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# Improving Sea Level Reconstructions Using Non-Sea Level Measurements

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Forming a sea level record that has the quality and duration necessary to compare past to present sea level is a challenge because of the limited spatial and temporal sampling, respectively, of tide gauge and satellite altimeter data records. To overcome these difficulties, combining the shorter but essentially complete global coverage offered by satellite altimetry with the longer but sparsely distributed tide gauge dataset is an active research area. We present a new method for reconstructing sea level involving cyclostationary empirical orthogonal functions (CSEOFs). We demonstrate the use of this reconstructed dataset for climate monitoring, focusing on climate signals in the Pacific Ocean. The CSEOF reconstruction technique can be used to create indices computed solely from sea level measurements for monitoring signals such as the eastern-Pacific (EP) ENSO, central-Pacific (CP) ENSO and Pacific Decadal Oscillation (PDO). We also estimate regional trends in sea level over the past century and discuss the sensitivity of these trends to different parameters affecting the reconstruction. In particular, we discuss how the reconstruction varies as a result of the domain used to compute the basis functions and the effect this has on the spatial variation of the secular trend in sea level.

Additionally, we show how other ocean observations, such as sea surface temperature, can be leveraged to create an improved reconstructed sea level dataset spanning the time period from 1900 to present. The distribution of tide gauges is very sparse prior to 1950, and using other ocean observations can lead to an improved estimation of the trend in sea level at both global and regional scales. We demonstrate the ability of CSEOFs to accommodate sea surface temperature measurements in a sea level reconstruction and compare the combined reconstruction to a reconstruction relying solely on sea level measurements. While the EP ENSO, CP ENSO and PDO are all well represented in the CSEOF reconstruction relying solely on sea level measurements from 1950 to present, we show that significant improvement can be made in the first half of the 20th century by including sea surface temperature measurements in the reconstruction. Finally, we discuss how the improved representation of climate signals in sea level reconstructions can lead to better estimates of both global and regional sea level rise.