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Quantifying paleo-reconstruction skill of the Southern Annular Mode in a model framework

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The Southern Annular Mode (SAM) is the leading mode of atmospheric variability in the Southern Hemisphere. It impacts rainfall and surface air temperature throughout the hemisphere and is also responsible for a significant proportion of the variability in air-sea carbon exchange. The recent positive trend in the SAM over the last $\sim$40 years has been linked to potential changes in ocean heat and carbon uptake, which could have a significant impact on the rate of anthropogenic warming. To investigate whether trends like this have occurred in the past, and how they may affect regional climate and atmospheric CO_2, paleo-reconstructions of the SAM have been created spanning roughly the last millennium.

Using the GFDL CM2.1 climate model, we attempt to assess the expected skill of these reconstructions using a pseudo-proxy approach and the popular weighted Composite Plus Scaling reconstruction method. This study covers non-stationary proxy-SAM relationships, the effects of calibration period length on reconstruction skill, the number of sites included in a reconstruction and the problem of relying too heavily on a single continent when sourcing proxies. We find that maximising the calibration window size, as well as sourcing proxies from a geographically diverse range of sites provides the most reliable reconstructions, accounting for up up to 58% of the model SAM variability (with realistic 31 year calibration window and 70 proxies).