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Stratospheric Dynamics and Tropopause Structure

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The height of the tropopause is often considered to be primarily set by the combined effects of a dynamically active troposphere and a stratosphere in near radiative equilibrium. Here, modifications of this picture due to stratospheric dynamics are quantified using a comprehensive climate model and simple idealized modeling. Stratospheric radiative equilibrium solutions are obtained using off-line radiative transfer calculations for given tropospheric climate as simulated by the climate model. That is, a hypothetical climate is obtained that has a realistic troposphere and a stratosphere in radiative equilibrium. The resulting tropopause height in these stratospheric radiative equilibrium solutions is reduced by several kilometers in the tropics but is increased by 1-2 km in the extratropics compared to the tropopause height in the (full-blown) climate model, reducing the equator-to-pole contrast in tropopause height by more than 50%. That is, more than half of the observed equator-to-pole contrast in tropopause height can be attributed to stratospheric dynamics. This is discussed in terms of the stratospheric residual mean meridional circulation which tends to lift the tropopause within its upward branch in the tropics and tends to lower the tropopause within its downward branch in the extratropics, especially during winter.