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The Brewer-Dobson Circulation in a changing climate: Trend versus natural variability

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The majority of recent modelling studies finds a strengthening of the stratospheric meridional overturning circulation, the Brewer-Dobson Circulation (BDC), under increasing greenhouse gas concentrations. Although there is a large spread in magnitude and source of the BDC trend among models and model configurations, the positive sign of the trend is found to be a robust response. However, derivations of the age of stratospheric air from tracer observations covering 10 to 30 years at different locations do not reveal any significant trend. This contradiction between modelling studies and observations could possibly be due to low-frequency variability of the BDC. In both observational datasets as well as model simulations BDC trends could be masked by or confused with long-term variability.

In this study, multi-century model simulations of different atmosphere-ocean General Circulation Models, which contribute to the Coupled Model Intercomparison Project 5, are analysed to identify the low-frequency modes of natural BDC variability. Possible connections to other sources of long-term variability in the Earth System, particularly the tropical sea surface temperatures, are investigated. The amplitude of the low-frequency natural BDC variability is compared to trends derived from both model and observational datasets, and thus it is assessed if the available observational datasets are adequate to allow for a detection of a robust trend in the BDC.