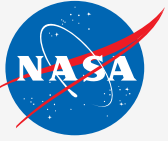




National Aeronautics and
Space Administration



ARSET

Applied Remote Sensing Training

<http://arset.gsfc.nasa.gov>

 @NASAARSET

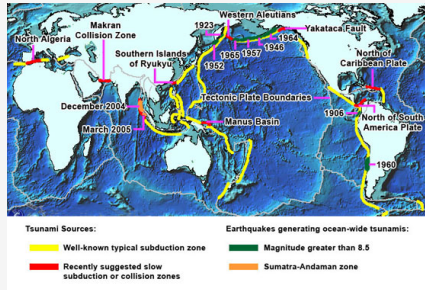
Introduction to Remote Sensing for Disaster Management

Week 4

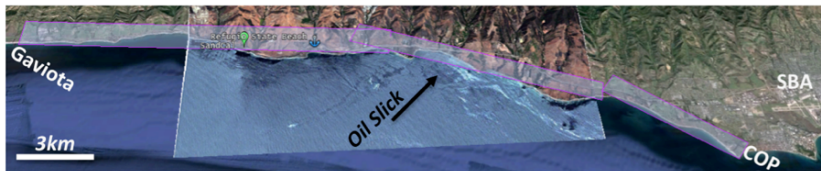
Monitoring Landslides, Storms, and Floods Using Remote
Sensing Observations

Course Outline

Week 1: Monitoring Earthquakes, and Tsunamis Using NASA Remote Sensing and Models



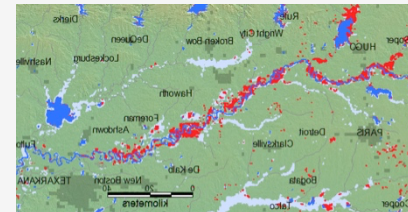
Week 3: Observation of Oil Spills Using Remote Sensing Measurements



Week 2: Overview of Remote Sensing for Wildfire Applications



Week 4: Monitoring Landslides, Storms, & Flooding Using Remote Sensing Observations



Course Structure

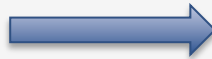
- **One session per week on June 9, 16, 23, and 30, 2016**
 - 11 a.m. – 12 p.m. EDT (UTC-4)
 - 6 p.m. – 7 p.m. EDT (UTC-4)
- **Each session may include**
 - Presentation
 - A homework assignment
- **Q&A following each session or by email to Tim Stough (stough@jpl.nasa.gov) or Amita Mehta (amita.v.mehta@nasa.gov)**

Course Material

<http://arset.gsfc.nasa.gov/disasters/webinars/disaster-overview-2016>

Webinar presentations, exercises, homework assignments, and recordings

Links will be available on the ARSET course page



The screenshot shows the ARSET (Applied Remote Sensing Training) website. The header includes the NASA logo, the ARSET logo, and the text 'Applied Remote Sensing Training'. Navigation links for 'Home', 'About', and 'Trainings' are visible. A search bar is present on the right. The main content area features a grid of six satellite images related to disaster management. Below the grid, the webinar title 'Using NASA Remote Sensing for Disaster Management' is displayed, along with dates (Thursday, June 9, 2016 to Thursday, June 30, 2016), times (11:00 a.m.-12:00 p.m. and 6:00-7:00 p.m. EDT (UTC-4)), and registration closing information (Monday, June 6, 2016). A sidebar on the right contains a 'Disasters' section with links for 'Disasters Webinars' and 'Disasters Workshops', and an 'Upcoming Training' section listing the current webinar.

Week-4: Agenda

- Finding the Slippery Slope: Detecting Landslide from Space

Guest Speaker: Dalia Kirschbaum
NASA-GSFC

- Monitoring Storms and Floods Using Remote Sensing Observations

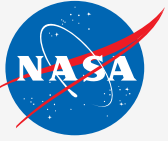
Speaker: Amita Mehta (ARSET)
NASA-GSFC

Finding the Slippery Slope: Detecting Landslides from Space

Dr. Dalia Kirschbaum
Research Scientist
NASA Goddard Space Flight Center



National Aeronautics and
Space Administration



ARSET

Applied Remote Sensing Training

<http://arset.gsfc.nasa.gov>

 @NASAARSET

Monitoring Storms and Floods Using Remote Sensing Observations

Outline

- Remote Sensing Measurements Used for Storm and Flood Monitoring
- Overview of NASA Hurricane and Tropical Storm Portal
- Overview of Flood Monitoring Tools Based on Remote Sensing Observations

An aerial photograph of a river delta, showing a complex network of channels and floodplains. The water is a deep blue, while the land is a mix of green and brown. A semi-transparent grey rectangular box is overlaid on the left side of the image, containing the title text.

Remote Sensing Measurements Used for Storm and Flood Monitoring

NASA Satellites and Sensors Used For Storm and Flood Monitoring

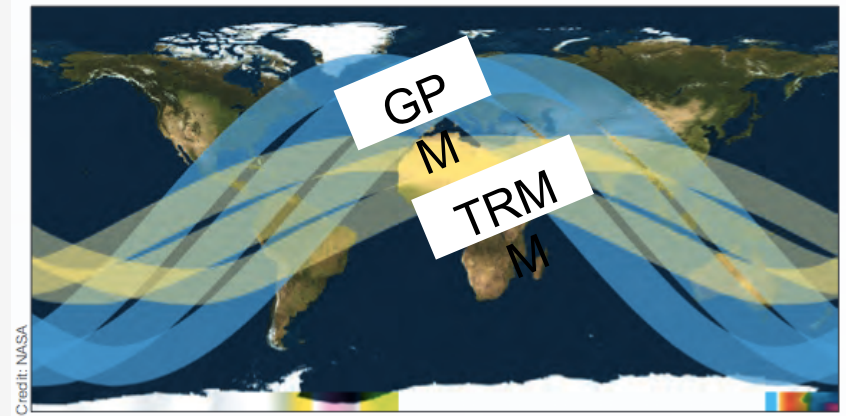


- Tropical Rainfall Measuring Mission (TRMM): 11/1997-15/2015
- Global Precipitation Measurements (GPM): 2/2014-present
- Terra: 12/1999-present
- Aqua: 5/2002-present

TRMM and GPM

<http://pmm.nasa.gov/>

- Both in non-polar, low-inclination orbits
- TRMM Precipitation Sensors:
 - TMI (TRMM Microwave Imager)
 - PR (Precipitation Radar)
 - VIRS (Visible and Infrared Scanner)
- GPM Precipitation Sensors:
 - GMI (GPM Microwave Imager)
 - DPR (Dual-frequency Precipitation Radar)



- TRMM measurements are limited to the tropics
- GPM measurements span middle & high latitudes

Multi-Satellite Precipitation From TRMM and GPM

<http://pmm.nasa.gov/science/precipitation-algorithms>

- TRMM & GPM Core satellites are used to calibrate microwave observations from a constellation of national and international satellites
- Allow improved spatial and temporal coverage of precipitation data
- TRMM Multi-satellite Precipitation Analysis (**TMPA**)
 - Widely used for applications
- TMPA will be extended to match Integrated Multi-satellitE Retrievals for GPM (**IMERG**)

TMPA and IMERG

Used for Storms and Flood Monitoring

	TMPA	IMERG
Spatial Resolution	0.25° x 0.25°	0.1°x0.1°
Spatial Coverage	Global, 50°S-50°N	Global, 60°S-60°N (will be extended from pole-pole)
Temporal Resolution	3 hours	30 minutes
Temporal Coverage	12/1997 – Present*	2/27/2014-Present ⁺

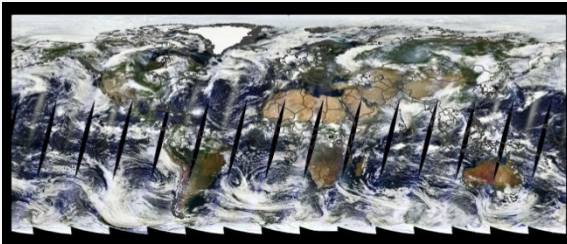
⁺ TMPA and IMERG combined data will be available in late 2017 at IMERG data resolution

* After 15 April 2015 TRMM climatological calibration is being used to generate TMPA

Terra and Aqua

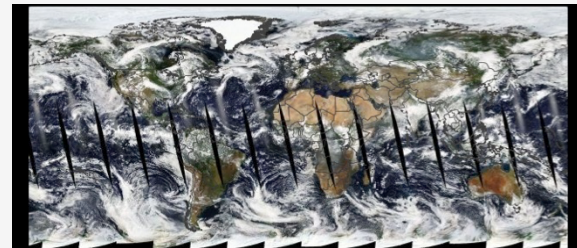
Terra

- Polar orbit, 10:30 a.m. equator crossing time
- Global coverage
- Dec 18, 1999 – present
- 1-2 observations per day
- Sensors:
 - ASTER, CERES, MISR, **MODIS**, MOPITT



Aqua

- Polar orbit, 1:30 p.m. equator crossing time
- Global coverage
- May 4, 2002 – present
- 1-2 observations per day
- Sensors:
 - AIRS, AMSU, CERES, **MODIS**, AMSR-E



MODerate Resolution Imaging Spectroradiometer (MODIS)

<http://modis.gsfc.nasa.gov>

- On-board Terra and Aqua
- Designed for land, atmosphere, ocean, and cryosphere observations
- Spatial Coverage and Resolution:
 - Global, Swath: 2,330km
 - Spatial Resolution Varies: 250m, 500m, 1km
- Temporal Coverage and Resolution:
 - 2000-present, 2 times per day


Spectral Bands

- 36 bands (red, blue, IR, NIR, MIR)
 - Bands 1-2: 250m
 - Bands 3-7: 500m
 - Bands 8-16: 1000m

Hurricane Katrina (8/29/2005)
Observed by Aqua/MODIS



<http://phys.org/news/2015-08-nasa-hurricanes.html>

An aerial photograph of a tropical coastline, showing a mix of green vegetation, brownish-yellow land, and blue water. A large, semi-transparent white rectangle is overlaid on the left side of the image, serving as a background for the title text.

Overview of NASA Hurricane and Tropical Storm Portal

Monitoring Hurricanes and Storms

- Satellite Images and Precipitation Products are used to monitor storms
- Web-tools are available for past and near real-time storm information:

Hurricanes and Tropical Storms

http://www.nasa.gov/mission_pages/hurricanes/main/index.html

Precipitation Measurement Mission (PMM) Tropical Cyclones

<https://pmm.nasa.gov/applications/tropical-cyclones>

Hurricanes and Tropical Storms

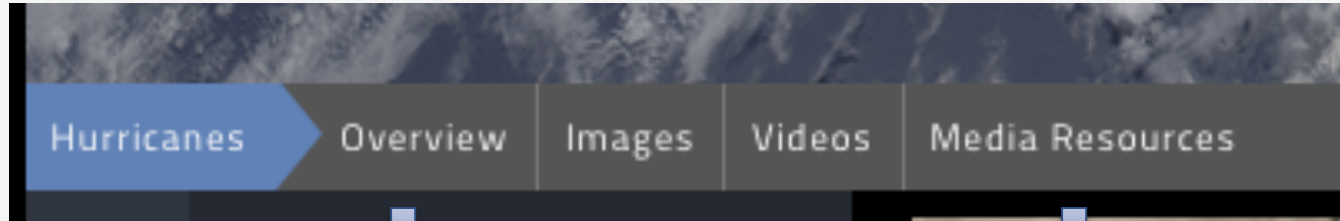
http://www.nasa.gov/mission_pages/hurricanes/main/index.html

The screenshot shows the NASA website's 'Hurricanes' page. At the top, there is a navigation bar with links for Topics, Missions, Galleries, NASA TV, Follow NASA, Downloads, About, and NASA Audiences, along with a search box. Below this is a secondary navigation bar with 'Hurricanes' highlighted in blue, followed by 'Overview', 'Images', 'Videos', and 'Media Resources'. On the left side, a sidebar contains a 'Learn More' button and a 'Related Topics' section with links for Climate, Earth, Hazards, and All Topics A-Z. The main content area is divided into four featured articles:

- Top Left:** A large satellite image of a tropical cyclone. Below it is a 'Hazards' tag and the headline 'NASA Sees Wind Shear Affecting Tropical Cyclone O2A'.
- Top Right:** A 3-D rainfall flyby visualization of Tropical Storm Danielle. It includes a play button icon, a 'Hazards' tag, and the headline 'NASA Sees Tropical Storm Danielle Ending Over Mexico'.
- Bottom Left:** A smaller satellite image of a tropical cyclone. Below it is a 'Hazards' tag and the headline 'NASA Sees Wind Shear Affecting Tropical Cyclone O2A'.
- Bottom Right:** A photograph of two technicians in white cleanroom suits working with equipment. Below it is an 'Earth' tag and the headline 'NASA's CYGNSS Microsatellites Pass Testing Milestone'.

Hurricanes and Tropical Storms

http://www.nasa.gov/mission_pages/hurricanes/main/index.html



- Hurricane Archive from 2005 to present
- Hurricane Research and Education Links

Related Links:

[National Hurricane Center](#)
[NASA's Emergency Operations Center](#)
[FEMA's Updates During Disasters](#)

NASA Research Links:

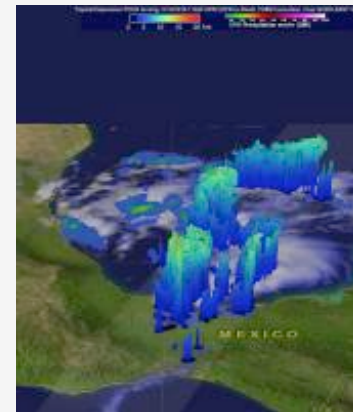
[GRIP Mission](#)
[HS3 Missions \(Hurricane and Severe Storm Sentinel\)](#)
[JPL Tropical Cyclone Information System](#)
[NASA's Sea Surface Temperature site](#)
[NASA African Monsoon Multidisciplinary Activities \(NAMMA\) M](#)
[NASA's Tropical Rainfall Measuring Mission \(TRMM\)](#)
[Flood Potential Models from TRMM](#)
[Previous Week of Global Rainfall from TRMM](#)
[Previous Three Hour Map of Global Rainfall from TRMM](#)
[The Tropical Cloud Systems and Processes \(TCSP\) mission](#)
[The Fourth Convection and Moisture Experiment \(CAMEX-4\)](#)
[MAP '06 -- Modeling, Analysis and Prediction Program](#)
[NASA Hurricane Data Products Portal](#)
[Earth Observatory Severe Storms web page](#)

PMM Tropical Cyclones


<http://pmm.nasa.gov/applications/tropical-cyclones>

The screenshot shows the PMM Tropical Cyclones website. The navigation bar includes Home, GPM, TRMM, Science, Applications, Meetings, Data Access, Resources, and Education. The main content area is titled "Tropical Cyclones" and features a video player with the title "NASA | GPM: The Trouble with Irene". Below the video is a text block that reads: "NASA's Global Precipitation Measurement mission, or GPM, a joint NASA/JAXA mission, provides rainfall data on storms and hurricanes like Irene that move out of the tropics. The data has been made available since the GPM Core Observatory launched in 2014 and shows in 3D how these storm systems develop and intensify as they move poleward. GPM's Core Observatory, partnered with a constellation of international satellites, provides a global picture of rain and snow every three hours." Below this text is a paragraph: "Constantly scanning the Earth's surface, the GPM Microwave Imager (GMI) allows scientists to both track tropical cyclones and forecast their progression. Used by NOAA's National Hurricane Center (NHC), the Joint Typhoon Warning Center (JTWC), and tropical cyclone centers in Japan, India, Australia and other countries, detailed microwave information provides data on the location, pattern and intensity of rainfall." The left sidebar contains a list of "Applications" such as Tropical Cyclones, Extreme Weather, Floods, Landslides, Land Surface Models, Climate Prediction, Soil Moisture, Agriculture, Freshwater Availability, World Health, and Training. It also includes "Connect With Us" with social media icons for Twitter, Facebook, and YouTube, and a "Need Help?" section with links to frequently asked questions, a glossary, and contact information.

- Near Real-time Monitoring using GPM
- Archives from TRMM & GPM



GPM sees Tropical Storm Danielle Forming : June 20, 2016

An aerial photograph of a flooded landscape, showing a large body of water in the foreground and a complex network of channels and floodplains in the background. The water is a deep blue, while the flooded areas are a mix of light brown and green. A semi-transparent white rectangular box is overlaid on the left side of the image, containing the title text.

Overview of Flood Monitoring Tools Based on Remote Sensing Observations

NASA Remote Sensing Observations for Flood Monitoring

<https://arset.gsfc.nasa.gov/disasters/webinars/advfloodwebinar>

There are primarily **3 types** of flood monitoring tools that use remote sensing observations:

1. Derive streamflow & runoff to monitor flooding conditions by using rainfall and weather data in a hydrology model
2. Infer flooding conditions by using satellite-derived precipitation
3. Detect flood water on previously dry land surfaces by using satellite-derived land-cover observations

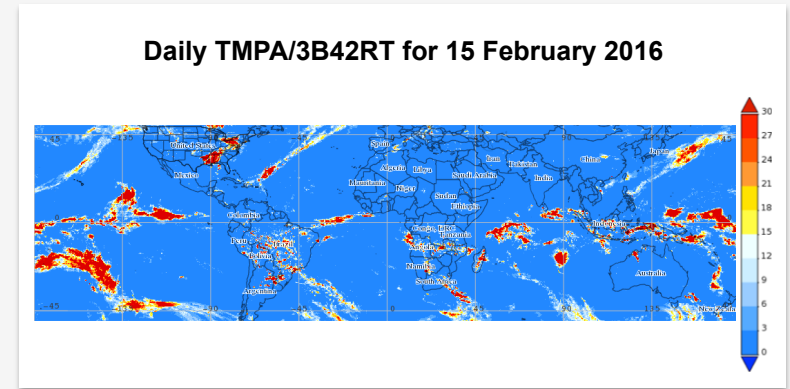
Flood Monitoring Using NASA Rainfall Observations

1. Derive streamflow & runoff to monitor flooding conditions by using rainfall and weather data in a hydrology model
 - Global Flood Monitoring System (GFMS): <http://flood.umd.edu>
2. Infer flooding conditions by using satellite-derived precipitation
 - Extreme Rainfall Detection System (ERDS): <http://erds.ithacaweb.org>
3. Detect flood water on previously dry land surfaces by using satellite-derived land-cover observations


NASA Rainfall Observations Used in GFMS & ERDS2

TRMM Multi-satellite Precipitation Analysis (TMPA)

- Combines precipitation from TRMM and several national/international satellites to obtain 3-hourly, $0.25^{\circ} \times 0.25^{\circ}$ resolution data with **global coverage between 50°S to 50°N**
- TMPA will be replaced with Integrated Multi-Satellite Retrievals (IMERG) for Global Precipitation Measurement (GPM) data with half-hourly, $0.1^{\circ} \times 0.1^{\circ}$ resolution and **global coverage between 65°S to 65°N**



Note: TRMM is no longer flying, but TRMM-based calibration is used to provide near real-time rainfall from a constellation of national & international satellites for flooding applications. Near real-time IMERG data is also available from: <ftp://jsimpson.pps.eosdis.nasa.gov>

A satellite image of a flooded region, likely a delta or coastal plain, showing extensive brownish water covering large areas of land. The water is surrounded by green vegetation and some urban or developed areas. A semi-transparent grey rectangular box is overlaid on the image, containing the title text and a horizontal line.

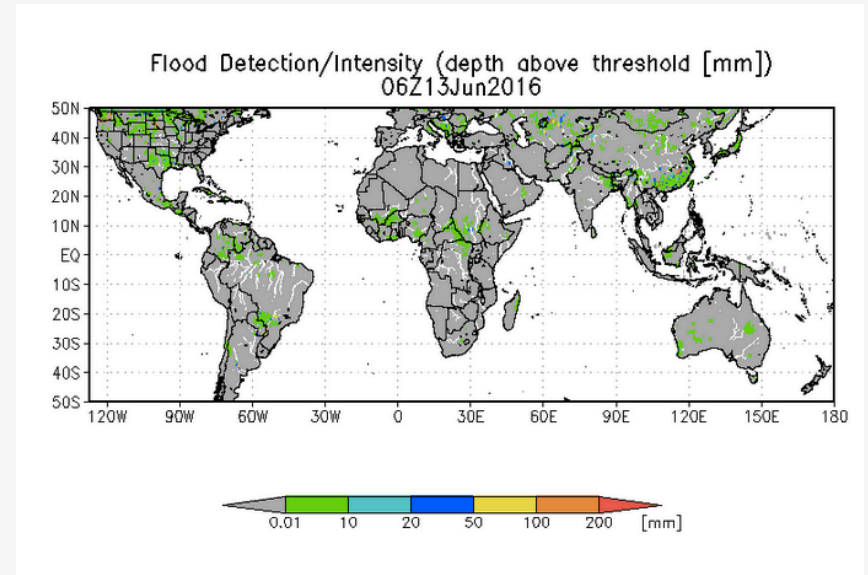
Global Flood Monitoring System (GFMS)

GFMS

<http://flood.umd.edu>

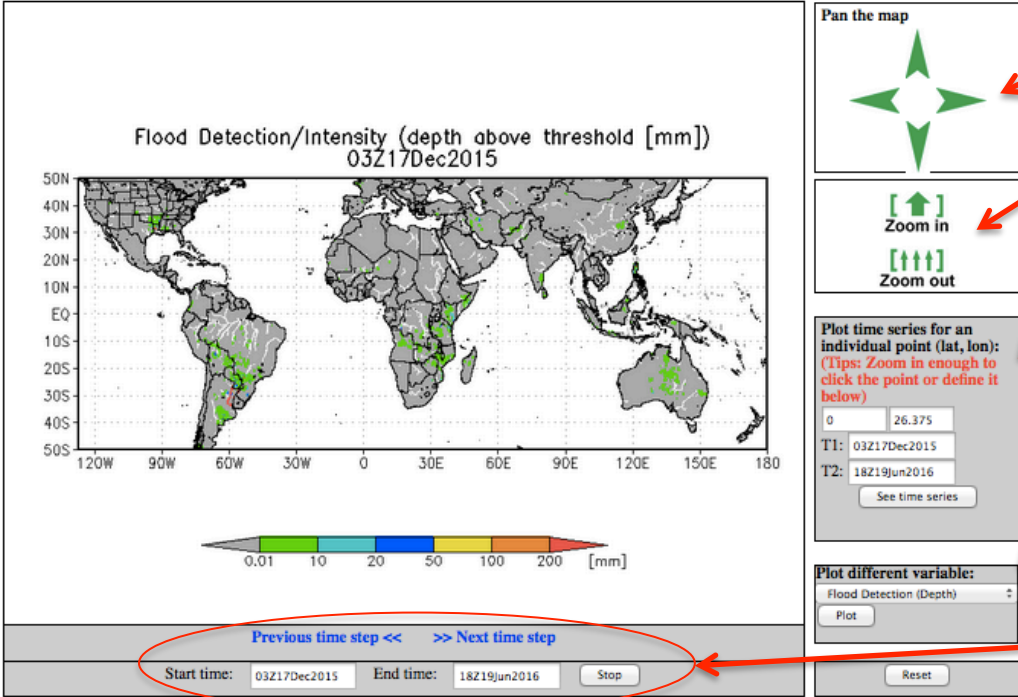
Provides global maps, time series, and animations (50°S-50°N) of:

- Instantaneous Rain
- Accumulated rain over 24, 72, and 168 hours
- Streamflow rates and flood detection at 1/8th degree (~12 km) and also at 1 km



GFMS Features

<http://flood.umd.edu>

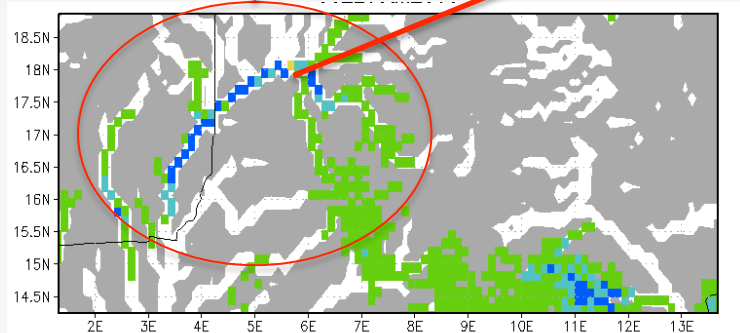
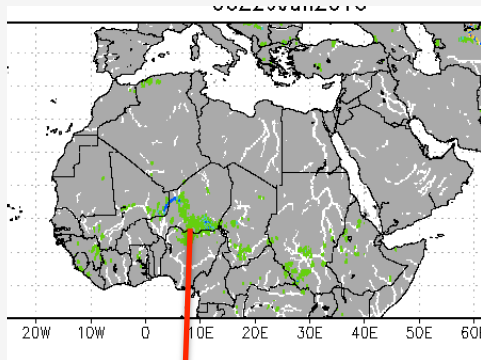


The screenshot displays the GFMS web interface. On the left is a world map titled "Flood Detection/Intensity (depth above threshold [mm]) 03Z17Dec2015". The map shows green and yellow areas indicating flood intensity. Below the map is a color scale legend ranging from 0.01 to 200 mm. At the bottom of the map area are navigation buttons: "Previous time step <<" and ">> Next time step", and a date range selector with "Start time: 03Z17Dec2015", "End time: 18Z19Jun2016", and a "Stop" button. On the right side, there are several control panels: "Pan the map" with a four-pointed green star; "Zoom in/out" with green arrows and text; "Plot time series for an individual point (lat, lon):" with input fields for latitude (0), longitude (26.375), and time (T1: 03Z17Dec2015, T2: 18Z19Jun2016), and a "See time series" button; "Plot different variable:" with a dropdown menu set to "Flood Detection (Depth)" and a "Plot" button; and a "Reset" button at the bottom.

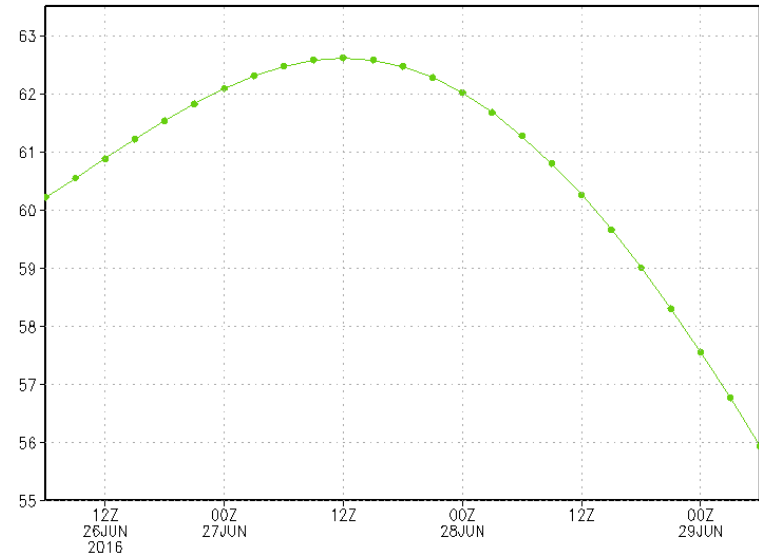
- Map navigation
- Zoom in/out
- Select individual grid point for data for time sequence
- Plot different variables
- 3-hourly output

Flooding in Niger River Basin – June 29, 2016

<http://flood.umd.edu>



Flood Detection/Intensity (depth above threshold [mm])
06Z26Jun2016 06Z29Jun2016



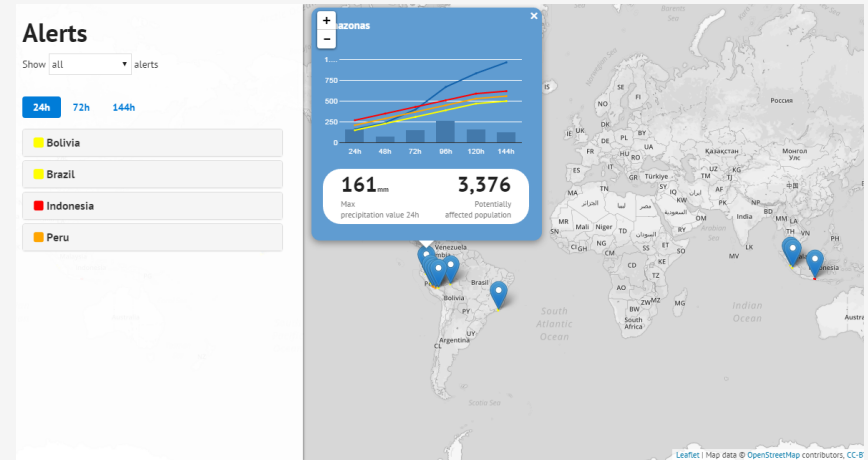
A satellite image of Earth showing a large body of water on the left and a landmass on the right. The landmass features a prominent river system with a large delta. A semi-transparent grey rectangular box is overlaid on the image, containing the text 'Extreme Rainfall Detection System (ERDS)'.

Extreme Rainfall Detection System (ERDS)

ERDS

<http://erds.ithacaweb.org/>

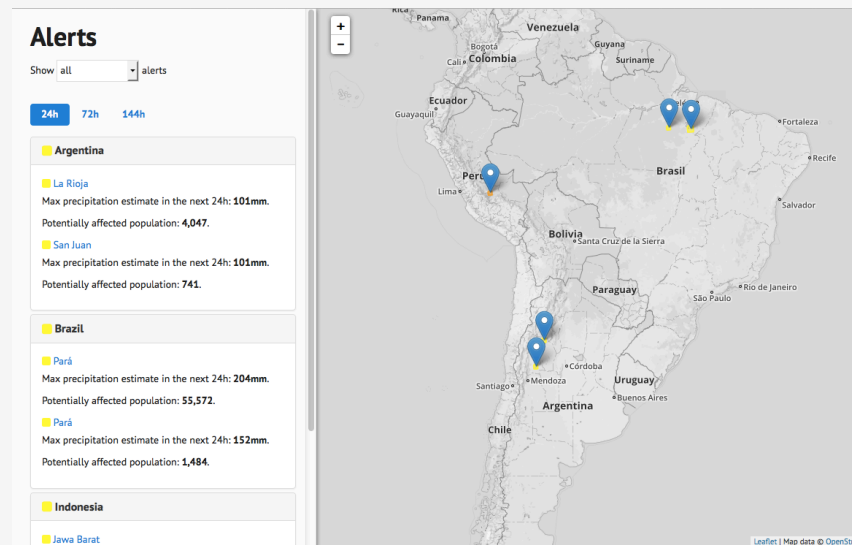
- Near real-time TRMM and NOAA-Global Forecasting System (GFS) data for monitoring & forecasting accumulated rainfall
- TRMM historical archive is used for calculation of extreme rainfall thresholds
- TRMM near real-time rainfall amount, GFS forecasted rainfall information, & reference data combine to generate flooding event-specific information



ERDS

<http://erds.ithacaweb.org/>

- Global maps and time series of near real-time (50°S-50°N) and forecasted accumulated rainfall over 24, 48, 72, 96, 120 & 144 hours
- Extreme rainfall alerts at 0.25°x0.25° level and at administrative districts level
- Event-specific information, including:
 - the list of the affected countries
 - an estimation of the affected population
- Currently the ERDS system is one of the tools used by OMEP, UN World Food Programme (WFP) Emergency Preparedness Unit



ERDS Alerts

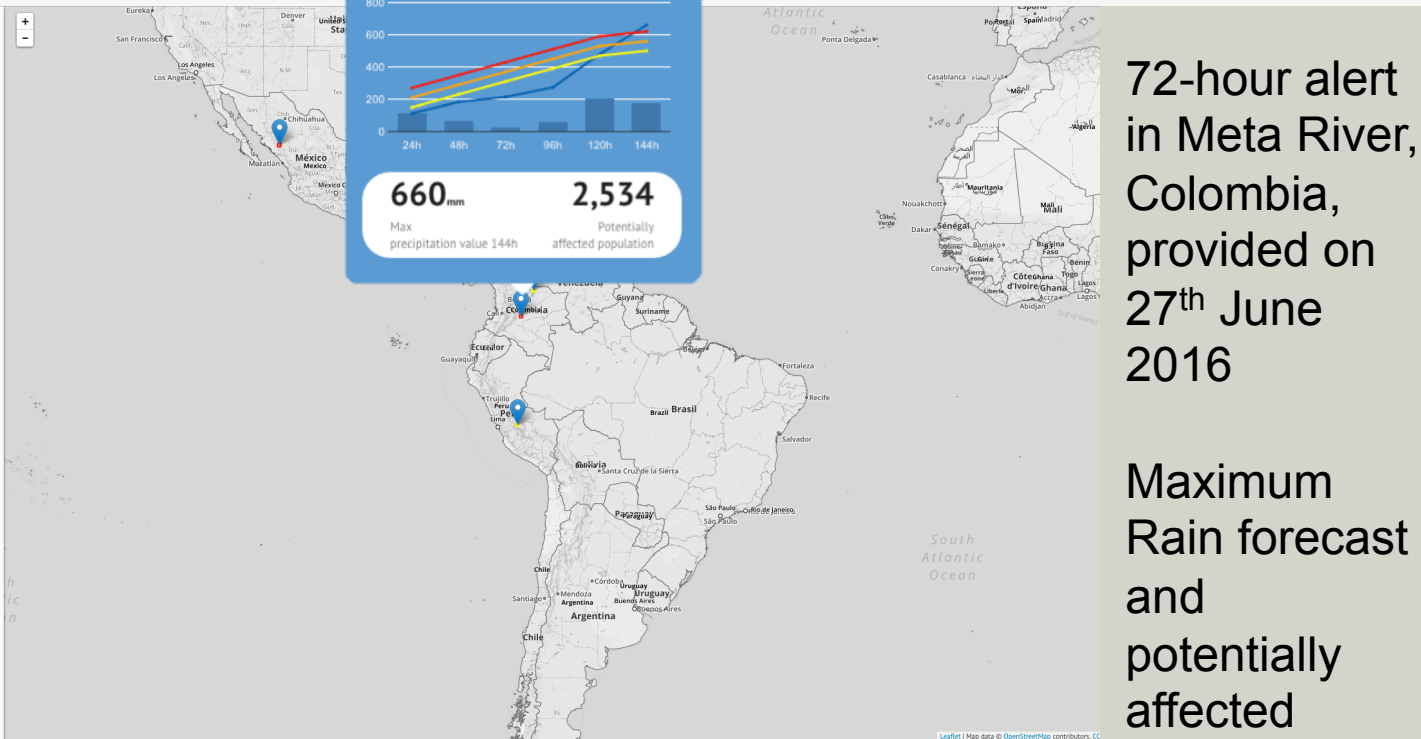
<http://erds.ithacaweb.org>

Alerts

Show: all alerts

24h 72h 144h

- Bhutan
- Cambodia
- China
- Colombia
- Ethiopia
- India
- Indonesia
- Laos
- Mexico
- Myanmar
- Nepal
- Nigeria
- Papua New Guinea
- Peru
- Sudan



72-hour alert in Meta River, Colombia, provided on 27th June 2016

Maximum Rain forecast and potentially affected population

NASA Remote Sensing Observations for Flood Monitoring

<http://arset.gsfc.nasa.gov/disasters/webinars/advfloodwebinar>

There are primarily **3 types** of flood monitoring tools that use remote sensing observations:

1. Derive streamflow & runoff to monitor flooding conditions by using rainfall and weather data in a hydrology model
2. Infer flooding conditions by using satellite-derived precipitation
3. Detect flood water on previously dry land surfaces by using satellite-derived land-cover observations

Inundation Mapping

Using Satellite-Derived Land-Cover Observations

3. Detect flood water on previously dry land surfaces by using satellite-derived land-cover observations
 - MODIS NRT Global Flood Mapping: <http://oas.gsfc.nasa.gov/floodmap>
 - Dartmouth Flood Observatory: <http://floodobservatory.colorado.edu>

Inundation Mapping

Using Terra/Aqua MODerate Resolution Imaging Spectroradiometer (MODIS)

- MODIS provides observations of land surface
- Reflectance from bands indicate presence of water on previously dry land
 - 1 (620-670nm)
 - 2 (841-876 nm)
 - 7 (2105-2155nm)
- Global reference database of water bodies formed at 250m resolution
- MODIS cannot see the surface through clouds

Flooding along the White Nile, Sudan

earthobservatory.nasa.gov



MODIS-Aqua
6/19/2003

MODIS- Terra
8/11/2003

A satellite image of a flooded landscape, showing a large body of water in the foreground and a flooded area in the background. The water is a deep blue, and the flooded area is a mix of brown and green, indicating submerged vegetation and soil. A semi-transparent grey rectangular box is overlaid on the image, containing the title text and a horizontal line.

MODIS Near Real-Time Global Flood Mapping

MODIS NRT Global Flood Mapping

- Flood mapping based on MODIS reflectance at 250m resolution
- Composited on 2, 3, and 14 days
- Flood maps available in 10°x10° tile
- Permanent water and surface flood water data available
- Cloud shadows or terrain shadows can be misinterpreted as surface water

NRT Global Flood Mapping

Global Map

Click for ArcGIS Portal map interface

10° Flood Map Tile Production

For more information, please contact floodmap at lists.nasa.gov

NOTE: THIS IS AN EXPERIMENTAL PRODUCT AND SYSTEM

News/Status

11-Nov-2014: ArcGIS Online Map available.
10-Nov-2014: MODIS flood product evaluation report available.

Go to News/Status page

NASA Official: Frederick Polcett
Page Last Updated: January 13, 2015

Privacy Policy & Important Notices
Contact Us

Provides near real-time and past flood mapping from April 2011.

<http://oas.gsfc.nasa.gov/floodmap>

MODIS NRT Global Flood Mapping: Available Quantities

<http://oas.gsfc.nasa.gov/floodmap>

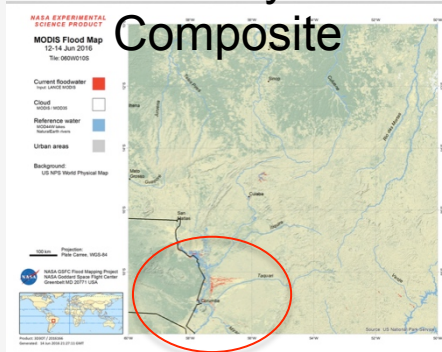
Products		Available Downloads	
MODIS Flood Map	MFM	png	
MODIS Flood Water	MFW	shapefile (.zip)	KMZ
MODIS Surface Water	MSW	shapefile (.zip)	KMZ
MODIS Water Product	MWP	geotiff	
README		pdf	txt

Check slide show for the last 10 days.

10-day Slides

MODIS Flood Mapping: Flooding in Southern Brazil June 12-14, 2016

3-day Composite



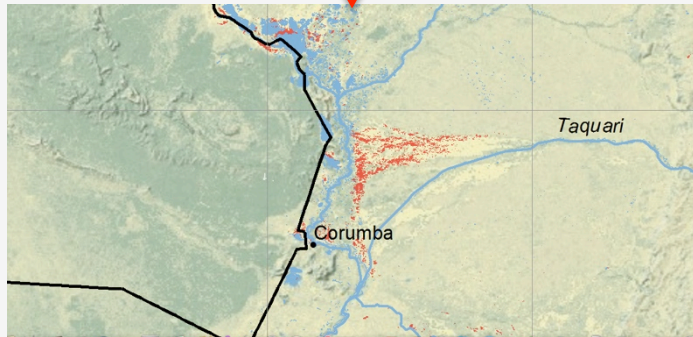
3 Day Composite | 2 Day Composite | 1 Day Composite | 14 Day Composite

« June 2016 »

S	M	T	W	T	F	S
		1	2	3	4	
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

Products	Available Downloads	
MODIS Flood Map	MFM	png
MODIS Flood Water	MFW	shapefile (.zip) KMZ
MODIS Surface Water	MSW	shapefile (.zip) KMZ
MODIS Water Product	MWP	geotiff
README	pdf	txt

Check slide show for the last 10 days.



Filename Convention:

PRODUCT_DATE_TILE_COMPOSITE_XTRA.EXT

MSW_2012009_020E000S_3D3O_V.shp

 MFM_2012009_020E000S_2D2O.png

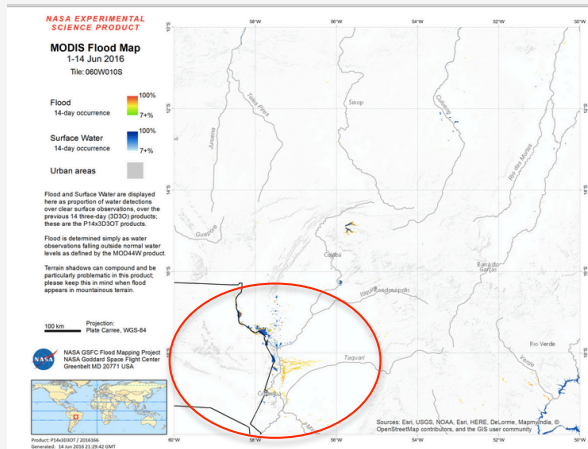
(yyyydoy lon-lat 2 or 3 day **O**bservations
 (Year and day of year)

MODIS Flood Mapping: Flooding in Southern Brazil 12-14, 2016

3 Day Composite	2 Day Composite	1 Day Composite	14 Day Composite
-- June 2016 --			
S	M	T	W T F S S
		1	2 3 4
5	6 7 8 9 10 11		
12 13	14 15 16 17 18		
19 20 21	22 23 24 25		
26 27 28 29 30			

Products		Available Downloads			
MODIS Flood Map	MFM	png			
MODIS Flood Water	MFW	percent (.tif)	any (.tif)	any (.shp)	any (.kmz)
MODIS Surface Water	MSW	percent (.tif)	any (.tif)	any (.shp)	any (.kmz)
README		pdf		txt	

Composites of the previous 14 days' 3-day product



Similar filename convention with additional processing for composite field:

N: No shadow masking

T: Terrain shadow masking

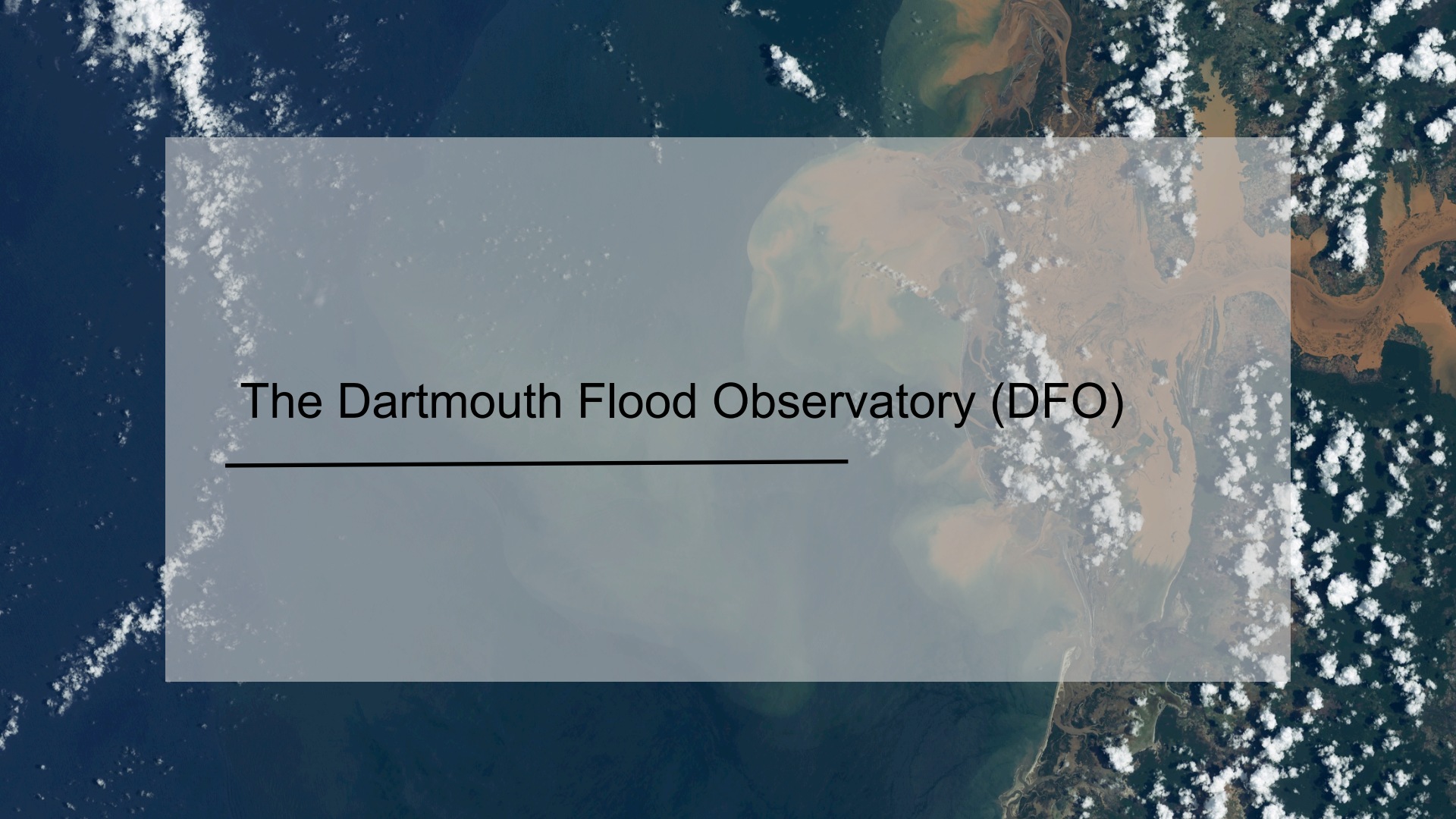
C: Cloud shadow masking

S: Both terrain & shadow masking

e.g. 2D2OT:

2 days imagery, 2 observations required, terrain shadow masking applied

- Provides occurrence of water as % clear observations over the last 14 days' products
 - GeoTIFF are 0-1 images (1 if % water is >0)

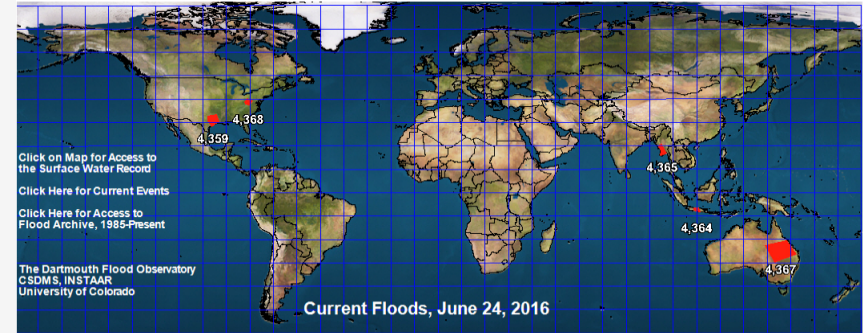
An aerial photograph of a river delta, showing a complex network of channels and floodplains. The water is a mix of blue and brown, indicating sediment. The surrounding land is green with dense vegetation. A semi-transparent grey rectangular box is overlaid on the left side of the image, containing the title text.

The Dartmouth Flood Observatory (DFO)

DFO

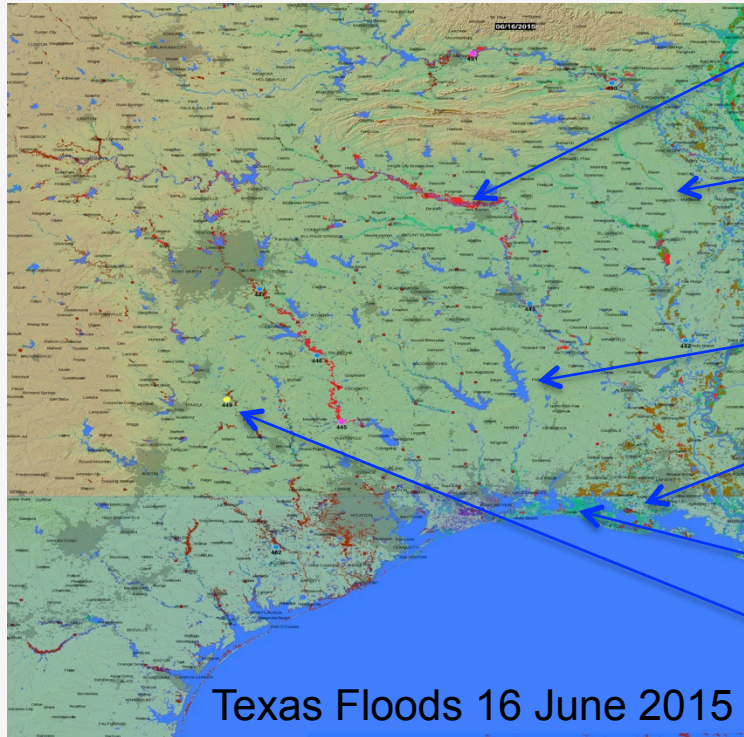
<http://floodobservatory.colorado.edu>

- Uses flood mapping based on MODIS reflectance
- Also uses Landsat-8 and EO-1 images and COSMO-SkyMed and Sentinel-1 synthetic aperture radar (SAR) images when available
- Experimental river discharge obtained by using Microwave data (AMSR, AMSR-2, TMI, GMIO and a run-off model)



Provides near-real time flood mapping and current/past flood event mapping

DFO Flood Event Mapping



Red: Flooding within past 14 days (MODIS animated product)

Light Red: Flooding during this event (earlier MODIS coverage of non-automated MODIS mapping)

Dark Blue: Permanent water, Feb 2000 (Shuttle Water Boundary Data)

Darker Red: Flooded areas (High resolution SAR or Landsat 8 data)

Bright Green: Past Floods

Colored dots show *access River Watch Site*

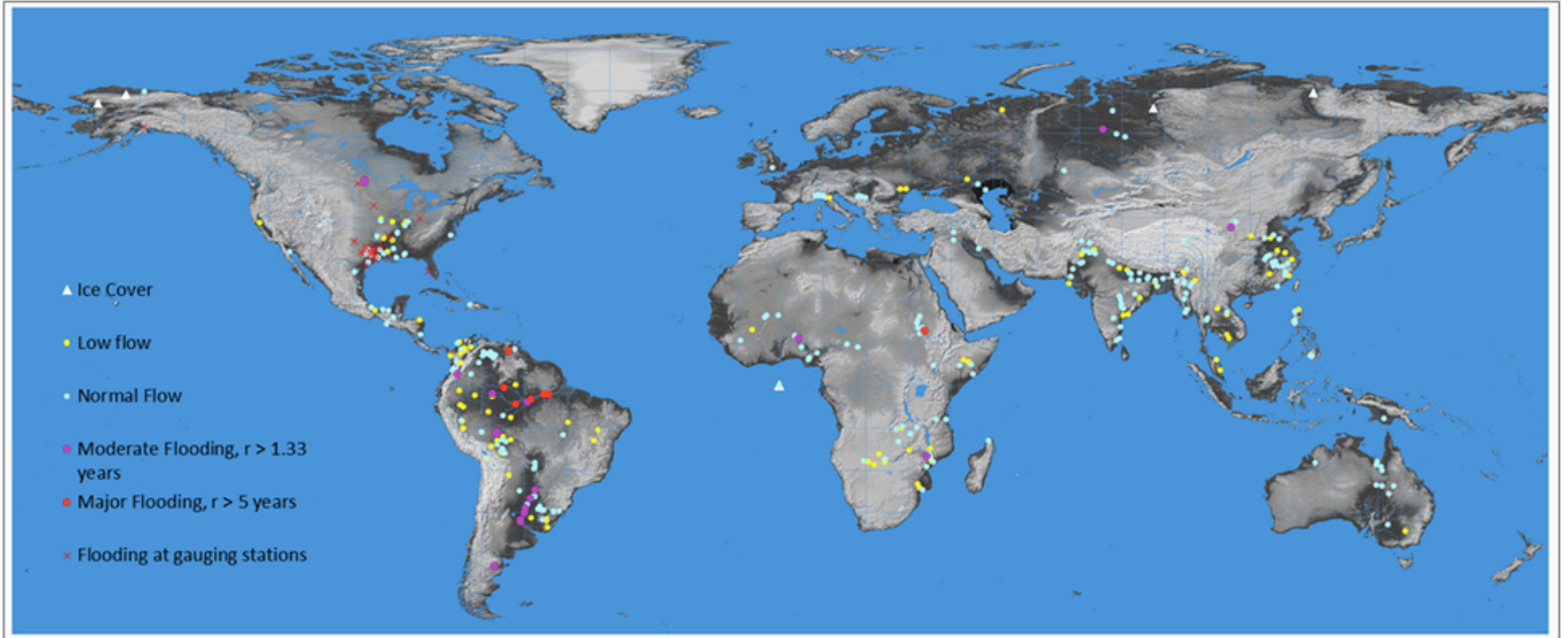
DFO Experimental River Watch

<http://floodobservatory.colorado.edu>

- Sensitive to portions of water and dry land:
 - Advanced Microwave Scanning Radiometer-2 from GCOM-W (Japanese Space Agency Mission)
 - TRMM Microwave Imager (ended 8 April 2015)
 - GPM Microwave Imager
- **These microwave observations are converted to actual river discharge** by combining them with surface discharge measurements and then to runoff by using a Water Balance Model (WBM)
- Runoff calculations are available starting in 2003, seven-day runoff deviation started in 2003-2007
- Mean runoff is mapped to indicate low, normal, moderate, and major flooding

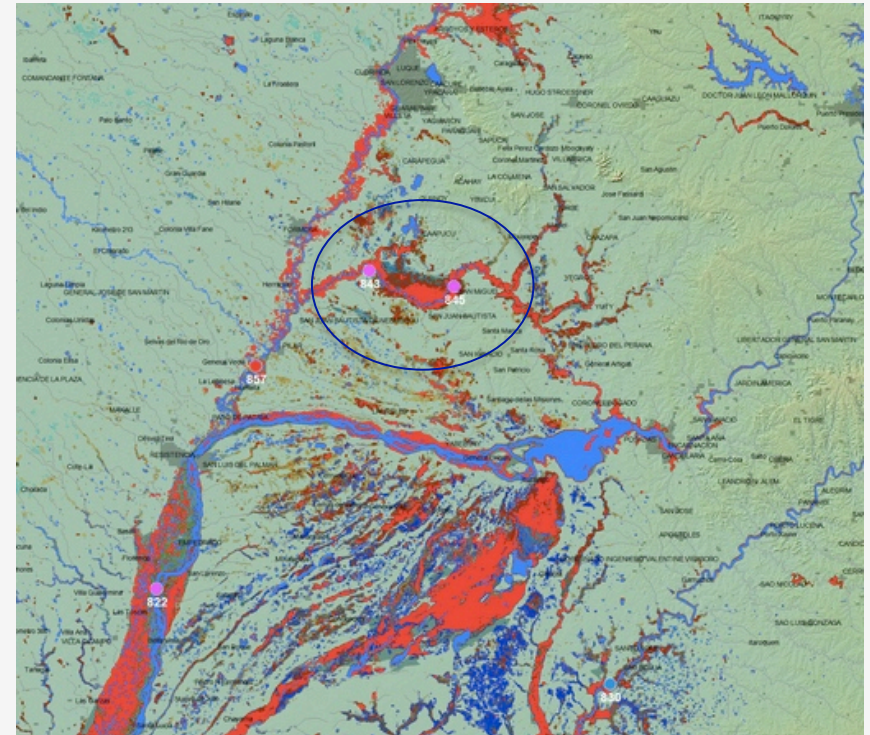
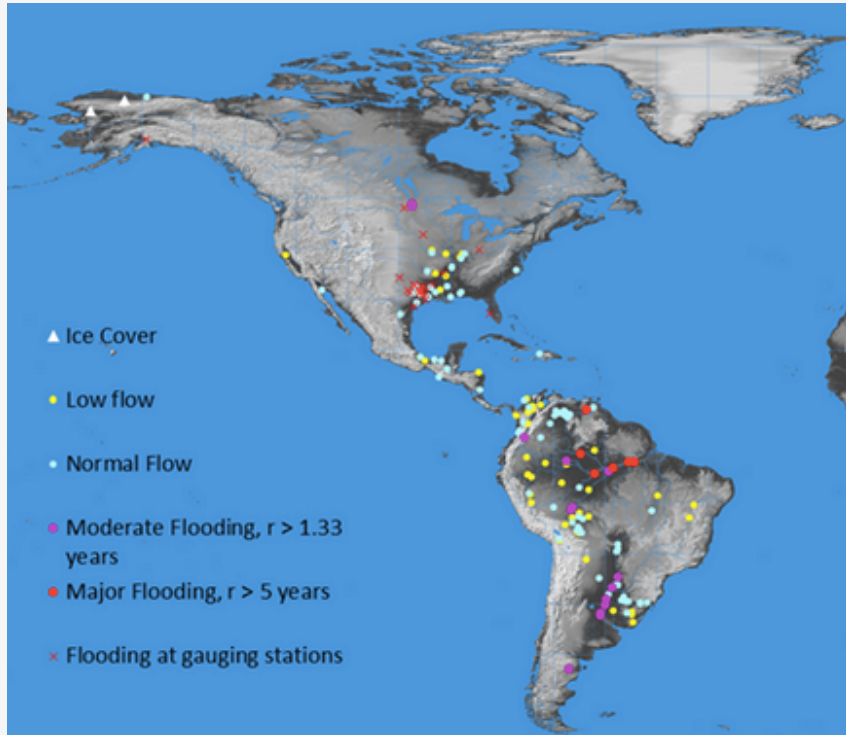
DFO River Watch Locations

<http://floodobservatory.colorado.edu>



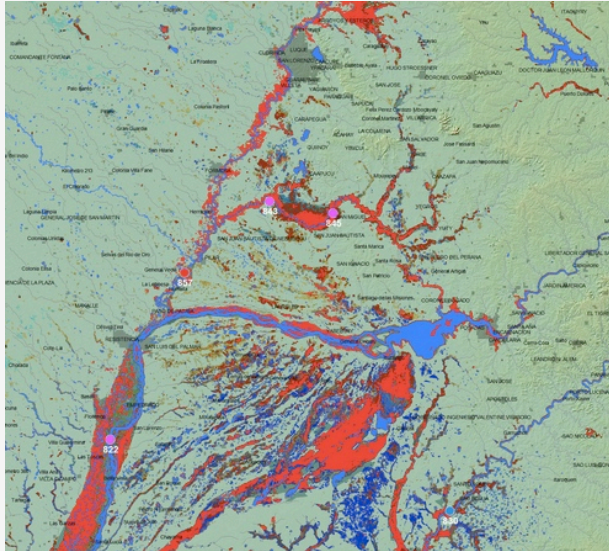
DFO River Watch Paraguay

<http://floodobservatory.colorado.edu>



DFO River Watch Paraguay

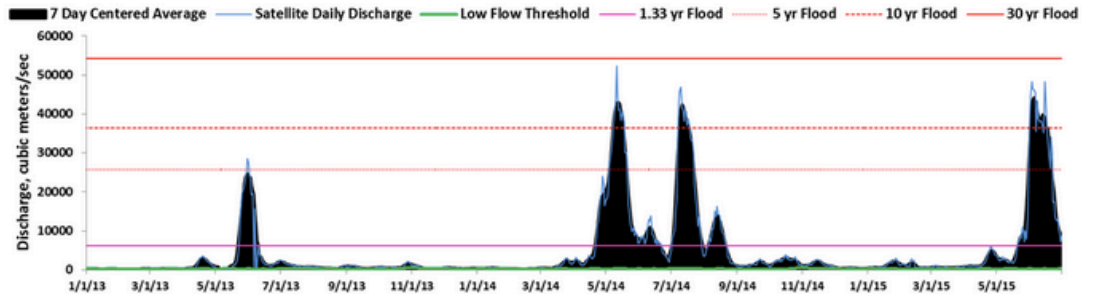
<http://floodobservatory.colorado.edu>



River Watch Version 2

Experimental Satellite-Based River Discharge Measurements using passive microwave radiometry

DFO Site Number	Site 854 (Paraguay)	Tribicuary	Center: -57.194	Long.
GFDS Site Number	845	River	Center: -26.505	Lat.
DRAFT		Paraguay		67905 sq km WBM contributing area
Last measured:	19-Jun-16			Obtain Data
Average Discharge:	562 m ³ /sec	Status: 2	(1, low flow; 2, normal flow; 3, moderate flood; 4, major flood, r >5 yr)	
7-day Runoff	#N/A mm	#N/A	(7-day runoff compared to 10 yr average for this date, 2003-2012)	
Recent Record				Technical Summary



Summary of Storm and Flood Web-Tools

Storms:

- http://www.nasa.gov/mission_pages/hurricanes/main/index.html
- <http://pmm.nasa.gov/applications/tropical-cyclones>

Floods

- <http://flood.umd.edu>
- <http://erds.ithacaweb.org>
- <http://oas.gsfc.nasa.gov/floodmap>
- <http://floodobservatory.colorado.edu>

Homework and Certificate

Certificate of Completion

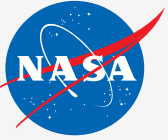
- Attend all 4 webinar sessions
- Complete all homework assignments
- Certificates will be emailed approximately 2 months after the course finishes, by Marines Martins (marines.martins@ssaihq.com)

Homework

- Answers to homework questions via Google form
- Available at: <http://arset.gsfc.nasa.gov/disasters/webinars/disaster-overview-2016>
- Assignments (**available now**)
 - Prerequisite on Fundamentals (Due June 13) – **deadline extended to June 30**
 - Assignment #1: Earthquakes, Tsunamis, Volcanoes, and Wildfire Disasters (**Due July 14**)
 - Assignment #2: Oil Spills, Storms, Floods, and Landslide Disasters (**Due July 14**)



National Aeronautics and
Space Administration



ARSET

Applied Remote Sensing Training

<http://arset.gsfc.nasa.gov>

 @NASAARSET

Thank You!
