![GHRC - Global Hydrology Resource Center]

Data User Guide

GPM Ground Validation Raw Autonomous Parsivel Unit (APU) IFloodS

Introduction

The GPM Ground Validation Raw Autonomous Parsivel Unit (APU) IFloodS dataset was collected by 14 Autonomous Parsivel Unit (APU) sites in eastern Iowa during the Global Precipitation Measurement (GPM) mission Iowa Flood Studies (IFloodS) field campaign. The campaign aimed to collect detailed measurements of precipitation at the Earth's surface using ground instruments and advanced weather radars while simultaneously collecting data from satellites passing overhead. APU is an optical disdrometer system that measures precipitation particle size and fall velocity. This dataset consists of APU-calculated parameters and unfiltered drop spectrum data. The dataset files are available in ASCII text format from April 1 through May 24, 2013. Officially, the IFloodS campaign ran from May 1 to June 15, 2013, but the APUs were installed and had begun collecting data prior to the start of the campaign.

Notice:
Timestamps in these raw files have not been adjusted for any time offset. See the *Known Issues or Missing Data* section.

Citation

Petersen, Walter, Patrick Gatlin, and Matthew Wingo. 2019. GPM Ground Validation Raw Autonomous Parsivel Unit (APU) IFloodS [indicate subset used]. Dataset available online from the NASA Global Hydrology Resource Center DAAC, Huntsville, Alabama, U.S.A. doi: http://dx.doi.org/10.5067/GPMGV/IFLOODS/APU/DATA401

Keywords:

NASA, GHRC, PMM, GPM GV, Iowa Flood Center, IFloodS, OTT, APU, optical disdrometer, particle diameter, fall velocity, temperature, rain rate, reflectivity, visibility

Campaign

The Global Precipitation Measurement mission Ground Validation (GPM GV) campaign used a variety of methods for validation of GPM satellite constellation measurements prior to and after the 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). These field campaigns accounted for the majority of the effort and resources expended by GPM GV mission. More information about the GPM mission is available at the [PMM Ground Validation webpage](#).

The Iowa Flood Studies (IFloodS) field campaign was a ground measurement campaign that took place in central-northeastern Iowa from May 1 to June 15, 2013. The main goal of IFloodS was to evaluate how well the GPM satellite rainfall data can be used for flood forecasting. Specifically, this meant collecting detailed measurements of precipitation at the Earth's surface using ground instruments and advanced weather radars while simultaneously collecting data from satellites passing overhead. Satellite datasets were obtained from NOAA, DMSP, NASA, EUMETSAT (METOP), JAXA, and GOES spaceborne instruments. The ground instruments were used to thoroughly characterize precipitation and contribute to improved satellite rainfall estimates; in particular, the improvement of algorithms that interpret raw data for the GPM mission's Core Observatory satellite. More information about IFloodS is available at the [IFloodS Field Campaign webpage](#) and more information about GPM's partner organization for this project, the Iowa Flood Center, is available on the [Iowa Flood Center website](#).
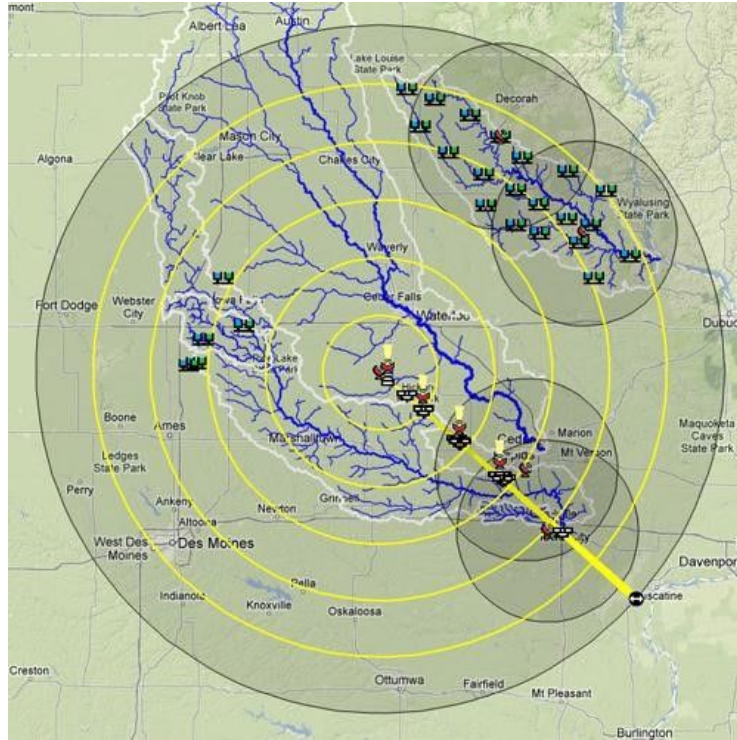
Figure 1: Areas of focus during the IFloodS campaign were the Cedar and Iowa River Basins, the South Fork Iowa River, and the Turkey River Basin in Northeast Iowa. (Image source: PMM IFloodS webpage)

Instrument Description

The Autonomous Parsivel Unit (APU) is an optical disdrometer based on single-particle extinction that measures particle size and fall velocity. The APU consists of the Parsivel[2], developed by OTT in Germany, and its data reporting support systems, designed and built by the University of Alabama in Huntsville. The Parsivel[2] disdrometer is a laser-based optical system for measuring all types of precipitation. The transmitter unit of the sensor generates a flat, horizontal strip or sheet of light, in which the receiver converts into an electrical signal. When no particles pass through the horizontal beam, the maximum voltage is detected at the receiver. The signal changes whenever a hydrometeor falls through the sheet anywhere within the measurement area. The blocked portion of the laser signal results in reduced voltage output. The degree to which the signal is dimmed is a measure of the size of the hydrometeor, and together with the duration of the blockage, the fall velocity can be derived. The Parsivel[2] can classify precipitation particles into 32 separate size classes ranging from 0 to 25 mm and 32 velocity classes ranging from 0 to 20 ms^{-1}. Additional information on the OTT Parsivel[2] instrument can be found in Tokay, Wolff, and Petersen (2014) and on the instrument's OTT HydroMet webpage. In Table 1 below are the 14 APU locations during IFloodS.

Table 1: APU serial numbers and locations

APU serial number	Latitude	Longitude
apu01	42.2388	-92.4637
apu02	42.1823	-92.3654
apu03	43.1260	-92.2817
apu04	42.1224	-92.2806
apu05	41.9927	-92.0602
apu06	41.9782	-92.0757
apu07	41.9927	-92.0914
apu08	41.9927	-92.0709
apu09	41.8614	-91.8853
apu10	41.8605	-91.8737
apu11	41.8471	-91.8603
apu12	41.8474	-91.8458
apu13	41.6406	-91.5418
apu14	41.6406	-91.5416

Figure 2: Two Autonomous Parsivel Units (APUs)
(Image source: NASA GHRC)

Investigators

Walter Petersen
NASA Marshall Space Flight Center
Huntsville, AL

Patrick Gatlin
NASA Marshall Space Flight Center
Huntsville, AL

Matthew Wingo
NASA Wallops Flight Facility
Wallops Island, VA

Data Characteristics

The GPM Ground Validation Raw Autonomous Parsivel Unit (APU) IFloodS dataset includes daily particle diameter and fall velocity, temperature, rain rate, reflectivity, visibility, and present weather data. These data are available in ASCII text format at a Level 1A processing level. More information about the NASA data processing levels is available on the EOSDIS Data Processing Levels webpage. The characteristics of this dataset are listed in Table 2 below.

Table 2: Data Characteristics

Characteristic	Description
Platform	Ground Stations
Instrument	Autonomous Parsivel Unit (APU)
Spatial Coverage	N: 42.142 , S: 41.383 , E: -91.323 , W: -92.275 (Iowa)
Spatial Resolution	Point
Temporal Coverage	April 1, 2013 - May 24, 2013
Temporal Resolution	Daily
Sampling Frequency	10 seconds
Parameter	Precipitation particle diameter and fall velocity, temperature, rain rate, reflectivity, visibility, present weather
Version	1
Processing Level	1A

File Naming Convention

The GPM Ground Validation Raw APU IFloodS dataset files are stored as zipped ASCII text files with the following naming convention:

Tarred data files: ifloods_apu[sn]_YYYYMMDD_[latitude_longitude]_raw.zip
Untarred data files: ifloods_apu[sn]_YYYYMMDD_[latitude_longitude]_raw.txt

Table 3: File naming convention variables

Variable	Description
[sn]	serial number of APU platform (e.g., apu01) 01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11, 12, 13, 14

	YYYYMMDD (e.g., 20130422) YYYY: four-digit year MM: two-digit month DD: two-digit day
YYYYMMDD	YYYYMMDD (e.g., 20130422) YYYY: four-digit year MM: two-digit month DD: two-digit day
[latitude_longitude]	geographic location of instrument (e.g., N420720.75_W921650.32 is North 42°07'20.75" and West 92°16'50.32")
.zip	ZIP archive file
.txt	Text file

Data Format and Parameters

The GPM Ground Validation Raw APU IFloodS dataset consists of daily ASCII encoded files containing APU-calculated parameters and unfiltered drop spectrum. This includes precipitation particle diameter and fall velocity classifications, temperature, rain rate, reflectivity, visibility, and present weather codes calculated by the Parsivel firmware. There are 32 diameter classes and 32 velocity classes measured by APU which combine to create a total of 1,024 bin classifications. Each bin is defined by a certain diameter class and velocity class (32 x 32 = 1024 bins). More detail is included in the PI documentation under the Level 1A data (*_raw.txt) sections. Within each daily file, data samples occur every 10 seconds. Each sample includes the data fields listed in Table 4 below.

Table 4: Data fields for *_raw.txt files

Field Number	Description	Unit
1	YYYYmmDDHHMMSS in UTC where: YYYY= four-digit year mm= two-digit month DD= two-digit day HH= two-digit hour in UTC MM= two-digit minute in UTC SS= two-digit second in UTC	-
2	Serial Number of APU Platform	-
3	Sensor Status	-
4	Temperature	°C
5	Number of Particles Detected	-
6	Rain Rate	mm/hr
7	Reflectivity	dBz
8	MOR (Meteorological Optical Range) Visibility	m
9	Weather code according to SYNOP WaWa Table 4680*	-
10	Weather code according to SYNOP WW Table 4677*	-

| 11-1034 | Number of particles within each diameter and velocity class* | - |

*The weather code information can be found in Appendix C of the PI documentation. Bin definitions can be found in Appendix A of the PI Documentation.

Algorithm

The Parsivel[2] uses an optical laser to measure raindrop size and fall speed. The time it takes a particle to pass through the laser beam is used to estimate the fall speed while the maximum attenuation of the signal is used to calculate the particle size. Other parameters such as rainfall rate and reflectivity are then derived from these measurements. More information on the Parsivel[2] measurement process can be found in Tokay et al. (2014).

Quality Assessment

The OTT Parsivel[2] is the improved version of the original Parsivel disdrometer. It is calibrated using high-precision reference particles of different sizes and using a rotating disk to simulate velocity. The Parsivel[2] measurement accuracy is ±1 size class for drops smaller than 2 mm diameter and ±0.5 size class for drops larger than 2 mm diameter. More information on the Parsivel[2] measurement accuracy is discussed in Tokay et al. (2014).

Software

No software is required to view these data files. The GPM GV Raw APU IFloodS ASCII text files can be viewed in a text editor or spreadsheet software, such as Microsoft Excel or Notepad++.

Known Issues or Missing Data

The measurement timestamps in the APU Level 1A data (*_raw.txt files) for the APUs listed below in Table 5 should be adjusted accordingly before processing. For example, add 58 seconds to APU14 raw data collected prior to 14:40 UTC on May 4, 2013.

Table 5: APU raw data time offsets

APU	Time offset from actual (seconds)	Adjust all data collected before
APU14	-58	14:40 UTC on May 4
APU13	-57	14:00 UTC on May 4
APU12	-145	13:47 UTC on May 5
APU11	-137	13:51 UTC on May 5
APU10	-134	13:55 UTC on May 5
APU09	-134	13:53 UTC on May 5
APU04	-136	20:38 UTC on May 4
APU02	-122	20:00 UTC on May 4

APU01	-118	18:30 UTC on May 4

Also, APUs began collecting data individually as they were installed. Therefore, the start date of the data collected will vary between the 14 different APUs.

References

Beard, K. V. (1976). Terminal velocity and shape of cloud and precipitation drops aloft. *Journal of the Atmospheric Sciences*, *33*, 851–864. https://doi.org/10.1175/1520-0469(1976)033%3C0851:TVASOC%3E2.0.CO;2

Gran, R. (2013). Improving Flood Forecasting. https://iowafloodcenter.org/nasa-university-of-iowa-ground-measurement-campaign-to-improve-flood-forecasting/

OTT HydroMet (n.d.). OTT Parsivel - Enhanced Precipitation Identifier For Present Weather, Drop Size Distribution And Radar Reflectivity - OTT Messtechnik, Germany https://www.wmo.int/pages/prog/www/IMOP/publications/IOM-94-TECO2006/P1(08)_Nemeth_Germany.pdf

OTT HydroMet (2019). OTT Parsivel[2] - Laser Weather Sensor. https://www.ott.com/en-us/products/meteorological-sensors-26/ott-parsivel2-laser-weather-sensor-2392/

Tokay, A., Wolff, D. B., & Petersen, W. A. (2014). Evaluation of the New Version of the Laser-Optical Disdrometer, OTT Parsivel[2]. *Journal of Atmospheric and Oceanic Technology*, *31*, 1276-1288. https://doi.org/10.1175/JTECH-D-13-00174.1

Related Data

All data collected by other instruments during the IFloodS field campaign are considered to be related datasets. These data can be located by searching 'IFloodS' in the GHRC HyDRO 2.0 search tool. Below are datasets from other GPM GV field campaigns and sites that used the APU to collect data:

GPM GROUND VALIDATION AUTONOMOUS PARSIVEL UNIT (APU) LPVEX (http://dx.doi.org/10.5067/GPMGV/LPVEX/APU/DATA301)

GPM GROUND VALIDATION AUTONOMOUS PARSIVEL UNIT (APU) GCPEX (http://dx.doi.org/10.5067/GPMGV/GCPEX/APU/DATA301)

GPM GROUND VALIDATION AUTONOMOUS PARSIVEL UNIT (APU) MC3E (http://dx.doi.org/10.5067/GPMGV/MC3E/APU/DATA301)

GPM GROUND VALIDATION AUTONOMOUS PARSIVEL UNIT (APU) IPHEX

(http://dx.doi.org/10.5067/GPMGV/IPHEX/APU/DATA301)

GPM GROUND VALIDATION AUTONOMOUS PARSIVEL UNIT (APU) OLYMPEX
(http://dx.doi.org/10.5067/GPMGV/OLYMPEX/APU/DATA301)

GPM GROUND VALIDATION AUTONOMOUS PARSIVEL UNIT (APU) HYMEX
(http://dx.doi.org/10.5067/GPMGV/HYMEX/APU/DATA301)

GPM GROUND VALIDATION AUTONOMOUS PARSIVEL UNIT (APU) Wallops Flight Facility (WFF)
(http://dx.doi.org/10.5067/GPMGV/WFF/APU/DATA101)

GPM GROUND VALIDATION AUTONOMOUS PARSIVEL UNIT (APU) NSSTC
(http://dx.doi.org/10.5067/GPMGV/NSSTC/APU/DATA201)

Contact Information

To order these data or for further information, please contact:
    NASA Global Hydrology Resource Center DAAC
    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: 12/18/19