Abstract View

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Mesoscale Modal Coupling

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ABSTRACT

Observations of mesoscale ocean eddies from the 1973 Mid-Ocean Dynamics Experiment (MODE) are used to calculate, by objective analysis, the modal coefficients, which are functions of horizontal position and time, in a representation based on the two most energetic vertical modes—the barotropic and first baroclinic. The gross energy levels associated with these modes are calculated and found to be generally consistent with previous estimates. Modal coupling statistics are also estimated: these are the volume integral modal energy exchange rate and the spatially lagged covariances between modal streamfunction and velocity fields. The former is found to be approximately zero and the latter have significant extrema at lag distances comparable to an eddy radius. Furthermore, the dominant contribution to these coupling signals comes from the time-averaged (over a little more than two months) mesoscale field, which from lengthy moored observations we can identify as an instantaneous realization of the very low frequency "secular scale" described by Schmitz (1978). Forecasts from this observational representation in a two-mode, quasi-geostrophic numerical model with no horizontal energy flux into the region of interest (an extreme statement of our observational ignorance of mesoscale processes outside the MODE region) consistently fail to preserve either these covariance relations or the secular scale mesoscale component for any significant time, with a possible exception of the zero energy transfer rate in a small]~ (100 km)^2 [, data dense region for a brief time (~ 10–15 days). Since these forecast failures occur on a time short compared to a turbulent predictability time, it is proposed that a missing, and observationally undocumented, process of exterior influence (such as radiation from the Gulf Stream region) is probably required to adequately model the mesoscale modal coupling in the MODE region.

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