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Probabilistic surface reconstruction of relative sea-level rise

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Relative sea level is shaped by multiple processes (mantle dynamic topography, plate tectonics, glacio-isostatic adjustment, present day melting of continental ice, anthropogenic causes…), most of which induce spatial gradients in relative sea level fluctuations. The evaluation of the global mean sea level rise is a also a key variable to decipher sea level evolution. Tide gauges represent the only mean to monitor sea-level rise on the scale of the 20th century, while the high quality satellite altimetry era is too short to be immune from short-term fluctuations. Tide gauge data compiled by the Permanent Service for the Mean Sea Level (PSMSL) converts into local estimates of sea level rise. Classically, these in situ observations are averaged spatially in order to infer the global mean sea level trend. However, the strongly heterogeneous distribution of tide gauges (e.g. very sparse in the Southern hemisphere) makes this approach relatively prone to uncertainties, given that sea level rise strongly varies geographically. Last, the societal consequences for coastal communities raise the prominent need for local (rather than global) sea level estimates. An alternative is therefore to provide a global surface reconstruction of relative sea level leading to both local variations and a better constrained global average. Here, we propose such a model from tide gauge records using a probabilistic scheme based on the reversible jump Markov chain Monte Carlo algorithm (as described by Bodin et al., JGR, 2012 for the example of the Australian Moho). This method allows to infer both model and parameter space so that not only the functions within the model but also the number of functions itself are free to vary. This is particulalry relevant to the case of tide gauges that are unevenly distributed on the surface of the Earth and whose record lengths are strongly variable. In addition, Bayesian statistics leads to a probabilistic representation (rather than a best fitting model) that is well adapted to the societal impact of relative sea level rise.