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Southern Annular Mode reconstructions using ships' logbook data

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The Southern Annular Mode (SAM) represents changes in the strength of the Southern Hemisphere westerlies, the strengthening of which in recent decades in austral summer has been linked to stratospheric ozone depletion. Extending the SAM record back further for all seasons is needed to put current changes in perspective and for evaluation of the ability of climate models to simulate the SAM.

This study will produce SAM reconstructions during the period 1750-1850 using meteorological observations from ships' logbooks from the Climate of the World's Oceans (CLIWOC) and East India Company (EIC) databases. As data are available all year round, this offers the possibility of SAM reconstructions for the four seasons, which will extend knowledge on seasonal SAM behaviour, and complement existing proxy-based reconstructions which are typically for the summer season or annual.

To determine regions with significant relationships between u-wind and the SAM index, correlation coefficients were calculated between regridded 10m u-wind speed from the ERA-interim reanalysis for the SAM index of Marshall (2003) over the period 1979-2010. These data were first regridded to 8 degree by 8 degree resolution, to provide large enough regions for sufficient seasonal logbook data to be available.

Regions of significant correlations overlap with the ship's routes and hence wind data from the EIC and CLIWOC datasets in all four seasons, with data coverage most dense in the Indian Ocean, around southern Africa and across the Atlantic Ocean towards South America.

As there is no overlap between the logbook and modern instrumental data, model fitting and calibration is undertaken using 10m u-wind from the ERA-interim reanalysis, and then these relationships applied to logbook data to produce the reconstructions. For each season domains were selected where data coverage and significant correlations overlapped. Principal component regression (PCR) was used to assess the potential of the dominant patterns of variability in the u-wind in these domains as predictors to reconstruct the SAM index. Fitting and validation statistics give confidence that reconstructions are viable in all four seasons, with reconstruction quality best in autumn and winter, seasons not typically represented in proxy reconstructions. The regression relationships derived in this fitting period will be applied to gridded seasonal mean logbook data to produce SAM reconstructions for periods between 1750 and 1850.

This work also highlights the importance of rescuing and digitising existing datasets. Regions of significant mid-latitude correlations also extend south of Australia to New Zealand, where currently digitised logbook data coverage is too sparse to be used for the reconstructions. Similarly, high latitude data from around the Antarctic (Wilkinson pers. comm.) would also provide valuable data for the reconstructions. Results of a sensitivity analysis to determine the potential for improvement in the SAM reconstructions using reanalysis data from these regions will be presented.