Clim. Past Discuss., 8, C181–C183, 2012
www.clim-past-discuss.net/8/C181/2012/

Climate of the Past Discussions

Interactive comment on "Tropical Pacific spatial trend patterns in observed sea level: internal variability and/or anthropogenic signature?" *by* B. Meyssignac et al.

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Received and published: 28 March 2012

In the main point of his review, we think Reviewer #2 raised an interesting question about why we analysed trends rather than mean sea level in our study. Several arguments lead us actually to discuss sea level trends instead of sea level. The first argument is that projections of the sea level variations based on the CMIP projects are interpreted in general in terms of trends of sea level over the XXth century or the XXIst century. For this reason if we want to compare the sea level observed by altimetry over the last 17 years (17- year window) with the sea level variations computed by the CMIP models and published in the literature it is easier to discuss sea level trends than sea

level itself. In particular it enables to estimate at a glance if the sea level trends over the 17-year window of the altimetry era, already show some characteristic features of the published sea level projections based on the CMIP models. The second argument is technical. When we began this study, our objective was to determine whether any signature of the anthropogenic warming could be found in the observed sea level variability over the Tropical Pacific or if it was largely dominated by the internal variability of the climate system. Very quickly this study turned out to be a "signal to noise ratio" study in which the signal to be found was the anthropogenic forcing signature on the regional variability of the sea level and the noise was the internal variability of the climate system. Given the slowly evolving anthropogenic warming signal, the anthropogenic signature, if any, should be very small on short time scales and should be overwhelmed by the internal variability of the climate system at these time scales. However at long time scales, the anthropogenic signature should get bigger, as the ocean is getting warmer with time, and maybe become visible despite the internal variability of the climate system. For this reason we focused on the signal with the lowest frequency contained in the altimetry record in the hope to find some anthropogenic signature. In a finite record, the lowest frequency recorded is the trend over the whole record period (i.e. the "17 year trends" in the case of altimetry record). This is the reason why we discussed the sea level trends instead of the sea level. Now, the fact that we could not find any anthropogenic signature in the "17 year sea level trends" suggests that we would not have found any anthropogenic signature at higher frequencies neither because the signal to noise ratio appears less favourable as time scales get shorter (as we said before). In this sense reviewer 2 is right, our study goes further than only the "17-year trends" variability. It suggests that the internal variability of the climate system dominate the sea level variability observed by satellite altimetry over the Tropical Pacific for all time scales between 1 to 17 years. In particular we agree with reviewer 2 when he points out that" power spectra of 10-yr running mean of sea level change probably show same results". In addition to the analysis proposed in the article we have done the same analysis with 15-year windows and 10-year windows instead of 17-year win-

dows and indeed we found the same results as for the 17-year window analysis. But when we took a 5-year window the result changed: the 5-year trends were following some high frequency of the ENSO signal (around 5- 6 years). The 17-year window had the advantage to be large enough actually to enable us to focus on the low frequency signal in the Tropical Pacific and not on the high frequency ENSO signal (i.e. between 2 and 6 yr). We have probably insisted too much on the result that the" 17 year trends" are dominated by the internal variability. We propose to add in the discussion section a sentence to explain that this result actually goes further and suggests that shorter time scales of the sea level variability are also dominated by the internal variability of the climate system mentioning in particular the results obtained by the analysis done with 15-year windows and 10-year windows.

Concerning the minor points raised by Reviewer #2 we corrected actually all of them in a revised version. We just want to argue here on the question of reviewer #2 about why we do not compare the sea level trend with Nino 3 index trend? In the tropical Pacific the sea level is mainly of steric origin so we expect the sea level to correlate strongly with the Nino 3 index because it is a temperature index (it is computed from sea surface temperatures). What is true for the sea level is true for the sea level trend: the sea level trend should correlate as well with the Nino3 index trend. But this point seems evident. In Fig4b instead what we try to do is to show that the variability of the "17 year sea level trends" follows the characteristic frequencies of the coupled Atmosphere-Ocean mode ENSO. We have chosen Nino 3 as a proxy of this mode. This is the reason why we compare the sea level trends with Nino3 and not with the trends in Nino3. The fact that the variability of the "17 year sea level trends" correlates with the low pass filtered Nino3 provide a new information: the 17-year sea level trends are linked with some low frequency of the ENSO mode which is not evident a priori.

Interactive comment on Clim. Past Discuss., 8, 349, 2012.