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Uncertainty in Satellite estimate of Global Mean Sea Level changes, trend and acceleration

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Satellite altimetry missions now provide more than 25 years of accurate, continuous and quasi-global measurements of sea level along the reference ground track of TOPEX/Poseidon. These measurements are used by different groups to build the Global Mean Sea Level (GMSL) record, an essential climate change indicator. Estimating a realistic uncertainty of the GMSL record is of crucial importance for climate studies such as estimating precisely the current rate and acceleration of sea level, analyzing the closure of the sea level budget, understanding the causes for sea level rise, detecting and attributing the response of sea level to anthropogenic activity, or estimating the Earth energy imbalance. Ablain et al., (2015) estimated the uncertainty of the GMSL trend over the period 1993-2014 by thoroughly analyzing the error budget of the satellite altimeters and showed that it amounts to $\pm$0.5 mm/yr (90% confidence level). In this study, we extend Ablain et al., (2015) analysis by providing a comprehensive description of the uncertainties in the satellite GMSL record. We analyse 25 years of satellite altimetry data and estimate for the first time the error variance-covariance matrix for the GMSL record with a time resolution of 10 days. Three types of errors that can affect satellite altimetry measurements are modelled (drifts, biases, noise) and combined together to derive a realistic estimate of the GMSL error variance-covariance matrix. From the error variance-covariance matrix we derive a 90% confidence envelop of the GMSL record on a 10-day basis. Then we use a least square approach and the error variance-covariance matrix to estimate the GMSL trend and acceleration uncertainties over any time periods of 2 years and longer in between October 1992 and December 2017. Over 1993-2017 we find a GMSL trend of 3.35$\pm$0.4 mm/yr (90% CL) and a GMSL acceleration of 0.12 $\pm$0.07 mm/yr^2 (90% CL) in agreement (within error bars) with previous studies. The full GMSL error variance-covariance matrix is freely available online.