BRCCC PROGRAMME

Programme for Building Regional Climate Capacity in the Caribbean

The Caribbean Institute for Meteorology and Hydrology

Satellite Data Training Workshop

Husbands, St. James
Barbados

May 3 – 6, 2016

REPORT

In partnership with

The Cooperative Institute for Research in the Atmosphere (CIRA), Colorado State University (CSU)

Objective: To build capacity in the Caribbean region for the utilization of remote sensing data in climate monitoring.

1. Introduction

1.1 Delivery of Training

Training on satellite data was both via presentations as well as hands on. Participants were provided with data and training manuals. The training manuals also contained instructions on how to download various forms of satellite data. There are several types of satellite data available. For the purpose of this workshop the data sets and products explored were:

- Climate Hazards group Infra-Red Precipitation with Stations, CHIRPS
- IMERG
- Optimum Interpolation Sea Surface Temperature, OISST v2
- NOAA/NESDIS Hydro-Estimator
- University of Delaware Air Temperature Dataset
- Derived Normal Difference Vegetation Index
- RGB Composite images

Training was conducted by experts from the Cooperative Institute for Research in the Atmosphere (CIRA), Colorado State University (CSU), Bernadette Connell and Erin Dagg.

1.2 Participants

Participants to the workshop were from National Meteorological and Hydrological Services across the Caribbean as well as from CIMH (see Appendix I).

1.3 Software

The software used in the training was McIDAs-V, a free open source software for 3D geophysical data analysis and visualization. It is easy to install and reads in and displays multiple types of data and imagery. The software allows the users to perform functions such as:

i. Data querying
ii. Viewing in different projections and area coverage
iii. Viewing layers of imager and data
iv. Performing calculations
v. Manipulating and combining imagery
vi. Looping imagery
vii. Adding text
viii. Outputing values to a file
ix. Outputing .gif or .jpeg files

2. Summary of Presentations

Presentations of types of satellites and satellite data were given by Bernadette Connell of CIRA CSU.

2.1 Satellites (GOES and POES) Overview

Dr. Connell gave an overview of two satellites; the GOES (Goestationary Operational Environmental Satellite) and the POES (Polar-orbiting Operational Environmental Satellite). The GOES follows a geo-synchronous orbit, 35,800 km above the earth whereas the POES follows a sun-synchronous orbit approximately 450-850 km above the earth.

The GOES satellite observes events and their evolution. It provides a full earth disk every three hours with a resolution of 1 km (visible), 4km (infrared) and 10km (sounder). The GOES is excellent in viewing the tropics providing the same viewing angle for a fixed point.

The POES satellite observes events at fixed and infrequent times and has a global coverage. The resolution is of 0.375-1 km (visible and infrared), 10-15 km (microwave) and 20 km (infrared).This satellite provides excellent viewing of all latitudes with a varying viewing angle.

2.2 CHIRPS

CHIRPS (Climate Hazards group Infra-Red Precipitation with Stations) is a combination of satellite and station data. Its evolution began as IR (InfraRed) Precipitation (IRP) data, which was then combined with TRMM (Tropical Rainfall Measuring Mission) precipitation data to produce the IRP (Infra-Red Precipitation). This was combined with Climate Hazards Precipitation Climatology (CHPClim), which included combined satellite observations, average station precipitation and rainfall predictors to produce the product CHIRP (Climate Hazards group Infra-Red Precipitation). The final addition was the inclusion of station data, thus the **C**limate **H**azards group **I**nfra-**R**ed **P**recipitation with **S**tations.

2.3 IMERG

The IMERG (**I**ntegrated **M**ulti-satellit**E** **R**etrievals for **G**PM[1]) is the unified algorithm that provides the multi-satellite precipitation product for the U.S. Global Precipitation Measurement (GPM) team. Sensors contributing to the IMERG product include:

From Low Earth Orbiting Satellites (LEO)(includes POES):

i. Active radar

ii. Passive microwave imagers

iii. Passive microwave sounders from Polar Orbiting Satellites

From both Geostationary Satellites and LEO:

iv. Infrared imagers

v. Infrared sounders

Surface based analysis:

vi. Precipitation gauge analyses

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1 Global Prediction Model

2.4 Rainfall Estimator (Bob Kuligowski, NOAA NESDIS)

In this virtual presentation Dr. Kuligowski described some algorithms used for estimating rainfall. These algorithms are based on assumptions. For example, the infrared algorithm assumes that the cloud top temperature is related to the cloud top height and that the cloud top height is related to the strength of the updraft. This type of algorithm does not work well for stratiform and cirrus type clouds. With respect to passive microwave algorithms they are poor at detecting precipitation in clouds with little or no ice. The promising way forward in obtaining precipitation data is to combine the two types of algorithms as precipitation can be derived from data in infrared or microwave portions of the spectrum.

The rainfall Hydro-Estimator (HE) compares precipitation values to that of the local averages and makes adjustments using the Numerical Weather Prediction (NWM) data. The current operational NESDIS (National Environmental Satellite, Data and Information Service) algorithm rainfall HE uses a single infrared channel. However, this will be replaced by a multispectral algorithm for GOES-R.

2.5 Blended Satellite Tool (Daniel Vila, INPE, Brazil)

In this virtual presentation Dr. Vila demonstrated the INPE/WMO Pilot Project: Sustained Coordinated Processing of Environmental Satellite Records for Nowcasting (SCOPE – Nowcasting). This is a blended satellite tool, which uses information from NESDIS. This tool provides a reliable source for global rainfall accumulation at the highest possible temporal and spatial resolution (global hydro-estimator); 1-hour accumulations with a 4 km spatial resolution; short-term forecast; 1 to 3 hour forecast; and blended near real time rainfall product. Access to this tool is web-based (available for free) and it has the capability for interactive use for emergency managers and civil defence authorities. There is also the ability to integrate additional products into the portal; such as for flash flood guidance.

2.6 NDVI (Bernadette Connell, CIRA CSU)

The Normalized Difference Vegetation Index (NDVI) is a simple formula which recognizes the difference in reflected solar light between two channels (near infrared and visible) and is used to determine areas of healthy/poor vegetation. For example, grass appears dark in the visible channel and lighter in the near infrared whereas water has very little reflectivity across the spectrum. Healthy grass will have a NDVI value of ~0.5, whereas water will have an NDVI value less than 0.1

2.7 Climate Products (Adrian Trotman, CIMH)

In his presentation Mr. Trotman stated that the aim of the workshop was to enhance national and regional products for climate services. One of the main aims of the workshop is to plug many of the special data gaps across the Caribbean including southern parts of Guyana and over the Caribbean sea. There are also missing months and years in the data sets of stations.

The CHIRPS data product gives an idea of how useful the merging of data could be to provide a secondary product.

2.8 GEONetCast (Kathy-Ann Caesar, CIMH)

GEONETCast is a global network of satellite-based data dissemination systems providing environmental data to a world-wide user community. There are five GEONETCast regions, Europe, China, Africa, the Americas and Japan. The aim of GEONETCast is to provide global information as a basis for sound decision making in a number of critical areas including public health, energy, agriculture, weather, climate, water, natural disasters and ecosystems. CIMH receives a GEONetCast feed.

2.9 Rainfall Estimator (Sabu Best, Barbados Meteorological Service)

Mr. Best gave a demonstration of a rainfall estimator at the Barbados Meteorological Service called SPIE (Satellite Precipitation Instantaneous Estimates). The SPIE compares well with actual radar products and it is also good at identifying spiral bands and locating the centre of a vortex. The drawback of the SPIE (channel 1) is that it is only available with visible light where best viewing is between 9 a.m. and 4 p.m. Channel 2 is available 24 hours in both infrared and near infrared channels and uses successful cloud "face" recognition algorithm. The disadvantage of channel 2 is that it runs in full view mode and products are received every 30 minutes and precipitation is over estimated by 10-15 per cent.

2.10 Validation of Data (Tarick Hosein, CIMH)

In going forward models need to be validated (bias corrections and correlations) and the pool of observational data needs to be increased. This is particularly important in the Caribbean, where most of our measurements represent discrete points over small land masses, with the wider ocean body unmeasured. The validation of precipitation data, as compared to temperature, is complicated by less measuring stations for an entity with greater geospatial and temporal variability.

In going forward GIS training is essential as GEONETCast products present an opportunity for greater access to data, integration and use in GIS and subsequent geospatial decisions. GIS training is slated for later in the year under the BRCCC programme.

3. Lab Exercises

Lab exercises were led by Ms Erin Dagg (CSU). Participants were given the opportunity to import and manipulate the presented satellite data sets in the McIDAs-V program. They were able also to compare satellite data to station data.

'Exercises focusing on temperature and precipitation gave participants practice loading and displaying various file formats, including real-time data. Formulas were applied to calculate both sums and long-term averages.' Exercises with NDVI and volcanic ash involved viewing data in different spectrums to identify poor vegetation or volcanic ash.

Participants had to familiarize themselves with the program, which was fairly easy to manipulate and no major issues of software manipulation were highlighted. The main challenge with the software was the large requirement of memory which at times caused systems to run slowly or abort.

4. Open Discussion

There was an open discussion in which participants made comments and also asked questions. Below is a compilation of comments and questions with responses.

Are there any recommendations with respect to data sets that can be pursued for drought?

- (Dr Connell) There are three data sets that can be combined to tackle drought, the Vegetation Health Index (VHI), precipitation and temperature. A decrease in precipitation and an increase in temperature would give rise to a (lagged) decrease in VHI.

- (Mr. Trotman) If we transform precipitation into the Standardized Precipitation Index (SPI) then we could eliminate the lag.

Mr. Trotman to Guyana Participants: Would this workshop assist in gathering information for southern Guyana?

- We have been checking the observed data with satellite images with respect to vegetation health. The comparisons were good in some parts. Now in a better position to monitor.

Mr. Trotman to Guyana Participants: What are your thoughts on CHIRPS?

- There is some possibility in using blended satellite products (not specifically CHIRPS)

Dr. Van Meerbeeck, CIMH: It would be good to obtain seasonal averages of temperatures.

- (Dr Connell) The 2-meter temperature used in lab exercises is surface based and of high quality. Satellite measurements are of "skin" surface temperature and pose challenges because of non-uniform emissivity of land surfaces, moisture in the column of air above the air, and clouds blocking what the satellite senses at the surface. For a realistic surface temperature, all 3 of these factors have to be accounted for. In order to match the skin value with the 2-meter temperature, as assumption of the atmospheric conditions between the surface and 2 m must be made. She recommends using 2-meter air temperature because of the high quality, but the challenge is the latency of this data (data from 2015 was not yet available for use at the workshop).

Mr Fimber Frank from Grenada Meteorological Service likes the McIDAs-V tool and asked whether the software can be merged with models to be used as a guide going forward.

- (Dr Connell) McIDAs-V can read in model data in different formats

3. Summary

After being exposed to different types of satellite data and understanding how they can be used, the next step would be to be able to validate any information one would generate. Mr Hosein suggested in his presentation that GIS integration would be the next focus. Participants showed interest in obtaining basic GIS skills. One participant even suggested that it would be good to have a specialist in each country who would then train the locals.

Certificates of participation were distributed to the participants.

Appendix I: Participant List

	Name		Affiliation
1.	Meade	Keithly	Antigua & Barbuda Meteorological Service
2.	Alexander	Marshall	Dominica Meteorological Service
3.	Frank	Fimber	Grenada Meteorological Service
4.	David	Donessa	Guyana HydroMeteorological Service
5.	Alves	Lyndon	Guyana HydroMeteorological Service
6.	Burke	Elmo	St Kitts & Nevis Meteorological Service
7.	Joyeux	Andre	St Lucia Meteorological Service
8.	Jeffers	Billy	St Vincent & The Grenadines Meteorological Service
9.	Rudon	Derrick	Belize HydroMeteorological Meteorological Service
10.	Jehu	Adam	Trinidad & Tobago Meteorological Service
11.	Moody	Ronald	Jamaica Meteorological Service
12.	Connell	Bernadette	Colorado State University
13.	Dagg	Erin	Colorado State University
14.	Trotman	Adrian	Caribbean Institute for Meteorology and Hydrology
15.	Niles	Grahame	Caribbean Institute for Meteorology and Hydrology
16.	Stoute	Shontelle	Caribbean Institute for Meteorology and Hydrology
17.	Hosein	Tarick	Caribbean Institute for Meteorology and Hydrology
18.	Moore	Anthony	Caribbean Institute for Meteorology and Hydrology
19.	Kirton-Reed	Lisa	Caribbean Institute for Meteorology and Hydrology
20.	Van Meerbeeck	Cedric	Caribbean Institute for Meteorology and Hydrology
21.	Scott	Wazita	Caribbean Institute for Meteorology and Hydrology
22.	Forde	Courtney	Caribbean Institute for Meteorology and Hydrology
23.	Boyce	Shawn	Caribbean Institute for Meteorology and Hydrology
24.	Reyes	Ashford	Caribbean Institute for Meteorology and Hydrology
25.	Caesar	Kathy-Ann	Caribbean Institute for Meteorology and Hydrology
26.	Polonge	Lawrence	Caribbean Institute for Meteorology and Hydrology