

## Role of tropical tropopause layer cooling on development of the equatorial typhoon Vamei and its concurrent cyclones

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Typhoon Vamei was formed near the equatorial South China Sea from a Borneo vortex. Formation of the tropical cyclones (TCs) so close to the equator is an exceptional event. However, the cold surge and Borneo vortex engendered the Vamei were nothing unusual. This means that there could be another factor which contributed the genesis of Vamei. It should also be noted that another TCs were formed concurrently in the southern hemisphere. This suggests a global nature of the environmental condition which favored a formation of the Vamei and concurrent TCs.

In late December 2001, a rapid cooling in the tropical tropopause layer (TTL) was induced by enhanced stratospheric mean meridional circulation due to a large sudden stratospheric warming (SSW) event in the northern hemisphere. As suggested in a previous study on the SSWs in Januaries 2009, and 2010 (Kodera et al., ACP, 2015), cooling in the TTL promoted a development of TCs through enhancing extreme deep convection. In the case of the Vamei, adding to a zonal cooling, regional decrease of the temperature in the TTL due to eastward propagation of the equatorial Kelvin wave from Africa further contributed to excited very deep convection near Borneo, by which shallow vortex excited by a cold surge developed into a deep one, or TC.

This result suggests that adding to a cold surge over the South China sea and a formation of Borneo vortex, sudden cooling in the TTL could contributed to a generation of the equatorial typhoon Vamei.

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