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Large impacts, past and future, of ozone depleting substances on Brewer-Dobson circulation trends: A multi-model assessment

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While multidecadal increases in carbon dioxide concentrations have long been known to cause an acceleration of the Brewer-Dobson circulation (BDC) by the end of the 21st century, the impact of ozone depleting substances (ODS) on the BDC has received little attention. A few recent studies have suggested that ODS might be important drivers of BDC trends, but these studies were conducted with individual models. Here we take a multi-model approach, and analyze BDC trends for the past (1960-2000) and for the future (2000-2080) in the models participating in both the CCMVal2 and CCMI intercomparison projects. Examination of both age-of-air and vertical velocity, using 20 different stratosphere-resolving models, reveals that ODS are very important drivers of BDC trends. First: we find that in the last few decades of the 20th century ODS have contributed roughly half of the modeled trends. Second: owing to present and future ODS reductions as a consequence of the Montreal Protocol, BDC trends in the next several decades are projected to be much smaller (roughly by a factor two) than trends in the late 20th century. Our multi-model study, therefore, robustly establishes the major impact of ODS on BDC trends, and highlights how the Montreal Protocol will be altering the stratospheric circulation until the end of the 21st century.