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Strengthening of the Brewer-Dobson circulation since 1980 seen from satellites

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Abstract:
The Brewer-Dobson circulation (BDC), a global residual circulation in the stratosphere, has been predicted to accelerate by general circulation models (GCMs) and chemistry-climate models (CCMs) in response to rising greenhouse gas concentrations and ozone depletion. Since the BDC and its changes have important implications on both stratospheric and tropospheric climate as well as stratospheric ozone chemistry, it is important to assess the simulated BDC changes with observations. The changes in the BDC have not been unambiguously detected from observations on the decadal time scale. Engel et al. (2009) have analyzed balloon-borne measurements of carbon dioxide (CO_2) and sulfur hexafluoride (SF_6) over the past 30 years to derive possible trends in the mean age of stratospheric air. They reported a small but insignificant increase of the mean age of air in the Northern Hemisphere (NH) midlatitude middle stratosphere, in contrast to an expected decrease in the age of stratospheric air as a result of an accelerated BDC. The interpretation provided in Engel et al., however, has been subject to debate. In this talk, I will present the change of the Brewer-Dobson circulation (BDC) since 1980 through a combined analysis of satellite Microwave Sounding Unit (MSU/AMSU) lower-stratospheric temperatures (T_{LS}), ERA-Interim reanalysis data, and observed estimates of changes in ozone, water vapor, well-mixed greenhouse gases, and stratospheric aerosols. The MSU/AMSU-observed tropical T_{LS} trend is first empirically separated into a dynamic component associated with the BDC changes and a radiative component due to the atmospheric composition changes. The derived change in the dynamic component suggests that the annual mean BDC has accelerated in the last thirty years, with most of the change coming from the Southern Hemisphere. The annual mean NH contribution to the acceleration is not statistically significant. The radiative component of tropical T_{LS} trends is independently checked using observed changes in stratospheric composition along with a radiative transfer model. By establishing a relationship between tropical residual vertical velocity at 70 hPa and T_{LS}, we show that the relative strengthening of the annual mean BDC is about 2.1% per decade since 1980, supporting the results from state-of-the-art chemistry-climate model simulations.

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Time: Refreshments at 3:15pm; Seminar at 3:30pm
FL2-1022, Large Auditorium

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