RSS WindSat Calibrated Top of the Atmosphere Level 1C Brightness Temperatures

Version 8.0

Data Set User Manual

Thomas Meissner, Frank Wentz and Marty Brewer

Remote Sensing Systems
444 Tenth Street, Suite 200, Santa Rosa, CA 95401, USA

Remote Sensing Systems
444 Tenth Street, Suite 200, Santa Rosa, CA 95401 (707) 545-2904

1 Data Set Description

1.1 Sensor

The WindSat Polarimetric Radiometer was developed by the Naval Research Laboratory (NRL) Remote Sensing Division and the Naval Center for Space Technology for the U.S. Navy and the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Integrated Program Office (IPO). It was launched on January 6, 2003, aboard the Department of Defense Coriolis satellite. WindSat was meant to demonstrate the capabilities of a fully polarimetric radiometer to measure the ocean surface wind vector from space.

Table 1 summarizes the WindSat channels and their properties.

Table 1. Overview of WindSat channels. Polarization basis: 1=vertical (V), 2=horizontal (H), 3= +45 (P), 4= -45 (M), 5=left circular (L), 6=right circular (R). BW = band width. τ = integration time, NEDT = noise equivalent delta T, EIA = earth incidence angle, IFOV – individual field of view footprint.

Frequency [GHz]	Polarizations	BW [MHz]	τ [msec]	NEDT	EIA [deg]	IFOV [km x km]
6.8	VH	125	5.00	0.48	53.8	39 x 71
10.7	VH PM LR	300	3.50	0.37	50.1	25 x 38
18.7	VH PM LR	750	2.00	0.39	55.6	16 x 27
23.8	VH	500	1.48	0.55	53.2	20 x 30
37.0	VH PM LR	2000	1.00	0.45	53.2	8 x 13

1.2 Contents of Data Set

The dataset contains the Level 1C WindSat Top of the Atmosphere (TOA) TB processed by Remote Sensing Systems RSS. The WindSat radiances are turned into TOA TB after correction for hot and cold calibration anomalies [5], receiver non-linearities [3,5], sensor pointing errors [1,5], antenna cross-polarization contamination [2,5], spillover [2,5], Faraday rotation [1,5] and polarization alignment [1,5]. The data are resampled on a fixed regular 0.125 deg Earth grid using Backus-Gilbert Optimum Interpolation. The sampling is done separately for fore and aft looks. The 10.7, 18.7, 23.8, 37.0 GHz channels are

resampled to the 10.7 GHz spatial resolution (35 km). The 6.8 GHz channels are given at their native spatial resolution (50 km). The 10.7, 18.7, 23.8, 37.0 GHz channels are absolutely calibrated using the GMI sensor as calibration reference [5,6]. The 6.8 GHz channels are calibrated using the open ocean with the RSS ocean emission model [4,7] and the Amazon rain forest [3] as calibration targets.

1.3 Gridding

The resolution of the fixed Earth is 1/8 =0.125 deg. The x-dimension of the grid is 3120 = (360 + 30)*8, which contains extra 30 deg longitude to accommodate the orbital tails. the y-dimension of the grid is 1440=180*8. Longitude and latitude of each grid cell are part of the variable set.

The look direction index is 1= fore look, 2= aft look.

1.4 Variables

The data set contains the following variables:

- Latitude and Longitude of each grid cell.
- Observation time. Seconds since 01 JAN 2000 00Z.
- Orbit position (fractional revolution number). 0.0 = South, 0.0 – 0.5 = ascending swath, 0.25 = equatorial crossing of ascending swath, 0.5 – 1.0 = descending swath, 0.75 equatorial crossing of descending swath, 1.0 = North.
- Earth incidence angles of each frequency band. The value is the average of the samples that fall within grid cell.
- Looking azimuth angles relative to N. The value is the average of the samples that fall within grid cell.
- Scan angles. The value is the average of the samples that fall within grid cell. convention: 0 = forward, +90 = left of forward, +180 = aft, +270 = right of forward.
- Geometric polarization basis rotation angles between surface and antenna. The value is the average of the samples that fall within grid cell.
- Faraday rotation angles. The value is the average of the samples that fall within grid cell.
- Quality Control flag. See section 1.5.
- Land fractions within the C-band and X-band footprints.
- Resampled L1C TOA TB of all 22 channels. The TB are organized into the 5 frequency bands (see Table 1). The polarization basis in each bands are 1=vertical

(V), 2=horizontal (H), 3= +45 (P), 4= -45 (M), 5=left circular (L), 6=right circular (R). The 6.8 and 23.8 GHz channels have only 1=V and 2=H polarizations.

1.5 Q/C Flag

The meaning of the bits in the Q/C flags are:

- bit 0 set: observations of one or more channels within a frequency band are missing.
- bit 1 set: bad earth incidence angle.
- bit 2 set: sun-glint.
- bit 3 set: RFI.
- bit 4 set: observations of 1 or more channels within a frequency band are bad.
- bit 5 set: observation falls within climatological sea-ice mask.

2 Citation and DOI

As a condition of using these data, we require you to use the following citation:

T. Meissner, F. Wentz and M. Brewer, Remote Sensing Systems WindSat Calibrated TOA Level 1C Brightness Temperatures, Version 8.0, doi: 10.5067/WSA80-1CRTB.

3 References

[1] T. Meissner and F. Wentz, Polarization rotation and the third Stokes parameter: the effects of spacecraft attitude and Faraday rotation, in IEEE Transactions on Geoscience and Remote Sensing, vol. 44, no. 3, pp. 506-515, March 2006, doi: 10.1109/TGRS.2005.858413.

[2] T. Meissner and F. Wentz, Ocean Retrievals for WindSat, 2006 IEEE MicroRad, 2006, pp. 119-124, doi: 10.1109/MICRAD.2006.1677074.

[3] T. Meissner and F. Wentz, Intercalibration of AMSR-E and WindSat brightness temperature measurements over land scenes, 2010 IEEE International Geoscience and Remote Sensing Symposium, 2010, pp. 3218-3219, doi: 10.1109/IGARSS.2010.5649513.

4] T. Meissner and F. Wentz, The Emissivity of the Ocean Surface Between 6 and 90 GHz Over a Large Range of Wind Speeds and Earth Incidence Angles, in IEEE Transactions on Geoscience and Remote Sensing, vol. 50, no. 8, pp. 3004-3026, Aug. 2012, doi: 10.1109/TGRS.2011.2179662.

[5] T. Meissner, F. Wentz and D. Draper, 2012, GMI Calibration Algorithm and Analysis Theoretical Basis Document, report number 041912, Version-G, Remote Sensing Systems, Santa Rosa, CA, 124 pp. https://doi.org/10.56236/RSS-au.

[6] F. Wentz and D. Draper, 2016, On-Orbit Absolute Calibration of the Global Precipitation Measurement Microwave Imager. J. Atmos. Oceanic Technol., 33, 1393–1412, DOI: 10.1175/JTECH-D-15-0212.1.

[7] F. Wentz and T. Meissner, 2016, Atmospheric absorption model for dry air and water vapor at microwave frequencies below 100?GHz derived from spaceborne radiometer observations, Radio Sci., 51, 381– 391, doi:10.1002/2015RS005858.

4 Acknowledgement

The production of this data set has been funded under NASA Grant 80NSSC21K0545: Development of Ocean Retrieval Algorithms for the Copernicus Imaging Microwave Radiometer CIMR.