

Gulf Stream Boundary Interactions

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LONG-TERM GOALS

I have sought to understand the influence of midlatitude jets on the surrounding ocean through observation, data analysis, theory and modelling. The interrelations between meandering, radiation of low frequency energy and resulting mean flow generation have been of particular interest and relevance to my recent work done under this grant.

OBJECTIVES

The guiding hypothesis is that the meandering of western boundary currents acts as a wavemaker in the ocean. The meanders are quite depth independent and force mainly barotropic motions exterior to them. These motions propagate as low frequency Rossby waves and those to the north of the stream eventually become topographic Rossby waves as they begin to feel the bottom topography. Simple theoretical arguments suggested that these waves should be preferentially forced where the Gulf Stream intersects the Grand Banks. I sought to observe this process through observation with an array of moored current meters and to understand the implications through theory and modeling.

APPROACH

The results from an array of current meters, deployed in late summer of 1995 on the Continental Rise to the west of the Grand Banks, are the inspiration for this study (Hogg, 2000). Although an interpretation of the low frequency variability in terms of topographic Rossby waves was compelling, it was clear that a number of the implicit assumptions were violated: namely small amplitude waves and gentle slopes. With the collaboration of Dr. Genta Mizuta, a visiting Japanese scientist, we used analytic and numerical methods (i.e. the Rutgers "ROMS" numerical model) to investigate this problem.

WORK COMPLETED

Two manuscripts were published, one describing the observations and the other the numerical and theoretical work.

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RESULTS

Although Topographic Rossby waves are clearly present in the current meter data, their amplitude was not enhanced in the manner hypothesized. However, we have found that significant longshore flows can be generated by such Rossby waves which are obliquely incident on the Continental Slope and Rise. Although the waves become increasingly bottom trapped as they shoal the resulting mean flow is only weakly depth dependent. Analytic solutions have been found which are in quite good agreement with the numerical experiments. Runs which are meant to be more realistic by including variable stratification and continuously varying topography show that longshore flows of order 20 Sverdrups can be forced by relatively weak (amplitude 2cm/s) Rossby waves. Our present work has two limitations: it allows only for dissipation at the bottom and considers topography with isobaths aligned zonally.

IMPACT/APPLICATIONS

This work suggests that radiation from western boundary currents can be quite effective at forcing longshore flows similar in transport to those observed. As the topographic waves become shorter and increasingly bottom trapped as they shoal it is not clear that this process is adequately reproduced in numerical models.

RELATED PROJECTS

None known to the PI.

PUBLICATIONS

Nelson G. Hogg, 2000: Low-frequency variability on the western flanks of the Grand Banks, *Journal of Marine Research*, **58**, 523-545.

Kyung-II Chang, Nelson G. Hogg, Moon-Sik Suk, Sang-Kyung Byun, and Kuh Kim, 2002: Mean flow and variability in the southwestern East Sea, *Deep-Sea Res. I*, **49**, 2261-2279.

Genta Mizuta, and Nelson G. Hogg: Structure of the Circulation Induced by a Shoaling Topographic Wave, *Journal of Physical Oceanography*, **34**, 1793-1810.

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An array of subsurface current meter moorings was deployed for two years on the western slope of the Grand Banks to investigate the possibility that low frequency waves (Topographic Rossby Waves) were being radiated westward along the Rise and Slope by disturbances in the Gulf Stream to the south. Wave motions consistent with these dynamics were clearly evident in the data and their amplitude was found to be especially large at periods shorter than about 10 days. At longer periods there was no special enhancement, thus disagreeing with the prior expectations which were based on simple theoretical arguments. This work was published in the Journal of Marine Research.

15. SUBJECT TERMS

Topographic Rossby Waves, Gulf Stream, Moorings, Grand Banks

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