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The Sensitivity of Moisture Fluxes into the Tropical Tropopause Layer to External Forcing

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The very low temperatures in the tropical tropopause layer (TTL) restrict the moisture entering the stratosphere, leading to its dryness. Whereas the water vapor flux into the stratosphere can be described via the cold point temperatures, our knowledge on the contribution of frozen moisture to the total flux is incomplete. This raises concerns regarding the ability of General Circulation Models (GCMs) to accurately predict changes in total stratospheric moisture following perturbations in the radiative budget due to volcanic aerosol or stratospheric geoengineering, as GCMs heavily rely on convective parameterizations. The emerging cloud-resolving simulations, however, offer the unprecedented possibility to gain insight into the sensitivity of a TTL, which is not strongly constrained by parameterized convection. Here we present the first results using global convection-resolving simulations to investigate the sensitivity of moisture fluxes within the TTL to an additional heating source. We address the question of how the partitioning of moisture fluxes into water vapor and frozen hydrometeors changes under perturbations.
This study shows an exceptional resilience of the TTL, keeping the flux partitioning constant - even at an average cold-point warming exceeding 8 K. In the perturbed and unperturbed simulation, frozen moisture contributes around 20 % of the moisture flux into the stratosphere.