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The impact of structural changes in the middle atmosphere on the Brewer-Dobson circulation

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Changes in atmospheric composition affect surface climate and alter atmospheric structure, dynamics, and transport, which in turn further affect the composition. In the middle atmosphere, the composition is influenced by the Brewer-Dobson circulation (BDC), a global-scale interhemispheric meridional overturning circulation. Namely, the BDC controls the distribution and trends of radiatively important gases like ozone and water vapour. Another robust aspect of the changes in greenhouse gas concentrations is the changing structure of the atmosphere across layers. The troposphere is thermally expanding, the stratosphere is cooling and contracting and this is then reflected in the mesosphere and above as a downward shift of the height of pressure levels. Particularly, the tropospheric expansion and the stratospheric contraction has been shown to interfere with diagnosed BDC trends. We developed an analytical methodology that allows us to partition between the pure acceleration of the circulation and other kinematic factors (vertical shift, widening) contributing to the net advective mass flux changes and quantify their roles precisely. We apply this methodology to different datasets (ERA5, CMIP6, CCMI-1) to analyze the variability and trends of advective transport between different layers of the middle atmosphere. Finally, we discuss how the net advective transport and the individual kinematic mechanisms contributing to it respond to external forcings.