HIGH RELATIVE HUMIDITY OF THE WATER-RICH ATMOSPHERE AND ITS IMPLICATION FOR THE INNER EDGE OF THE HABITABLE ZONE. F. Ding[1] and R. T. Pierrehumbert[1], [1]Department of the Geophysical Sciences, University of Chicago, 5734 S. Ellis Avenue, Chicago, IL 60637, fding@uchicago.edu

Introduction: The onset of the runaway greenhouse of water vapor is one of the important criteria defining the inner edge of the habitable zone, and has been extensively studied in one-dimensional (1D) radiative-convective models. One limitation of 1D simulations is the assumption of the fully saturated troposphere. In the real atmosphere, sub-saturated regions are created by the large-scale subsidence of air. These regions significantly delay the onset of the runaway greenhouse by playing the role of "radiator fins" that allow more infrared radiation escaping the planet. Here, we show that the degree of sub-saturation in the atmosphere strongly depends on the mass of background non-condensable component (e.g., N_2) in an idealized three-dimensional general circulation model (3D GCM).

GCM simulations: We specially develop a 3D GCM to simulate the climate dynamics of water-rich atmospheres, based on the GFDL finite-volume dynamical core, a two-stream gray-radiation scheme and an energy-conserving convection scheme. **Figure 1** shows that the mid-troposphere is more saturated by reducing the background partial pressure from 10^5 Pa to 500 Pa. This increase in relative humidity can be explained by the increase in static stability of the atmosphere when water vapor becomes dominated.

In general, the mass of the background non-condensable components on potentially habitable exoplanets could be regulated by many processes including the volcanic outgassing, stellar wind and impact erosion. These processes may also play an important role in determining the inner edge of the habitable zone besides the stellar spectral type and planetary rotation.

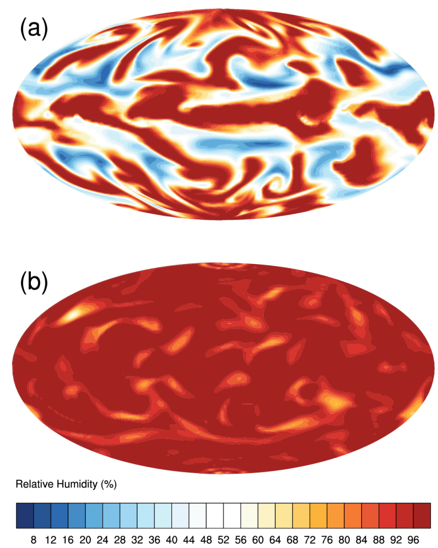

Figure 1: The daily-mean mid-tropospheric relative humidity distribution simulated by an idealized GCM, when water vapor is dilute (<2%, a) and dominated (~70%, b) in the atmosphere.