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# Multidecadal internal variability role in estimating sea level acceleration: Fremantle case study

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Low frequency internal signals bring challenges to signify the role of anthropogenic factors in sea level rise and to attain a certain accuracy in trend and acceleration estimations; thus, modelling these signals is crucial. Due to both spatially and temporally poor coverage of the relevant data sets, identification of internal variability patterns is not straightforward. In this study, the identification and role of low frequency internal variability (decadal and multidecadal) in sea level change of Fremantle tide gauge station is analysed using two climate indices, Pacific Decadal Oscillation (PDO) and Tripole Interdecadal Pacific Oscillation (TPO). The wavelet transform is applied on the sea level and climate indices time series for this purpose. It is shown that the multidecadal sea level variability is anticorrelated with corresponding components of climate indices in the Pacific Ocean, with correlation coefficients of -0.9 and -0.76 for TPO and PDO, respectively. The correlations are comparatively low in decadal time scale, by correlation coefficient of approximately -0.5 for both indices. To estimate trend and acceleration in Fremantle, three trajectory models are tested. The first model is a simple second-degree polynomial comprising trend and acceleration terms. Low passed PDO, representing decadal and interdecadal variabilities in Pacific Ocean, is added to the first model to form the second model. For the third model, decomposed signals of decadal and multidecadal variability of TPO are added to the first model. For all trajectory models, different noise models are tried and according to Akaike and Bayesian information criteria, the best noise model is AR(5). In overall, TPO explains the low frequency internal variability better than PDO for sea level variation in Fremantle. Although the estimated trends does not change significantly for the three models, the estimated acceleration is substantially different. The accelerations estimated from the first and second models are statistically insignificant, 0.006 ± 0.012 mm.yr$^{-2}$ and 0.01 ± 0.01 mm.yr$^{-2}$ respectively, while this figure for the third model is 0.018 ± 0.01 mm.yr$^{-2}$. The outcome exemplifies the importance of modelling low frequency internal variability in acceleration estimations for sea level rise in regional scale.