ON THE VERTICAL STRUCTURE OF OCEANIC ROSSBY WAVES

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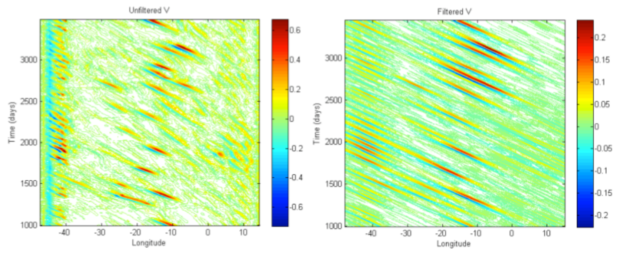
1.INTRODUCTION

The advent of satellite altimetry prompted renewed interest in Rossby wave theories, but owing to the lack of suitable in-situ data, new theories have been mostly tested on their ability to account for the surface signature of the waves only. This is not sufficient, however, to discriminate between theories based on different physical assumptions, e.g., TMC01. To make progress, theories need to be tested on their predictions for the Rossby wave vertical structures, which for the moment can only be meaningfully explored in high-resolution numerical simulations. This work reports on a comparison of empirically determined vertical structures and theoretical ones by analyzing meridional velocity anomalies in a 10 year simulation of the CLIPPER model at the latitude 25S in the South Atlantic, whose resolution is 1/6 degree on a mercator grid, see Lecointre et al. (2008).

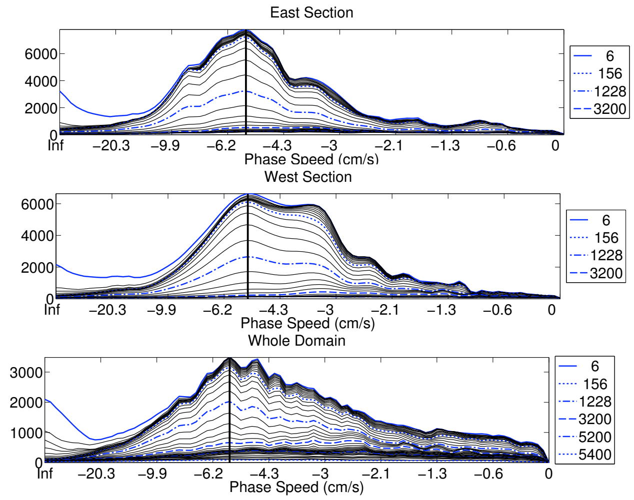
2. FILTERING OF THE WAVES

The westward propagating component of the meridional velocity anomalies is isolated by applying a Gaussian filter around the dominant phase speed found by the Radon transform, and then back-transformed in velocity space, as shown in Figure.



3. VERTICAL COHERENCE OF THE WAVES

A key assumption in Rossby wave theory is that actual Rossby waves propagate as a vertically-coherent signal, which was recently challenged by Lecointre et al. (2008). In our analysis, however, the Radon transform applied to meridional velocity anomalies reveal the existence of a common peak at all depths, suggesting vertically coherent propagation at 25S.

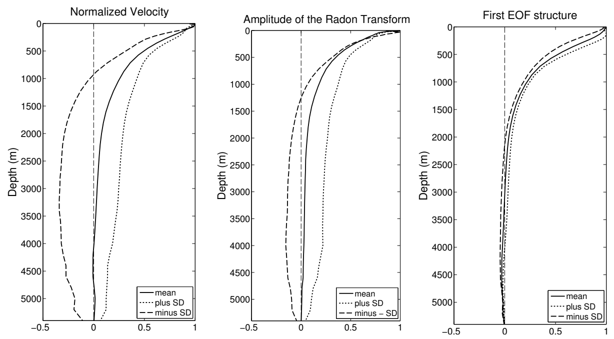


3. EMPIRICALLY DETERMINED VERTICAL STRUCTURES

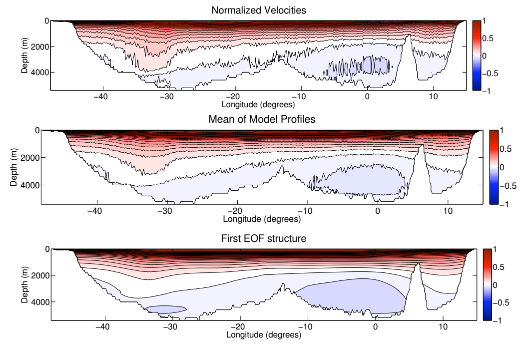
Empirical vertical structures are obtained from the filtered data by:

1) Using mean and normalized velocities
2) Amplitude of the Radon transform as a function of depth
3) Classical EOF

All structures suggest surface intensification, with little evidence of sign reversal with depth

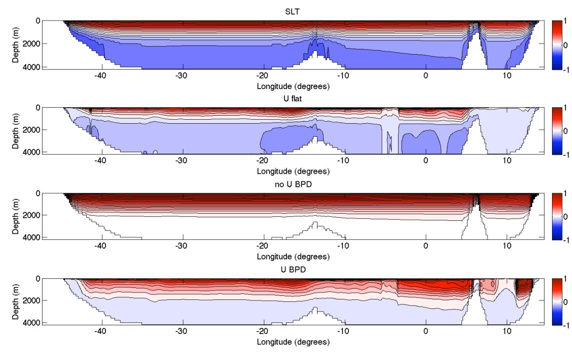


5.LONGITUDE VARIATIONS OF EMPIRICAL STRUCTURES



The empirical structures are compared with those predicted by 4 different theories:

1) Standard linear theory (flat bottom, no mean flow)
2) Zonal mean flow only (flat bottom, as in KCS97)
3) Bottom compensation Theory only (TMC01)
4) Zonal mean flow + bottom compensation theory



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References:

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5. CONCLUSIONS Westward propagation at 25S in the South Atlantic is vertically coherent, in contrast to Lecointre et al. (2008)'s findings. Empirical vertical structures from three different methods are compared with 4 different theoretical vertical structures. Best agreement is achieved with theory including a background mean flow and a representation of bottom topography, although agreement is not perfect, and other theories occasionally perform better for parts of the structures, requiring a more refined analysis.