SSH and velocity frequency and wavenumber spectra in the Atlantic Ocean, estimated from altimetry and a hierarchy of numerical simulations

Stavroula Biri, Nuno Serra, Martin G. Scharffenberg and Detlef Stammer

Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG

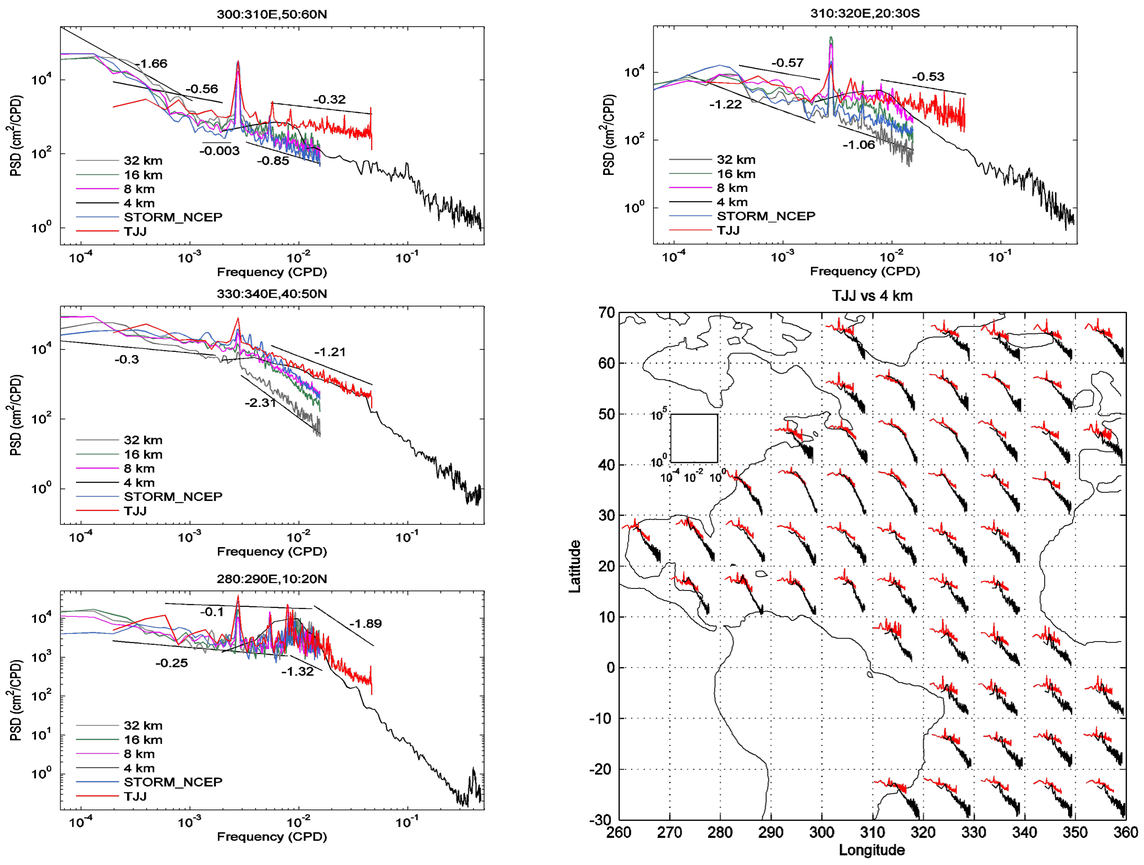
Centrum für Erdsystemforschung und Nachhaltigkeit / Universität Hamburg

cen

Summary We present frequency and wavenumber spectra computed regionally from the 19 year (1993-2010) long altimeter data set, and from output of the MITgcm model configured for the Atlantic Ocean with resolutions of 32 km, 16 km, 8 km, 4km. Also included are results from the STORM_NCEP model. Model resolution is essential for reproducing the observed spectra shape and in some regions the high-resolution model results agree well with altimetry. However, discrepancies remain for small frequencies and wave numbers over many regions. Nevertheless, all model results show a small-wavenumber plateau similar to altimetry. Regarding the altimetry we do not have conclusive evidence that for ranges between sub-mesoscale and shorter scales the signal is purely noise.

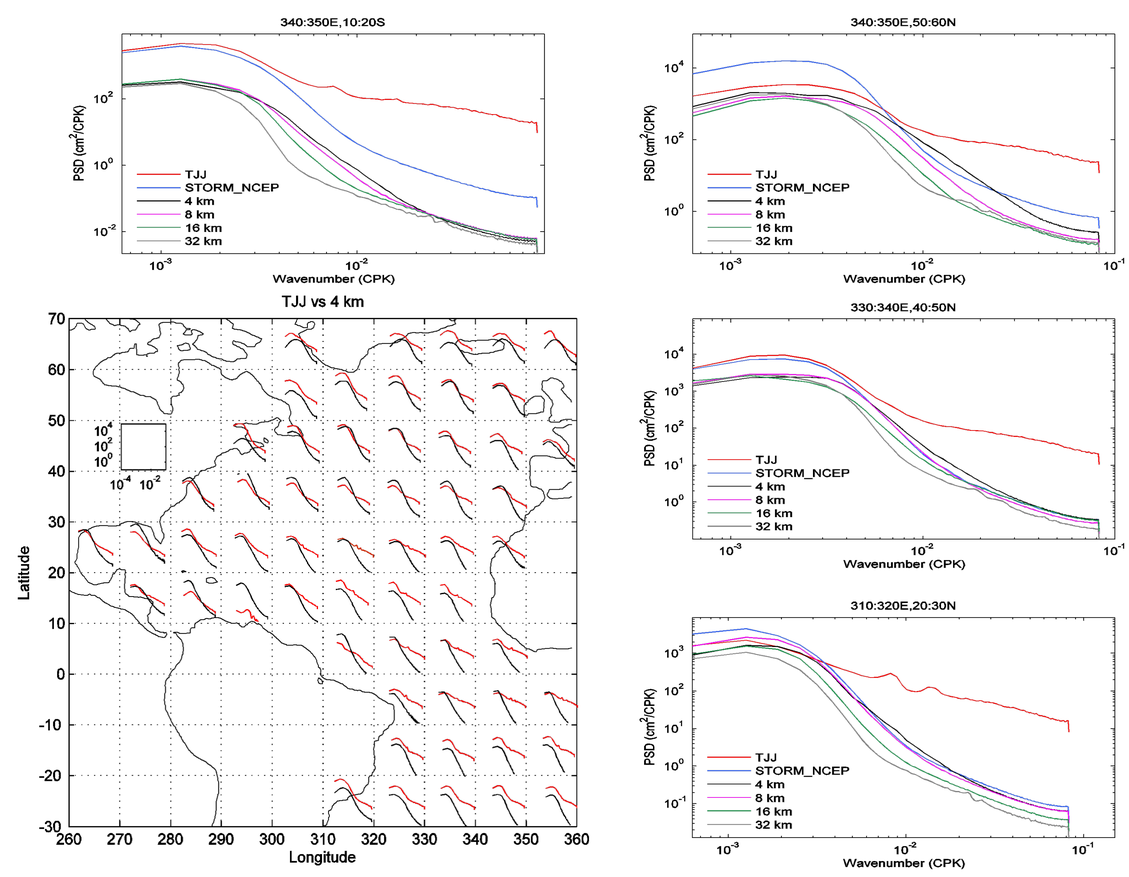
Model velocity spectra as for SSH, improve with increasing resolution. Most differences either in shape and/or magnitude are located in the tropics.

Frequency Spectra – SSH



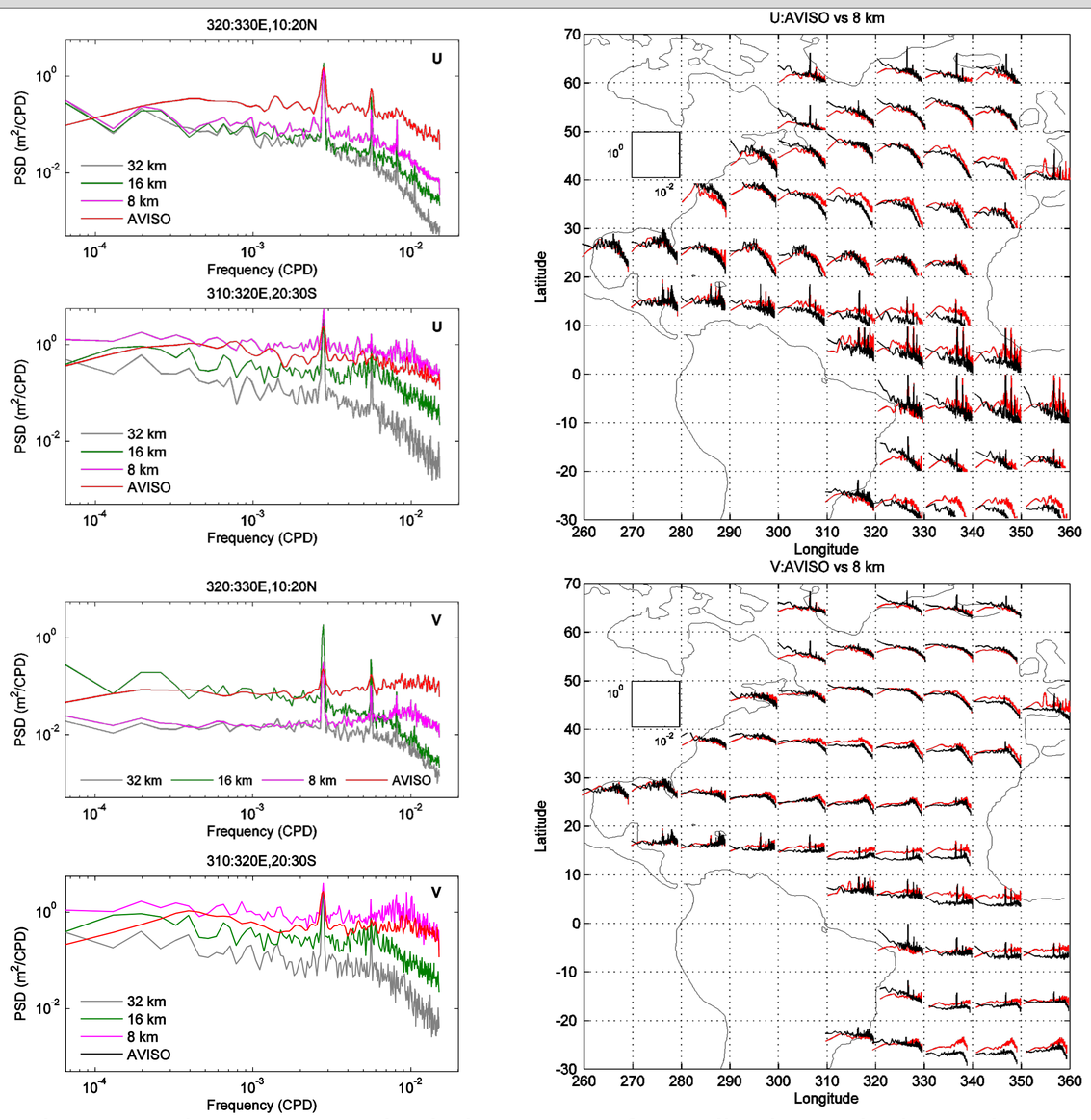
With increasing resolution of the model, model spectra closer resemble altimetric results. However, even the highest resolution available spectra fails to describe the same spectral density contained in TJJ at high frequencies, though the spectral slopes tend to be qualitatively close.

Wavenumber Spectra – SSH



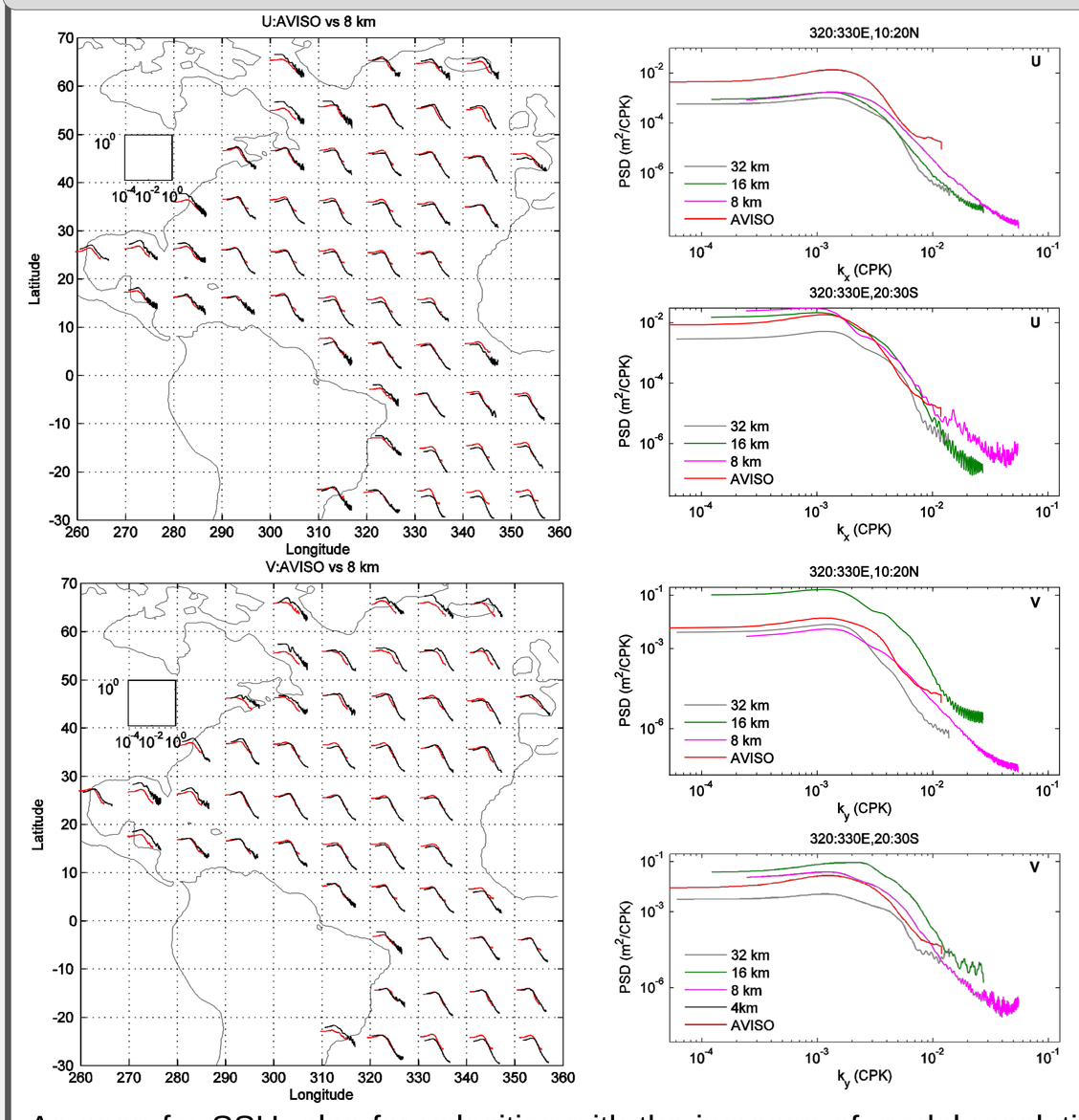
There is a clear shift towards smaller scales and higher amplitudes as the model resolution increases rendering the spectra much closer to TJJ. However, an obvious unexplained wedge remains between altimetry and model results on high wavenumbers where the model spectra have steeper slopes than TJJ.

Frequency Spectra – Velocity



There is a good agreement both in terms of amplitude and shape between Aviso and 8 km velocities, especially in mid and high latitudes. The 16 and 32 km have steeper slopes than Aviso in high frequencies.

Wavenumber Spectra – Velocity



As seen for SSH, also for velocities with the increase of model resolution, the spectra shape draws closer to the one derived from Aviso.

Methodology The altimeter data were interpolated in time and space. A windowed FFT method was used to compute the frequency and wavenumber spectra. Before the computation of the frequency spectra any remaining trend was removed. Frequency spectra were computed for every along-track position and then averaged globally or regionally. For the computation of wavenumber spectra of SSH the methodology described by Scharffenberg and Stammer [2011] was followed. The MITgcm and AVISO velocity spectra were computed on the grid.

Reference: Scharffenberg, M. and Stammer, D. (2011). Statistical parameters of the geostrophic ocean flow field, estimated by jason-1-topex/poseidon tandem mission. *J. Geophys. Res.*, 116(C12011):1--14, doi:10.1029/2011JC007376.