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Emergence of Southern Hemisphere circulation changes in response to ozone recovery

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Ozone depletion in the Southern Hemisphere (SH) stratosphere in the late 20th century cooled the air there, strengthening the SH stratospheric westerly winds near 60°S and altering SH surface climate. Since ~1999, trends in Antarctic ozone have begun to recover, exhibiting a flattening followed by a sign reversal in response to decreases in stratospheric chlorine concentration due to the Montreal Protocol, an international treaty banning the production and consumption of ozone-depleting substances. Here we show that the post-1999 increase in ozone has resulted in thermal and circulation changes of opposite sign to those that resulted from stratospheric ozone losses, including a warming of the SH polar lower stratosphere and a weakening of the SH stratospheric polar vortex. Further, these altered trends extend to the upper troposphere, albeit of smaller magnitudes. Observed post-1999 trends of temperature and circulation in the stratosphere are about 20–25% the magnitude of those of the ozone depletion era, and are broadly consistent with expectations based on modeled depletion-era trends and variability of both ozone and reactive chlorine, thereby indicating the emergence of healing of dynamical impacts of the Antarctic ozone hole.