Past and Future Brewer-Dobson Circulation Changes and the Main Drivers

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As shown by emerging evidences, the Brewer-Dobson Circulation (BDC) has been strengthening in the past decades. This strengthening is likely driven primarily by anthropogenic forcings. For example, substantial increases in the atmospheric concentration of well-mixed greenhouse gases (notably CO_2), such as those projected to occur by the end of the 21st century under large radiative forcing scenarios, have long been known to cause an acceleration of the Brewer-Dobson circulation. More recently, however, several single-model studies have proposed that ozone-depleting substances might also be important drivers of BDC trends. As these studies were conducted with different forcings over different periods, it is difficult to combine them to obtain a robust quantitative picture of the relative importance of ozone-depleting substances as drivers BDC trends. Therefore, the output from 20 similarly-forced models, gathered from two recent chemistry-climate modeling intercomparison projects, is analyzed here over identical past and future periods. The multi-model analysis reveals that ozone-depleting substances are responsible for more than half of the modeled BDC trends in the decades before the year 2000. In addition, as a consequence of the Montreal Protocol, decreasing concentrations of ozone-depleting substances in coming decades will strongly decelerate the BDC until the year 2080, and thus substantially mitigate the impact of increasing CO_2. As ozone depleting substances impact BDC trends, primarily, via the depletion/recovery of stratospheric ozone over the South Pole, they impart seasonal and hemispheric asymmetries to the trends which may offer opportunities for detection in coming decades.