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A Numerical Study on the Influence of the Mid-Atlantic Ridge on Nonlinear First-Mode Baroclinic Rossby Waves Generated by Seasonal Winds

Bernard Barnier

Mesoscale Air Sea Interaction Group, The Florida State University, Tallahassee, Florida

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ABSTRACT

A numerical model simulation investigates the influence of the mid-Atlantic ridge on nonlinear first-mode baroclinic Rossby waves generated by seasonal wind fluctuations. The North Atlantic is simulated by a square-box, two-layer quasi-geostrophic (QG) model. The bottom topography is ridge-like and compromises the QG approximation and the actual shape of the ridge. Sponge layers protect all boundaries except the eastern one from wave reflection and eliminate the build-up of the western boundary current. The model is forced by a purely fluctuating wind stress curl derived from the most significant EOFs of the FGGE winds. A flat bottom and a ridge experiment are compared.

In both experiments the eastern boundary is an important source of annual-period baroclinic Rossby waves. Wave trains having a wavelength of about 1060 km and a westward phase speed around 3.4 cm s^{-1} propagate energy westward at 3 cm s^{-1}. In the flat bottom experiment a source of directly wind-forced baroclinic waves of annual period is found in the middle of the basin. Their amplitude is smaller and they have a noticeable northward phase propagation and a southward group velocity component. In the topography experiment the ridge blocks the waves coming from the eastern boundary but generates new wave trains whose phase vector is almost normal to the ridge crest. Those waves propagate energy mostly westward at 2.9 cm s^{-1}. The northern waves are out of phase with the southern ones because of the structure of the dominant wind pattern over the ridge region where they are generated. All waves have a small group velocity component in the meridional direction. It is northward (at 0.34 cm s^{-1}) for the northern waves and southward (at 0.32 cm s^{-1}) for the southern waves.

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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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