ARSET
Applied Remote Sensing Training
http://arset.gsfc.nasa.gov
@NASAARSET

NASA Flood Monitoring and Mapping Tools
Outline

- Overview of Flood Monitoring Tools Based on Remote Sensing Observations
  - Global Flood Monitoring System (GFMS)
  - Extreme Rainfall Detection System-2 (ERDS2)
  - MODIS Near Real Time (NRT) Flood Mapping
  - Dartmouth Flood Observatory (DFO)

- Demonstration of GFMS, ERDS2, MODIS NRT and DFO
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

3. Detect flood water on previously dry land surfaces by using satellite-derived land-cover observations
Combines precipitation from TRMM and several national/international satellites to obtain 3-hourly, 0.25°x0.25° 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°x0.1° 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](ftp://jsimpson.pps.eosdis.nasa.gov)
SERVIR GLOBAL

http://servirglobal.net

• Works in 30 countries
• Remote Sensing-based data products and training available via websites
• Flood monitoring and mapping based on TMPA rainfall and CREST hydrological model
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

- Map navigation
- Zoom in/out
- Select individual grid point for data for time sequence
- Plot different variables
- 3-hourly output
Flooding in Bolivia – January 26, 2014

http://flood.umd.edu
Extreme Rainfall Detection System (ERDS)
• 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/
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

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

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Inundation Mapping
Using Satellite-Derived Land-Cover Observations

3. Detect flood water on previously dry land surfaces by using satellite-derived land-cover observations
   – 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
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

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

<table>
<thead>
<tr>
<th>Products</th>
<th>Available Downloads</th>
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<tbody>
<tr>
<td>MODIS Flood Map</td>
<td>MFM png</td>
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<tr>
<td>MODIS Flood Water</td>
<td>MFW shapefile (.zip) KMZ</td>
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<td>MODIS Surface Water</td>
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<td>MWP geotiff</td>
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<td>README</td>
<td>pdf txt</td>
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Check slide show for the last 10 days.

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

3-day Composite

Filename Convention:

PRODUCT_DATE_TILE_COMPOSITE_XTRA.EXT

MSW_2012009_020E000S_3D3O_V.shp
MFM_2012009_020E000S_2D2O.png

(yyydoy  lon-lat  2 or 3 day Observations)
(Year and day of year)
MODIS Flood Mapping: Flooding in Southern Brazil 12-14, 2016

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)
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, GMI0 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

Texas Floods 16 June 2015
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
Live Demonstration: GFMS
Live Demonstration: MODIS NRT
Overview Demo: ERDS
Overview Demo: DFO
Next:
Hands-on Exercise of Flood Mapping