Ocean Sci. Discuss., 8, C400–C402, 2011
www.ocean-sci-discuss.net/8/C400/2011/

Ocean Science Discussions

Interactive comment on "The vertical structure of oceanic Rossby waves: a comparison of high-resolution model data to theoretical vertical structures" *by* F. K. Hunt et al.

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Received and published: 12 July 2011

Summary:

The authors revisit the question of matching observations of Rossby waves in the ocean to theoretical predictions for their structure and phase speed. In the present work, the authors use the output of an ocean general circulation model (CLIPPER) to investigate the vertical structure of Rossby waves produced by the simulation. The entire investigation focuses on a longitudinal section at 24S in the Atlantic. A Radon transform of the meridional velocity component is filtered to extract the signal with the largest westward amplitude, and this part of the field is then back-transformed to physical space. Three different methods are then used to diagnose the vertical structure of

the waves: a time-average in physical space, direct extraction in transformed space, and the generation of EOFs from the physical space field.

One of the most striking (if unsurprising) results of the study is that the Radon-transformed fields clearly demonstrate vertical coherence for the waves (Fig. 2). Vertical coherence is necessary to even define an oceanic Rossby wave, but it is not trivial to find in the model data.

The extracted vertical structures are then compared to those predicted by four different theories. The four theories are all variants of plane-wave solutions to the linearized quasigeostrophic equations, varying only by their inclusion or neglect of zonal mean flow and topography (bottom-pressure compensation). Not surprisingly, including both mean flow and topography results in the best fit of vertical structure.

This is a straightforward paper, and presents a competent study of a popular topic in physical oceanography. It makes an important, if modest contribution to our understanding of the nature of putative observations of Rossby waves from satellite altimetry. It does not go far beyond what Aoki et al (2009) do, but the radon transform at each depth makes it a worthy of publication in Ocean Science Discussions, with minor improvements.

Comments:

1. I do not understand why the authors chose to include the three methods for extraction of vertical structure. No rationale is offered for why any is superior to the other, apart from the noted limitation of direct analysis of the Radon-transformed fields, which removes all longitudinal dependence. In my opinion, the EOF method seems clearly superior to the other two. Taking a 'model mean' of the three methods is completely unsupportable. I would strongly recommend the authors choose the best method, explain the logic of their choice, and go on with the comparison to theory. This would clean up the presentation. In addition,

the description of the EOF method should be improved, perhaps by adding an appendix.

2. My major comment is directed somewhat at this paper, but perhaps more at the entire trail of papers that have followed Chelton and Schlax (1996, hereafter CS). Nearly all the theories considered are based on linear, quasigeostrophic, plane-wave solutions. The fact that CS compared their observations to the "Standard Linear Theory" (SLT – local, flat-bottom, no-mean-flow, no-topography, plane-wave QG solutions) ensured this would become a hugely cited paper, because SLT is hugely over-simplified relative to what I would expect is needed to properly understand Rossby wave propagation in the ocean. If SLT had worked, that would have been amazing; that it does not fully explain the observations, on the other hand, is hardly surprising. Likewise, the 'radical' ideas of including the effects of mean flow and topography were sure to improve the theory, and these seem to get outsized attention compared to the range of other possibilities, including, for example:

    - Non-quasigeostrophic effects (e.g. Paldor et al, 2007, JPO 37, 115–128)
    - Basin-modes (e.g. Isachsen et al, 2007, JPO 37, 1177-)
    - Finite-wavelength effects and baroclinic instability (e.g. Tulloch et al, 2009, JGR-O 114)

Interactive comment on Ocean Sci. Discuss., 8, 1089, 2011.