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Oceanic Quasi-geostrophic Turbulence Forced by Stochastic Wind Fluctuations

Anne Marie Treguier and Bach Lien Hua

IFREMER, Centre de Brest, BP 337 29273 Brest Cedex, France

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ABSTRACT

The quasi-geostrophic response to stochastic wind fluctuations is calculated using a doubly periodic nonlinear model, with a vertical resolution of three modes in most cases. The influence of various parameters on the response is investigated: space and time scale of the forcing, stratification, bottom friction and β-effect. One aim of this study is to understand the influence of nonlinear transfer, and therefore, most simulations are situated in a parameter range where nonlinearities are important. The model "pseudodispersion relation" clearly shows two regimes: a linear regime made of resonant Rossby waves for the barotropic large scales and a nonlinear regime that is dynamically similar, for example, to quasi-geostrophic turbulence forced by baroclinic instability. The forcing time scale and β-effect have little influence on the response. The most important parameter is found to be the ratio $R = \kappa_1/K_{min}$ of the largest forced wavelength to the wavelength of the first baroclinic mode Rossby radius. When R grows, the amount of energy in the linear regime grows, and the kinetic energy becomes essentially barotrophic (currents are then depth-independent). For our model, R must be of order 5 in order to obtain a realistic vertical structure, while observations show that R is larger than 10. From this discrepancy we conclude that other physical mechanisms have to be taken into account to reproduce the vertical structure of the oceanic response, although our results confirm that wind fluctuations can effectively generate eddy energy in the ocean.

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Headquarters: 45 Beacon Street Boston, MA 02108-3693
DC Office: 1120 G Street, NW, Suite 800 Washington DC, 20005-3826
amsinfo@ametsoc.org Phone: 617-227-2425 Fax: 617-742-8718
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