GPM Ground Validation Pluvio Precipitation Gauges OLYMPEX

Introduction

The GPM Ground Validation Pluvio Precipitation Gauges OLYMPEX dataset contains one-minute precipitation rate and precipitation accumulation measurements, as well as start and end times of precipitation events, that were collected during the Olympic Mountain Experiment (OLYMPEX) field campaign on the Olympic Peninsula in the Pacific Northwest of the United States. Pluvio weighing bucket gauges created by OTT Hydromet were used to collect precipitation data at three different sites: Neilton Point, Wynoochee Trailer, and Upper Quinault Enchanted Valley. Data were collected from October 31, 2015 through January 31, 2016, but exact dates vary by site as instrument operation was not consistent. Data files are available in ASCII-tsv format.

Notice:
The Pluvio at the apu04 site did not operate from December 15, 2015 through January 5, 2016. Instrument operation dates can be determined from the data type files within the dataset.

Citation

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Keywords:

NASA, GHRC, OLYMPEX, Washington, droplet size, liquid precipitation, drizzle, rain, precipitation amount, precipitation rate, liquid water equivalent, snow water equivalent, solid precipitation, total surface precipitation rate, rain gauges, pluvio, precipitation events

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/.

One of the GPM Ground Validation field campaigns was the Olympic Mountains Experiment (OLYMPEX) which was held in the Pacific Northwest during November 2015 - March 2016. The goal of OLYMPEX was to validate rain and snow measurements in midlatitude frontal systems as they move from ocean to coast to mountains and to determine how remotely sensed measurements of precipitation by GPM can be applied to a range of hydrologic, weather forecasting, and climate data. The campaign consisted of a wide variety of ground instrumentation, several radars, and airborne instrumentation monitoring oceanic storm systems as they approached and traversed the Peninsula and the Olympic Mountains. The OLYMPEX campaign was part of the development, evaluation, and improvement of GPM remote sensing precipitation algorithms. More information is available from the NASA GPM Ground Validation web site https://pmm.nasa.gov/olympex and the University of Washington OLYMPEX web site http://olympex.atmos.washington.edu/.

Figure 1: OLYMPEX Domain
(Image Source: https://pmm.nasa.gov/OLYMPEX)
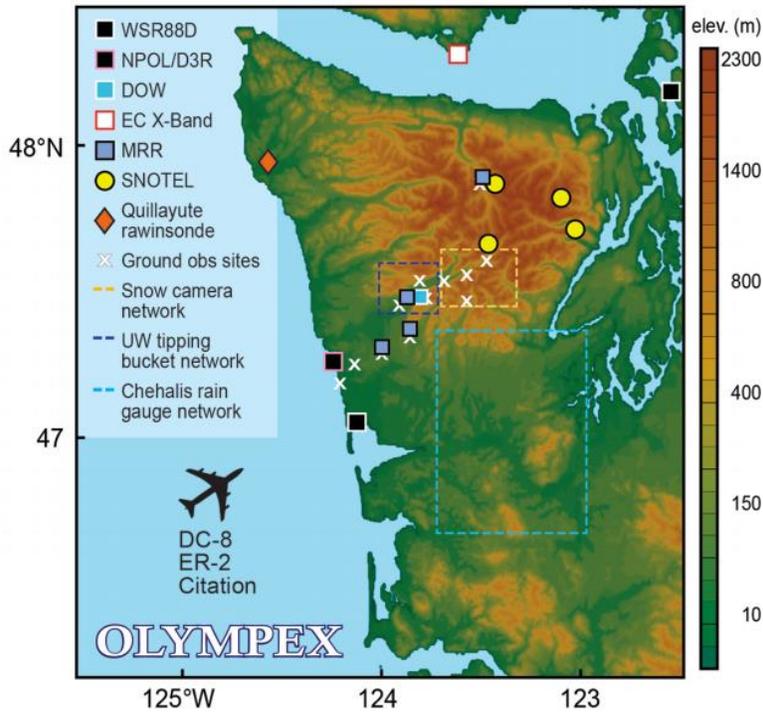
Figure 2: OLYMPEX Field Locations
(Image Source: https://pmm.nasa.gov/OLYMPEX)

Instrument Description

The Pluvio[2] is a weighing precipitation gauge produced by OTT Hydromet in Kempten, Germany that continuously monitors liquid, solid, and mixed precipitation accumulation. To provide the best possible data, the load cell and sensor electronics are hermetically sealed against the environment. The Pluvio[2] model 400 (Pluvio400) instrument has a 400 cm² opening for precipitation collection and can reliably measure in all weather conditions even for small amounts of precipitation. The minimal threshold is 0.1 mm/min and data are reported in 1 minute intervals. Rainfall intensity does not affect the instrument's measurement accuracy. Precipitation values are reported in millimeter per minute (mm/min) and millimeter per hour (mm/hr). Precipitation event summaries consist of start/stop times for rain events separated by a 1 hour or longer rain-free period. For OLYMPEX, the Pluvio400 was located at three ground sites co-located with Autonomous Parsivel Units (APU). The sites are apu04, apu10, and apu30.

Table 1: OLYMPEX Pluvio sites

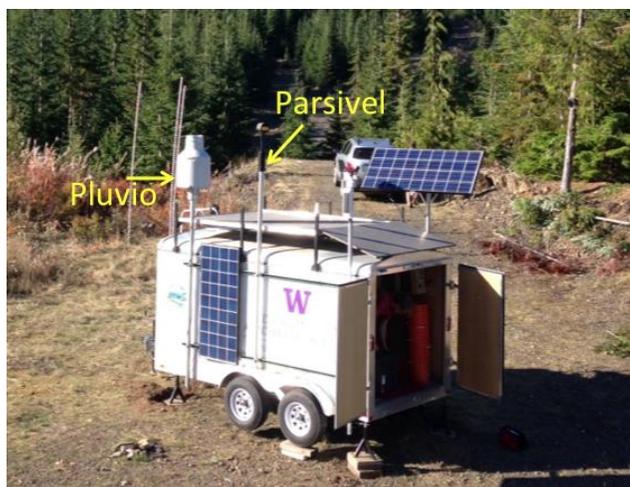| Site	Latitude (°)	Longitude (°)
apu04 - Neilton Point	47.389	-123.867
apu10 - Wynoochee Trailer	47.497	-123.581
apu30 - Upper Quinault Enchanted Valley	47.680	-123.841

Figure 3: Instrumented trailer installed on the southern side of the Olympic Mountains. The Pluvio and Parsivel are mounted high on the trailer to keep them above the accumulating snowpack. Photo by Joe Zagrodnik.
(image source: https://earthobservatory.nasa.gov/blogs/fromthefield/category/olympex-2015/)

More information about the Pluvio400 gauge can be found at http://www.ott.com/en-us/products/meteorological-sensors-26/ott-pluvio2-weighing-rain-gauge-963/. More information about the accuracy of the Pluvio400 gauge can be found at Nemeth, 2008 and Tumbusch, 2003.

Investigators

Walter A. Petersen
NASA Marshall Space Flight Center
Huntsville, Alabama

Ali Tokay
NASA Goddard Space Flight Center
Greenbelt, Maryland

Patrick N. Gatlin
NASA Marshall Space Flight Center
Huntsville, Alabama

File Naming Convention

The GPM Ground Validation Pluvio Precipitation Gauges OLYMPEX dataset has four types of files. The file names have the following naming convention:

Pluvio Data files: olympex_pluvio400_apu##_YYYYMM_<filetype>.txt

Table 2: File naming convention variables

Variable	Description
olympex_pluvio400	OLYMPEX Pluvio400 instrument files
apu##	Site location (apu04, apu10, or apu30)
YYYY	Four-digit year
MM	Two-digit month
<filetype>	*data:* timestamp every 10 minutes to indicate instrument is operating *precip:* timestamp and four different precipitation rates reported when rain occurs. *preciprate:* precipitation rates in mm/min and mm/hr *preciptable:* list of precipitation event summaries
.txt	Tab delimited ASCII text file

Data Format Description

The GPM Ground Validation Pluvio Precipitation Gauges OLYMPEX data are available in ASCII-tsv format (tab separated data). The ASCII-tsv files are available at data processing level 3.

Table 3: Data Characteristics

Characteristic	Description
Platform	Ground stations
Instrument	Pluvio Precipitation Gauges
Spatial Coverage	N: 47.680, S: 47.389, E: -123.581, W: -123.867 (Olympic Mountains Washington)
Spatial Resolution	Point measurement
Temporal Coverage	Start date: October 31, 2015 Stop date: January 31, 2016
Temporal Resolution	1 month
Sampling Frequency	1 minute
Parameter	Precipitation rate, precipitation amount, precipitation events
Version	1
Processing Level	3

Data Parameters

The GPM Ground Validation Pluvio Precipitation Gauges OLYMPEX dataset consists of precipitation rate and precipitation amount measurements in ASCII-tsv format. There are four types of files available: data, precip, preciprate, and preciptable.

Data file type: The data files contain the timestamp of the data so the reader can distinguish whether or not the instrument was functioning in the other associated file types. Table 4 shows the description for each column of the data files.

Table 4: Column Descriptions for the data file type contents. Note that timestamps only exist in this file type when the instrument is operating.

Column	Description
1	Year
2	Day of the year
3	Hour
4	Minute

Precip file type: The precip file type contains the timestamp and four different precipitation rates only when any of the first three precipitation rates are above zero. These files do not contain any data if there is no precipitation to report. There is a five-minute delay in the record for the accumulated precipitation, however, since these precipitation accumulations are the most accurate observations, the timestamp has been adjusted to represent the time of precipitation occurrence correctly. The precipitation rates are from instrument manufacturer software output. Table 5 shows the description for each column value in these precip files.

Table 5: Column description for olympex_apu##_pluvio400_YYYYMM_precip.olympex files

Column	Description
1	Year
2	Day of the year
3	Hour
4	Minute
5	Real time precipitation intensity in mm per minute. Discrimination threshold is 0.1 mm/min or 6mm/hr. This measurement is considered suitable to determine the heavy precipitation for alarm management and is not meant to be used for daily and monthly totals.
6	Accumulated real time precipitation in mm/min that has equal to or larger than 0.1 mm/min precipitation, and non-real-time precipitation where the accumulation is less than 0.1 mm/min. Discrimination threshold is 0.1 mm within an hour. If the amount of precipitation exceeds the discrimination threshold of 0.1 mm/min, Pluvio outputs the measurement result in real-time; otherwise, it collects the fine precipitation over a maximum of an hour and outputs the measured value in non-real-time. If the fine precipitation does not reach the discrimination threshold within 1 hour, no precipitation measurement is recorded. This is value is considered particularly suitable for daily or monthly totals and for alarm management.
7	Accumulated non-real-time precipitation over the sampling interval with a fixed delay of 5 minutes. Discrimination threshold is 0.1 mm within 1 hour. If the amount of precipitation reaches the discrimination threshold within an hour, precipitation measurement is recorded with a 5-minute delay; otherwise, there is no output. This measurement is suitable for daily and monthly totals.
8	Accumulated total non-real-time precipitation since the Pluvio started operation with a fixed 5 minute delay. Discrimination threshold is 0.1 mm/hr. If the amount of precipitation reaches the discrimination threshold within an hour, Pluvio records the measurement with a 5-minute delay; otherwise, there is no output. No loss of collected precipitation amounts occurs and it is suitable for daily and monthly totals.

9	Real-time bucket content. The real-time bucket content is unfiltered and is related to the current bucket level. It is give in mm and is collected at one-minute intervals. Outputs have a value between 80-100 mm for an empty bucket, 610-630 mm for a 70% full bucket, and 830-850 mm for a 100% full bucket.
10	Non-real-time bucket content. The non-real-time bucket content is filtered and is suitable for determining the bucket level in calculating the evaporation. It is given in mm at one-minute intervals.

Preciprate file type: The preciprate type files contain the precipitation rate based on the accumulated total non-real-time precipitation measurements listed in column 8 of the precip files. Table 6 shows the descriptions for each column in the preciprate files.

Table 6: Column Descriptions of olympex_apu##_pluvio400_YYYYMM_preciprate.txt

Column	Description
1	Year
2	Day of the year
3	Hour
4	Minute
5	Precipitation rate in mm per minute
6	Precipitation rate in mm per hour

Preciptable file type: The preciptable type files provide the precipitation event summaries. The events are separated by one hour or longer rain-free periods. The time series contained in the precip data files are used to create the event summaries. Table 7 provides the descriptions for each column in these preciptable files.

Table 7: Column description for olympex_apu##_pluvio400_YYYYMM_.preciptable.txt

Column	Description
1	Year
2	Event start day of the year
3	Even start hour and minute
4	Event end day of the year
5	Event end hour and minute
6	Number of precipitation minutes
7	Event precipitation total based on the accumulated non-real-time precipitation (column 7) and accumulated total non-real-time precipitation measurements (column 8) values of the precip files.

Quality Assessment

When collecting measurements, there is a five-minute delay in the record for the accumulated precipitation. Given the fact that these precipitation accumulations are the most accurate observations, a timestamp adjustment has been applied to represent the precipitation data correctly. Also, discrimination threshold limit the measured precipitation. These discrimination values are listed in Table 5.

The measurement range of the Pluvio400 is from 0.1 mm/min to 30 mm/min. Rainfall intensity does not affect the instrument's measurement accuracy. More information about

the accuracy of the Pluvio400 instrument can be found at Nemeth, 2008 and Tumbusch, 2003. The positioning of the three OLYMPEX Pluvio instruments did not include the installation of wind fences or shields (Alter and Tretyakov) and due to the remote locations and very heavy snow rates, occasional swamping of the instruments by heavy snow, or prolonged non-operation periods did occur.

Software

No software is required to view GPM Ground Validation Pluvio Precipitation Gauges OLYMPEX files as these are ASCII-tsv files.

Known Issues or Missing Data

Pluvio400 at the apu04 site did not operate from December 15, 2015 through January 5, 2016.

References

M.L. Tumbusch (2003): Evaluation of OTT Pluvio Precipitation Gage versus Belfort Universal Precipitation Gage 5-780 for the National Atmospheric Deposition Program. USGS Water-Resources Investigations Report 03-4167 (https://pubs.usgs.gov/fs/fs07703/fs07703.pdf)

Nemeth, K. (2008). OTT Pluvio2: Weighing precipitation gauge and advances in precipitation measurement technology. OTT Messtechnik GmbH & Co. KG: Kempten, Germany (http://www.wmo.int/pages/prog/www/IMOP/publications/IOM-96_TECO-2008/P2(18)_Nemeth_Germany.pdf)

OLYMPEX Project Homepage (https://pmm.nasa.gov/olympex)

Related Data

All other data collected during the OLYMPEX field campaign are considered related datasets to this Pluvio dataset. Other OLYMPEX data can be located using the GHRC HyDRO search too with the search term OLYMPEX. In addition, the Pluvio was used for other GPM Ground Validation field campaigns. These other Pluvio datasets are listed below.

GPM Ground Validation Pluvio Precipitation Gauge GCPEx (http://dx.doi.org/10.5067/GPMGV/GCPEX/PLUVIO/DATA301)

GPM Ground Validation Pluvio Precipitation Gauge LPVEx (http://dx.doi.org/10.5067/GPMGV/LPVEX/PLUVIO/DATA301)

Contact Information

To order these data or for further information, please contact:
      NASA Global Hydrometeorology Resource Center DAAC

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

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