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The Sea Level Rise in the Gulf of Venice observed by Satellite Altimetry and In Situ Observations in the ESA SL_CCI project

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Tracking the variability of Sea level rise is an essential step for the safeguard of coastal settlements. In Europe, one of the most important is the city of Venice, threaten by the combined effects of subsidence and eustatism, either antropogenic and natural, which gradually have increased the vulnerability of the historical city to the action of storm surges. Even if the MOSE barrier was designed to defend Venice against such devastating phenomenon, the gradually rising sea levels has long term implications that have not been sufficiently investigated yet. Moreover, the contributions from the various mechanisms responsible of the relative sea level rise have been not clearly isolated and quantified. The European Space Agency (ESA) Climate Change Initiative (CCI) project on “Sea Level” has supplied a revised set of satellite-based sea level products (e.g., monthly mean sea levels and trends) by reprocessing altimeter data over 1993-2015. This study aims to assess the quality of the Sea Level CCI products in the Gulf of Venice, northern Adriatic Sea, comparing them with in-situ measurements of sea level taken by the historical tide gauges of Venezia (Punta della Salute, CNR Acqua Alta Platform) and Trieste (Molo Sartorio). We try also to isolate the contribution of the atmospheric pressure and the subsidence in the relative sea level rise budget. While in Venice, in the period 1993-2015, a relative sea level rise trend of about $+6.4 \pm 2.1$ mm y^{-1} has been determined from in situ data, in Trieste the local tide gauge registered a trend of about $+4.5 \pm 2.0$ mm y^{-1}. At the closest CCI grid points, the SL CCI time series show similar trend: $+4.0 \pm 1.3$ mm y^{-1} in Venice and $+3.4 \pm 1.2$ mm y^{-1} in Trieste. The differences between the in-situ and the altimetry product fitting slope is partly ascribable to vertical land movements and to inverted barometer effect. After removal of the isostatic part of the inverted barometer effect, determined by using time series of atmospheric pressure from in situ measurements and reanalysis products, the fitting slope of the in situ sea level in Venice and Trieste is marginally lowered ($+6.2 \pm 1.5$ mm y^{-1} and $+4.2 \pm 1.4$ mm y^{-1} respectively), but an effective result is that also the slope standard deviation is reduced. These findings will permit to estimate the importance of vertical land movements and better estimate local processes that might impact on the local sea level rise. During the CCI+ phase (2018-2019) particular efforts will be dedicated to the retrieval of sea level from altimeters in the coastal zone. This work will contribute to identify problems and challenges to extend the sea level climate record to the coastal zone with quality comparable to the open ocean.