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The tropical stratospheric upwelling sets the tropical equilibrium climate sensitivity by reducing the effective forcing

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Several modeling studies identified a climate-chemistry feedback mechanism that modulates the global equilibrium climate sensitivity (ECS) through changes in the tropical upper-tropospheric and lower-stratospheric (UTLS) water vapor. The main factors producing this feedback are the upward shift of the tropical tropopause layer (TTL) and the acceleration of the Brewer-Dobson circulation (BDC). These two processes change the ozone (O_3) concentration, resulting in a drier UTLS region than without O_3 changes. Thus, the planetary long-wave emissivity increases and the ECS decreases. However, the BDC alone provides a tropical dynamical cooling in the UTLS region. This cooling is modified by the carbon dioxide (CO_2) diabatic effects. Thus, the magnitude of the BDC changes can directly impact the tropical, if not the global, ECS. We build upon the work of Dacie et al. (2019), who analyzed how O_3 changes affected the tropical ECS and TTL temperature. We study how the changes in the tropical upwelling directly affect the tropical ECS using the forcing-feedback framework. We find that the tropical upwelling changes dampen the effective radiative forcing, thereby reducing the ECS. Adding O_3 chemistry shows that the changes in upwelling greatly enhance the climate chemistry-feedback but, more importantly, enhance the dampening of the effective radiative forcing and the reduction in ECS. Nonetheless, we cannot answer if these tropical effects of upwelling affect the global ECS until we include the extratropical regions.