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Stratospheric influence on circulation changes in the Southern Hemisphere troposphere in coupled climate models

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Circumpolar circulation in the Southern Hemisphere intensified during last decades of the 20th century with changes being observed mostly in austral summer and autumn. The intensification has been attributed to external forcing such as stratospheric ozone depletion and greenhouse gas (GHG) increase, although some studies suggest that it may be just a manifestation of natural variability. There is strong observational evidence that trends in the troposphere are linked to those in the stratosphere but the exact physical mechanisms of the downward trend propagation are not yet understood. Several studies have shown that atmospheric models (coupled to either a simplified or dynamical ocean) are able to simulate observed changes when forced by observed ozone trends or combined ozone and GHG trends. However, as some of these studies suffered from erroneously specified forcing, the reason for intensification of circulation remains debatable. Here, we re-approach this issue using data from coupled climate models that participated in the IPCC AR4 assessment. Some of these models accounted for stratospheric ozone depletion while others did not. Separation of these models allowed us to isolate the effect of ozone depletion. We demonstrate that only models that include ozone depletion simulate downward propagation of the circulation changes from the stratosphere to the troposphere similar to that observed, with GHG increase causing only small Antarctic mean geopotential height and temperature trends. These changes are simulated by the majority of the ozone forced models used in the IPCC AR4 assessment except in those with the lowest vertical resolution

in the lower stratosphere.