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

August 16, 2017

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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.
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What Data Do I Use?

HDF5 files from low-Earth orbit microwave imager/sounders and radars
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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
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What Motivates This Work?

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.
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
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- Post-Processed HDF5 into CZML (Cesium Markup Language), storing a rolling 24 hours of data
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- 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.
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- 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:
AFTER:

STORM Virtual Globe

[Image of STORM Virtual Globe interface]
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
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- 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

#### Search Results

**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).

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<th>Algorithm</th>
<th>Download / View</th>
<th>Start Time</th>
<th>Stop Time</th>
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Total Granules selected: 0

1 1 2 Records from 1 to 16 of 23

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**Number of granules 23**

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**Privacy Policy and Important Notices**

Curator: Matthew Lammers  
Last Updated: 8/18/2015
STORM Event Viewer

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:
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- I performed a massive survey collocating GPM overflights with tropical cyclones
STORM Event Viewer

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- 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
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- 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
Latest Event: Hurricane Franklin 8/9/17

Franklin 2017080900
Approaching hurricane force, Franklin has sustained winds around 80 knots near the center, as observed by the Hurricane Hunters. The storm appears upsidedown, with dry air impinging on the northwestern side, while the southeastern side features intense rainfall, observed by GMI. DPR shows a tall cell above 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?

The Dual-frequency Precipitation Radar and GPM Microwave Imager data are products of a joint mission between NASA and JAXA. If you are interested in the data, it is accessible through the MISSION ordering interface.

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

Mobile Version (EVMini) and Embeddable Version (EVMicro)


This 3-D view of tropical storm Franklin was derived from GPM's Radar (DPR Ku)
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

By Taken byfir0002 | flagstaffotos.com.au
Canon 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