

Intermodel upwelling difference in the tropical tropopause layer among CMIP5 models.

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A climatology of the upwelling in the tropical tropopause layer (TTL) is examined by using the models that participated in the Coupled Model Intercomparison Project Phase 5 (CMIP5). This study investigates how large the intermodel upwelling difference is and what causes it in both historical climate simulations (1979-2003) and future climate projections (2075-2099) based on the Representative Concentration Pathway (RCP) 8.5.

Large intermodel upwelling difference in the TTL occurs in the historical simulation. The difference between the two extreme values is larger than annual cycle of the upwelling in reanalysis and each CMIP5 model. To clarify the contribution of the sea surface temperature, comparison is performed between SST prescribed simulations and ocean-coupled simulations. The result shows that contribution of intermodel SST difference to the upwelling is smaller than that of the atmospheric model difference. According to upwelling diagnosis based on the zonal momentum budget, the meridional eddy momentum flux and planetary scale waves at around 100 hPa largely control the intermodel upwelling difference. Additionally, composite analysis shows that strong upwelling models tend to have strong amplitude of equatorial waves like Matsuno-Gill type waves and weak upwelling models tend to express equatorward-propagating extratropical waves weakly.

Future climate simulations indicate a strong tied relationship to its historical simulation. The models with strong TTL upwelling in the historical simulation project strong upwelling amplification in the future simulation, and vice versa. Upwelling diagnosis illustrates that intermodel difference in upwelling change comes from same factors as the historical cases, which consists of the meridional eddy momentum flux and planetary scale waves. The models, which have strong upwelling drivers, tend to project large upwelling enhancement in the TTL, and it controls future projection of the upwelling.

Key words: Tropical tropopause layer, CMIP5, Brewer-Dobson circulation, equatorial waves