



AMPR WH²yMSIE 2024

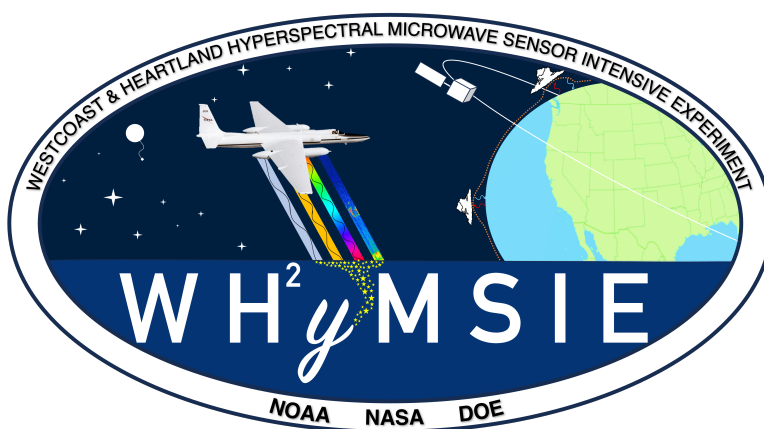
Science Dataset

Level 2B, Version R1

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1. Introduction

Data were acquired by the Advanced Microwave Precipitation Radiometer (AMPR) during the Westcoast & Heartland Hyperspectral Microwave Sensor Intensive Experiment (WH²yMSIE) during October-November 2024.

These files include the Level 2B geo-referenced brightness temperatures (TBs) for the four AMPR-observed frequencies (10, 19, 37, 85 GHz). These data are archived in a self-describing, Climate and Forecasting (CF) 1.6-compliant Version 4 Network Common Data Format (netCDF4) format.

Python software has been developed for reading, plotting, and providing some additional analysis capabilities. This software is available from: <https://github.com/nasa/pyampr>. The AMPR instrument is explained in more detail here: <https://doi.org/10.1175/JTECH-D-19-0218.1>.

These data have been determined to be viable for publishable scientific research, and also should be useful for generating quicklooks or understanding what happened during a flight. Note: AMPR is not expected to provide useful data during significant aircraft maneuvers.

AMPR is a significant project at MSFC. If you plan to use the final version of these data in a publication, please contact the principal investigator (PI), Timothy Lang (timothy.j.lang@nasa.gov), to discuss potential co-authorship.

2. Data Description

The primary data in these files are brightness temperatures at all AMPR frequencies and polarization channels (i.e., 10.7, 19.35, 37.1, and 85.5 GHz mixed-pol A/B channels, as well as deconvolved pure horizontal and vertical polarizations; H & V).

In addition to the brightness temperatures, an objectively determined quality control (QC) metric is provided. The quality control metric is estimated based on the brightness temperature difference of a pixel within a 9x9 kernel of neighboring brightness temperatures. The QC metric is a discretized indicator of the difference within 5-Kelvin increments. Typical scene values fall in the QC 1 & 2 bins. However, very noisy scenes - generally indicative of instrument issues or potential scene contamination or excessive instrument noise - are isolated to values ≥ 4 . As with any objective measure based on thresholding, however, there is a gray area in the higher bins where some of the data is of high quality, but physical phenomena are generating sharp, local features that are flagged as suspect. This, in and of itself, could be useful for those wanting to isolate features (e.g., the edges of a strong convective cell).

An incidence angle flag has also been included for quickly identifying pixels associated with large incidence angles typically encountered during aircraft roll maneuvers. During a roll, often the edge pixels began to see very large incidence angles or may even contain off-Earth sidelobe contamination. However, non-edge pixels may still be receiving observations from a

typical/moderate (say -45° to 45°) incidence angle. Thus, we have opted for use of incidence angle flagging directly versus simply eliminating entire scans when the $|\text{roll angle}|$ is greater than a threshold.

Pixel field of view (FOV) water fractions are included for all flights. A 1-km gridded land/water fraction dataset - constructed from 250-m Moderate Resolution Imaging Spectroradiometer (MODIS) land/water mask (<https://lpdaac.usgs.gov/products/mod44wv006/>) - has been used, together with the instrument FOV beamwidths to estimate the percent FOV that contains surface-water features. These data can be used to quickly identify (and eliminate if desired) those pixels originating from a mixed-surface (land and water) scene. The 250-m MODIS land/water mask includes water flagging for inland water bodies. However, no land-water mask is perfect, and it is possible that some smaller inland water bodies are missed. If so, then our FOV estimates will also be missing the water fraction contributions in such cases.

TBs were corrected for cross-track and absolute bias using adapted Remote Sensing Systems radiative transfer code. To aid with this, atmospheric profiles and ocean surface information from the Global Data Assimilation System (GDAS) 6-hourly analysis product (DOI: 10.5065/D6M043C6) were remapped onto the AMPR swath. Cloud-free, over-water portions of the 23 October, 7 November, and 12 November flights were used to develop these corrections for all flights.

Notes:

- This new version (R1) has improved H & V TBs. The radiative transfer corrections are applied directly to raw H & V deconvolved data, rather than correcting the mixed-polarization A & B channels first and then deriving corrected H & V from the deconvolved corrected A & B after that. The updated process was found to mitigate cross-track TB biases and be more consistent with Amiot et al. (2021).
- The 37 GHz (B) channel had a minor cross-track sinusoidal noise signal that occurred occasionally. It manifested when the radiative transfer corrections were insufficient.
- The 85 GHz (A) channel often became severely noisy late in some flights and during descents. This generally occurred after primary science operations were completed.
- The 85 GHz (B) channel suffered from extra noise during much of the 30 October 2024 flight. Other channels also featured poor calibration and excessive noise during the second half of the flight, due to an unknown but temporary malfunction.
- Filtered brightness temperatures, which provide smoothed data to reduce noise at the expense of spatial resolution, are available as a separate product for the 37 and 85-GHz channels.

3. Identifying Likely Good Data

As an example, to quickly identify typical good data, a series of flagging based on the following conditions may be used:

QC incidence angle = 1
Pixel FOV < 0.1 or pixel FOV > 0.9 (i.e., mostly land or mostly water)
QC flag value <= 4

It is possible that sharp but valid contrasts near precipitation/clouds edges will be flagged by this. Thus, recommended usage of these criteria is only as a guide and not an objective mask.

Appendix A. AMPR File Structure

Notable variables in AMPR data files are listed below.

(Note: Order in documentation does not necessarily match order in data files)

Dimensions

- AlongTrackDim = Variable, depends on flight length
- CrossTrackDim = 50
- BandDim = 4
- FilterDim = 2
- ChannelDim = 4

AMPR-specific variables in all files

- float Frequency(BandDim)
- char Channel(ChannelDim) - A = Mixed-pol, left scan edge pure vertical, right scan edge pure horizontal; B = Opposite polarizations from A; H = Deconvolved horizontal polarization; V = Deconvolved vertical polarization
- double Time(AlongTrackDim)
- double TB(ChannelDim, BandDim, AlongTrackDim, CrossTrackDim) - Brightness temperatures for all channels/bands.
- double FilterTB(ChannelDim, FilterDim, AlongTrackDim, CrossTrackDim) – Filtered brightness temperatures for 37/85-GHz channels/bands (9-pt median filter).
- double ScanAngle(CrossTrackDim)
- double Lat(AlongTrackDim, CrossTrackDim)
- double Lon(AlongTrackDim, CrossTrackDim)
- double IncidenceAngle(AlongTrackDim, CrossTrackDim)
- double RelativeAzimuth(AlongTrackDim, CrossTrackDim)
- double LandFraction(BandDim, AlongTrackDim, CrossTrackDim)
- short QC(ChannelDim, BandDim, AlongTrackDim, CrossTrackDim)
- short IncidenceAngleQC(AlongTrackDim, CrossTrackDim)

Aircraft-related data derived from the ER-2 IWG1 feed

- double GPSAltitude(AlongTrackDim)
- double GPSLatitude(AlongTrackDim)
- double GPSLongitude(AlongTrackDim)
- double Pitch(AlongTrackDim)

- double Roll(AlongTrackDim)
- double Yaw(AlongTrackDim)
- double Head(AlongTrackDim)
- double WindDirection(AlongTrackDim) - Refers to wind direction at aircraft's position
- double WindSpeed(AlongTrackDim) - This refers to wind speed at the aircraft's position
- double AirSpeed(AlongTrackDim)
- double GroundSpeed(AlongTrackDim)
- double Pressure(AlongTrackDim)
- double Temperature(AlongTrackDim)