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Influence of changing predictor networks and proxy covariance on ENSO reconstructions over the last Millennium

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The El Niño-Southern Oscillation is a complex mode of climate variability in the equatorial eastern Pacific region. It describes a coupled circulation system between atmospheric processes and variations in the sea surface temperatures. Many ENSO reconstructions covering the last centuries are based on different proxy records from the ENSO core region and surrounding areas. However, the agreement among the different reconstructions is very low prior to the instrumental period. In addition to varying reconstruction targets and seasons, local noise and uncertainties in the proxy records, this disagreement could possibly be explained by changes in teleconnection patterns influencing remote proxy records. This project aims to evaluate those changes in the relationship between ENSO proxy records over time and to provide explanations for the disagreement among the ENSO reconstructions. We use principal component analysis using annually resolved proxy records from around the globe, selecting only those records that correlate significantly with the NINO3.4 index over 1930-1990. The first principal component (PC1) of this selection explains over 80% of ENSO variance over 1930-1990. This approach not only allows for a very simple but highly skilful reconstruction using proxy PC1, but also to evaluate changes in the ENSO proxy network over time. To do so, a "classical" ENSO reconstruction using PC1 is compared to a PC analysis using running temporal windows over the last 1000 years.

Running correlations between the "classical" and running PC1 reconstructions reveal good matching periods as well as periods of disagreement. These discrepancies may be caused by changes in ENSO teleconnection patterns or artefacts in the input data that are unrelated to ENSO. The identified temporal changes in the coherence of the proxy network are used to explain some of the discrepancies in existing reconstructions.

Spatial patterns and changes in teleconnections are assessed by analysing the changes of the loadings on PC1 over time. Records with high and stable loadings on PC1 are identified and suggested as good ENSO predictors. Our quantification of the changing reliability of ENSO reconstructions over time will help to improve future assessments of the influence of the tropical Pacific on global climate over the past Millennium.