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Coherence of off-shore steric height and island sea level.

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What is the relationship between the sea level at a deep-ocean island tide gauge and that offshore? For every mid-ocean island in the OCCAM 1/12 model we compared sea level close to the island with the sea-level, steric, and bottom-pressure signals averaged over a ring of deeper water around the island. Analysis of these time series clearly illustrates the propagation of barotropic and baroclinic signals to the coast on time scales for which Rossby waves dominate, but suggests that sea-level signals associated with eddies may not influence the coastal signal as strongly.

At frequencies higher than the allowed baroclinic Rossby wave frequency range, the coastal signal is poorly predicted by offshore density, but coastal sea level and off-shore bottom pressure tend to be well-correlated, indicating a dominance of barotropic processes. Baroclinic Rossby waves are prohibited at periods shorter than a latitude-dependent limit — about 1 month for $\pm 5^{\circ}$N, rising to 5 months at $\pm 25^{\circ}$N — and this dependence shows up clearly. At the lowest frequencies, the off-shore steric signal is well correlated with the coastal signal. However, there is an intermediate band of frequencies, in the region of the baroclinic Rossby waves cut-off frequency, for which off-shore sea level is not strongly related to coastal sea level. The low frequency cut-off of this band is also latitude dependent and corresponds well to the maximum eddy duration by latitude seen in satellite altimeter data by Chelton et al. (2011) — about 3.5 months at $\pm 5^{\circ}$N, rising to 24 months at $\pm 25^{\circ}$N. In this band, we hypothesise that a mixture of behaviours may occur, perhaps with off-shore and coastal sea levels being correlated for wave-like behaviour and poorly correlated for eddies.

In the Southern Ocean, linear baroclinic wave speeds become irrelevant, but a switch between high frequency barotropic signals and an increasingly important steric contribution at lower frequencies still occurs in many regions. The steric contribution is consistent with what would be expected of the observed equivalent-barotropic structure in this region.

Reference

D. B. Chelton, M. G. Schlax, and R. M. Samelson (2011), Global observations of nonlinear mesoscale eddies, *Progress In Oceanography*, *91*(2), 167 – 216, doi:10.1016/j.pocean.2011.01.002.