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Is the Brewer-Dobson circulation increasing or moving upward? A definitive answer.

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The meridional overturning mass circulation in the middle atmosphere, i.e. the Brewer- Dobson circulation (BDC), was first discovered before decades based on the distribution of trace gases and a basic analytical concept of BDC has been derived using the transformed Eulerian mean equations. Since then, BDC is usually defined as consisting of a diffusive part, and an advective, residual mean circulation.

Climate model simulations robustly show that the advective BDC part accelerates in connection to the greenhouse gas induced climate change and this acceleration dominates the middle atmospheric changes in climate model projections. A prominent quantity that is being studied as a proxy for advective BDC changes is the net tropical upwelling across the 70 hPa, which measures the amount of mass advected by residual circulation to the stratosphere and upwards.

Another robust aspect of the changes in greenhouse gas concentrations is the changing structure of the atmosphere across layers. Particularly, it was debated whether the increasing BDC is not driven by the vertical shift of the circulation. In our research, we give a complete and definitive answer to this question. We developed an analytical method that allows us to attribute the changes in tropical upwelling to kinematic causative factors such as increasing residual mean vertical mass flux, vertical shift of the circulation and for the first time, changes in width of the upwelling region and changing curvature of the 70hPa level. Our results demonstrate that this is the complete set of kinematic factors influencing the net upwelling and that all of these factors are important contributions to the net upwelling change.