System of 3D Geopotential Height, Temperature and Wind Correlations with Respect to Forecast Errors[1]

Oleg A. Alduchov[2], Vladimir A. Gordin[3]

The correlation model, proposed by [1-5], was applied for 3-years time series of forecast errors (differences observation-forecast) with respect to the forecast fields used in Hydrometeorological Center of Russia, Moscow. The subset of 843 (from available 1055 during three years) upper-air stations over globe were used for calculations. Even three years is too short period for reliable evaluations of correlations, some very preliminary results may be obtained.

The correlations were calculated under following conditions:

a) all differences were normalized (see our previous article here) by local (for each upper-air station) mean and sigma:

$$f(\vec{x},p)=\frac{F(\vec{x},p)-\overline{F}(\vec{x},p)}{\sigma_{F(\vec{x},p)}};$$

b) for each 30-degrees latitudinal zone the fields of such normalized forecast errors are considered as homogeneous and isotropic with respect to horizontal coordinates;

c) it was assumed (because of too short period of accumulated time series) that normalized forecast errors are homogeneous during whole three years (without months partitioning).

The full set of auto- and cross-correlations $\{\mu(r_k,P_i,P_j)\}$ for geopotential height (*H*), temperature (*T*), transversal (*N*) and longitudinal (*L*) wind's components forecast errors at *15* standard pressure levels from *925* to *10* hPa and for *50*-km distance intervals from *0* to *3000* km were calculated.

Resulted correlations were approximated by expressions

$$\mu(r_k,p_i,p_j)=a_0(p_i,p_j)\cdot\delta(r_k)+\sum_{l=1}^{N}a_l(p_i,p_j)\cdot\mathbf{J_0}(r_k/d_l) \qquad (1)$$

where $\delta(r_k)$ is the Dirac-function equal to *0* everywhere except point $r=0$, where it is equal to 1; $\mathbf{J_0}$ - Bessel-function; $\mathbf{A}_l=\{a_l(P_i,P_j)\},l=0,...,N$ are positively defined matrices of coefficients to be defined; $d_l,l=1,...,N$ are some scale coefficients to be defined too. (*N=4* for the current case).

Being defined as result of the task solution, the positively defined matrixes $\mathbf{A}_l$ guarantee the positively definiteness of approximated functions μ and its closeness to original coefficients μ. So, RMS differences between originally calculated correlations and their positively defined approximations are about *0.01*. Again, approximation (1) allows distinguishing between local errors (including observation errors and local field disturbances) and macro scale errors by very simple technique under reasonable assumptions.

Some cross-sections of approximated correlations of forecast errors with comparison to original coefficients fore middle latitudes of Northern hemisphere are shown on the Figure. Correlations *HxL, TxL* and *NxL* are theoretically equal to 0. It is obvious that correlations are significantly varying for different levels. It is easy to see also that correlations for stratospheric levels (above *100* hPa level) are much more significant comparing troposphere levels. It means that forecast into troposphere is much more close to really observed values against the stratosphere. Comparison with correlations of observed upper-air parameters [3,5], shows that correlation radius for forecast errors is remarkable smaller.

1. Alduchov O.A., Gordin V.A. (AG): *3-D Correlation Functions of Upper-Air Parameters.* Research Activities in Atmospheric and Oceanic Modeling. 1998, N 27/865, pp.1.1-1.2.
2. AG: *3D Correlation Functions - Variational Problem.* Ibid, N 28, 1999, pp.1.1-1.2.
3. AG: *Complete system of 3-D geop. height, temperature and wind correlations.* Ibid, N 29, 2000, pp.1.1-1.2.
4. Gordin V.A.: *Mathematical Problems and Methods in Hydrodynamic Weather Forecasting.* Gordon Breach Publ. House, 2000, 842p.
5. AG: *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.

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[2] Russian Inst. of Hydrometeorological Information-Word Data Center, Obninsk, Russia, aoa@wdc.meteo.ru
[3] Hydrometeorological Center of Russia, Moscow, Russia, vagordin@vagordin.mccme.ru

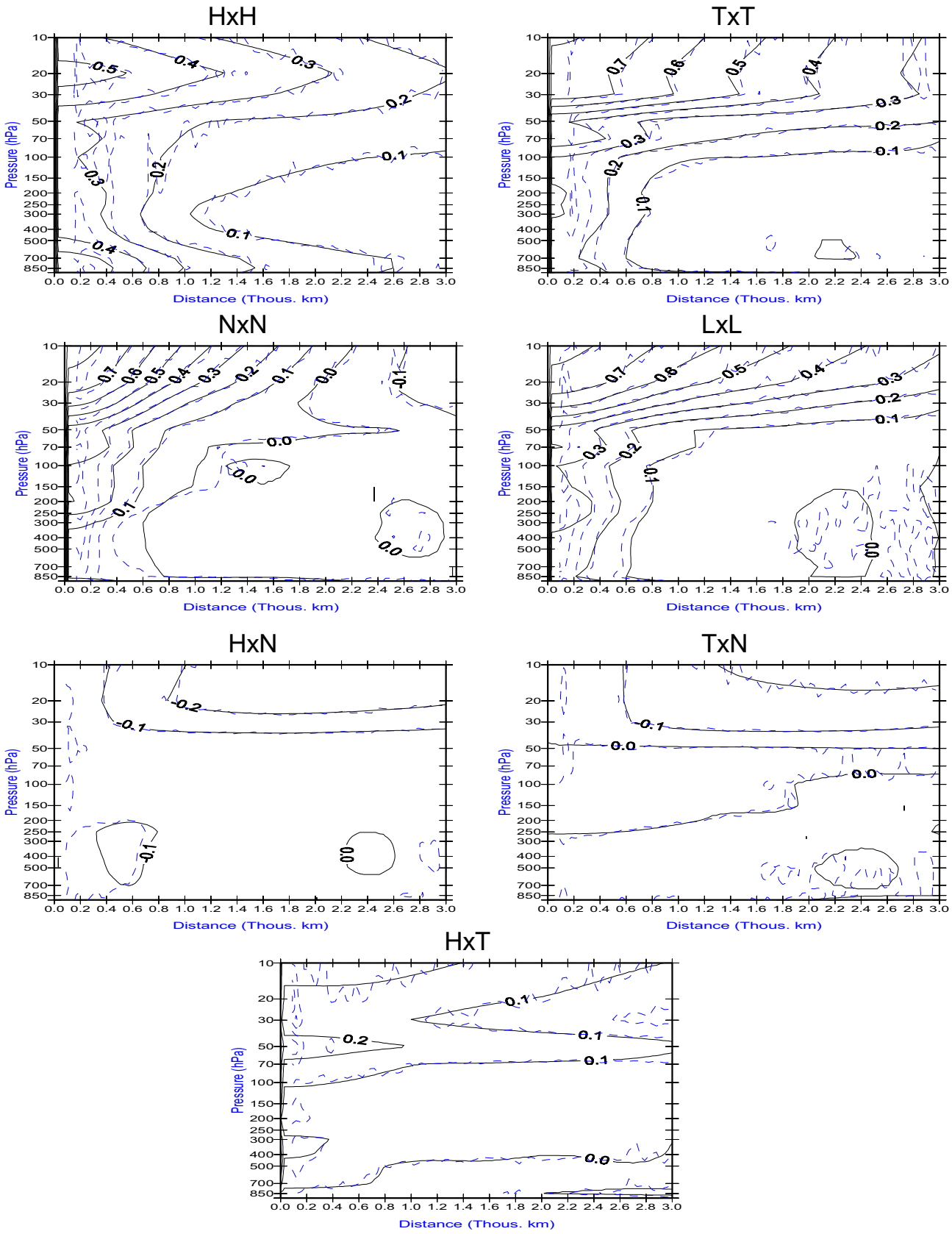

Figure. Auto- (HxH, TxT, NxN and LxL) and cross- (HxN, TxN and HxT) correlation functions for 30-60 degree latitudes of Northern hemisphere, 1998-2000 years.
Dashed line - originally calculated correlations, solid line - approximated.