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Multi-linear regression of sea level in the south west Pacific as a first step towards local sea level projections

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Rising sea levels are a critical concern in small island nations. The problem is especially serious in the western south Pacific, where the total sea level rise over the last 60 years is up to 3 times the global average. In this study, we attempt to reconstruct sea levels at selected sites in the region (Suva, Lautoka, Noumea – Fiji and New Caledonia) as a mutiple-linear regression of atmospheric and oceanic variables. We focus on interannual-to-decadal scale variability, and lower (including the global mean sea level rise) over the 1979-2014 period. Sea levels are taken from tide gauge records and the ORAS4 reanalysis dataset, and are expressed as a sum of steric and mass changes as a preliminary step. The key development in our methodology is using leading wind stress curl as a proxy for the thermosteric component. This is based on the knowledge that wind stress curl anomalies can modulate the thermocline depth and resultant sea levels via Rossby wave propagation. The analysis is primarily based on correlation between local sea level and selected predictors, the dominant one being wind stress curl. In the first step, proxy boxes for wind stress curl are determined via regions of highest correlation. The proportion of sea level explained via linear regression is then removed, leaving a residual. This residual is then correlated with other locally acting potential predictors: halosteric sea level, the zonal and meridional wind stress components, and sea surface temperature. The statistically significant predictors are used in a multi-linear regression function to simulate the observed sea level. The method is able to reproduce between 40 to 80% of the variance in observed sea level. Based on the skill of the model, it has high potential in sea level projection and downscaling studies.