Three-Dimensional Covariances of Temperature and Salinity Fields Estimated from Argo Data

Yu.D. Resnyansky, B.S. Strukov, M.D. Tsyrulnikov, and A.A. Zelenko

Hydrometeorological Research Center of the Russian Federation, Moscow, Russia

E-mail: resn@mecom.ru

The 3-D covariances of global oceanic temperature and salinity fields are estimated. Deviations of Argo measurements from the climatology WOA2001 (Conkright et al., 2002) are studied.

1. Data

Argo floats observations for the period 2005–2007 were used. The data were grouped in 10-day portions, and a simple algorithm was employed that generated super observations by averaging neighboring observations within 5-km thinning distance.

The observation data were interpolated to 21 fixed vertical levels ranged from 10 to 1400 m. The data were quality controlled with the rejection threshold $\pm 3\sigma$, with σ taken from WOA2001. The total amount of data is about 2.2×10^5 in the upper levels and 1.3×10^5 at depth 1400 m.

2. Methodology

One-point statistics (means and standard deviations) and two-point second-order moments (3-D covariances and correlations) were examined. Quasi-homogeneous regions were selected, for which the covariances were estimated relying on the local horizontal homogeneity hypothesis of the underlying temperature and salinity random fields. Without dividing the oceans into properly selected regions, spurious long-distance correlations appear, probably, due to inadequacies in the climatology used (which, in turn, may be caused by the global warming, e.g. Levitus et al., 2005). The 12 selected regions include western and eastern parts of the oceans in three latitude belts, 20°–65°N, 20°S–20°N, and 20°–65°S.

3. Results and discussion

The following conclusions can be drawn from this study (see Figs. 1–3).

1. Positive biases for temperature are apparent in the upper 1 km layer (not shown), most likely, due to global warming.
2. One-point second moments (standard deviations) for salinity monotonically decrease with depth, whereas temperature standard deviations have maximum at about 100 m depth.
3. Horizontal correlations decrease with depth from the surface down to 500–1000 m and slightly increase with depth within the layer 1000–1400 m.
4. In the Western parts of the oceans, horizontal correlations appear to be sharper – due to narrower western currents and the eddy perturbations associated with them.
5. In the near-surface layer, salinity correlations turn out to be sharper than temperature correlations (probably, due to the influence of rather spotty atmospheric precipitation field and larger-scale heat flux patterns generated by atmospheric forcing).
6. In the upper 300-400 m layer, tropical horizontal correlations, particularly in the Pacific Ocean, appear to be significantly anisotropic, with longer length scales in the zonal direction, obviously, related to the anomalies associated with El-Nino/La Nina phenomenon.
7. Vertical length scales grow with depth. Vertical correlations are, roughly, symmetric (upward vs. downward) in the z-coordinate system.
8. At the resolution provided by the Argo observational network, both horizontal and vertical correlations exhibit lack of differentiability at zero distances, implying that there is a significant amount of energy at the non-resolved scales (synoptic perturbations, jet streams, fronts).

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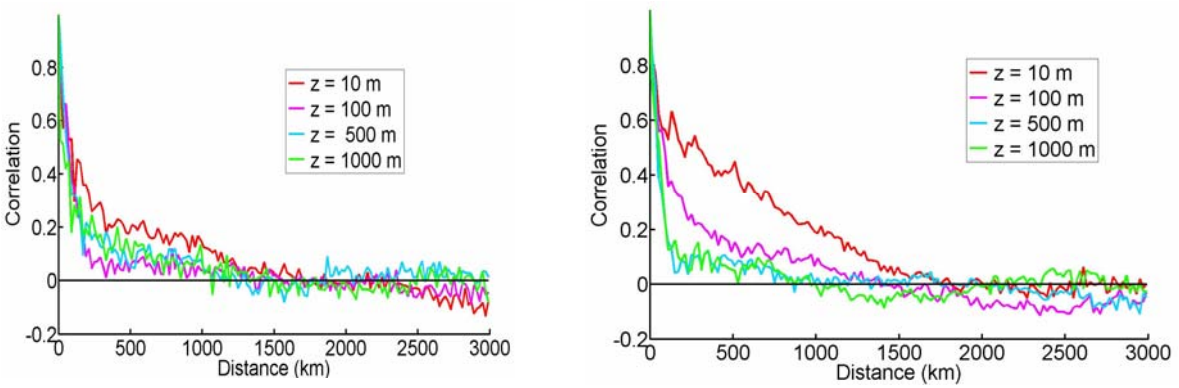

Fig. 1. North Atlantic horizontal correlations at a number of depths (see the legend): western part (left) and eastern part (right)

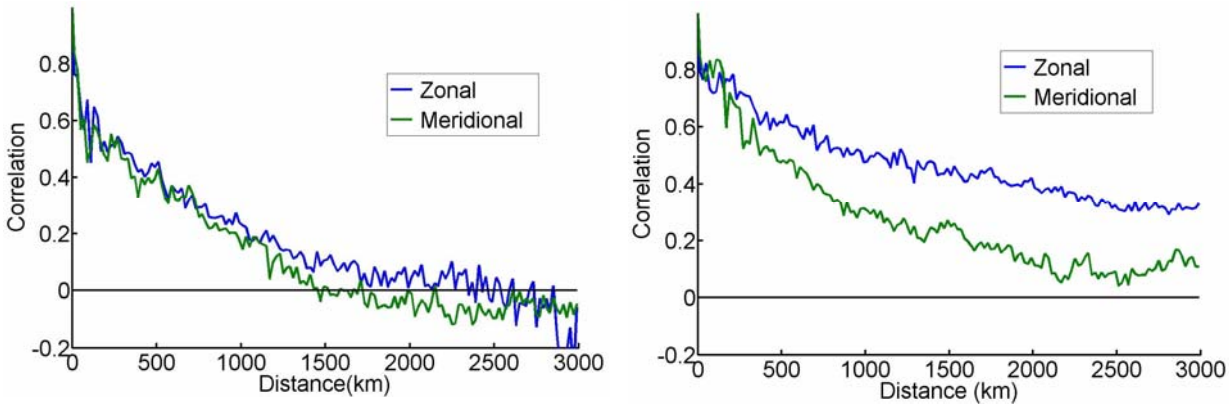

Fig. 2. Horizontal anisotropy for temperature at 10 m depth: zonal correlations (blue) vs. meridional ones (green). Left panel – Eastern North Atlantic, right panel – Eastern Tropical Pacific.

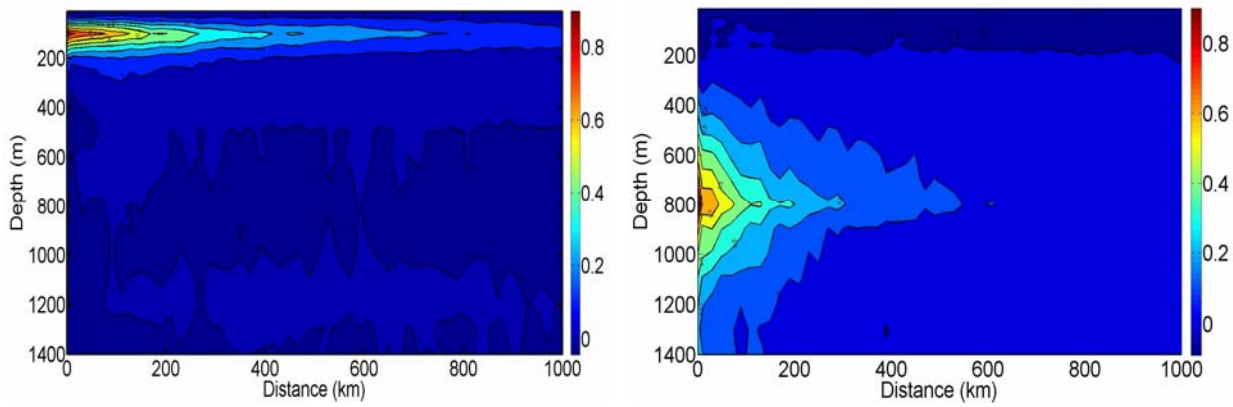

Fig. 3. Vertical cross-sections of 3-D correlations for the reference levels: 100 m (left) and 800 m (right)

References

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Levitus, S., J. Antonov, and T. Boyer, 2005: Warming of the world ocean, 1955–2003. *Geophysical Research Letters*, **32**, L02604, doi:10.1029/2004GL021592.