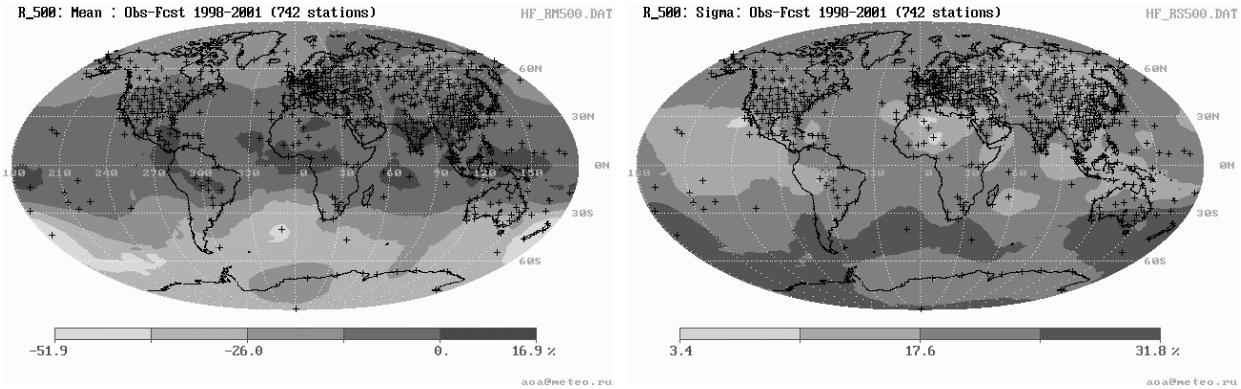

Fig. 5. Mean (left) and variability (right) of differences observations-forecast for relative humidity at level 500 hPa over 1998-2001 years.