



Data User Guide

GPM Ground Validation USDA ARS Soil Moisture IFloodS

Introduction

The GPM Ground Validation United States Department of Agriculture (USDA) Agricultural Research Service (ARS) Soil Moisture IFloodS dataset was collected during the Iowa Flood Studies (IFloodS) ground measurement campaign from April 17, 2013 to June 4, 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. A total of 15 stations were deployed near the South Fork River in North Central Iowa. The soil moisture probes measure hourly instantaneous measurements of the real dielectric permittivity, soil temperature, bulk electrical conductivity, and volumetric soil moisture. This dataset also consists of precipitation amount, air temperature, relative humidity, vapor pressure, wind speed, wind direction, and solar radiation measurements. The data files are available in ASCII-csv and Excel file formats.

Citation

Cosh, Michael H. 2017. GPM Ground Validation USDA ARS Soil Moisture 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/PROBES/DATA301>

Keywords:

NASA, GHRC, IFloodS, GPM GV, Iowa, soil moisture probes, dielectric permittivity, soil temperature, volumetric soil moisture, volumetric water content, precipitation, tipping bucket, air temperature, relative humidity, vapor pressure, wind speed, wind direction, solar radiation

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. 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 <https://ghrc.nsstc.nasa.gov/home/field-campaigns/ifloods>. Additional information about the Iowa Flood Center is available at <http://iowafloodcenter.org/>.

Instrument Description

The GPM Ground Validation United States Department of Agriculture (USDA) Agricultural Research Service (ARS) Soil Moisture IFloodS dataset consists of measurements from 15 stations located on the USDA ARS Soil Moisture platform deployed near the South Fork River in North Central Iowa (Figure 1 and Table 1). The soil moisture probes measured hourly instantaneous measurements of the real dielectric permittivity, soil temperature, bulk electrical conductivity, and volumetric soil moisture. There were 4 Stevens Water Hydra Probes installed at each station with the center of each sensor located at depths of 5 cm, 10 cm, 20 cm, and 50 cm. The Stevens Water Hydra Probe is a rugged soil sensor that measures soil moisture, salinity, and temperature simultaneously. It weighs about 7 ounces and measures up to 5 inches in length. In addition, there were 2 precipitation gauges located at each site, a Texas Electronics 525 (TE525) and a MetOne 380. More information about Stevens Water Hydra Probes can be found at http://www.stevenswater.com/resources/datasheets/hydraprobe_brochure_web.pdf. Two stations, SF01 and SF13 had additional instrumentation allowing for measurements of wind speed and direction, air temperature and relative humidity. See table 4.

The Met One Model 380 Precipitation Gauge, manufactured by Met One Instruments Inc., is a tipping bucket rain gauge which measures the amount of fallen precipitation. The gauge

has a 12 inch (30.5cm) diameter catchment funnel that directs precipitation to a tipping bucket assembly. When 0.01 inch (0.254mm) of precipitation is collected, the tipping bucket assembly tips, draining the collection and activating a mercury switch for recording data. Figure 2 below shows an example of two rain gauges at a NASA platform. More information about the Met One Model 380 Precipitation Gauge can be found at http://www.metone.com/docs/370_380_precipitation_gauge.pdf.

The TE525 was manufactured by Texas Electronics, and it is a tipping bucket rain gauge which measures the amount of fallen precipitation. The gauge has a 6.06 inch (15.4 cm) diameter catchment funnel that directs precipitation to a tipping bucket assembly. When 0.01 in (0.254 mm) of precipitation is collected, the tipping bucket assembly tips. Figure 3 below shows an example of the TE525 rain gauge instrument. More information about TE525 is available at <https://www.campbellsci.com/te525-l#detaileddescription>.

More information about the USDS ARS Soil Moisture data can be found in Coopersmith et al., 2015.

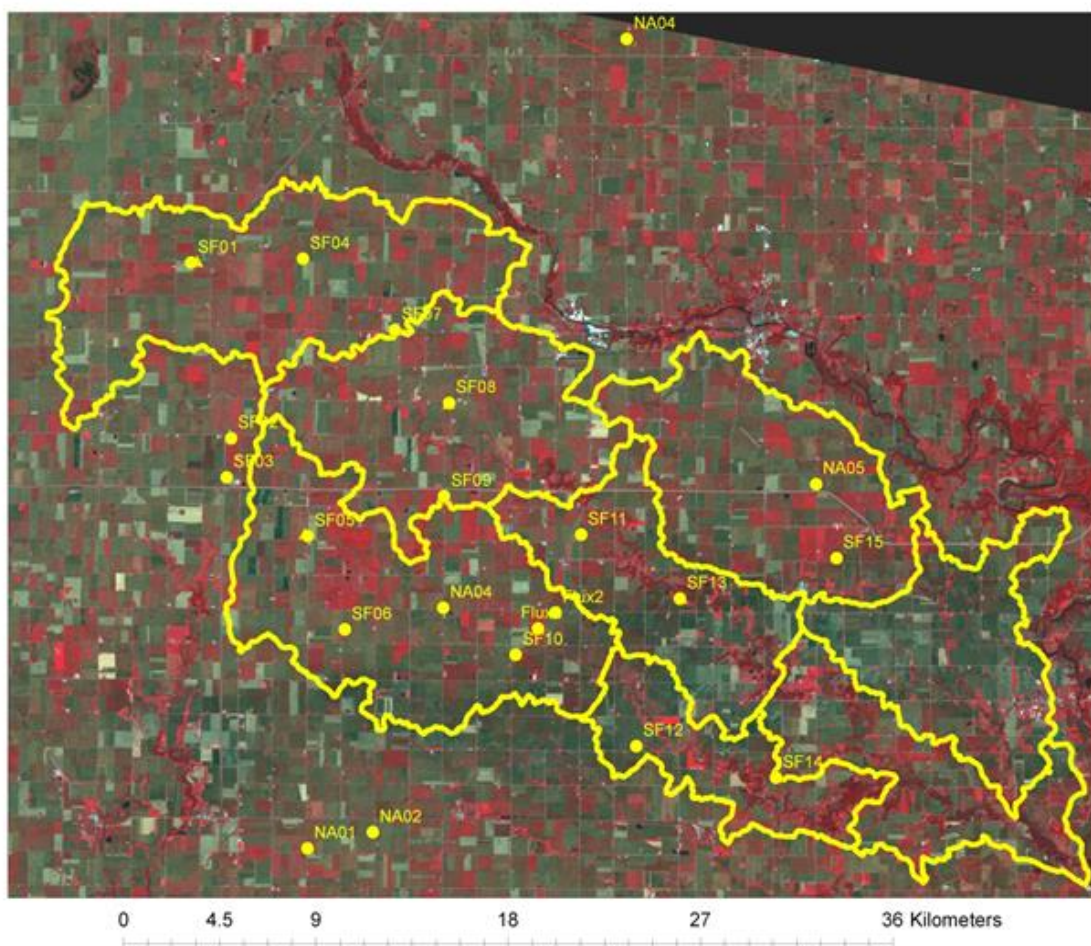


Figure 1: South Fork Experimental Watershed - USDA ARS Soil Moisture station locations labeled SF01 - SF15.

(image source:
https://fcportal.nsstc.nasa.gov/pub/gpm_validation/ifloods/ARS_soil_moisture/doc/USDA_ARFLOODS_readme.docx)

Table 1: USDA ARS soil moisture and rain gauge stations in and around the South Fork Experimental Watershed

Site ID	Latitude	Longitude
SF01	42.542620	-93.589060
SF02	42.469300	-93.565450
SF03	42.452960	-93.567970
SF04	42.544590	-93.525270
SF05	42.428570	-93.521580
SF06	42.389600	-93.500130
SF07	42.515010	-93.472710
SF08	42.484630	-93.441490
SF09	42.445560	-93.444050
SF10	42.379370	-93.402930
SF11	42.429750	-93.365960
SF12	42.341400	-93.334220
SF13	42.403180	-93.309710
SF14	42.328310	-93.254860
SF15	42.420340	-93.220770

Investigators

Michael H. Cosh
USDA-ARS Hydrology and Remote Sensing Laboratory
Beltsville, Maryland

Data Characteristics

The GPM Ground Validation USDA ARS Soil Moisture IFloodS data are available in both ASCII-csv files and and Excel files. The data are repeated in both files. The data processing level is 1A.

Table 2: Data Characteristics

Characteristic	Description
Platform	USDA ARS Soil Moisture Platform
Instruments	Stevens Water Hydra Probes Texas Electronics 525 (TE525) rain gauge MetOne 380 rain gauge
Projection	n/a
Spatial Coverage	N: 42.545, S: 42.328, E: -93.221, W: -93.589 (Iowa)
Spatial Resolution	point
Temporal Coverage	Start date: April 16, 2013 Stop date: June 4, 2013
Temporal Resolution	daily
Sampling Frequency	varies
Parameters	volumetric water content, total precipitation amount, soil temperature Two stations (SF01 and SF13) also have air temperature, relative humidity, vapor pressure, wind speed, wind direction, and solar radiation measurements
Version	1
Processing Level	1A

File Naming Convention

The GPM Ground Validation USDA ARS Soil Moisture IFloodS data are in ASCII-csv and Excel formats and have the following naming convention:

Text files: ifloods_ars_SF##_[letter]_[DailyHourlyRain].csv

Excel files: ifloods_ars_SF##_[letter]_[DailyHourlyRain].xlsx

Table 3: File naming convention variables

Variable	Description
SF##	South Fork Station Number
[letter]*	alternate designation of A, B, C, or D*
Daily	Daily file for station
Hourly	Hourly file for station
Rain	Rainfall file for station in second increments
.xlsx	Microsoft Excel file format
.csv	Comma Separated Value ASCII file

*some stations have an alternate designation of A, B, C, or D, which is an old naming convention for 4 sites that have operated for a longer time period.

Data Format and Parameters

The GPM Ground Validation USDA ARS Soil Moisture IFloodS data are available in ASCII-csv and Excel formats. The first 4 rows are header lines, and rows after that are data. Table 4 describes each column of data. More information about these data are in the [Data Provider Documentation](#).

Table 4: Data Field Descriptions

Field Name	Description	Unit
TIMESTAMP	Date and time in hh:mm:ss hh: hour in CST mm: minute in CST ss: seconds in CST	-
RECORD	Record number	-
Site	Site ID number	-
VWC_1	Volumetric Water Content at 5 cm depth	-
VWC_2	Volumetric Water Content at 10 cm depth	-
VWC_3	Volumetric Water Content at 20 cm depth	-
VWC_4	Volumetric Water Content at 50 cm depth	-
Rain_TE_Tot	Precipitation from the TE525 tipping bucket rain gauge	mm
Rain_Met_Tot	Precipitation from the MetOne 380	mm
Temp_1	Soil temperature at 5 cm depth	°C
Temp_2	Soil temperature at 10 cm depth	°C
Temp_3	Soil temperature at 20 cm depth	°C
Temp_4	Soil temperature at 50 cm depth	°C
Batt_Volt_Min	Minimum battery voltage	V
AirTC_Min**	Minimum air temperature during the day of record	°C
AirTC_Max**	Maximum air temperature during the day of record	°C
AirTC_Avg**	Average air temperature	°C
RH_Avg**	Average relative humidity	%
e_sat**	Saturation vapor pressure	-
e_act**	Actual vapor pressure	-
WindSpeed_Mean**	Mean wind speed	m/s
WindDir_Mean***	Mean wind direction (0 North)	°
WindDir_SD**	Standard deviation of the wind direction	°
SLR_W_Avg**	Solar radiation	W/m ²

** only two stations have these parameters: SF01 and SF13

Quality Assessment

The Stevens Water Hydra Probe measures soil temperatures from freezing (0°C) to +55°C; however, the standard range is from -10°C to +55°C with an accuracy of 0.3° C. For real dielectric permittivity, it has a range of 1 to 80 (where 1 = air and 80 = distilled water) with an accuracy of $\pm \leq 1.5\%$ or 0.2, whichever is greater. For measuring soil moisture for inorganic and mineral soil, the probe can range from completely dry to fully saturated with an accuracy of ± 0.01 WFV for most soils $\pm \leq 0.03$ for fine textured soils (accuracy may vary with some soil textures). For Bulk electrical conductivity (salinity) which ranges from 0.1 to 1.5 S/m, the accuracy is $\pm 2.0\%$ or 0.02 S/m, whichever is great. The variability between sensors, which need no calibration, is ± 0.012 WFV.

The Met One Model 280 rain gauge have a reported accuracy of $\pm 0.5\%$ at 13 mm/hr and $\pm 1\%$ at 25 - 75 mm/hr. Errors in tipping bucket rain gauge measurements have been reported in Ciach, 2003.

The TE525 rain gauge have a reported accuracy of $\pm 1\%$ at 25.4 mm/hr and has a high precision rate tipping at 0.01 in increments. More information about the accuracy of the TE525 is available at <https://www.campbellsci.com/te525-l#detaileddescription>.

Software

No special software is needed to view the GPM Ground Validation ARS Soil Moisture IFloodS ASCII-csv and Excel files.

References

Ciach, Grzegorz J. (2003). Local random errors in tipping-bucket rain gauge measurements, *J. Atmos. Oceanic Technol.*, 20, 752-759. doi:10.1175/1520-0426(2003)20<752:LREITB>2.0.CO;2

Coopersmith, Evan J., Michael H. Cosh, Walter A. Petersen, John Prueger, and James J. Niemeier (2015). Soil Moisture Model Calibration and Validation: An ARS Watershed on the South Fork Iowa River. *J. Hydrometeor.* 16, 1087–1101, doi: 10.1175/JHM-D-14-0145.1.

Related Data

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

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/>