Weather from 250 Miles Up:
Visualizing Precipitation Satellite Data (and Other Weather Applications) using CesiumJS

August 16, 2017

Matt Lammers (matthew.r.lammers@nasa.gov)
Senior Science Data Visualization Analyst/Software Engineer
Who Am I?

I maintain the STORM data portal for Global Precipitation Measurement (GPM) Mission satellite data at NASA Goddard.
Who Am I?

I maintain the STORM data portal for Global Precipitation Measurement (GPM) Mission satellite data at NASA Goddard.

Before this I worked at MesoWest (University of Utah) building APIs and visualizations using surface weather observations.
Who Am I?

I maintain the STORM data portal for Global Precipitation Measurement (GPM) Mission satellite data at NASA Goddard.

Before this I worked at MesoWest (University of Utah) building APIs and visualizations using surface weather observations.
What Data Do I Use?

HDF5 files from low-Earth orbit microwave imager/sounders and radars
What Data Do I Use?

HDF5 files from low-Earth orbit microwave imager/sounders and radars

Most of the time, the data are stored by the swath
What Data Do I Use?

HDF5 files from low-Earth orbit microwave imager/sounders and radars

Most of the time, the data are stored by the swath

Sometimes it’s on a latitude-longitude grid
What Data Do I Use?

Variables include brightness temperature, reflectivity, precipitation phase, and precipitation rate.

Some demos I will be showing also include model output of wind speed and reflectivity, as well as modeled tracers of air quality.
What Tool Do I Use?

CesiumJS!

Source: The East Japan Earthquake Archive
What Tool Do I Use?

CesiumJS!
What Tool Do I Use?

CesiumJS!
When I came to NASA, project scientists were making decisions about data acquisition based on static images.
Files could be ingested into THOR data viewer tool, but visualization was limited to two dimensions.

With Near Real Time data, they had no ability to preview files.
What Motivates This Work?

One day, I saw this demo in the Cesium showcase…
If Cesium could handle weather model data like that, I could use the same principles to display precipitation satellite information.
What Motivates This Work?

One approach is to use image tiles, which remains 2D, but can still be placed on a 3D globe.
So where did I start? Near Real Time Data…

https://storm.pps.eosdis.nasa.gov/storm/cesium/GPMNRTView.html
GPM Near Real Time Viewer
GPM Near Real Time Viewer
- Post-Processed HDF5 into CZML (Cesium Markup Language), storing a rolling 24 hours of data
- Post-Processed HDF5 into CZML (Cesium Markup Language), storing a rolling 24 hours of data

- Each 5-/6-minute segment is stored as a series of points that are time dynamic. Cesium interpolates between the points and colors to present smooth transitions.
- Post-Processed HDF5 into CZML (Cesium Markup Language), storing a rolling 24 hours of data

- Each 5-/6-minute segment is stored as a series of points that are time dynamic. Cesium interpolates between the points and colors to present smooth transitions.

- Each scan time, the point positions/colors are dumped out and stored as the satellite and time dynamic points move forward. These dumped points are erased after 15 minutes of scan.
GPM Near Real Time Viewer

A close-up to illustrate how this process works…
Moving on to “production” data, and STORM Virtual Globe

https://storm.pps.eosdis.nasa.gov/storm/data/Service.jsp?serviceName=Order
STORM Virtual Globe

BEFORE:
STORM Virtual Globe

AFTER:
STORM Virtual Globe

29 Products Available
- AJAX Request sent to Java Apache Tomcat server, which pulls in the HDF5 file

- Java code converts the relevant data to JSON

- JavaScript parses the JSON and loops through it, generating CesiumJS PointPrimitives
- AJAX Request sent to Java Apache Tomcat server, which pulls in the HDF5 file

- Java code converts the relevant data to JSON

- JavaScript parses the JSON and loops through it, generating CesiumJS PointPrimitives

- Gridded, swath, and 3D data are all treated the same
- AJAX Request sent to Java Apache Tomcat server, which pulls in the HDF5 file

- Java code converts the relevant data to JSON

- JavaScript parses the JSON and loops through it, generating CesiumJS PointPrimitives

- Gridded, swath, and 3D data are all treated the same

- Only 15 minutes of swath data allowed at a time to avoid overloading Cesium
### STORM Virtual Globe

#### Required for Order Submission

Left click on the header to sort columns. Right click to view additional info (file name, satellite, instrument, format and version).

<table>
<thead>
<tr>
<th>Select</th>
<th>Data Type</th>
<th>Algorithm</th>
<th>Download / View</th>
<th>Start Time</th>
<th>Stop Time</th>
<th>Orbit #</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2A</td>
<td>2AGPROFAMS</td>
<td>![Icon]</td>
<td>2017-08-01 02:44:36</td>
<td>2017-08-01 04:23:28</td>
<td>27692</td>
<td>hdf5</td>
</tr>
<tr>
<td></td>
<td>2A</td>
<td>2AGPROFAMS</td>
<td>![Icon]</td>
<td>2017-08-01 04:23:29</td>
<td>2017-08-01 06:02:21</td>
<td>27683</td>
<td>hdf5</td>
</tr>
<tr>
<td></td>
<td>2A</td>
<td>2AGPROFAMS</td>
<td>![Icon]</td>
<td>2017-08-01 15:55:40</td>
<td>2017-08-01 17:34:32</td>
<td>27700</td>
<td>hdf5</td>
</tr>
<tr>
<td></td>
<td>2A</td>
<td>2AGPROFAMS</td>
<td>![Icon]</td>
<td>2017-08-02 02:27:32</td>
<td>2017-08-02 04:06:44</td>
<td>27707</td>
<td>hdf5</td>
</tr>
<tr>
<td></td>
<td>2A</td>
<td>2AGPROFAMS</td>
<td>![Icon]</td>
<td>2017-08-02 16:38:56</td>
<td>2017-08-02 18:17:48</td>
<td>27710</td>
<td>hdf5</td>
</tr>
<tr>
<td></td>
<td>2A</td>
<td>2AGPROFAMS</td>
<td>![Icon]</td>
<td>2017-08-03 02:32:14</td>
<td>2017-08-03 04:11:06</td>
<td>27711</td>
<td>hdf5</td>
</tr>
<tr>
<td></td>
<td>2A</td>
<td>2AGPROFAMS</td>
<td>![Icon]</td>
<td>2017-08-03 04:11:07</td>
<td>2017-08-03 05:50:00</td>
<td>27703</td>
<td>hdf5</td>
</tr>
<tr>
<td></td>
<td>2A</td>
<td>2AGPROFAMS</td>
<td>![Icon]</td>
<td>2017-08-03 15:43:19</td>
<td>2017-08-03 17:22:11</td>
<td>27704</td>
<td>hdf5</td>
</tr>
<tr>
<td></td>
<td>2A</td>
<td>2AGPROFAMS</td>
<td>![Icon]</td>
<td>2017-08-04 03:10:30</td>
<td>2017-08-04 04:46:23</td>
<td>27706</td>
<td>hdf5</td>
</tr>
<tr>
<td></td>
<td>2A</td>
<td>2AGPROFAMS</td>
<td>![Icon]</td>
<td>2017-08-04 14:47:42</td>
<td>2017-08-04 16:26:34</td>
<td>27707</td>
<td>hdf5</td>
</tr>
<tr>
<td></td>
<td>2A</td>
<td>2AGPROFAMS</td>
<td>![Icon]</td>
<td>2017-08-04 16:26:35</td>
<td>2017-08-04 18:05:27</td>
<td>27708</td>
<td>hdf5</td>
</tr>
<tr>
<td></td>
<td>2A</td>
<td>2AGPROFAMS</td>
<td>![Icon]</td>
<td>2017-08-05 03:58:46</td>
<td>2017-08-05 05:37:38</td>
<td>27709</td>
<td>hdf5</td>
</tr>
<tr>
<td></td>
<td>2A</td>
<td>2AGPROFAMS</td>
<td>![Icon]</td>
<td>2017-08-05 15:30:58</td>
<td>2017-08-05 17:09:50</td>
<td>27710</td>
<td>hdf5</td>
</tr>
<tr>
<td></td>
<td>2A</td>
<td>2AGPROFAMS</td>
<td>![Icon]</td>
<td>2017-08-05 03:03:09</td>
<td>2017-08-05 04:42:01</td>
<td>27711</td>
<td>hdf5</td>
</tr>
<tr>
<td></td>
<td>2A</td>
<td>2AGPROFAMS</td>
<td>![Icon]</td>
<td>2017-08-06 14:35:21</td>
<td>2017-08-06 16:14:13</td>
<td>27712</td>
<td>hdf5</td>
</tr>
</tbody>
</table>

**Total Granules selected:** 0

Records from 1 to 16 of 23

---

**SECURITY**

NASA / PPS may provide links to Web pages that are not part of the NASA Web family or nasa.gov domain. These sites are managed by organizations, companies, or individuals and not under NASA control, and NASA is not responsible for the information or links you may find there. NASA provides links to these sites merely as a convenience. NASA is not responsible for the information collection practices of non-NASA sites. Once you link to another site, you are subject to the privacy policy of the new site, and you should read that site's policies on privacy and information collection.

---

Curator: Matthew Lammers  
Last Updated: 8/18/2015

---

*Privacy Policy and Important Notices*  

---

Lammers – Page 32  
FOSS4G 2017  
August 14-19, 2017
What about really important, high impact events?
https://storm.pps.eosdis.nasa.gov/storm/cesium/EventViewer.html
STORM Event Viewer

With tens of thousands of GPM orbits, isolating the ones that contain high-impact events is a priority.
Three ways “Events” get selected:
Three ways “Events” get selected:

- I performed a massive survey collocating GPM overflights with tropical cyclones
Three ways “Events” get selected:

- I performed a massive survey collocating GPM overflights with tropical cyclones

- I see events occurring in the NRT Viewer and isolate them for preservation in the Event Viewer
STORM Event Viewer

Three ways “Events” get selected:

- I performed a massive survey collocating GPM overflights with tropical cyclones

- I see events occurring in the NRT Viewer and isolate them for preservation in the Event Viewer

- A researcher or project member requests a specific case get highlighted for a press release or to feature in a presentation
STORM Event Viewer

Latest Event: Hurricane Franklin 8/9/17

Approaching hurricane force, Franklin has sustained winds around 60 knots near the center, as observed by the Hurricane Hunters. The storm appears loosed, with dry air impinging on the northeastern side, while the southeastern side features intense rainfall, observed by GMI. DPR shows a tall cell (above 10km) in the eye wall, with deep convection in outer bands as well. The storm is expected to continue intensifying into a Category 1 storm before it makes landfall on the Mexican coast less than 24 hours from now.

Want to see other events in STORM Event Viewer? Have questions about the technology behind it?

Curator: Matt Lammers
NASA Official: Erich Stocker
STORM Event Viewer

Mobile Version (EVMini) and Embeddable Version (EVMicro)


moved from Mexico’s Yucatan Peninsula into the southwestern Gulf of Mexico’s Bay of Campeche. GPM’s Microwave Imager (GMI) and Dual-Frequency Precipitation Radar (DPR) data showed that Franklin contained a few heavy bands of convective rainfall. GPM’s DPR found rain falling at a rate of over rain 2.4 inches (62 mm) per hour in bands of intense storms moving around the southwestern side of the storm.
Other Demos

Where else has this CesiumJS journey taken me?
Other Demos

High-Resolution Weather Model Output

https://storm.pps.eosdis.nasa.gov/storm/cesium/HWRF.html
Other Demos

Generating Videos from Gridded Data and Previewing Them on the Globe

https://storm.pps.eosdis.nasa.gov/storm/cesium/VidTest.html
Other Demos

Animating Modeled Particle Transport
This is just scraping the surface of what can be done with remote sensing and other atmospheric data in CesiumJS. It is on this generation (and future generations) of researchers to leverage innovative tools to make scientific investigation easier to perform and results easier to share online with colleagues and the public.
…THANK YOU!

matthew.r.lammers@nasa.gov
Oh Yeah!

Demos and Discussions
Tomorrow (Thursday) at Noon at the CesiumJS Booth
…THANK YOU!

matthew.r.lammers@nasa.gov
Extra Slides…
Who Am I?

Then, I saw weather from the ground

[Image: Clouds over a landscape, with attribution to Taken byfir0002 | flagstaffotos.com.auCanon 20D + Canon 17-40mm f/4 L - Own work, GFDL 1.2, https://commons.wikimedia.org/w/index.php?curid=893031]
Who Am I?

Now, I see it from space
Other Demos

High-Resolution Weather Model Output
https://storm.pps.eosdis.nasa.gov/storm/cesium/HWRF_v2.html