Online Resource to: Coastal Sea Level Changes, Observed and Projected during the 20th and 21st Century

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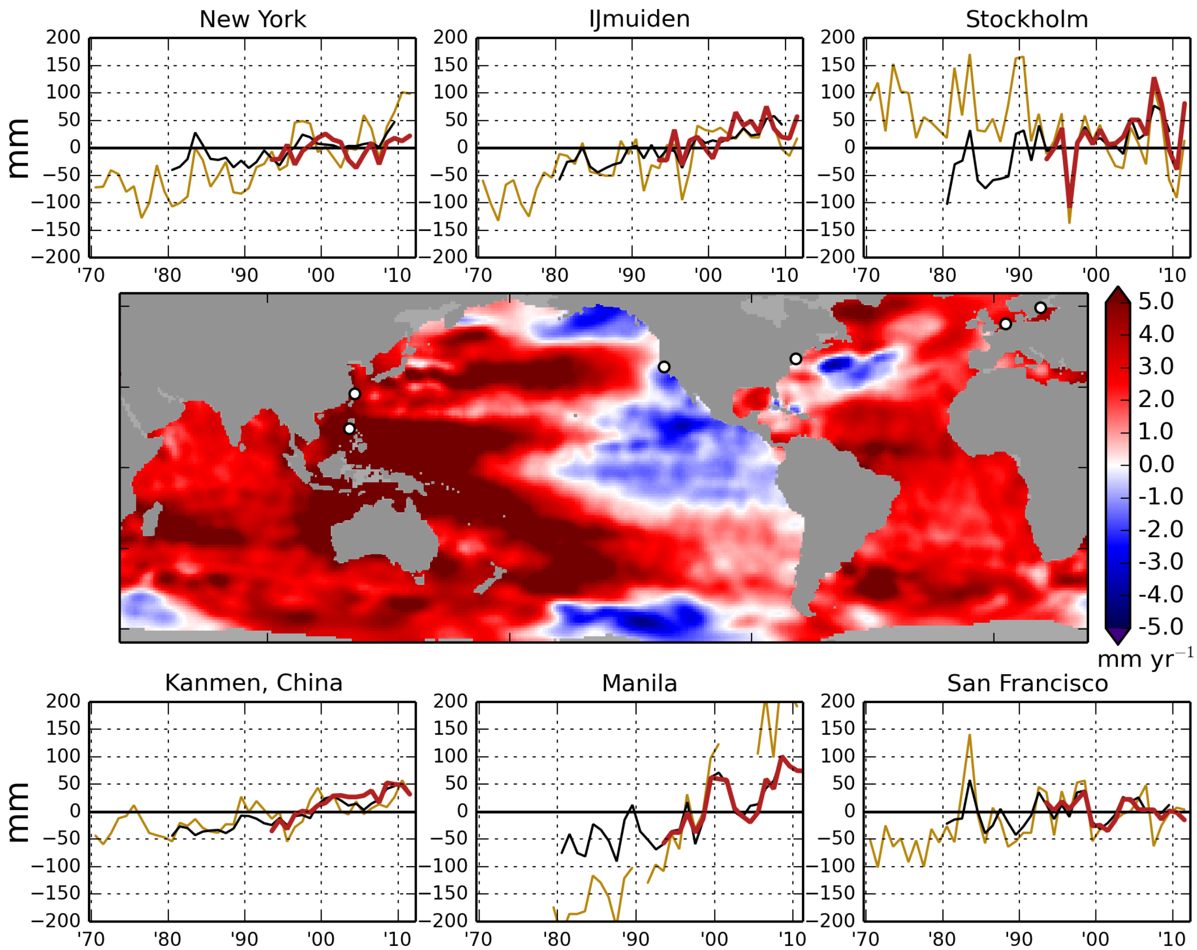
Present-day SLC

To quantify present-day observed sea level changes and to highlight the processes involved, we examine the observed present-day regional sea-level changes (Online Resource Fig. 1a) and compare time series of satellite altimetry (red), tide gauges (gold), and the CW09 sea surface height reconstruction (black). As was discussed in several papers (see Stammer et al., 2013 for a review) the altimetric changes during the period 1993-2012 to a large extent represent sea level changes imposed through modes of climate variability. The outer panels show time series of sea level observations from a few representative locations which are labeled in the panel titles. In order to highlight the various local processes that need to be accounted for in addition to model SSH and land ice melt, tide gauges were not corrected for vertical land motions due to GIA or subsidence, whereas the altimetry and reconstruction products are not corrected for GIA, nor for water extraction subsidence. Due to the absence of a GIA signal for the altimetry and reconstructed SSH time series, neither match the tide gauge time series for New York or Stockholm. New York is experiencing noticeable GIA sinking, causing RSL to increase over what is measured by the satellite altimeter. Stockholm is undergoing strong GIA uplift, which is causing an otherwise local increase in SSH to translate into a decreasing relative sea level measured by the tide gauge there (Online Resource Fig. 1, upper right corner). When the altimetry and reconstructions are corrected for the known vertical land motion in these areas, they match the tide gauge records better (not shown). The tide gauge at Manila shows a huge departure from the slope of SSH trend that is detected by the satellite altimeter. This is estimated to be mostly due to ground water extraction in the city, which is causing land subsidence on a large scale (Rodolfo and Siringan, 2006; Raucoules et al, 2013). Land subsidence due to ground water extraction has mostly been studied regionally and not globally, and is difficult to project into the future, or even include in a global historical dataset such as CW09. For places where these additional processes are not as large a factor in RSL, such as Kanmen, IJmuiden, and San Francisco, the slopes of local satellite-era SSH and tide gauge records match fairly well – the trends all fall within ± 1.2 mm yr^{-1} of each other. However, it should be noted that the reconstruction is not expected to match any single tide gauge perfectly, even if corrected for vertical land motions such as GIA (Church et al, 2004). Also, due to the use of satellite altimetry data for calculating the EOFs used as the cost function for the tide-gauge reconstruction, it is possible that any decadally varying signal not well resolved during the satellite missions will not be properly reproduced in the reconstruction.



Online Resource Figure 1: **Observed present-day regional sea-level changes.** *Inner panel* Satellite altimetry sea surface height trend, 1993-2012, in mm yr^{-1} (cm decade^{-1}). *Outer panels* Time series of satellite altimetry (red), tide gauges (gold), and the CW09 updated sea suface height reconstruction (black) in cm. Locations are labeled in the panel titles. Tide gauges are unprocessed, so land motions due to GIA or subsidence are retained, whereas the altimetry and reconstruction products are not corrected for GIA, nor for water extraction subsidence. This helps highlight processes not normally included in global climate models, such as the changes in Manila and Stockholm (see text).

References

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