Anisotropy of Meteorological Fields[1]

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If we consider meteorological field as representations of stochastic (scalar and vector, with 3D argument) fields, the first moments – climate fields - include most essential information about the fields. But the second moments – correlation functions (CFs) – give some additional information about meteorological fields. Adequate CFs are necessary for many task with meteorological fields assimilation. This is a reason why CFs as well as their Fourier images - spectral densities - are investigated during last century, see [2] for details.

We have estimated, [1], the matrix-valued 3D CFs of geopotential height, temperature, and horizontal wind using most full global aerological dataset CARDS (Comprehensive Aerological Reference Data Set), 1948-2001 of radiosonde observations under homogeneity and isotropy hypotheses.

There is a strong mathematical problem here: to provide a positive definiteness of the approximated CFs. We solve the problem as a variational one using perturbation theory of Hermitian operators, [1,2]. We estimate the CFs for various months and geographical zones. The homogeneity and isotropy hypotheses were used here.

However the isotropy hypothesis is not strongly adequate especially is tropical zone – in [3-4] it has demonstrated, for separate points, but not for CF. Estimations on the base of 38-year observed data shows that anisotropy coefficients (relation of distance to equal correlations along of X-axis to Y-axis) are significantly above 1.0 for tropical zone (see Fig. 1-2). One have keep in the mind that number of observation is remarkable low for Southern hemisphere with respect to the Northern one. It is a reason for smoother estimations at Northern hemisphere.

To provide more adequate hypothesis we suppose to introduce a new Riemann metric for horizontal coordinates:

$$ds^2 = a(y,p)\cdot dx^2 + b(y,p)\cdot dx\cdot dy + c(y,p)\cdot dy^2, \quad \text{where } a,c>0,\ ac-b^2/4>0$$

and assume that CFs are isotropic in the new metrics.

Next step is to optimize the tensor's coefficients a,b,c according to our observational data. As a result we will get universal metric for description of anisotropic correlations.

References

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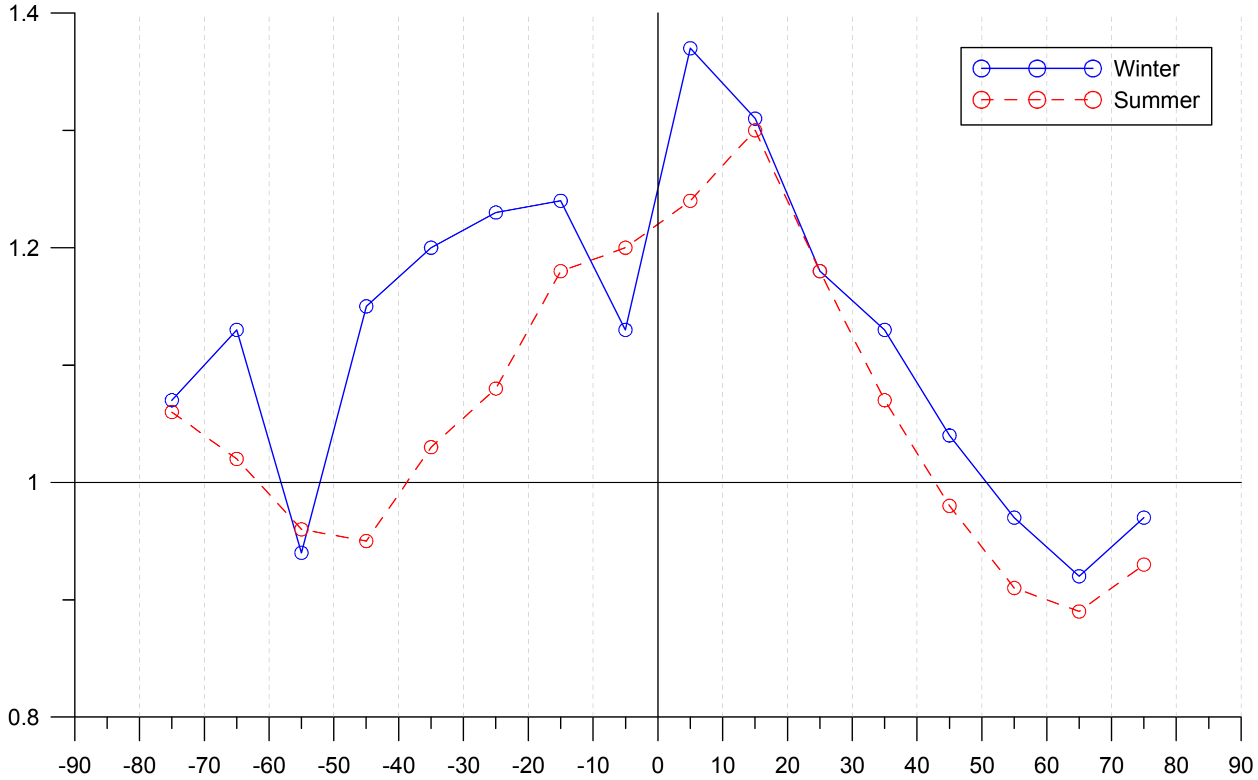

Figure1. Estimation of anisotropy coefficient for temperature at level 500 hPa.

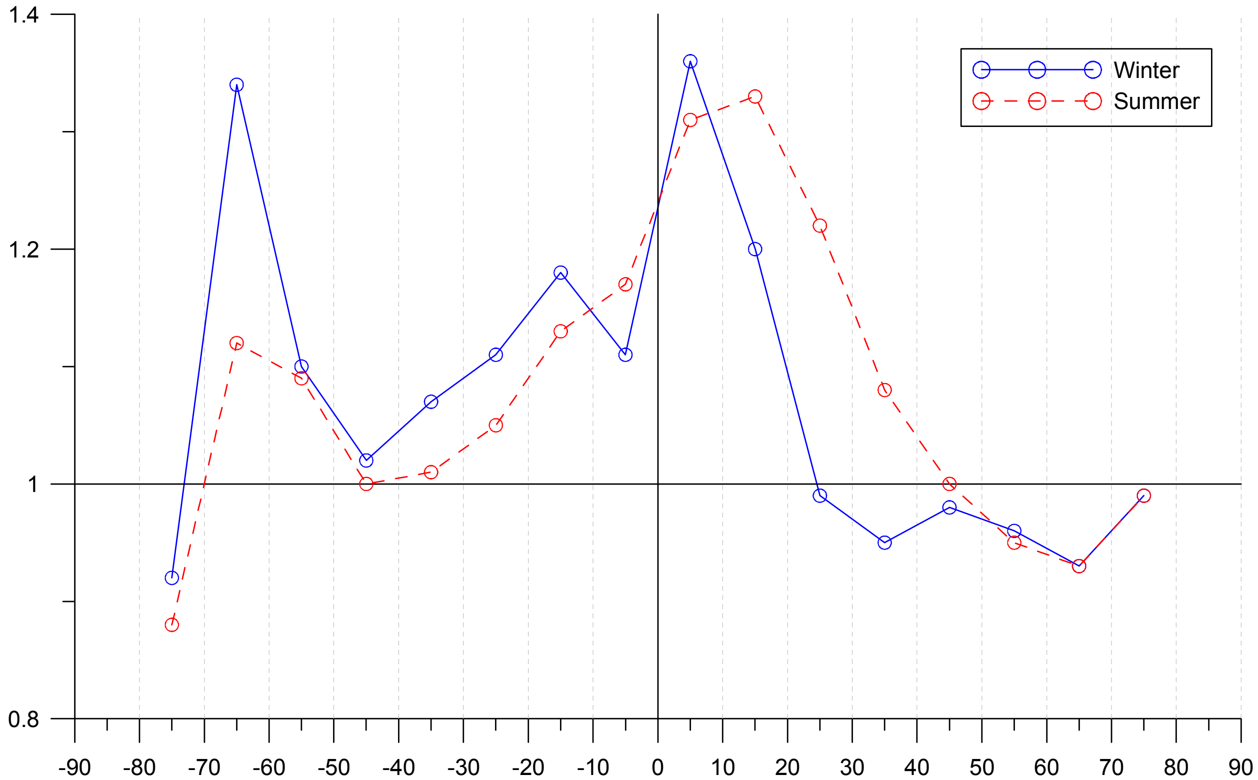

Figure 2. Estimation of anisotropy coefficient for geopotential height at level 500 hPa.