An assessment of rain "contamination" in ARM two-channel microwave radiometer measurements

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Motivation

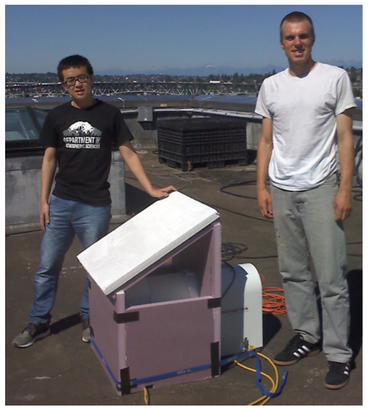
Microwave radiometers (MWRs) are the most commonly used and accurate instruments ARM has to retrieve cloud liquid water path. Unfortunately, MWR data are not easily used in precipitating conditions. There are two reasons for this:

1. The measurements are "contaminated" by water on the MWR radome.
2. Precipitating particles can scatter microwave radiation, yet traditional MWR retrievals neglect scattering.

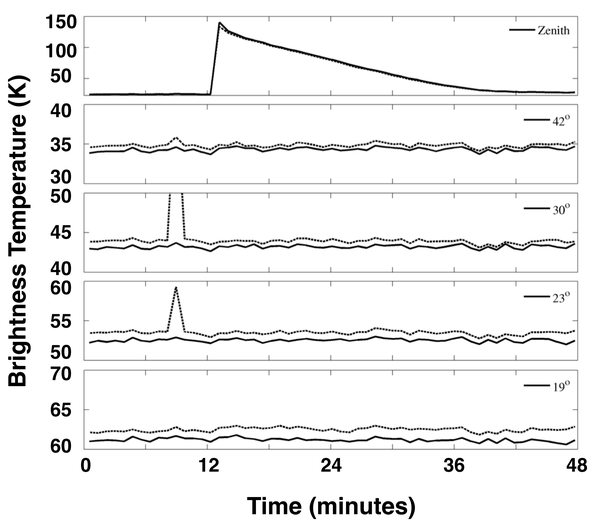
We designed an experiment that alleviates the "wet radome" problem.

The Experiment

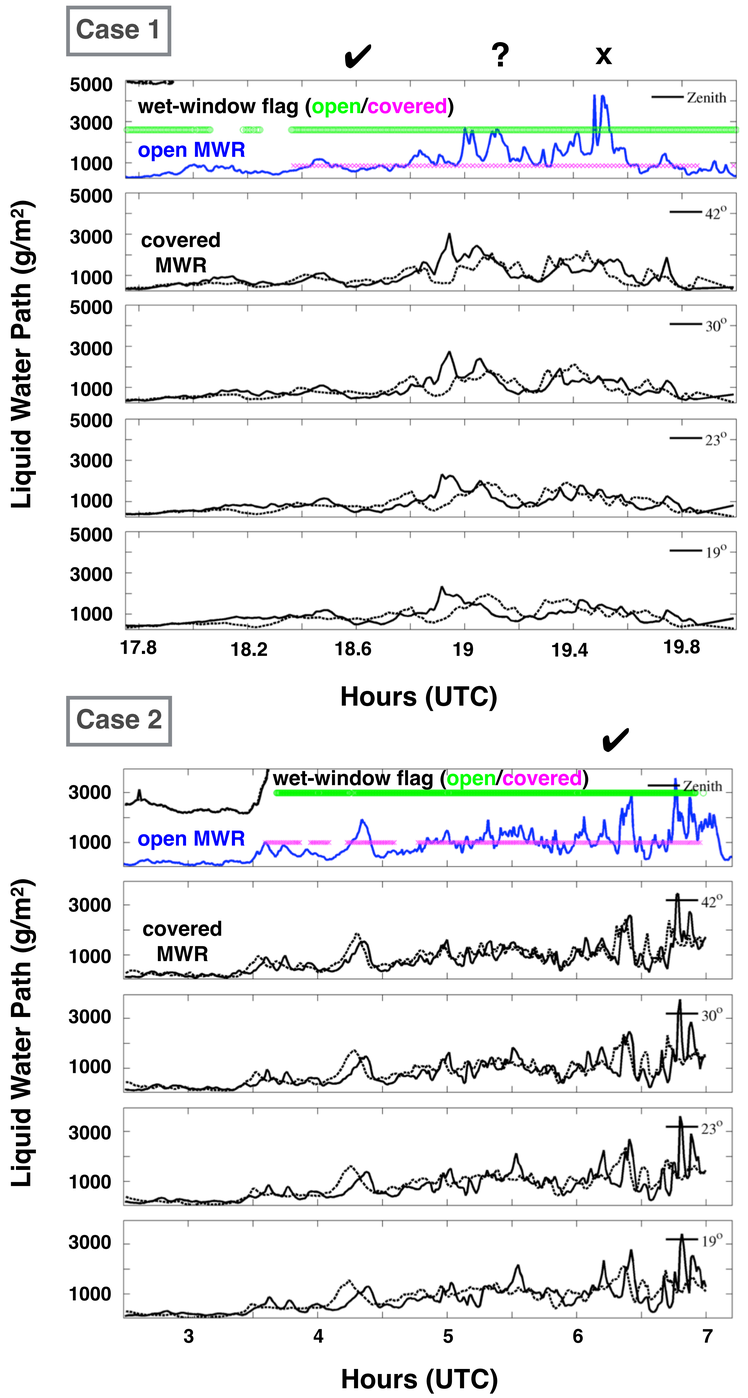
Two MWRs were operated side by side in a "scanning" or tip-cal mode. One MWR was placed under a cover that kept the radome dry while still permitting measurements away from zenith (photograph below). The other MWR was operated normally, with the radome exposed to the sky. We refer to these as the "covered" and "open" MWRs, respectively. Coincident measurements from the covered and open MWRs are compared to estimate contamination due to a wet radome.



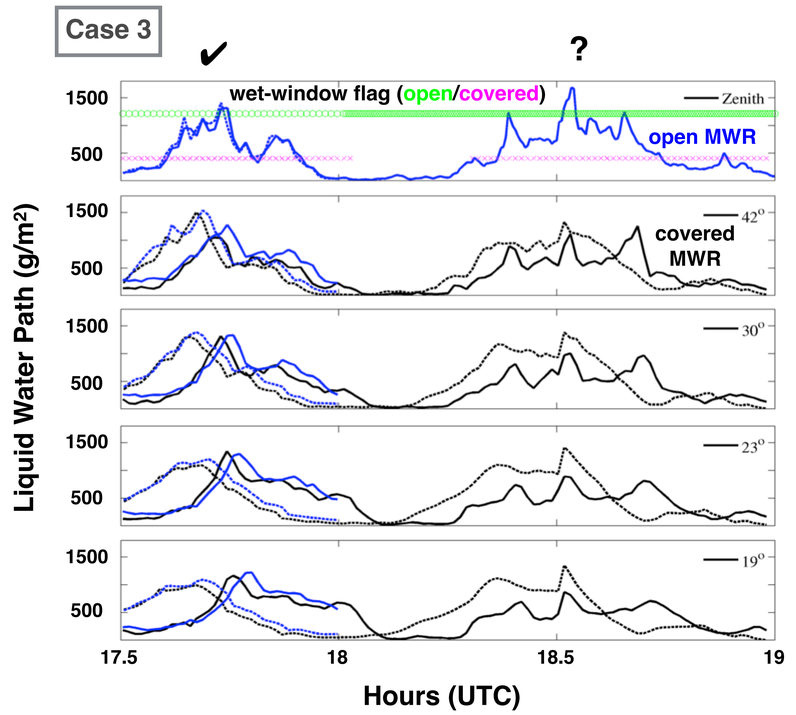
◄ Photograph of the covered MWR. The cover is made of styrofoam, which is nearly transparent to microwaves. The open MWR was operated to the right of the covered MWR, just out of the frame.



◄ Cover Test A bucket of water was poured on the MWR cover during a warm, clear day. This plot shows a time series of 31.4 GHz brightness temperature measured at different elevation angles. Note that only measurements at zenith were contaminated.



▲ Case Studies Time series of liquid water path during three rain events. Measurements from different elevation angles are shown (top right corner). Dashed and solid lines shown east- and west-facing measurements, respectively. The wet-window flag indicates that a sensor near the radome is wet. When it is triggered, measurements are traditionally discarded.



Note the marked times:

- ✔ - open and covered MWRs agree despite wet-window flag, likely because the radome on the open MWR is dry during light rain and drizzle
- **x** - open and covered MWRs disagree, likely because of wet-radome contamination during heavy rain
- **?** - difficult to tell if there is wet-radome contamination because the difference between open and covered MWRs is comparable to magnitude of spatial variability

Summary of Preliminary Findings

- Wet-radome contamination on uncovered MWRs is difficult to quantify because of large spatial variability in liquid water path during precipitating conditions. Correcting for it seems unlikely.
- Current methods for keeping MWRs dry appear to work better than we expected. Wet-radome contamination is small during drizzle or light-rain events, suggesting that data are currently being discarded unnecessarily during these periods.
- Using a cover could allow for high-quality measurements from MWRs during precipitating conditions, provided that scattering effects are accounted for in the retrieval. This would greatly expand the percentage of time that high-quality measurements can be made by MWRs.