Comment on “Low-frequency sea level variation and its correlation with climate events in the Pacific”

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The tide gauge results exhibit strong multi-decadal oscillations with detected periodicities up to a quasi-60 years. This translates in the requirement of at least 60–70 years of continuously recorded data without any quality issue and the use of a procedure appropriate for time series with periodic components to infer the acceleration trend. This is not what is done in many recent papers where the oscillating behaviour is neglected and short or incomplete records arbitrarily extended or reconstructed are used to infer wrong accelerating trends. All the tide gauges of enough length and quality show the sea levels are oscillating with important multi-decadal periodicities but absolutely not positively accelerating. The satellite radar altimeter reconstruction of the global mean sea level only available since 1993 shows despite the many uncertainties of a still imperfect procedure a not positively accelerating behaviour. The presence of acceleration in the reconstructed or extended data sets and the lack of acceleration in all the individual tide gauge measurements of enough quality and length certainly deserve further discussion. This is a comment to a previously published original paper made on the basis of other previously published results and not a new original paper.

sea level acceleration, sea level multi-decadal oscillations, tide gauge results, Pacific Ocean

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The time series of global mean sea level (GMSL) variations between 1948 and 2007 are reconstructed in [1] by combining satellite altimeter measurements and tide gauge observations to compute a huge acceleration $0.010 \pm 0.009 \text{ mm/a}^2$ of GMSL rise in the second half of 20th century. The individual tide gauge results of enough length and quality show the sea levels are oscillating with important multidecadal periodicities but absolutely not positively accelerating. The satellite radar altimeter reconstruction of the global mean sea level only available since 1993 also shows despite the many uncertainties a not positively accelerating behaviour. The presence of acceleration in many reconstructions and the lack of acceleration in all the individual tide gauge measurements of enough quality and length certainly deserve further discussion.

Figures 1 and 2 present the monthly average sea levels and parabolic fitting for Sydney, NSW; Honolulu, HI; San

Diego, CA; San Francisco, CA; Seattle, WA; Victoria, BC; Vancouver, BC; Tofino, BC. Data are from [2]. Figure 1 presents the 2nd order polynomial fitting of all the available data, while Figure 2 presents the fitting of only the data 1948 to 2007 as considered in the commented paper. The 12 months moving averages are also superimposed to clear out the data of the oscillations of periodicity less than 1 year. The 2nd order coefficients are small both positive and negative. The average acceleration or deceleration over the period of observation is twice this coefficient. There is more than an order of magnitude difference of the truly measured quantities and the value computed in the paper. The oscillations since 1948 have been clearly previously measured and there is no sign of any sharp positive acceleration 1948 to present that would have translated in much larger oscillations.

It is worth of mention that a 60 years' time window is the minimum length of a tide gauge result to clear out the longer term trend of the inter annual and multi-decadal oscillations

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Figure 1 Monthly average sea levels and parabolic fitting for Sydney, NSW; Honolulu, HI; San Diego, CA; San Francisco, CA; Seattle, WA; Victoria, BC; Vancouver, BC; Tofino, BC. Data from PSMSL, 2012. The 2nd order coefficients are small both positive and negative.

Figure 2 Monthly average sea levels and parabolic fitting for Sydney, NSW; Honolulu, HI; San Diego, CA; San Francisco, CA; Seattle, WA; Victoria, BC; Vancouver, BC; Tofino, BC. Data from PSMSL, 2012. Time window of data is now 1948 to 2007 as in the commented paper. The 2nd order coefficients are small both positive and negative.

Figure 3 Computed sea level rises (SLR) by linear fitting of 20, 30, 60 years or all the data for Sydney NSW; Honolulu HI; San Francisco, CA; San Diego, CA; Seattle, WA; Victoria, BC; Vancouver, BC; Tofino, BC. Data from PSMsL, 2012. Short time windows return oscillating values. Time windows larger than 60 years return sea level rises oscillating about the longer term value.

Figure 4 Top: Global mean sea level reconstruction based on satellite radar altimeters (data from University of Colorado sea level research group, 2012). The parabolic fitting has a negative 2nd order coefficient. Left: TOPEX/POSEIDON raw data before any filtering or sliding mean average October 1992 to April 2000 [12]. Right: Sea levels computed from the Envisat signal since 2004 before and after the April 2012 adjustment [13].

up to the known quasi-60 years periodicity [3–12]. Smaller time windows may return very large or small velocities and accelerations as shown by [6].

Figure 3 presents the computed sea level rises (SLR) by linear fitting of 20, 30, 60 years or all the data for Sydney NSW; Honolulu HI; San Francisco, CA; San Diego, CA; Seattle, WA; Victoria, BC; Vancouver, BC; Tofino, BC. In general, the SLR_{20} and SLR_{30} have large oscillations while the SLR_{60} has these fluctuations significantly reduced. Over the last 60 years, the SLR_{20} , SLR_{30} and SLR_{60} have been moving up and down without a positive acceleration trend. The present values have been previously recorded and exceeded in all the stations. The 12 months moving averages oscillate regularly about the linear trends. The SLR_A generally approaches the final long term value after 65–70 years as in Sydney and Honolulu but sometimes it requires much more than the 65–70 years as in San Francisco where the SLR_A is still changing significantly after 150 a. In all the stations, the SLR_{60} is not approaching the maximum value at the present time and is regularly oscillating over the last 6 decades.

Figures 1–3 consistently indicate that the measured sea levels from high quality, long recording tide gauges are oscillating and not accelerating. The reconstructed sea levels

in theory based on the same results should return the same trends. The presence of acceleration in many reconstructions and the lack of acceleration in all the individual tide gauge measurements of enough quality and length certainly deserve further discussion.

Further discussion is provided in [6].

Figure 4 (top) finally presents the global mean sea level (GMSL) reconstruction based on satellite radar altimeters. Data are from [13]. The GMSL is theoretically less affected by the oscillations, and within the limits of accuracy of the computation, certainly requiring further mathematical development and more validation/calibration vs. the high quality tide gauge results, this result does not support any positive acceleration claim having the parabolic fitting a negative 2nd order coefficient. The average acceleration or deceleration over the period of observation is twice this coefficient. This result is only available since 1993 and it is not free of criticism similarly to all the other reconstructions. Which is the contribution of what is actually measured by the satellite to the reconstructed trend is difficult to be understood, because the raw satellite altimetry data are usually not provided. Figure 4 also presents (left) the TOPEX/POSEIDON raw data before any filtering or sliding mean average 1992 to 2000 (from [14]) and (right) the sea levels

computed from the ENVISAT signal 2004 to 2011 before the 2012 correction of the adjustment (from [15]). These completely different behaviors also certainly deserve further discussion.

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