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Separating the radiative and dynamical responses to Antarctic stratospheric ozone depletion

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Recent observed Southern Hemisphere summer trends in geopotential height, surface temperature and winds can be simulated well in response to observed changes in stratospheric ozone concentration. The mechanisms which are responsible for this result are investigated in this study.

The largest tropospheric response in geopotential height is seen in the summer months, whereas the maximum ozone depletion occurs in the spring. This has led to two potential mechanisms being proposed for this result. Previous studies have shown the dynamical linkages between the stratosphere and the troposphere, and the downward propagation of anomalies from the middle atmosphere to the surface. The delay in the surface response could be explained by the dynamical response descending from the stratosphere to the surface. The other possible mechanism is a radiative response. The maximum ozone depletion near the tropopause occurs in the summer months and the delay in the surface response may therefore be directly because of the radiative forcing occurring in summer rather than dynamical cooling.

The climate response to ozone depletion is simulated using the 64 level version of Hadley Centre slab model HadSM3-L64. We investigate the relative contributions of the radiative and dynamical forcing components by running two simulations of the response to stratospheric ozone depletion, one of which resolves both radiative and dynamical responses to prescribed ozone depletion, and a second in which the dynamical heating is fixed at control values.