Abstract View

Volume 27, Issue 8 (August 1997)

Journal of Physical Oceanography
Article: pp. 1729–1742 | Full Text | PDF (263K)

Characterization of Three-Dimensional Lagrangian Circulation Associated with Tidal Rectification over a Submarine Bank

John W. Loder and Yingshuo Shen

Fisheries and Oceans, Canada Bedford Institute of Oceanography, Dartmouth, Nova Scotia, Canada

Herman Ridderinkhof

Netherlands Institute for Sea Research, Texel, the Netherlands

(Manuscript received May 31, 1996, in final form January 21, 1997)

DOI: 10.1175/1520-0485(1997)027<1729:COTDLC>2.0.CO;2

ABSTRACT

Two approaches to the quantitative characterization of Lagrangian circulation in three-dimensional (3D) time-periodic current fields are used to describe major features of a model-derived flow field for barotropic tidal rectification on Georges Bank. The first approach is an extension of the 2D “saddlepoint” method used by Ridderinkhof and Loder to describe the vertically averaged Lagrangian circulation associated with various forcings over outer Gulf of Maine banks. Application of the method to representative sigma (terrain-following) surfaces and comparison with particle trajectories in the 3D current field indicate that the circulation saddlepoints and associated separation lines (between recirculation and throughflow regions) in the vertically averaged flow over Georges Bank are qualitatively representative of the entire water column, but that there is significant vertical structure in the Lagrangian circulation. In particular, the horizontal extent of the tidally rectified clockwise gyre on Georges Bank is greater in the lower water column, due to an on bank component of near-bottom Lagrangian flow. The second approach—evaluation of the 3D Lagrangian residual displacement field from particle tracking in the 3D current field—confirms the presence of a significant Stokes velocity associated with tidal rectification on Georges Bank. The around-bank component of the Stokes velocity is counterclockwise with magnitude approximately one-third that of the mean Eulerian velocity arising from tidal rectification, thereby partially offsetting the mean Eulerian velocity. The cross-bank component of the Stokes velocity also generally opposes the mean Eulerian flow and has a comparable magnitude. It accounts for the onbank near-bottom Lagrangian flow on the southern flank and northern edge of the bank (and hence the expanded gyre in the near-bottom region), and illustrates the importance of including the tidal velocity in model studies of Lagrangian circulation in tidally energetic regions.

top

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
Allen Press, Inc. assists in the online publication of *AMS* journals.