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Impacts of increase in greenhouse gases and ozone depletion and recovery on the Brewer-Dobson circulation

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In this study, present and future changes in stratospheric transport characteristics are examined using multi decadal simulations carried out with a chemistry-climate model (CCM) developed at the Meteorological Research Institute (MRI-CCM). We performed a reference run from 1960 to 2100 under a prescribed forcing in which both the greenhouse gases (GHGs) and ozone depleting substances (ODSs) vary transiently in time. In addition, we also performed two sensitivity runs in which either GHGs or ODSs held fixed at 1960 levels. We compared the two sensitivity runs with the reference run to separate effects of the ODS and GHG forcings on the stratospheric transport characteristics.

In the late 21st century, increasing of GHGs induces stronger stratospheric residual circulation with enhanced eddy horizontal transport in the mid-latitudes stratosphere. The eddy transport is especially enhanced in the northern hemisphere. In the beginning of the 21st century, when the large ozone depletion is simulated in the Antarctic, annually-averaged residual circulation and mean N_2O transport for the reference run become significantly stronger not only in the Antarctic lower stratosphere but in the southern upper stratosphere.

Keywords: climate projections, stratospheric transport, chemistry-climate model