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The Alongshore Tilt of Mean Dynamic Topography and Implications for Nearshore Circulation and Regional Vorticity Balance

Christoph Renkl and Keith R. Thompson
Department of Oceanography, Dalhousie University, Halifax NS, Canada (christoph.renkl@dal.ca)

Coastal tide gauge observations in combination with the latest generation of geoid models are providing observations of the alongshore tilt of mean dynamic topography (MDT) with unprecedented accuracy. Additionally, high-resolution ocean models are providing better representations of nearshore circulation and the associated tilt of MDT along their coastal boundaries. The alongshore tilt of MDT is an important component of the alongshore momentum balance. As shown by Stewart (1989), it can also be related to the stress gradient at the coastal boundary and vorticity transport to the ocean interior. In this study we explore how different boundary conditions and stress parameterizations affect the alongshore tilt of MDT and, conversely, what the observed tilts of MDT can tell us about nearshore circulation and regional distributions of vorticity.

Using a regional-scale configuration of the NEMO ocean model with a grid spacing of 1/36°, the tilt of MDT along the coast of Nova Scotia and Gulf of Maine is predicted, using different lateral boundary conditions and stress parameterizations, and then compared to independent estimates of MDT based on tide gauge observations referenced to the Canadian Gravimetric Geoid model (CGG2013). We first show that the observed and predicted tilts are in good agreement. It is next shown that the nearshore circulation depends on the form of the coastal boundary condition but, somewhat counterintuitively, the associated alongshore tilt of MDT does not. Reasons for this are given. The alongshore tilt is next related to the regional distributions of vorticity and the possibility of using observed alongshore tilts of MDT to validate ocean models, and monitor shelf circulation, is discussed.