COMPARATIVE STATISTICAL ANALYSIS OF OCEAN DYNAMICS HINDCASTED BY OCEAN MODEL AND OBSERVED BY SATELLITE ALTIMETRY

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A research program for joint statistical analysis of ocean dynamical processes observed by satellite altimeter and simulated by the ECCO-MIT ocean numerical model run at JPL is described. The range of spatial and temporal scales under consideration includes primarily quasi-geostrophic motions. However, shorter-scale dynamics and long-term trends will be also explored using a variety of statistical approaches. A few examples are illustrateted based on 10 years worth of altimeter (T/P and Jason) sea surface height measurements and numerical ocean model (MIT-ECCO) hindcasts. QG motions are characterized separately for four relatively narrow bands of timescales varying between one year and one decade. Data analysis is carried out for a set of small ocean areas of the Pacific in order to assess spatial (primarily, latitudinal) variations of the statistical characteristics (such as meridional and latitudinal length scales, magnitude and direction of phase propagation, etc.) of oceanic motions. The ocean numerical model is shown to reproduce many features of observed ocean dynamics rather faithfully.

Example of 2D Spectral Analysis of SSH variations in the tropical Pacific

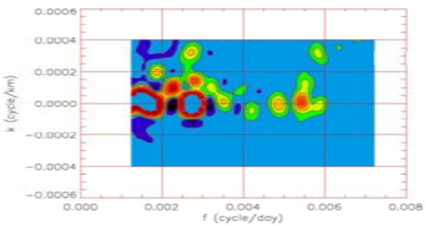
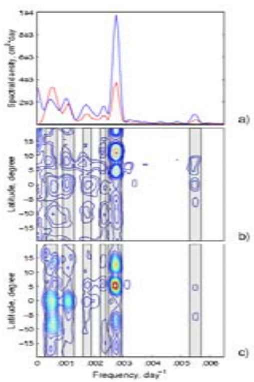


Fig. A. Power spectrum F(ω,**k**) of zonal and temporal variations of the SSH field at 14.50 N in the Pacific. Based on Topex data. (Please, ignore blue areas inside large annual and inter-annual peaks at k=0. They are actually dark red.)



•Latitudinal dependence of oceanic variability on timescales from semi- to inter-annual, based on ECCO-model-simulated (panel c) and satellite-observed (panel b) variations of the SSH field in the period 1993-2002. Panel 'a' shows the mean frequency spectra obtained by averaging all individual spectra over the (19.5oS -- 19.5oN) band: blue curves represent T/P data, red curves represent the ECOO model data.

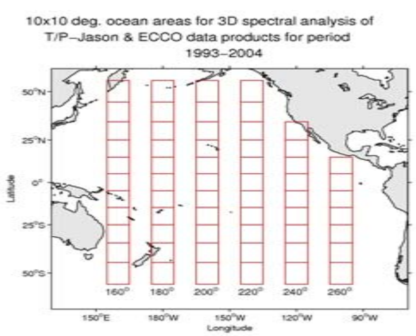


Fig. B. Regions used for spectral analysis of SSH field using 11 years of ECCO model hindcast and altimeter measurements.

Variations of frequency spectra with latitude for the meridional bands in Fig. B. Computed from Topex altimeter- and ocean numerical model-based (ECCO-MIT) data products to facilitate interpretation of SSH variations. The latter are caused by both steric and hydrodynamic mechanisms. Ocean-model-based analysis allows assessing relative impacts of heat content and ocean currents on the SSH variations in different regions.

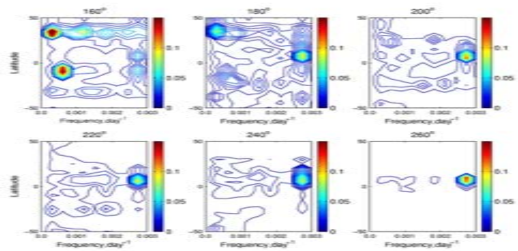


Figure 2: Altimeter-based frequency spectra $S(\omega)$ of SSH variations vs latitude for each meridional section. These 1D spectra are obtained by integrating 3D spectra over all wavenumbers (k_x, k_y).

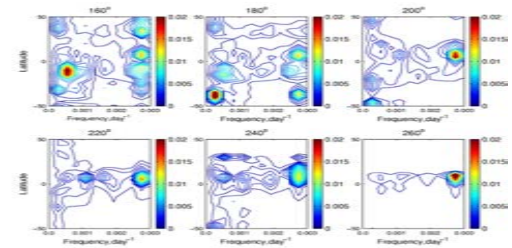


Figure 3: ECCO-model-based frequency spectra of SSH variations vs latitude, analogous to Fig.1

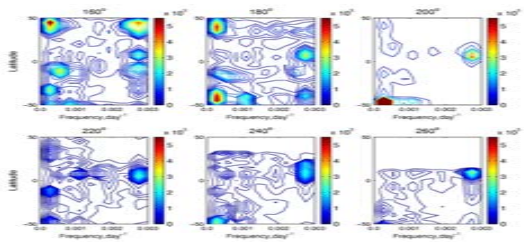


Figure 4: ECCO-model-based frequency spectra of Heat Content (i.e., vertically integrated C_pT) vs latitude, analogous to Fig.2

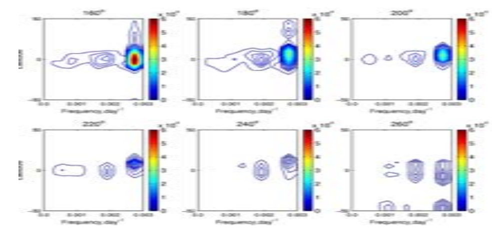


Figure 5: ECCO-model-based frequency spectra of the kinetic energy of oceanic motions (i.e., vertically integrated $(u^2+v^2)/2$ vs latitude, analogous to Fig.2

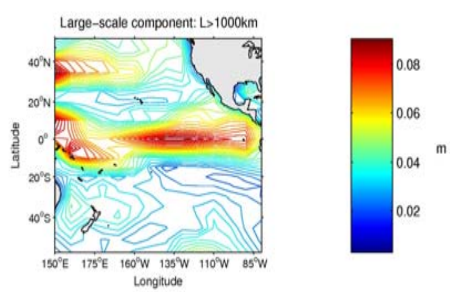


Fig. 5. SSH variability due to the lowest wavenumber range centered at k= 0 rad/km, as exemplified in Fig. A.

Conclusions:

- 3D spectra of SSH contain a great deal of information whose interpretation requires additional effort.
- OGCM data products are very useful as an experimental tool to better understand statistical characteristics of SSH variability
- 2nd statistical moments do not tell the full story, - other techniques are needed to study additional aspects (intermittency, long-term trends, etc.).
- Additional approaches and techniques to be used in this 3-year project will address these aspects of oceanic variability.