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Quantifying the effect of aerosols on the Southern Annular Mode: do aerosols tip the balance?

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Global increases in greenhouse gasses (GHGs) and the recovery of stratospheric ozone (sO_3) are known to have opposing effects on the position of the Southern Hemisphere (SH) jet stream. These two forcings are the principal drivers of atmospheric variability in this hemisphere, particularly in the Austral summer. To date, GHG and sO_3 forcings have driven a poleward jet shift, but in recent decades the recovery of sO_3 is expected to counteract this poleward trend. Recently, mechanisms have been proposed by which primarily Northern Hemisphere aerosol may also affect SH circulation. In light of the opposing trends of GHGs and sO_3, the influence of anthropogenic aerosols (AAs) is expected to become more important.

Using the Southern Annular Mode (SAM) as a diagnostic of SH atmospheric variability across high and low frequency time scales, we use ensemble empirical mode decomposition (EEMD) to extract non-linear non-stationary trends from a subset of CMIP5 models under a range of historical forcings. We quantify the influence and statistical significance of historical AA, GHG and all forcing trends on the SAM over the last c.150 years. We present detailed trend analysis of single forcings experiments, discuss individual model trends in the context of the wider implications of accurately accounting for aerosol processes in climate models, and examine the implications of assuming a linear paradigm for combined single forcings. We conclude by assessing the capability of AAs in tipping the balance between a GHG-sO_3 jet-shift stalemate.