The RHUBC-II Campaign: Best-Guess Water Vapor Profiles and Their Impact on Far-Infrared (IR) Spectroscopic Studies

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The far-infrared (far-IR, $15 < \lambda < 100$ μm) is an extremely important spectral region. Nearly 40% of the outgoing longwave radiation and a significant portion of the infrared radiative cooling in the middle-to-upper troposphere are directly attributable to far-IR radiative processes. Surface radiation measurements in typical conditions contain no pertinent information about these radiative processes due to absorption by water vapor in the intervening lower atmosphere. The relatively high uncertainty in our knowledge of these processes is reflected in a corresponding uncertainty in climate models' predictions for the mid-to-upper troposphere. The Deptartment of Energy Atmospheric Radiation Measurement Program conducted a set of field experiments, the Radiative Heating in Underexplored Bands Campaigns (RHUBC), targeted at lowering these uncertainties. RHUBC-II was held from August–October 2009 at a site at 5400 m in the Atacama Desert of Chile, during which the precipitable water vapor (PWV) during clear periods was as low as 0.2 mm. RHUBC-II included a number of instruments that provided spectrally resolved measurements in strong H_2O absorption bands in the far-IR and in the sub-millimeter. Improving spectroscopic parameters in these spectral regions using RHUBC-II measurements requires accurate specification of the water vapor profiles in the radiating column above the site. Vaisala RS-92 radiosondes were regularly launched during operational periods of RHUBC-II, but these radiosondes have well-known accuracy issues in conditions of low humidity and during daytime. This study utilizes an optimal estimation approach to refine the radiosonde profiles using observations from the 183.31-GHz GVRP instrument. Different retrieval approaches will be evaluated, as will the accuracy of the methodology specified by Miloshevich et al. (2009), for removing biases in radiosonde H_2O profiles. The impact of the various water vapor profiles on far-IR and sub-millimeter radiance calculations will be shown.

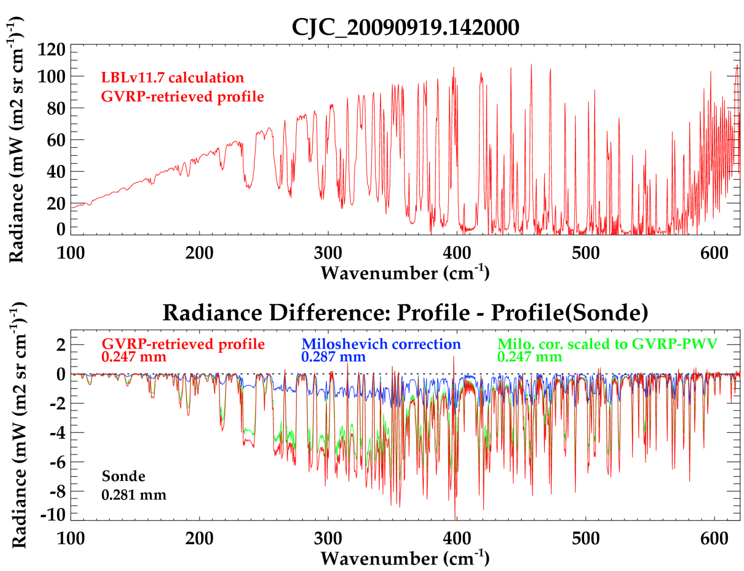

Figure 1. Water vapor profiles above the RHUBC-II site are constructed from the original radiosonde measurements as well as 3 additional methods. The top panel is a model calculation of the far-IR radiance using the optimal-estimation retrieved profile (red). Differences in calculated far-IR radiances between the 3 additional methods and the original radiosonde profile are shown in the bottom panel. The total PWV for each method is given for reference.