Abstract View

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Time and Length Scales of Baroclinic Eddies in the Central North Pacific Ocean

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ABSTRACT

The time and length scales of baroclinic eddies in the eastern half of the North Pacific Subtropical Gyre are examined using four data sets: 1) single vertical sections of temperature, based on closely spaced bathy-thermograph (BT) casts (cast spacing <50 km); 2) a set of similarly spaced BT observations distributed in both horizontal dimensions; 3) sub-surface temperature times series of four months to ten years duration from fixed moorings; and 4) a data set identical to the first above, only repeated along the same section at one month intervals for 16 months.

The first data set allows calculation of wavenumber power spectra which reveal that the major contribution to the temperature variance comes from wavelengths >100 km. The spectra attenuate toward higher wavenumbers as the square of the wavenumber over the range 200 to 600 km. Spatial autocorrelation in both horizontal dimensions of the second data set yields a correlation matrix with a first zero crossing at 150 km in both dimensions, implying significant energy at 600 km wavelength, isotropically distributed. Oceanic subsurface perturbations of this isotropic scale are referred to as mesoscale eddies.

The third data set allows calculation of frequency power spectra which reveal that the major temperature variance contribution comes from periods >2 days. The frequency spectra roughly follow an inverse square law bearing a similarity to the wavenumber spectrum over the range of 2 days to 6 months. This similarity indicates a linear relationship between time and length scales exceeding 2 days and 200 km, respectively. This suggests that the eddies are “frozen” features, carried along by the mean flow. To further examine this possibility, we consider the fourth data set, wherein baroclinic eddies of 480 km wavelength were dominant, propagating westward from one month to the next at a speed of 4.5±2 cm sec^{-1}. This is comparable to, but definitely larger than, the observed maximum mean baroclinic flow observed in the fourth data set (1.4±0.8 cm sec^{-1} to the west).

These results indicate that the eddies are not composed of a uniform water mass carried along by the mean flow. Rather the view is adopted that the eddies possess a wave-like nature. The type of waves that have the same time and length scales as the eddy motions, in addition to sharing the property of baroclinicity, are non-dispersive baroclinic

planetary waves. These waves have a phase speed (-4.2 cm sec^{-1}) that is in excellent agreement with the observed eddy propagation speed.

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