The observed relationship between water vapor and ozone in the tropical tropopause saturation layer and the influence of meridional transport

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We examine balloonsonde observations of water vapor and ozone from three Ticosonde campaigns over San José, Costa Rica [10°N, 84°W] during northern summer and a fourth during northern winter. The data from the summer campaigns show that the uppermost portion of the tropical tropopause layer between 360 and 380 K, which we term the tropopause saturation layer or TSL, is characterized by water vapor mixing ratios from ~3 to 15 ppmv and ozone from ~50 ppbv to 250 ppbv. In contrast, the atmospheric water vapor tape recorder at 380 K and above displays a more restricted 4-7 ppmv range in water vapor mixing ratio. From this perspective, most of the parcels in the TSL fall into two classes - those that need only additional radiative heating to rise into the tape recorder and those requiring some combination of additional dehydration and mixing with drier air. A substantial fraction of the latter class have ozone mixing ratios greater than 150 ppbv, and with water vapor greater than 7 ppmv this air may well have been transported into the tropics from the middle latitudes in conjunction with high-amplitude equatorial waves. We examine this possibility with both trajectory analysis and transport diagnostics based on HIRDLS ozone data. We apply the same approach to study the winter season. Here a very different regime obtains as the ozone-water vapor scatter diagram of the sonde data shows the stratosphere and troposphere to be clearly demarcated with little evidence of mixing in of middle latitude air parcels.

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