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Ocean Science Discussions

Interactive comment on "A harmonic projection and least–squares method for quantifying Kelvin wave activity" *by* Andrew Delman et al.

Anonymous Referee #1

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This paper proposes a statistical method for extracting the Kelvin wave signal from altimetric data in the Indian ocean both along the equator and along the coast. While I find the topic worth addressing and relevant, I have reservations regarding the method.

1) The paper mentions the study by Boulanger and Menkes (1999) which is a method that provides estimate of the equatorial Kelvin based on the projection of the theoretical meridional wave structures. We wonder why the authors do not test this method to compare with theirs, since the method by BM99 was validated from independent observations (by reconstructing the wave-induced zonal currents and comparing to TAO data). This would provide more confidence in their results if both methods compare to some extent. The method should be at least applied to the equatorial Pacific and compared with estimates from Boulanger and Menkes (1995, 1999).

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Discussion paper

2) The equatorial Kelvin wave while impinging along the coast of Indonesia could be trapped or reflect as Rossby wave depending on its vertical structure and frequency (Clarke and Shi, 1991). Since the method does not discriminate explicitly the frequencies in the raw SLA, it is not clear to which extend it is able to actually grasp the share of the variability that is trapped along the coast from the one that radiates off-shore as Rossby wave. In fact, the cross-shore scale of the Kelvin wave that is extracted indicates that there is probably a mixture between Kelvin and Rossby waves, and might explain the large residual at some places (Figures 7 and 8). Could the authors comment on that? How are altered the results of the projection when the raw SLA data are filtered in the frequency domain so as to retain intraseasonal frequencies?

3) While in the Pacific the equatorial Kelvin wave structure can be assumed to reduce to the one of the first baroclinic mode, this is certainly not the case for the Indian ocean where the wave structure is more complex and result from the superposition of a number of baroclinic modes. This is a difficulty that is not discussed in the paper and that could be of importance. In fact it is not clear what is the purpose of doing the y-projection considering that this projection does not provide the Kelvin wave coefficient. We would expect that if the method is applied on the raw SLA data at each latitudes (without performing the y-projection), the results of the projection onto the basis functions (i.e. K(y)) should have a meridional structure of a Kelvin wave (i.e. a Gaussian curve) from which a phase speed could be inferred. Could the authors verify that? This would be a stringent test that the method does allow extracting the Kelvin wave signal from the raw SLA. It is also expected that the zonal change in the meridional structure reflects the sloping thermocline (i.e. larger value of c to the west).

Other comments:

p. 4, l. 105: please provide a reference for this formula (1)

p. 4, l. 115: this is surprising. Could you illustrate that? I think this is due to the fact that r=5°S. Please explain what is the purpose of the y-projection.

p. 5, l. 137-142: It is not clear if with such a tapering, the basis functions are still a basis? Also this tapering is in fact modelling the dissipation of the waves, it may need to be better justified physically and the sensitivity of the results to the tapering parameters would need to be evaluated.

p. 7, l. 195-200: What is called "The Kelvin wave y-projection" has nothing to do with the wave coefficient associated to the Kelvin wave. The wording is confusing. This quantity does contain variability associated to the Rossby wave, so there is no reason why Figure 3b should exhibit more Kelvin-wave-like properties than the raw SLA. In fact performing the y-projection might be a problem since you mix waves having different propagating characteristics (i.e. phase speed and dissipation rate) so that where the amplitude of Ky accounts for the contribution of the Rossby wave and Kelvin wave in a proportion that does not correspond to the actual ratio expected from the local wind forcing.

p. 8, l. 210: it would be more convincing if a hovmuler of SLA along the coast of Sumatra was provided over an extended period of time.

p. 8, section 3.2: While mathematically correct, I find the test not really relevant. You use the basis functions of propagating modes to construct a surrogate sea level field that you perturb with noise, and then project again on the same basis functions. It is not so surprising that you come up with something you want. However this is not testing if the method is actually able to extract the Kelvin wave signal from altimetric data. It would be more relevant to compare with BM99's method and apply it on data over the equatorial Pacific.

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