Water Vapor and Liquid Water Path Retrievals from the Ground-based Scanning Radiometer During RHUBC

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The NOAA-CU Center for Environmental Technology (CET) has developed and deployed a Ground-Based Scanning Radiometer (GSR) during two important Arctic Experiments relevant to climate research. The first was the Artic Winter Radiometric Experiment during March-April 2004 and the second is the Radiative Heating in Underexplored Bands Campaign (RHUBC) in February-March 2007. Both of these Intensive Observation Periods (IOPs) were conducted at the Atmospheric Radiation Measurement (ARM) Program's "Great White" field site near Barrow, Alaska. The primary goal of the 2004 deployment was to demonstrate that millimeter wavelength radiometers can substantially improve water vapor observations during the Arctic winter. The primary goal of the RHUBC 2007 deployment was to use the GSR data to supplement high spectral-resolution infrared observations of downwelling radiances observed across the near- and far-infrared spectrum.

The GSR operates over a broad frequency range (50 to 400 GHz), including several channels near the strong water vapor absorption lines at 183.31 and at 380.2 GHz The set of frequencies was selected for the simultaneous retrieval of atmospheric temperature profiles, precipitable water vapor (PWV), cloud liquid water path (LWP), and cloud depolarization ratio. The GSR performs an atmospheric scan and calibration sequence every 1-2 min that includes dwells at a discrete set of angles equally spaced in air mass followed by followed by observations of two external calibration targets. Rapid (14 ms) observations of internal noise sources are also part of the calibration-scene sequence.

The millimeter- and submillimeter-wave channels are very sensitive to low water vapor content and allow for accurate observations even in the extremely dry and cold conditions typical of the Arctic. Moreover, window channels (e.g., at 90 and 340 GHz with horizontal and vertical polarizations) show a high sensitivity to Artic clouds over an extended range of liquid water content. During RHUBC, and during conditions when the PWV was less than 2 mm, these radiometers were supplemented by frequent Vaisala RS92 radiosonde observations at the ARM site.

Using Brightness Temperature observations from the two channels at 89 GHz (H and V Pol.) and the seven channels around the 183.31 GHz water vapor line, retrievals of PWV and LWP are derived. These retrievals are also compared with operational retrievals from a dual-channel MicroWave Radiometer (MWR) that was co-located with the GSR. Based on comparisons with 87 RS920 RAOB launches, GSR PWV retrievals achieved almost unprecedented accuracy of 0.1 mm, or about 7 % of the mean PWV during the operating period. The GSR continues to demonstrate a high potential as a research tool for cold (-20 to -40 Deg. C) and dry (< 2 mm PWV) Arctic conditions.