Abstract View

Volume 14, Issue 1 (January 1984)

Journal of Physical Oceanography
Article: pp. 145–167 | Abstract | PDF (1.63M)

A Comparison of Georges Bank, Gulf of Maine and New England Shelf Tidal Dynamics

Wendell S. Brown

Ocean Process Analysis Laboratory, Department of Earth Sciences. University of New Hampshire, Durham, NH 03824

(Manuscript received March 23, 1983, in final form September 12, 1983)

DOI: 10.1175/1520-0485(1984)014<0145:ACOGBG>2.0.CO;2

ABSTRACT

The semidiurnal tidal currents associated with the near-resonant response of the Gulf of Maine-Bay of Fundy system are amplified over the relatively shallow depths of Georges Bank, thus leading to enhanced energy dissipation, vertical mixing and secondary flows on the Bank. Within the western Gulf of Maine the tidal sea level amplitudes are larger but currents are less energetic than those observed on Georges Bank, while on the New England shelf the tidal response is the least energetic of the three regions. In this paper we explore some of the details of the tidal dynamics in these three very different tidal regimes by estimating terms in the volume-integrated momentum equations using observations of current and bottom pressure. The computations are performed for the M_2 semidiurnal tidal constituent, which is the dominant tide in all of the regions, and are presented in terms of an instantaneous “stress” balance.

Results show that in the across-isobath direction on George Bank the M_2 inertial term is balanced principally by the sum of the Coriolis and pressure gradient terms plus a small residual term, while in the along-isobath direction the principal balance is between the inertial and Coriolis terms. Even in this region of relatively high currents the nonlinear terms are found to be small in both directions, thus justifying the use of monochromatic input data. The instantaneous dynamic balances and the clockwise rotary elliptical currents are quantitatively consistent with the signature of an across-isobath propagating, forced gravitational-gyroscopic progressive wave which is strongly influenced by bottom slope. In the western Gulf of Maine a sum of the inertial and Coriolis terms in both the along- and across-isobath directions is balanced by the relatively large pressure gradient terms—dynamic balances that are consistent with those of a rotary standing wave. The distribution of counterclockwise rotary elliptical currents suggest the presence of a reflected Kelvin wave in the western Gulf. On the less energetic New England shelf the across-isobath inertial term is balanced by a sum of the Coriolis and pressure gradient terms as found on Georges Bank. However in the along-isobath direction, unlike Georges Bank, the same dynamical balance is found because of the importance of coastline irregularities in producing significant along-isobath tidal pressure gradients. The tidal response of the New England shelf combines the dynamical characteristics of those on Georges Bank and on the New Jersey shelf to the southwest and is less easily described in terms of the

simple forced-wave models that are reasonably successful in the adjacent regions.

The Georges Bank and Gulf of Maine observed tides are compared with the Greenberg fine-grid numerical results with generally good overall result. Some small systematic difference which are found, may be due to the way friction is specified in the numerical model. Other results concerning the vertical structure and frictional character of Georges Bank tidal flow, which are presented here, suggest that the continued study of the way tidal energy dissipation is computed is warranted.

top