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Mesoscale activity in the subtropical North Pacific: striations versus eddies

Nikolai Maximenko[1], Oleg Melnichenko[1], Niklas Schneider[1], Jan Hafner[1], Emanuele Di Lorenzo[2]

[1]International Pacific Research Center, SOEST, University of Hawaii, Honolulu, USA
[2]Georgia Institute of Technology, Atlanta, USA

Abstract

The ongoing OSTST project provides new evidences of recently detected quasi-zonal jet-like features (striations) and reveals new aspects of their interaction with mesoscale eddies. Spatiotemporal correlations, calculated using the Aviso sea level anomalies, contain in the subtropical North Pacific both the eddy signal, decaying at space lag corresponding to the characteristic eddy radius of a few hundred kilometers, and the striation signal, remaining significant at zonal lag up to 2000 km. Striations appear in group and form a parallel pattern resembling a monochromatic wave of 500 km wavelength and 5-degrees azimuth of the wavevector with respect to the southward direction, with the equator-ward phase speed of 0.35 cm/s and local period of 5 years. Parameters of the wave may correspond to the Rossby wave dynamics.

At the same time, majority of eddies in the study area are found to be aligned along the striations. The study provides arguments that the observed pattern is not a result of self-organization of the eddy field. On contrary, the striations control the formation of new eddies and thus organize the otherwise stochastic eddy field. Striations correspond to the most unstable local wave, suggested by Lee and Niiler (1987), and can extend zonally across the Hawaiian Ridge that serves as a barrier to the eddies, moving westward. This study is the next step to understanding mesoscale ocean variability and its relevance to the concept of 'turbulence'.

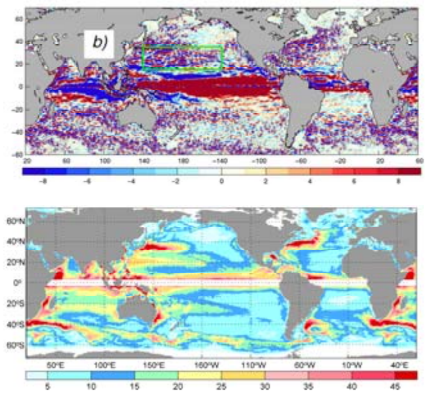

Figure 1. Striations in the 18-week averaged Aviso geostrophic velocity anomaly (top) and r.m.s. Aviso geostrophic velocity (bottom). Units are cm/s.

Are striations real? If yes, what fraction of mesoscale variability are they responsible for?

Choice of study domain

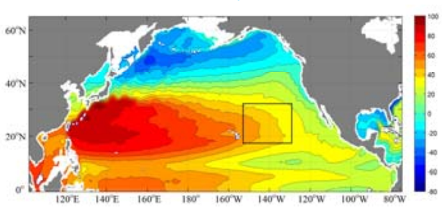

Figure 2. Study domain (rectangle) superposed on contour of the mean dynamic topography. Units are cm.

Choice of filter

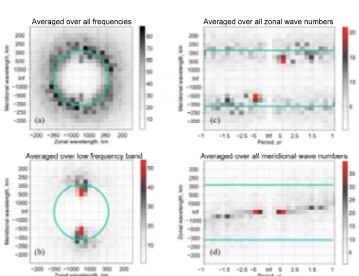

Figure 3. Projections of the longitude-latitude-time Fourier power spectrum of anomaly of geostrophic vorticity in the study domain shown in Fig.2. Units are 10^{-13} $s^{-2}deg^{2}$ (a,b), 10^{-13} $s^{-2}deg{\cdot}year$(c,d).

Striations appear in sets and form a pattern of monochromatic wave with properties of a Rossby wave and also close to the fastest growing wave of Lee and Niiler [1987]

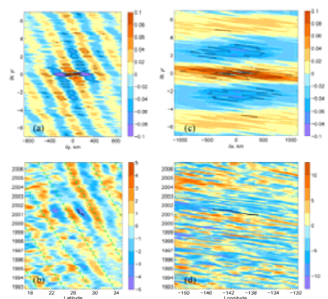

Figure 6. Latitude-time (left) and longitude-time (right) correlations (top) and diagrams (bottom) of high-pass filter sea level anomaly.

Space correlations reveal a co-existence of eddies and striations.
Are they independent from each other?

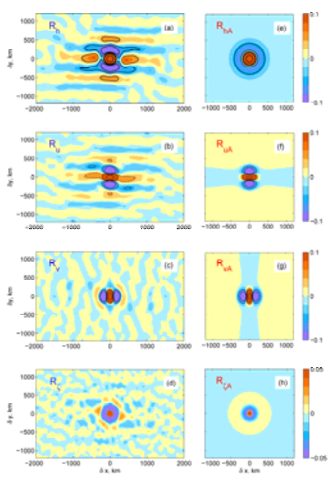

Figure 5. Spatial correlation coefficients of high-pass filtered sea level anomaly (top row), zonal (2nd row) and meridional (3rd row) geostrophic velocity anomaly and geostrophic vorticity anomaly (bottom row) calculated from the Aviso data (left column) and Aviso mapping function (right column).

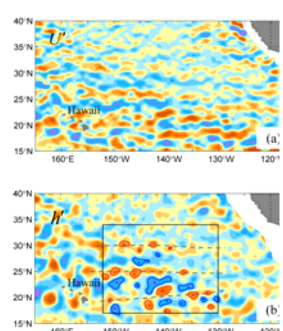

Figure 4. Weekly maps of the Aviso zonal geostrophic velocity anomaly (top) and sea level anomaly, filtered with the 2D high-pass Hanning filter of a 500 km half-width. Contour show eddies and dashed lines denote striations.

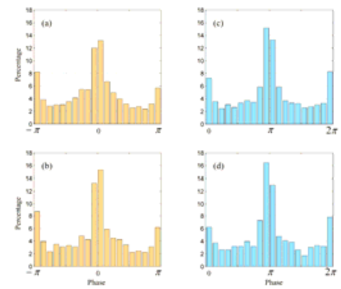

Figure 7. Distribution of locations of all (top) and newly-formed (bottom) cyclonic (left) and anticyclonic (right) eddies relative to the phase of local striations.

Formation of new eddies is controlled by striations rather than eddies self-organize into trains.

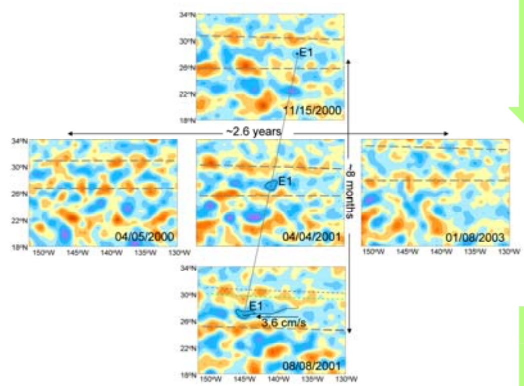

Figure 8. A sequence of maps of high-pass filtered sea level anomaly, tracking individual striations (dashed lines) and a cyclonic eddy (contours).

Westward propagation of mature eddies is synchronized with the equator-ward propagation of striations.

High-pass filtered Aviso SSHA in August 2001.

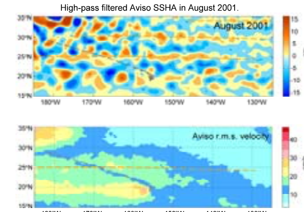

Figure 9. A map of the high-pass filtered sea level anomaly in August 2001 (top) and r.m.s. Aviso geostrophic velocity anomaly (bottom).

The Hawaiian Ridge is a barrier for eddies, not for striations. While striation extends across the ridge new eddies are quickly formed in the shadow of the ridge.

Preliminary results

1. Time-variant striations are neither an artifact of eddies nor a result of their self-organization.

2. Striations demonstrate properties of a monochromatic Rossby wave and may be a mode of local instability.

3. Eddy field is significantly regularized by striations controlling production of new eddies.

Contact: maximenk@hawaii.edu