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Sea level reconstructions from altimetry and tide gauges using independent component analysis

Sandra-Esther Brunnabend (1,2), Jürgen Kusche (2), Ehsan Forootan (2,3)

(1) Leibniz-Institut für Ostseeforschung Warnemünde, Sektion Physikalische Ozeanographie und Messtechnik, APMG, Rostock, Germany (sandra.brunnabend@io-warnemuende.de), (2) Institute of Geodesy and Geoinformation, University of Bonn, Nussallee 17, 53115 Bonn, Germany , (3) School of Earth and Ocean Sciences, Cardiff University, Park PL, Cardiff CF10 3AT, UK

Many reconstructions of global and regional sea level rise derived from tide gauges and satellite altimetry used the method of empirical orthogonal functions (EOF) to reduce noise, improving the spatial resolution of the reconstructed outputs and investigate the different signals in climate time series. However, the second order EOF method has some limitations, e.g. in the separation of individual physical signals into different modes of sea level variations and in the capability to physically interpret the different modes as they are assumed to be orthogonal. Therefore, we investigate the use of the more advanced statistical signal decomposition technique called independent component analysis (ICA) to reconstruct global and regional sea level change from satellite altimetry and tide gauge records.

Our results indicate that the used method has almost no influence on the reconstruction of global mean sea level change (1.6 mm/yr from 1960-2010 and 2.9 mm/yr from 1993-2013). Only different numbers of modes are needed for the reconstruction. Using the ICA method is advantageous for separating independent climate variability signals from regional sea level variations as the mixing problem of the EOF method is strongly reduced. As an example, the modes most dominated by the El Niño-Southern Oscillation (ENSO) signal are compared. Regional sea level changes near Tianjin, China, Los Angeles, USA, and Majuro, Marshall Islands are reconstructed and the contributions from ENSO are identified.