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Analysing interdecadal sea level variations around Australia using over 25 years of satellite altimetry data and climate indices

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The most common way of quantifying sea level variations is fitting linear trend. Meanwhile embedded nonlinear patterns may impact the accuracy of the calculated linear trend. A few studies recently have been conducted to account for the nonlinear variations of the sea level with largely focus on interannual signals. Additionally, climate variations cause many small and large scale changes in sea level as dynamic parameters. This induces spatial and temporal variability to sea level and should be considered in investigating sea level in different basins.
This study aims at identifying interdecadal impacts on the sea level change around Australia and their relation to the climate indices. For this, two data types are utilized, satellite altimetry data of Topex/Posiedon, Jason-1, Jason-2 and Jason-3 missions as well as four climate indices, MEI, PDO, IPO and DMI. The Least squares Spectral Analysis (LSSA) are applied on climate indices to detect the presence of significant interdecadal signals. The Power spectrum density of the resultant analysis highlights 8 interdecadal signals with annual, 1.5 year, 1.8 year, 2.5 year, 3 year, 4.3 year, 5.7 year and 11.2 year periods. In order to see the effect of these signals in the sea level variations around Australia Harmonic Analysis is applied on 1 Hz altimetry bins. Apparently, each of the frequencies detected in the climate indices has a different area of influence in the basins surrounded Australia. Among the periods pointed out the 1.5 and 2.5 year are eliminated as their contribution in sea level variations is so little in terms of both amplitude and spatial distribution. The annual signal represents the most powerful interdecadal effect by exceeding 250 mm of amplitude in Gulf Carpentaria. The rest of the signals are not as strong as annual one but still present a homogenous spatial distribution on specific areas of the basins.
Trend estimation is significantly depends on how fine the model represents the cyclic variations in long term and, in this respect, detecting the interdecadal and decadal signals would assist in accurate trend determination. So the sea level trend is sought in each bin time series by augmenting the simple linear regression with above-mentioned interdecadal and 11.2 year signals. Comparison of the trend map with the recent studies in this area shows 2-3 mm smaller values for the northern part of Australia, Gulf Carpentaria in particular. The main reason of this would be the effect of 11.2 signal in the time series of the previous studies.
Keywords: Sea level trend, interdecadal sea level signals, satellite altimetry, climate indices