Introduction

Mesoscale circulation features contribute significantly to cross-shelf transport of biological production from nearshore areas to the deep sea. As part of the U.S. GLOBEC Northeast Pacific program, we are studying the linkage between mesoscale features and the distribution of chlorophyll and secondary production in upwelling areas of Oregon and northern California. Dynamic mesoscale physical features develop through the summer upwelling season in coastal areas of the California Current System and move offshore. The larger of these are generated in fairly predictable, topographically-controlled locations and persist from weeks to months.

In our study area, mesoscale activity and zooplankton biomass and distribution vary seasonally and interannually, with peak biomass typically coinciding with peak mesoscale energy.

Mesoscale variance is a dominate source of energy in our study area, second only to the annual cycle.

Variability in Mesoscale Physical Activity in the Northern California Current and its Effects on Biological Distributions

Wavelet Analysis

Methods

Wavelet methods were based on Torrence and Compo (1998). The wavelet power spectrum is constructed by convolving the time series (Xk) with a scaled wavelet (ψs), to produce a matrix of N data points by scale factors: $R(s,t) = \sum_{k=-\infty}^{\infty} X_k \psi^* \left(\frac{t-kT}{s}\right)$ and the power is defined as: $P(s,t) = R^2(s,t)$

Here, we use the Morlet wavelet (with $\omega_0=6$), which is comprised of a sine wave modified by a Gaussian:

$\psi(t) = \pi^{-1/4} e^{-t^2/2} \sin(\omega_0 t)$

The local wavelet power shown in figures is the square of the wavelet coefficients normalized by the variance of each time series. Significance was tested at each location by comparing the wavelet variance to a red-noise background spectrum defined by the variance and length of each individual time series.

Wavelet power is an important tool for detecting both long-lasting phenomena and transient events.

Results

Wavelet power spectra (Figure 5) show significant energy in the 4-12 week periods (scales) as the periods of mesoscale circulation variability. To examine fluctuations in power contained within a range of periods (scales), we scale-averaged across several periods at each time point and present the averaged power as a time series. Wavelet power spectrum is constructed by convolving the time series with a scaled wavelet.

Conclusions

• Wavelet analyses successfully located temporal changes in productivity in our study area.
• We found statistically significant spatial and inter-annual variability in SSH variance.
• The dominant periods of variability in our study area differ spatially (Figure 4).
• Our analysis of the scale-averaged wavelet power at the 4-12 week periods shows that the northern locations compared to the southern locations.

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References