A surrogate ensemble study of sea level reconstructions

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We investigate the possibility of reconstructing past global mean sea
levels. Such methods rely on historical measurements from tide gauges
combined with knowledge about the spatial covariance structure of the sea
level field obtained from a shorter period with spatially well resolved
satellite measurements. We apply a surrogate ensemble method based on
sea levels from a 500 years climate model simulation. Tide gauges are
simulated by selecting time-series from grid-points along continental
coastlines and on ocean islands. Reconstructions of global mean sea
levels can then be compared to the known target and the ensemble method
allows an estimation of the statistical properties originating from the
stochastic nature of the reconstructions.

We study different reconstruction methods previously used in the
literature including projection and optimal interpolation methods based
on EOF analysis of the calibration period. We also include methods where
these EOFs are augmented with a homogeneous pattern with the purpose
of better capturing a possible geographically homogeneous trend. These
covariance based methods are compared to a simple weighted mean method.

We conclude that the projection and optimal interpolation methods are very
sensitive to the length of the calibration period. For realistic lengths
of 10 and 20 years very large biases and spread in the reconstructed
1900-1949 trends are found. Including a homogeneous pattern in the basis
drastically improves the reconstructions of the trend. For the projection
method - which together with the weighted mean is the best method - biases
are now less than 10 %. However, the spread is still considerable.
The amplitude of the year-to-year variability is in general strongly
overestimated by all reconstruction methods. With regards to year-to-year
variability several methods outperform the simple mean.