HOW SENSITIVE IS GENERALISED LINEAR ROSSBY WAVE THEORY TO UNCERTAINTIES IN THE DETERMINATION OF THE BACKGROUND MEAN FLOW?

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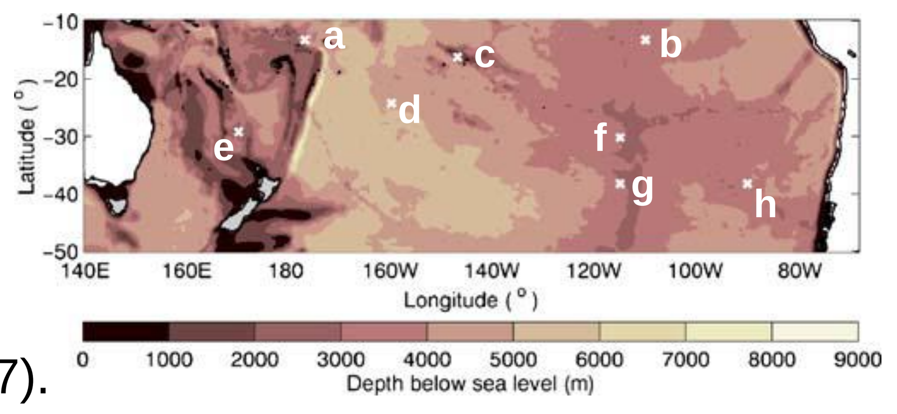
1.BACKGROUND

- •Bathymetry and mean flow significantly affect Rossby wave propagation.
- •Testing extended Rossby wave theories is challenging because estimating the background mean flow from observations is difficult.
- •Previous tests have only considered the effect of the baroclinic component of the mean flow, using climatological observations of T and S.
- •The barotropic part of the mean flow is critical to explain Rossby wave propagation at high wavenumbers (Tailleux 2012).
- •The exclusion of a non-linear term in the Killworth and Blundell (2004) theory which formed the basis for observations/theory comparisons in Maharaj et al. (2007) potentially affects the latter's results at high wavenumbers.
- •We seek here to test the sensitivity of the extended theory with high resolution data and compare the results from Maharaj et al. (2007) with the correction to theory proposed by Tailleux (2012)

2. METHOD AND CASE STUDIES

The sensitivity of the predictions of the extended theory were investigated using 20 years of ECCO2 data from 1992 to 2012.

The case studies will be the same as those described in Maharaj et al. (2007). See Fig 1a for locations. A particular example corresponding to case (a) is depicted in Fig. 1b



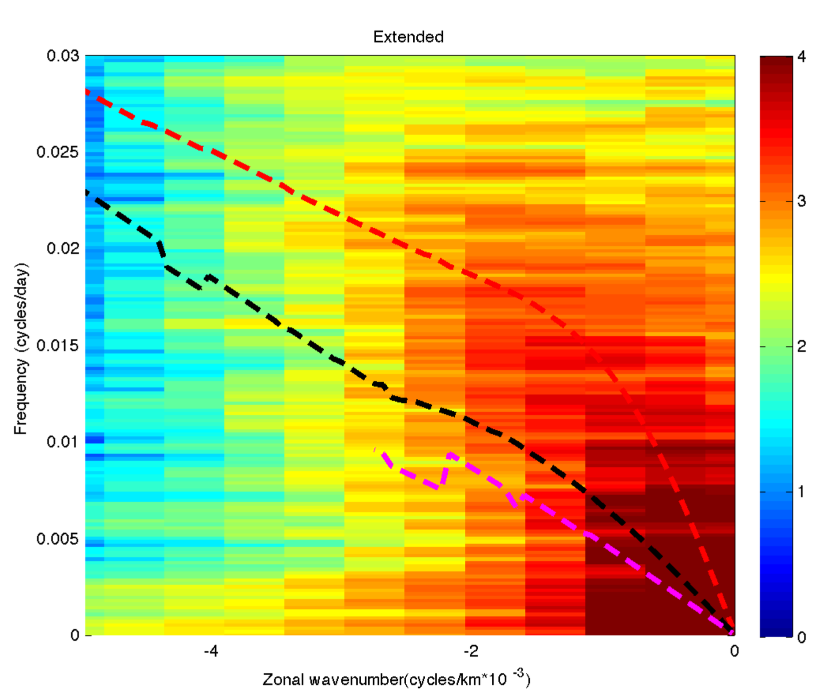


Figure 1a: *Figure 5 from Maharaj et al. (2007) showing study locations, superimposed on Smith and Sandwell (1997) bathymetry.*

Figure 1b: *Comparison of empirical dispersion relation at 13S, 173E-193E (South Pacific) with the predictions of the extended theory by Killworth and Blundell (2004, 2005) for the first three baroclinic modes with w-k spectra from ¼° merged TP/ERS 1992-2007 .*

3. FEATURES OF THE VARIABILITY AT 13S, 173E-193E FROM ECCO2

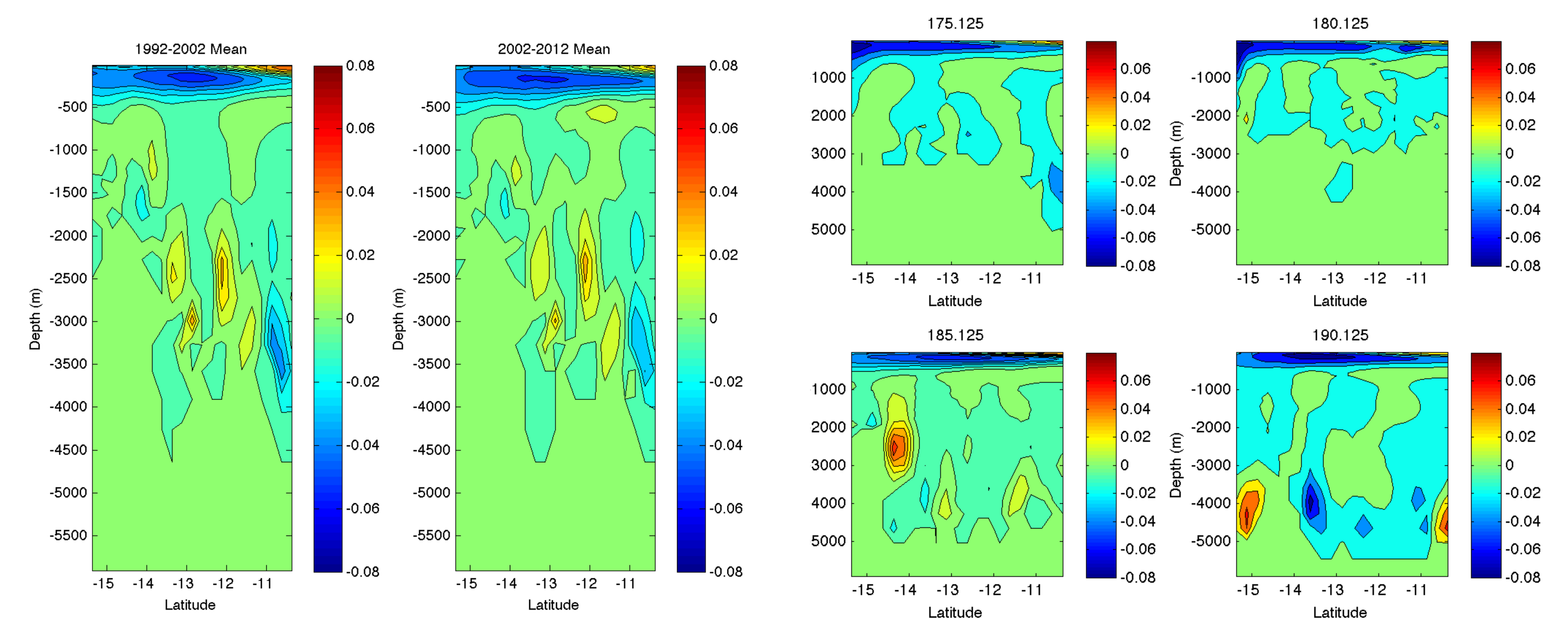


Figure 2: *The two left panels show some difference between the time mean zonal velocity (ms^{-1}) taken for the decade 1992-2002 versus the decade 2002-2012, in the latitude band centred around 13S. The two corresponding vertical profiles are illustrated in the left panel of Fig. 3 below. The 4 right panels illustrate the longitudinal variations in the zonal mean velocity (ms^{-1}) averaged over the full 20 years at 4 different longitudes, in a latitude band centred around 13S. The corresponding vertical profiles are illustrated in Fig. 4 below.*

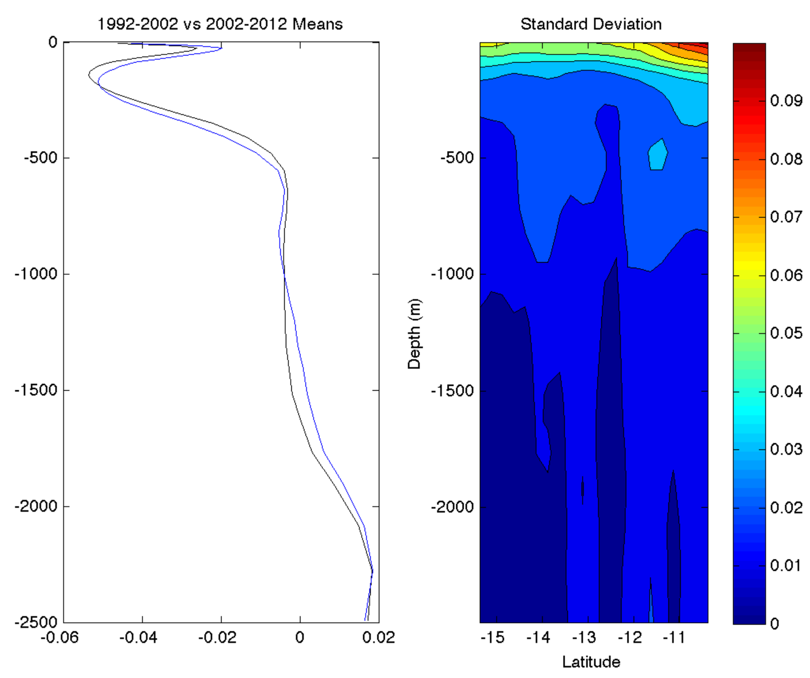


Figure 3: *Let panel illustrates the differences between the time mean zonal velocity at 13S between the two decades 1992-2002 versus 2002-2012. The right panel illustrates the standard deviation, which is very large in this region.*

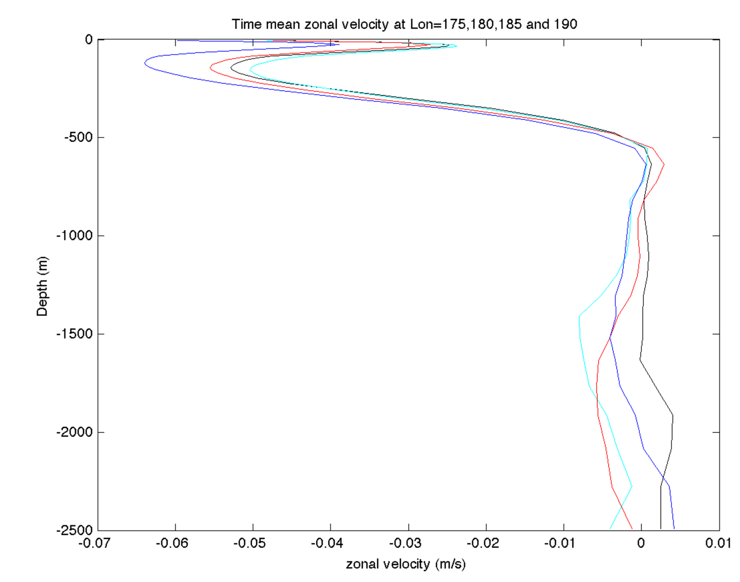


Figure 4: *The different vertical profiles at 13S corresponding to the 4 different longitudes depicted in the 4 right panels of Figure 2.*

The case study considered is characterised by a zonal mean flow that is surface intensified and westward at most depth, with a reversal in the deep ocean. The surface currents exhibit strong variability, which often exceeds the mean. The mean flow is predominantly baroclinic, with a very weak barotropic component.

4. RESULTS

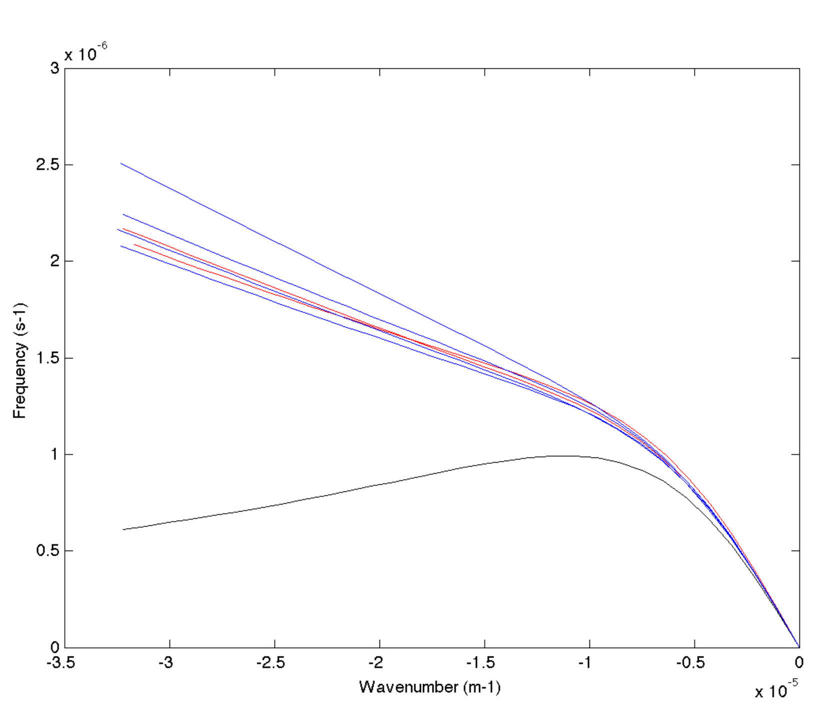


Figure 5: Representations of the first baroclinic mode. *The black line represents the standard linear theory. The red lines represent the predictions of Killworth and Blundell extended theory for the temporal means 1992-2002 and 2002-2012, whereas the blue lines represent the dispersion relations associated with the longitudinal variations of the zonal mean flow.*

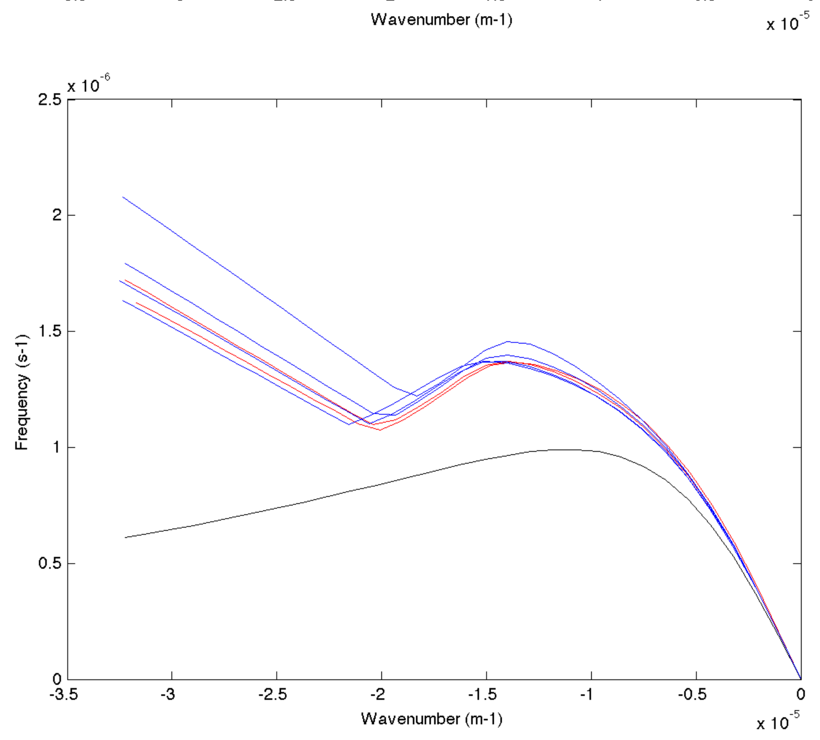


Figure 6: *Same as for Figure 5, but with the extended theory corrected as described in Tailleux (2013).*

References:

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5. CONCLUSIONS

The present results confirm that the error in Killworth and Blundell (2003)'s theory identified in Tailleux (2013) dramatically affects the nature of the theoretical dispersion relation at high wavenumbers. Conclusions based on Killworth and Blundell (2003)'s theory should be revisited by using the correct eigenvalue problem as discussed in Tailleux (2012). In the case study considered, neither the time variations nor the longitudinal variations of the zonal mean velocity appear to affect inferences based on the temporal mean at the central longitude of the domain considered. The standard deviation in the region considered, however, appears to be very large compared to the mean zonal velocity, raising the question of the validity of the linear approximation. In regions dominated by westward propagating eddies, which are described in Chelton et al. (2007), the eddies can also contribute to the definition of the zonal mean velocity, raising the question of the correct theoretical approach to studying linear Rossby waves. The remaining 7 case studies from Maharaj et al. (2007) will be compared in a similar fashion and with updated altimetry data.