Using Microwave and Submillimeter Radiometer Observations to Improve Climate Models

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Radiation processes, such as the absorption of radiation by water vapor and clouds, must be parameterized accurately in global climate models (GCMs), as inaccurate radiation parameterizations can lead to large errors in GCM simulations. One of the largest sources of uncertainties in these radiation parameterizations is the magnitude of the water vapor continuum absorption. If the modeled continuum absorption is too strong or weak, then the model atmosphere will radiate at a different level in the vertical, which will impact the local vertical circulation and potentially the larger scale planetary circulation in the simulation.

Microwave and submillimeter-wave observations have been (and are) primarily used for remote sensing applications. These applications include the determination of precipitable water vapor (PWV), profiles of vapor and temperature, and cloud liquid water path (LWP) values. These observations are typically used to characterize the state of the atmosphere and for a wide range of process studies, such as boundary layer development, aerosol-cloud interactions, precipitation studies, and more.

This presentation will present a story about how ground-based microwave radiometer observations were used to improve the water vapor continuum model in the far-infrared (wavelengths longer than 15 μm). The radiation emitted in far-infrared portion of the spectrum is about 40% of the total outgoing longwave radiation (OLR) emitted by the planet. Also, the absorption by water vapor in the far-infrared plays a critical role in the vertical heating of the atmosphere, which drives local vertical motions and impacts the planetary circulation. The story is complete, in that it starts with the basic microwave radiometer observations themselves, the subsequent improvement of the water vapor continuum model (which included improvement of commonly used microwave absorption models such as Hans Liebe's 1987 and 1993 models as well as two others), the use of submillimeter and far-infrared spectroscopic observations to evaluate the updated radiative transfer model in a new environment, and the demonstration of the impact of the improved model on a GCM simulation.