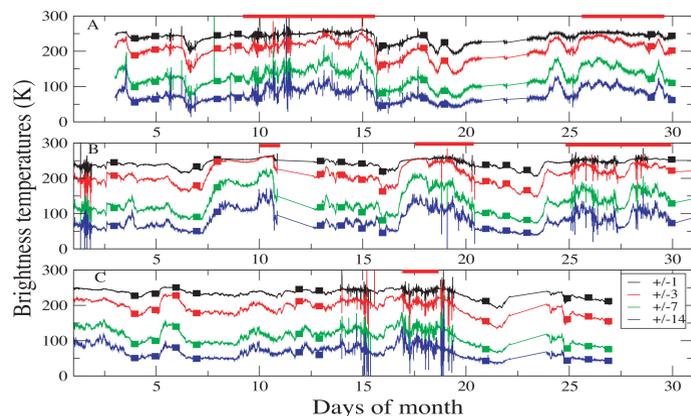


Motivation

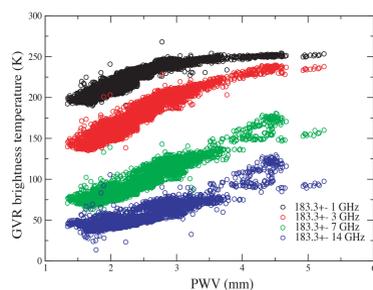
The G-Band Water Vapor Radiometer (GVR) is part of a suite of instruments designed to improve observations of low amounts of precipitable water vapor (PWV < 5 mm) and low amounts of liquid water (LWP < 50 g/m²). Traditional ground-based measurements employ two or more channels located in the spectral region of water vapor absorption at 22 GHz. However, retrieval errors achieved with traditional linear statistical retrievals are around 0.4 mm for PWV and 0.02 mm (20 g/m²) for LWP. During the cold Arctic winter, the amount of PWV is often less than 4 mm. In addition, the presence of thin clouds with a low amount of liquid water makes it desirable to achieve increased accuracy in the retrievals.

Measurements-model comparison (clear sky)

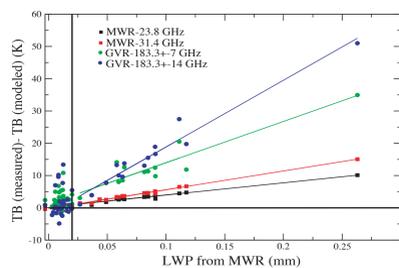
Measured (solid lines) and modeled (squares) brightness temperatures at the North Slope of Alaska (NSA) for November (A), December (B) and January (C). The frequencies are 183.3 ± 1 (black line), 183.3 ± 3 (red line), 183.3 ± 7 (green line), and 183.3 ± 14 GHz (blue line). The horizontal red bars indicate times during which the surface temperature was higher than 255 K. **Agreement with model is satisfactory.**



Sensitivity to PWV and LWP



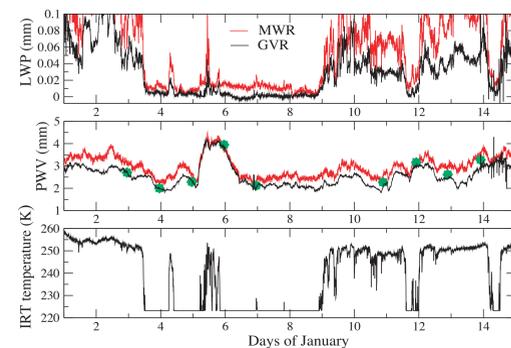
Brightness temperatures measured by the GVR as a function of PWV retrieved from the MWR. Clear sky cases only (IRT < 224 K).



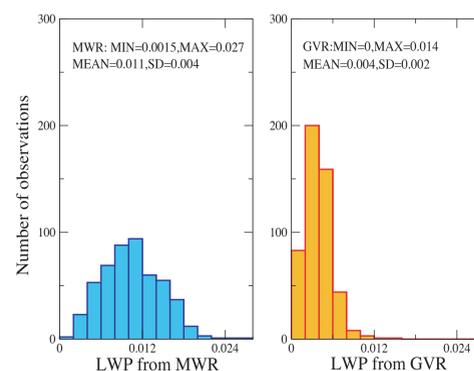
Difference between measured and modeled brightness temperatures for clear and cloudy cases. The differences are attributable to the effect of cloud liquid only.

- **Sensitivity to PWV at 183.3 ± 1 and ± 3 GHz is ~ 30 times greater than at 23.8 GHz for PWV < 3 mm.**
- **Sensitivity to LWP at 183.3 ± 14 GHz is ~ 3.5 greater than at 31.4 GHz.**

Retrieval results



PWV and LWP retrieved by the GVR (black line) and the MWR (red line). Radiosonde measurements are the green circles.



Distribution of LWP retrieved by the MWR (left) and the GVR (right) during clear-sky conditions.

GVR estimated retrieval errors:
PWV~0.1 mm
LWP~0.006 mm

Conclusions

- Instrument working for the past year. Several hardware/ RFI problems identified during trial period.
- Satisfactory agreement with model.
- High sensitivity to PWV and LWP.
- PWV estimated accuracy ~ 0.1 mm.
- Clear case LWP distribution, mean=0.004 mm, sd = 0.002 mm.
- GVR can improve retrievals when PWV < 2-3 mm, but loses sensitivity at higher PWV.
- **GVR data now available at the archives.**

The 183.3 GHz (GVR) and the MWR Microwave Radiometers

The two-channels microwave water vapor radiometer (MWR) shown in Fig. 1 measures brightness temperatures at the microwave frequencies of 23.8 and 31.4 GHz. Brightness temperatures are converted to opacity and used to retrieve PWV and LWP by means of a linear statistical regression. Root mean square error of retrieval is 0.4 mm for PWV and 0.02 mm (20 g/m²) for LWP. MWRs are located at all ARM sites.

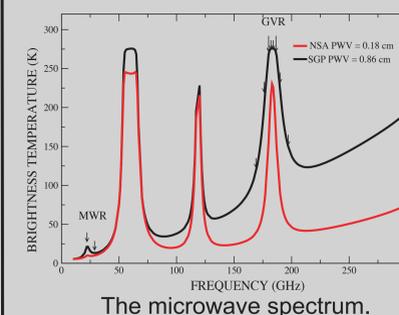
The GVR (Fig. 2) has 4 double side-band channels at 1, 3, 7, and 14 GHz from 183.3 GHz. Brightness temperatures can be used to retrieve PWV and LWP with a theoretical accuracy of 0.1 and 0.004 mm respectively. The GVR is located at the NSA facility in Barrow, Alaska



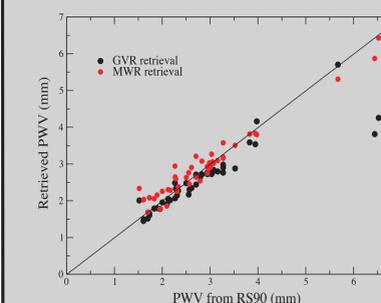
Fig. 1 The MWR operating at the Central Facility in Lamont, OK.



Fig. 2 The GVR prototype operating in Barrow, AK.



The microwave spectrum.



In the spectral region where the GVR operates sensitivity to water vapor is enhanced. This makes the GVR suitable for the retrieval of small amounts of PWV and LWP (PWV < 3 mm, LWP < 50 g/m²).

PWV measured by radiosonde and retrieved (N=47 cases).