Data User Guide

GPM Ground Validation Goddard Profiling Algorithm (GPROF) 2014 IFloodS

Introduction

The GPM Ground Validation Goddard Profiling Algorithm (GPROF) 2014 IFloodS dataset consists of precipitation data derived from microwave radiometers and sounders located on multiple satellites, including the Defense Meteorological Satellite Program (DMSP) F16-18, the Global Change Observation Mission – Water "Shizuku" (GCOM-W1), the European Space Agency's (ESA's) Meteorological Operational satellite programme (MetOp) series, and NOAA's Polar Operational Environmental Satellites (POES) series. The data have been consistently processed for the Iowa Flood Studies (IFloodS) field campaign conducted in eastern Iowa during spring 2013. The goals of the IFloodS campaign were to collect detailed measurements of precipitation at the Earth's surface using ground instruments and advanced weather radars and to simultaneously collect data from satellites passing overhead. The GPROF 2014 data files are available from March 31 to July 2, 2013 in HDF-5 format.

Notice:

These data are specially produced by the Precipitation Measurement Missions (PMM) for IFloodS.

Citation

Kummerow, Christian D. 2018. GPM Ground Validation Goddard Profiling Algorithm (GPROF) 2014 IFloods [indicate subset used]. Dataset available online from the NASA EOSDIS Global Hydrology Resource Center Distributed Active Archive Center, Huntsville, Alabama, U.S.A. doi: http://dx.doi.org/10.5067/GPMGV/IFLOODS/GPROF/DATA101

Keywords:

NASA, GHRC, GPM, IFloodS, Iowa, GPROF, precipitation, total column water vapor, DMSP, F16, GCOM-W1, MetOp-A, MetOp-B, NOAA-18, NOAA-19, SSMIS, AMSR2, MHS

Campaign

The Global Precipitation Measurement (GPM) mission Ground Validation campaign used a variety of methods for validation of GPM satellite constellation measurements prior to and after launch of the GPM Core Satellite, which launched on February 27, 2014. The instrument validation effort included numerous GPM-specific and joint agency/international external field campaigns, using state of the art cloud and precipitation observational infrastructure (polarimetric radars, profilers, rain gauges, and disdrometers). Surface rainfall was measured by very dense rain gauge and disdrometer networks at various field campaign sites. These field campaigns accounted for the majority of the effort and resources expended by GPM GV. More information about the GPM mission is available at https://pmm.nasa.gov/GPM/.

The Iowa Flood Studies (IFloodS) campaign was a ground measurement campaign that took place in eastern Iowa from May 1 to June 15, 2013. The goals of the campaign were to collect detailed measurements of precipitation at the Earth's surface using ground instruments and advanced weather radars and to simultaneously collect data from satellites passing overhead. The ground instruments characterize precipitation – the size and shape of raindrops, the physics of ice and liquid particles throughout the cloud and below as it falls, temperature, air moisture, and distribution of different size droplets – to improve rainfall estimates from the satellites, and in particular the algorithms that interpret raw data for the GPM mission's Core Observatory satellite, which launched in 2014. More information about IFloodS is available at http://dx.doi.org/10.5067/GPMGV/IFLOODS/DATA101. Additional information about the Iowa Flood Center is available at http://iowafloodcenter.org/.

Instruments and Satellites

These files contain surface rainfall and vertical hydrometeor profiles on a pixel-by-pixel basis generated from satellite microwave radiometer brightness temperature data using the Goddard Profiling algorithm named GPROF2014 (Kummerow et al., 2015). The following passive microwave sensors are used: SSMIS onboard the DMSP F16, AMSR2 onboard the GCOM-W1, and MHS onboard the NOAA-18, NOAA-19, MetOp-A, and MetOp-B.

MHS onboard the MetOp Satellites and the NOAA Satellites

The Microwave Humidity Sounder (MHS) is a self-calibrating microwave radiometer, observing the Earth with a field of view of ±50 degrees across nadir. MHS operates in five frequency channels of the millimeter-wave band (89-190 GHz). It is used to study profiles of atmospheric water vapor and provide improved input data to the cloud-clearing algorithms in Infrared (IR)/Microwave (MW) sounder suites. The MHS instruments were launched on NOAA's Polar Operational Environmental Satellites (POES) series starting with NOAA-18 launched in May 2005, continuing with NOAA-19 launched in February 2009. The European Space Agency's (ESA's) Meteorological Operational satellite programme (MetOp) series starting with MetOp-A launched in October 2006, continuing with MetOp-B launched in September 2012.

SSMIS onboard the DMSP F16, F17, and F18

The Special Sensor Microwave Imager/Sounder (SSMIS) instruments onboard the Defense Meteorological Satellite Program (DMSP) F16, F17, and F18 satellites estimate atmospheric temperature, moisture, and surface parameters from data collected at frequencies ranging from 19 to 183 GHz over a swath width of 1707 km.

AMSR2 onboard the GCOM-W1

The Global Change Observation Mission – Water "Shizuku" (GCOM-W1) satellite was launched on May 17, 2012. The Advanced Microwave Scanning Radiometer 2 (AMSR2) instrument onboard the GCOM-W1 observes precipitation, water vapor, wind velocity above the ocean, sea water temperature, water levels on land areas, and snow depths.

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Data Characteristics

The GPM Ground Validation Goddard Profiling Algorithm (GPROF) 2014 IFloodS dataset contains HDF-5 format data files at a Level 2 processing level. More information about the NASA data processing levels are available on the NASA Data Processing Levels website. Table 1 lists the characteristics of this dataset.

Table 1: Data Characteristics

Characteristic	Description
Platforms	DMSP F16-18, GCOM-W1, MetOp-A, MetOp-B, NOAA-18, NOAA-19
Instruments	SSMIS (DMSP F16-18), AMSR2 (GCOM-W1), MHS (NOAA-18, NOAA-19, MetOp-A, and MetOp-B)
Projection	Equirectangular
Spatial Coverage	N: 51.907, S: 32.052, E: -59.978, W: -123.830
Spatial Resolution	10-17 km
Temporal Coverage	March 31, 2013 - July 2, 2013
Temporal Resolution	One file per orbit
Sampling Frequency	1-3 seconds
Parameter	precipitation, total column water vapor, temperature, snow cover, water path, surface type
Version	3
Processing Level	2

File Naming Convention

The GPM Ground Validation Goddard Profiling Algorithm (GPROF) 2014 IFloodS dataset consists of HDF-5 format data files. The files are named using the following convention:

Data files: L2A-CS-iFloods.<sat>.<sensor>.<algorithm>.YYYYMMDD-Shhmmss-Ehhmmss.<######>.<version>.HDF5

Table 2: File naming convention variables

Variable	Description
<sat>	Satellites: F16, F17, F18, GCOMW1, METOPA, METOPB, NOAA18, NOAA19
<sensor>	Sensors: SSMIS, AMSR2, MHS *described in instrument section above
<algorithm>	Algorithm used for data: **GPROF2014v1-2 or GPROF2014v1-4**: Goddard Profiling Algorithm GPROF2014; Version 1
YYYYMMDD	Start date: YYYY: Four-digit year MM: Two-digit month DD: Two-digit day
Shhmmss	Start time in UTC: hh: Two-digit hour mm: Two-digit minute ss: Two-digit second
Ehhmmss	End time in UTC: hh: Two-digit hour mm: Two-digit minute ss: Two-digit second
<######>	Six-digit orbit number
<version>	Product version number
.HDF5	HDF-5 format

Data Format and Parameters

The GPM Ground Validation Goddard Profiling Algorithm (GPROF) 2014 IFloodS dataset consists of HDF-5 format data files containing surface rainfall and vertical hydrometeor profiles. These data are organized in swath orientation with pixels (i.e., radiometer footprints) across swath. Table 3 describes the data parameters in the data files.

Table 3. Data Fields

Group	Field Name	Data Type	Unit

./GprofDHeadr	speciesDescription	uint8	-
	hgtTopLayer	float32	km
	temperatureDescriptions	float32	C
	clusterProfiles	float32	-
./S1	Longitude	float32	degrees
	Latitude	float32	degrees
	sunGlintAngle	int8	degrees
	totalColumnWaterVapor	float32	kg/m^2
	surfacePrecipitation	float32	mm/hr
	probabilityOfPrecip	float32	percent
	precip1stTertial	float32	mm/hr
	precip2ndTertial	float32	-
	mostLikelyPrecipitation	float32	mm/hr
	liquidPrecipFraction	float32	-
	convectPrecipFraction	float32	-
	totalColumnWaterVaporIndex	int8	mm
	surfaceSkinTempIndex	int16	K
	temp2mIndex	int16	-
	iceWaterPath	float32	kg/m^2
	cloudWaterPath	float32	kg/m^2
	mixedWaterPath	float32	kg/m^2
	rainWaterPath	float32	kg/m^2
	pixelStatus	int8	-
	qualityFlag	int8	-
	orographicLiftIndex	int8	-
	spareIndex	int8	-
	profileScale	float32	-
	databaseExpansionIndex	int8	-
	numOfSignificantProf	int16	-
	retrievalType	int8	-
	snowCoverIndex	int8	-
	spare	int16	-
	surfaceTypeIndex	int8	-
	profileNumber	int16	-
./S1/ScanTime	MilliSecond	int16	ms
	Minute	int8	minutes
	Year	int16	years
	SecondOfDay	float64	s

	Second	int8	s
	DayOfYear	int16	days
	Hour	int8	hours
	Month	int8	months
	DayOfMonth	int8	days
./S1/SCstatus *SC stands for spacecraft	SCorientation (SC = spacecraft)	int16	degrees
	SClatitude	float32	degrees
	SClongitude	float32	degrees
	SCaltitude	float32	km
	FractionalGranuleNumber	float64	-

Algorithm

These files contain surface rainfall and vertical hydrometeor profiles generated from microwave radiometer brightness temperature data using the GPROF2014 algorithm (Kummerow et al., 1996; Kummerow et al., 2015). In this algorithm, the GPM core satellite is used to create a database of observed cloud and precipitation profiles (the so called 'a-priori' database). Once the a-priori database of potential rain profiles and associated brightness temperatures is established, the retrieval employs a straightforward Bayesian inversion methodology that searches the a-priori database and retrieves a weighted average based upon the proximity of the observed brightness temperature to the simulated brightness temperature. The GPROF2014 algorithm is fully parametric, which means that it is consistent for all passive microwave sensors with specified sensor descriptions including error and characteristics.

More detailed information about the GPROF2014 algorithm can be found at http://rain.atmos.colostate.edu/ATBD/ATBD_GPM_Aug1_2014.pdf, https://pps.gsfc.nasa.gov/Documents/IntroductionToDataProducts.pdf, Kummerow et al., 1996, and Kummerow et al., 2015.

Quality Assessment

The major sources of systematic errors in the GPROF2014 algorithm are the quality of the a-priori database, the estimate of the forward model uncertainty, and the ancillary information used to subset the a-priori database.

Because passive microwave signatures at the pixel level represent primarily integrated quantities, neither the vertical structure nor the near-surface precipitation from radiometers are typically as good as their radar counterparts. Solutions are also smoothed by the Bayesian scheme, leading to fewer extremes relative to a radar.

Version 1 of GPROF constitutes the pre-launch version of the algorithm and it does NOT make use of the GPM core satellite as the source of its a-priori database. Instead, the a-priori database was put together from a variety of imperfect sources as described in the algorithm ATBD.

Research intended to examine climate aspects of precipitation should consider waiting for Version 2 of the GMI algorithm that will be constructed using the GPM core satellite database and should be available one year after launch.

Furthermore, while the ocean algorithm is reasonably mature, the land algorithm is quite new and some artifacts continue to appear - particularly at interfaces between surface types containing snow and ice. These are being addressed as they are discovered and users are encouraged to check for periodic updates during the early phases of GPM data release.

Software

The data files are self-describing HDF-5 format. Panoply can be used to easily view these HDF-5 data files.

Known Issues or Missing Data

Known gaps for these data can be found from the PPS Partner Satellite Data Discrepancies Reports.

For the cross-track scanning MHS GPROF in this early algorithm version, there is a known issue with precipitation over the tropical oceans being too low. This was being worked on. As a result, users are cautioned by basing any publication results on these earlier versions of MHS GPROF retrievals over the tropical oceans (source: https://storm.pps.eosdis.nasa.gov/storm/GPROF_2014_Caveat.pdf). For the most recent information about GPROF algorithm issues, check the PPS web site at https://storm.pps.eosdis.nasa.gov/storm/Product.jsp

References

Kummerow, Christian D., David L. Randel, Mark Kulie, Nai-Yu Wang, Ralph Ferraro, S. Joseph Munchak, and Veljko Petkovic (2015). The evolution of the Goddard profiling algorithm to a fully parametric scheme.
J. Atmos. Oceanic Technol., 32, 2265–2280. doi: https://doi.org/10.1175/JTECH-D-15-0039.1.

Kummerow, Christian, William S. Olson, and Louis Giglio (1996). A simplified scheme for obtaining precipitation and vertical hydrometeor profiles from passive microwave sensors. *IEEE, Trans. on Geoscience and Remote Sensing*, 34(5), 1213-1232. doi: https://doi.org/10.1109/36.536538.

Related Data

All data collected during the IFloodS field campaign should be considered related data sets. To locate other IFloodS data, use the GHRC search tool HyDRO 2.0 with the search term

IFloodS.

More recent versions of GPROF data are available from the Goddard Earth Sciences Data and Information Services Center (GES DISC):

10.5067/GPM/SSMIS/F16/GPROF/2A/05

10.5067/GPM/SSMIS/F17/GPROF/2A/05

10.5067/GPM/SSMIS/F18/GPROF/2A/05

10.5067/GPM/AMSR2/GCOMW1/GPROF/2A/05

10.5067/GPM/MHS/METOPA/GPROF/2A/05

10.5067/GPM/MHS/METOPB/GPROF/2A/05

10.5067/GPM/MHS/NOAA18/GPROF/2A/05

10.5067/GPM/MHS/NOAA19/GPROF/2A/05

Contact Information

To order these data or for further information, please contact:

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User Services
320 Sparkman Drive
Huntsville, AL 35805
Phone: 256-961-7932
E-mail: support-ghrc@earthdata.nasa.gov
Web: https://ghrc.nsstc.nasa.gov/

Created: August 16, 2018