University of Notre Dame Santa Ynez Airport Microwave Radiometer Data

Author: Griffin Modjeski
Position: PhD Student at the University of Notre Dame
Address: A59 Fitzpatrick Hall of Engineering
Notre Dame, IN 46656
Email: gmodjesk@nd.edu
Cell: +1-248-880-6393

1.0 Data Set Description

The University of Notre Dame (UND) employed a microwave radiometer (MWR) at the Santa Ynez Airport (SYA) during the Sundowner Winds Experiment (SWEX) campaign that lasted from April 1 to May 15, 2022. The SYA site was located on the western side of the Santa Ynez Valley, north of the Santa Ynez Mountains. The MWR recorded data in a continuous sense up to 10 kilometers above ground level during SWEX.

Data version: 1.0 (submitted September 28, 2023, last updated May 16, 2022)
Data status: final
Time period covered by data: March 25, 2022 – May 16, 2022

2.0 Instrument Description

The Radiometrics MP-3000A Portable Profiling Microwave Radiometer utilizes atmospheric radiation that lies between 20 and 200 gigahertz. Below in Figure 1 is an absorption spectrum, showing the different resonances of oxygen, water vapor, and cloud liquid (for cloud liquid a lack thereof of resonance) at sea level height and 8-kilometer height above MSL at a "typical mid latitude," according to Radiometrics.

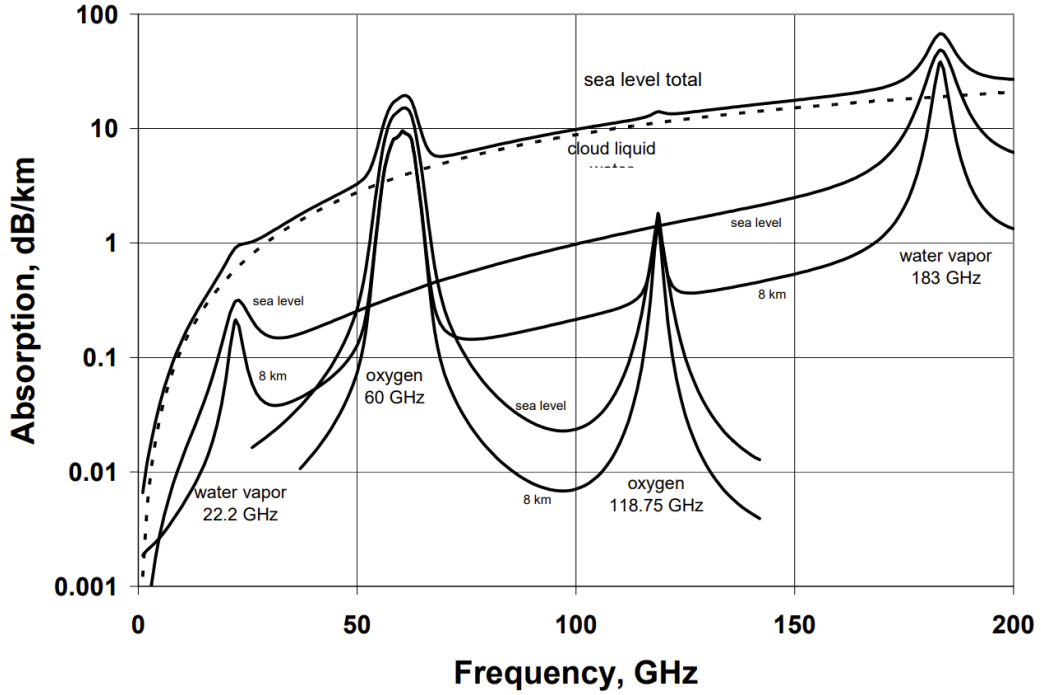

Figure 1: The different bands between water vapor and oxygen at sea level and 8 km height, on a spectrum of absorption versus frequency.

The water vapor resonances are ~22 and ~180 GHz, and the oxygen resonances lie around 60 and 120 GHz. To contrast this, the cloud liquid spectrum (the dotted line in Figure 1) has no peaks and goes as (frequency)^2 approximately. Around the 60 GHz peak, the MWR measures brightness temperature and can retrieve temperature, density, and altitude information through inversion and the use of neural networks. The neural networks used are an assimilation of artificial data and data from radiosonde launches; for this reason, the neural networks are highly site dependent. The MWR conducts a similar process for water vapor, using the lower 22 GHz band for information in humid conditions and the higher 183 peak in arid conditions. From the water vapor brightness temperatures, the water vapor profile is also obtained by the MWR through neural networks. Using the above frequency bands, thus, the MWR generates profiles from the surface up to 10 km for temperature, relative humidity, and water vapor. In addition to these profiles, the MWR includes air temperature, relative humidity, and barometric pressure sensors to measure surface-level meteorological quantities. There is also a rain sensor, with a heated blower and hydrophobic radome to ensure accurate measurements in most precipitation conditions.

3.0 Data Collection and Processing

The MWR took continuous data from March 25 – May 16, which envelops the period of SWEX, which lasted from April 1 – May 15, 2022. It first converts the voltage readings (in the `lv0` files) into some basic parameters, which are in the lv1 files: ambient temperature, relative humidity, pressure, rain, brightness temperature, angle of azimuth, and angle of elevation. After the neural networks invert the data (in the lv2 files), the output profiles are temperature, water vapor, liquid water content, and relative humidity while the output integrated quantities are vertically integrated water vapor and liquid. Figure 2 below illustrates one of these profiles over the data collection period.

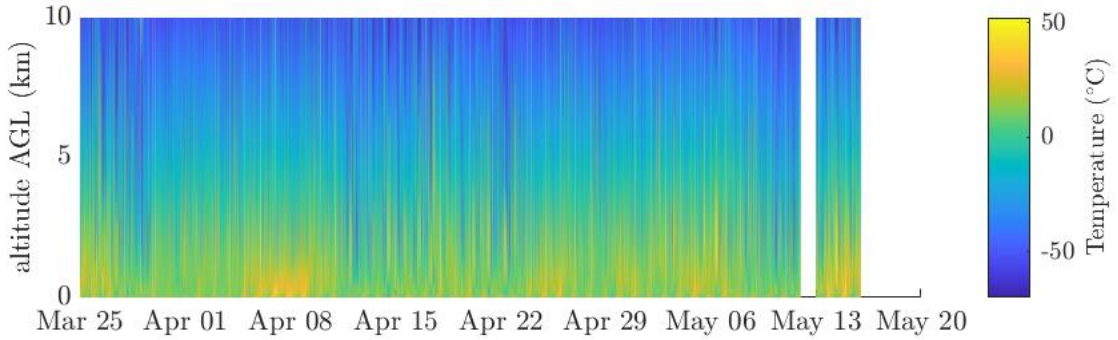

Figure 2: A temperature profile for the data collection period. Note the missing data towards the end of the record.

4.0 Data Format

Output files from the MWR are .csv files, which means they are human-readable and organized into a tabular structure. The MWR generates the file names automatically according to the template:

`yyyy-mm-dd_hh-mm-ss_xxx.csv`,

where `yyyy` is the year when the file was started, `mm` is the month, `dd` is the day, `hh` is the hour, `mm` is the minute, `ss` is the second, and `xxxx` indicates the output file type (`lv0`, `lv1`, `lv2`, `tip`, `ln2`, `ser`). Now each file type will be summarized, starting with `lv0` files.

The `lv0` (level 0) files are raw, unprocessed voltage data, which can be reprocessed with different configurations, calibrations, or algorithms. For further details, consult the operator's manual. The `lv1` files contain the brightness temperatures, some surface meteorological measurements

(pressure, temperature, and relative humidity), and a rain indicator. The `lv2` files are the retrieved profiles for air temperature, water vapor content, relative humidity, and liquid water content, as well as the surface measurements that are included in the `lv1` file.

5.0 Data Remarks

From March 25, the only missing data is from May 13 to May 14, just before the conclusion of SWEX on May 15, 2022. The `lv2` data seems to be quality controlled, with physical values for the temperature and humidity.

These data are compatible with two different software packages, the first is Radiometrics' in-house software VizMet-B and the second Rawinsonde Observation Program (RAOB). The former software is the one the UND team used to capture the data and write the output files; it also provides an easy way to visualize the output. The latter program, RAOB, can be used to visualize radiosonde profiles as well as microwave radiometer contours (variables plotted over altitude and time), with additional software package purchases.

6.0 References

Radiometrics Corporation "Profiler Operator's Manual," (2008). Heading 1 (utah.edu)