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Decadal variability of tropical tropopause temperatures and its relation to the Pacific Decadal Oscillation

Dr. Wuke Wang

GEOMAR - Helmholtz Centre for Ocean Research Kiel

wwang@geomar.de

Tropopause temperatures (TPTs) in the tropics control the amount of water vapor entering the stratosphere. Stratospheric water vapor influences chemistry, radiation and circulation in the stratosphere, and is also an important driver of surface climate. However, decadal-to-multidecadal variability and long-term trends in tropical TPTs as well as stratospheric water vapor are largely unknown. Further, mechanisms of tropical TPT variability are poorly understood.

This study presents for the first time, from both observations and the state-of-the-art coupled climate-chemistry model CESM-WACCM, evidence of decadal variability in tropical TPTs being tightly linked to the Pacific Decadal Oscillation (PDO), the leading mode of North Pacific sea surface temperature (SST) variability. A negative PDO phase is linked to anomalously cold SSTs in the tropical east and central Pacific. This drives a stronger Pacific Walker Circulation and a weaker Hadley Circulation, which leads to less (more) convection and subsequently warmer (cooler) TPTs over the central Pacific (Indo-Pacific). A negative PDO phase is associated with positive sea level pressure anomalies over the North Pacific. This damps the upward and poleward wave propagation, weakens the Brewer Dobson circulation, and hence warms the tropopause in the tropics. The reverse is true for the positive phase of the PDO. Such ocean-troposphere-stratosphere interactions may provide an important feedback on the Earth's global surface temperatures.