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Observations of water vapour in the lower tropical troposphere and their implication for a preferred mode of cloudiness near the triple point

Bjorn Stevens (1), Helene Brogniez (2), Christoph Kiemle (3), and Johannes Killiani (1)

(1) Max-Planck-Institut für Meteorologie, Hamburg, Germany (bjorn.stevens@zmaw.de), (2) Laboratoire Atmospheres, Milieux, Observations Spatiales, 78280 Guyancourt, France, (3) Deutsches Zentrum für Luft- und Raumfahrt, 82234 Wessling, Germany

Airborne measurements from NARVAL-2 are used to characterize the structure of water vapor in the lower tropical troposphere, below the height, z_*, of the triple-point isotherm, T_*. Elevated moist layers, perhaps associated with a a preferred level of convective detrainment are found to be common and are shown to be associated with radiative cooling profiles that would effectively drive circulations that reinforce such features. These findings are consistent with a well documented preferred mode of cloudiness near z_* being associated with a preferred deposition of moisture at temperatures near T_*. A theory for this preferred level of cumulus termination is advanced, whereby differences in the temperatures at which primary ice forms, and T_* gives a 'first-mover advantage' to glaciating cumulus convection, thereby concentrating the regions of the deepest convection and leading to more convection in other regions terminating below the level of primary ice formation, causing increased cloudiness and moisture near the triple point. The airborne measurements, including water vapor profiling by lidar, are used to evaluate microwave humidity retrievals from space to assess the ability of such measurements to identify how wide-spread such features are. The retrievals capture the general features, but the water vapor in the retrievals is more bottom heavy than is observed. If systematic, these biases would imply an underestimate of the amount of mid-level water vapor and its effect on circulations within the lower troposphere.