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# Assessment and Consequences of the Delayed Breakup of the Antarctic Polar Vortex in Chemistry-Climate Models

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Many atmospheric general circulation models (GCMs) and chemistry–climate models (CCMs) are not able to reproduce the observed polar stratospheric winds in simulations of the late 20th century. Specifically, the polar vortices break down too late and peak wind speeds are higher than in the ERA-40 reanalysis. Insufficient planetary wave driving during the October–November period delays the breakup of the southern hemisphere (SH) polar vortex in versions 1 (V1) and 2 (V2) of the Goddard Earth Observing System (GEOS) chemistry–climate model, and is likely the cause of the delayed breakup in other CCMs with similarly weak October-November wave driving. Differences in the models' response to years when the modelled eddy heat flux at 100hPa is relatively weak or relatively strong allow the consequences of the late breakup of the polar vortex to be evaluated. In the V1 model, the delayed breakup of the Antarctic vortex biases temperature, circulation and trace gas concentrations in the polar stratosphere in spring. The V2 model behaves similarly (despite major model upgrades from V1), though the magnitudes of the anomalous effects on springtime dynamics are smaller.

As greenhouse gas concentrations continue to rise, the atmospheric temperature structure and resulting zonal wind structure are expected to change. Clearly, if CCMs cannot duplicate the observed response of the polar stratosphere to late 20th century climate forcings, their ability to simulate the polar vortices in future may be poor. Understanding model weaknesses and improving the modelled stratospheric winds will be necessary for accurate predictions of ozone recovery.