



## **Deep convective cross-tropopause transport in the tropics and evidence by A-Train satellites**

P. Wang, S. Su, Z. Charvat, M. Setvak, and K. Cheng

University of Wisconsin-Madison, Atmospheric and Oceanic Sciences, Madison, United States (pao@windy.aos.wisc.edu)

Cross-tropopause transport by deep convective clouds can be an (and perhaps the most) important source of water vapor in the stratosphere. Our previous studies have verified that deep convective cross-tropopause transport does occur rather regularly in midlatitudes. This transport is demonstrated by the presence of cloud top features of above anvil cirrus plumes and jumping cirrus phenomenon that have been observed by aircraft, satellite and ground-based observations.

The present paper will demonstrate that the same mechanism occurs in the tropics. Because the tropics typically have weaker wind shear at the tropopause level, previous observation did not show clear evidence of the presence of such cross-tropopause features. But the recent NSAS A-Train satellites, especially CloudSat, CALIPSO and MODIS, provide both horizontal cloud top and vertical cross-sectional views of the cloud structure and making the identification of such features much less unambiguous. In this study, we will first use cloud resolving model simulations of tropical deep convective storms to show that the gravity wave breaking mechanism and instability will cause moisture (condensed water and vapor) to be transported through the tropopause even in this weaker wind shear environment. Model animations will be shown in the conference. We will then show that the modeled storm top features match well with many recent observations by A-Train satellites. The model results and satellite observations agree not only in morphological similarity but also in the spatial extent and structure in both horizontal and vertical structure. Thus, both the model results and satellite observations demonstrate unambiguously that cross-tropopause transport of water vapor by deep convective clouds in the tropics does occur, and it should be assessed carefully for its global climatic impact.