Global Hydrology Resource Center

Data User Guide

GPM Ground Validation Environment Canada (EC) Visibility Sensor FD12P C3VP

Introduction

The GPM Ground Validation (GV) Environment Canada (EC) Visibility Sensor FD12P C3VP dataset consists of visibility and precipitation data collected at the Environment Canada Canadian Climate station at the Centre for Atmospheric Research Experiments (CARE) site during the Canadian CloudSat/CALIPSO Validation Project (C3VP) field campaign. The campaign took place in southern Canada in support of multiple science missions, including the NASA GPM mission, in order to improve the modeling and remote sensing of winter precipitation. The GPM GV Visibility Sensor FD12P C3VP data are available from October 4, 2006 through March 31, 2007 in a Microsoft Excel comma-separated variable spreadsheet.

Citation

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Keywords:

NASA, GHRC, C3VP, EC, CARE, Microsoft Excel, visibility, precipitation

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 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 (Ground Validation) mission. More information about the

GPM mission is available on the Precipitation Measurement Mission (PMM) Ground Validation webpage.

The Canadian CloudSat/CALIPSO Validation Project (C3VP) was an collaborative international field campaign that took place in southern Canada during the 2006/2007 winter season. With the help of multiple organizations, including the NASA GPM and PMM science teams, the campaign used various ground-based and airborne instrumentation to thoroughly study cold season precipitation systems and therefore improve the modeling and remote sensing of snowfall. The campaign took place in the vicinity of the Centre for Atmospheric Research Experiments (CARE) in the Great Lakes region of Ontario, Canada (Figure 1). The site was operated by the Meteorological Service of Canada (MSC). The main objectives of the campaign were to capture more ground and airborne observations of winter precipitation, to validate data from the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO) and NASA CloudSat satellites, and to further improve the remote sensing and modeling of winter precipitation. More information about the C3VP field campaign is available on the NASA GPM C3VP webpage.

Figure 1: CARE facility located in the southern Canadian province of Ontario (left); CARE site in relation to NASA CloudSat overpasses (right)
(Image source: NASA GPM C3VP webpage)

Instrument Description

The Vaisala FD12P sensor, as described in the Vaisala user guide, measures precipitation intensity and type, as well as visibility, specifically the meteorological optical range (MOR). The MOR is the distance over which light emitted from a known source through the atmosphere is reduced to 5% of its original intensity. The visibility is measured using a forward scatter measurement. Light scatters from particles whose diameter in the order of magnitude of the light wavelength. The amount of scatter is proportional to the attenuation of the light beam. Meanwhile, larger particles are typically precipitation droplets. The FD12P detects these droplets from rapid signal changes and can then calculate the precipitation intensity by analyzing the amplitudes of these changes. The intensity estimate is proportional to the volume of the precipitation droplets. This optical signal can provide some information on precipitation type, but this is not considered appropriate enough for accurate identification. The FD12P uses a second measurement, the estimate of the water content of precipitation, to more accurately determine precipitation type. Overall, the FD12P sensor is capable of observing 11 different precipitation types. The water equivalent is equal to the volume in rain, while the optical volume is as much as 10 times larger than the water equivalent in snow. Lastly, the station reports 52 weather condition codes from the World Meteorological Organization code tables 4678 and 4680. Specifications of the FD12P sensor are given in Table 1, below.

Table 1: Vaisala FD12P Instrument Characteristics

Characteristic	Value
Instrument	Forward Scattering observations for visibility via the FDT12B transmitter and the FDR12 Receiver Rain detection via the DRD12 rain detector
Power Supply	115/230 V ±20 %, 50/60 Hz
Power Consumption	35 W + 100 W heating element
I/O Connections	RS-232, RS-485
Meteorological Optical Range (MOR) range	10 - 50,000 m
Visibility Consistency	±4%
Light Transmitter	Peak wavelength: 875 nm Modulation frequency: 2.3 kHz
Light Receiver	Spectral response: max responsivity at 850 nm, 0.55 A/W (in range 550 - 1050 nm over 0.3 A/W)
Precipitation Detection	Above 0.05 mm/hr, within 10 minutes
Precipitation Intensity	Range 0.00 - 999 mm/hr
Operating Temperature	-40 - +55°C
Operating Humidity	Up to 100% relative humidity

Figure 2: A Vaisala FD12P observation station.
(Image source:Vaisala FD12P instrument overview)

Investigators

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Data Characteristics

The GPM Ground Validation Environment Canada (EC) Visibility Sensor FD12P C3VP dataset files are stored in Microsoft Excel in a comma-separated variable (csv) format. These data are available at a Level 2 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 1 below.

Table 1: Data Characteristics

Characteristic	Description
Platform	Environment Canada (EC) Surface Meteorological Station
Instrument	Vaisala FD12P Visibility Sensor

Spatial Coverage	N: 44.242, S: 44.222, E: -79.772, W: -79.791 (Southern Ontario, Canada)
Spatial Resolution	Point
Temporal Coverage	October 4, 2006 - March 31, 2007
Temporal Resolution	1 min
Sampling Frequency	15 s
Parameter	Visibility, precipitation, precipitation type
Version	1
Processing Level	2

File Naming Convention

The GPM Ground Validation Environment Canada (EC) Visibility Sensor FD12P C3VP dataset file is stored in Microsoft Excel in a comma-separated variable (csv) format and named used the following convention:

Data file: c3vp_FD12P.csv

Table 2: File naming convention variables

Variable	Description
.csv	Microsoft (MS) Excel comma-separated variable format

Data Format and Parameters

The GPM Ground Validation Environment Canada (EC) Visibility Sensor FD12P C3VP dataset file is stored in Microsoft Excel comma-separated variable (csv) format.
The single document has 14 columns of data for the entire period of record. The details are provided in Table 3, below.

Table 3: Data Fields

Field Name	Description	Unit
SEA_FILEROOT		-
ISO8601	Time	-
SYSTIME		s
TYPE		
ID		
STATUS		
VIS_1MIN_AVG_M	Meteorological optical range averaged over 1 minute	m
VIS_10MIN_AVG_M	Meteorological optical range averaged over 10 minutes	m
WX_NWS_CODE		
WX_INSTANT_CODE		
WX_15MIN_CODE		
WX_1HR_CODE		
PRECIP_MM_PER_H	Precipitation rate	mm/hr

Commented [1]: Search documents for descriptions

Commented [2]: Just about everything is in the user guide, except for an explanation of the output.

Commented [3]: You may want to reach out to Peter asking him for descriptions on these variables. His email is peter.rodriguez@canada.ca

Commented [4]: Got it! Thanks!

CUMM_WATER_MM	Cumulative amount of precipitation for the event	mm

Algorithm

The Meteorological Optical Range (MOR), used for visibility, is obtained by measuring the intensity of infrared light scattered at an angle of 33 degrees. This angle is used as the light scattered produces a stable response in various types of natural fog and precipitation droplets will scatter light in a different manner, which requires a separate analysis. For visibility, the analysis calculates the difference of the measurement signal and offset averages for the visibility algorithm. The difference value, or frequency, is given as a parameter to a calibrated transfer function. This is then converted into MOR. One hertz provides a signal conversion to 4500 m visibility. The instrument averages the 15 s visibility values to get one- and ten- minute averages. For signals less than 0.23 Hz (visibility over 15 km), the instrument performs extra filtering in the one-minute average MOR values. As such, the instantaneous values have decreasing weight in the averaged MOR as the signal gets lower.

The FD12P instrument detects precipitation onset from measuring the signal peaks from precipitation droplets. These peak amplitudes are summed over 10 minutes. Once this summed value exceeds a threshold, the FD12P indicates precipitation. The end of precipitation occurs when the summed optical signal amplitude decreases below a lower threshold value. The precipitation ending detection will often occur within a few minutes, but could take up to 10 minutes in low intensity precipitation.

For precipitation intensity, particularly for rain, the precipitation particle is proportional to the volume of the particle. The precipitation intensity is then calculated from the distribution data of signal change, which is then scaled by multiplying with the rain intensity scale. The DRD12 instrument is also used to observe precipitation intensity. For liquid precipitation, a low and high pass filters are applied on one-second samples. In snow, the DRD12 intensity is proportional to the water content of the snow. This is noted as being lower than the real water content due to an undercatching of snow.

Precipitation accumulation is the accumulation of water, or water content for frozen precipitation. The FD12P instrument resets at 99 mm for rain and 999 mm for snow. For rain, the optical intensity values are directly scaled to sum increments and added to the running total. An internal scaling factor is used for non-rain precipitation. Snow accumulation follows a similar approach, but this is only a course estimate.

The FD12P precipitation type is derived from the ratio of the optical intensity and the DRD12 intensity estimates. Temperature observations are used to discriminate between rain and snow events. Further limits in the derived ratio are used to further discern snow versus hail as well as mixed precipitation.

In cases without precipitation, the weather type is derived from visibility. The FD12P splits this into fog and haze/mist. Fog is reported when the visibility is less than 1 km over a 10 minute average. A fog trend is derived from the one-hour data. This trend uses the change in the average of the latest and earliest 20 minutes of data. Haze/mist is observed when the estimated relative humidity is low and the 10-minute averaged visibility is less than the haze limit. Meanwhile, if the relative humidity is high, mist is used instead of high. Smoke/dust/sand is observed if the estimated humidity is low and the visibility is less than 1000 m. When the visibility is above the haze limit, the conditions are clear.

For the FD12P weather classes, these are divided into continuous, showers, or intermittent. Continuous is used when there are less than two clear periods in the previous hour. Showers and intermittent are used when there are more than two clear periods in the previous hour.

Lastly, the FD12P provides a weather code observation. These use the World Meteorological Organization code tables 4678 and 4680. Additionally, the full list of codes used is in Appendix A, page 143, of the Vaisala user guide. The weather type is selected every 15 seconds derived from the above observations. The instantaneous weather type comes from the current 15-second observation.

More information can be found in the Vaisala user guide.

Quality Assessment

The Vaisala FD12P instrument system utilizes several built-in tests for quality assessment. The system checks for voltage limits and optical contamination for the transmitter and receiver. If hardware failure is suspected, visibility data are not output and a ///// is substituted. A corresponding status is listed in the status bits and the analog output is set to zero.

Software

No special software is required to view the Microsoft Excel Spreadsheets.

Known Issues or Missing Data

The file starts on October 4, 2006, but no data are recorded until October 6, 2006. There are minor outages (no more than 5-10 minutes) throughout the file. However, there are significant gaps in data between:

- 10/6/2006 at 23:34 - 10/12/2006 at 16:02
- 10/19/2006 at 14:59 - 10/19/2006 at 16:15
- 10/19/2006 at 17:31 - 10/19/2006 at 18:37
- 10/31/2006 at 17:24 - 10/31/2006 at 18:25
- 11/2/2006 at 4:15 - 11/2/2006 at 16:44
- 1/18/2007 at 16:57 - 1/18/2007 at 17:26
- 3/5/2007 at 15:06 - 3/6/2007 at 17:05

References

Vaisala (2002). Weather Sensor FD12P User's Guide.
https://www.vaisala.com/sites/default/files/documents/FD12P%20User%20Guide%20in%20English.pdf

Petersen, W. A., D. Hudak, V. N. Bringi, P. Siqueira, A. Tokay, V. Chandrasekar, L. F. Bliven, R. Cifelli, T. Lang, S. Rutledge, G. Skofronick-Jackson, and M. Schwaller, 2007. NASA GPM/PMM Participation in the Canadian Cloudsat/CALIPSO Validation Project (C3VP): Physical process studies in snow. *33rd Intl. Conf. on Radar Met.* Amer. Meteor. Soc., Cairns, Australia. 6-10 August 2007. P12A.8.
https://radarmet.atmos.colostate.edu/c3vp/petersenetal_C3VP.pdf

Related Data

Data collected from other instruments during the C3VP field campaign are considered to be related datasets. These data can be located by searching 'C3VP' in the GHRC HyDRO 2.0 search tool. Listed below are datasets from other field campaigns and studies that used the Vaisala FD12P instrument:

GCPEX GPM Ground Validation Environment Canada Visibility Sensor FD12P
http://dx.doi.org/10.5067/GPMGV/GCPEX/FD12P/DATA201

Contact Information

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

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