Improving Sea Level Reconstructions Using Non-Sea Level Measurements

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We present a new method for reconstructing sea level involving cyclostationary empirical orthogonal functions (CSEOFs). While we show results from a CSEOF reconstruction using basis functions computed from satellite altimetry and subsequently fit to tide gauge data, our focus is on how other ocean observations such as sea surface temperature can be leveraged to create an improved reconstructed sea level data set spanning the time period from 1900 to present. Basis functions are computed using satellite measurements of sea surface temperature, and using a simple regression technique, these basis functions are transformed to represent a similar temporal evolution to corresponding satellite altimeter-derived sea level basis functions. The resulting sea level and sea surface temperature basis functions are fit to tide gauge data and historical sea surface temperature data, respectively, to produce a reconstructed sea level data set spanning the period from 1900 to present. We demonstrate the use of this reconstructed data set for climate monitoring, focusing primarily 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) El Niño–Southern Oscillation (ENSO), central Pacific (CP) ENSO, and Pacific Decadal Oscillation (PDO). The EP ENSO, CP ENSO, and PDO signals are all well represented in the CSEOF reconstruction relying solely on sea level measurements from 1950 to present; however, significant improvement can be made in reconstructing these signals during the first half of the twentieth century by including sea surface temperature measurements in the sea level reconstruction procedure.

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