National Aeronautics and Space Administration

Satellite Remote Sensing for Flood Monitoring and Management

Amita Mehta and Erika Podest

18-19 November 2018

Training Outline: 18 November 2018

Time	Topic	Type	Presenter
	Session 1		
10:30-11:30 AM	Overview of NASA Satellite Remote Sensing and Earth System Modeling Relevant For Flood Monitoring	Presentation	Amita Mehta
11:30 AM-1:00 PM	Data Access and Analysis: Precipitation, Soil Moisture, Weather Data, Terrain, Socioeconomic Data	**Demonstration GDeX, SEDAC, Hands-on Exercise:** QGIS, Giovanni AppEEARS	Amita Mehta Erika Podest
1:00-2:00 PM	**Lunch**		
	Session 2		
2:00-2:30 PM	Data Access and Analysis: Continue	**Hands-on Exercise (continue)**	Amita Mehta Erika Podest
2:30-3:30 PM	Overview of ISRO Satellite Remote Sensing for Flood Monitoring and Mapping	Presentation	C. M. Bhatt
3:30-3:45 PM	**Break**		
	Session 3		
3:45-5:100PM	Data Access and Analysis: Hydrological variables, optical, SAR, scatterometer & altimeter	**Hands-on Exercise:** Bhuvan, NDC	Praveen K. Thakur C M Bhatt
5:00-5:45 PM	Presentation by Participants	QGIS Analysis from Session-1&2	
5:45-6:00 PM	Summary & Q/A		

Outline: 19 November 2018

Time	Topic	Type	Presenter
	Session 4		
9:30-10:00 AM	Overview of Flood Monitoring and Mapping Based on Remote Sensing of Land Cover	Presentation	Amita Mehta
10:00-11:00 AM	Overview and Applications of Synthetic Aperture Radar (SAR)	Presentation	Erika Podest
11:00-11:15 AM	Break		
11:15 AM-12:30 PM	SAR Application for Flood Mapping (SNAP)	**Hands-on Exercise**	Erika Podest , Praveen K. Thakur, Amita Mehta
12:30-1:00 PM	Overview of Flood Monitoring and Mapping Based on Precipitation Data	Presentation	Amita Mehta
1:00-2:00 PM	**Lunch**		
	Session 5		
2:00-2:30	NRT Flood Monitoring (ERDS, GDACS, DFO)	**Demonstration**	Amita Mehta
2:30-3:30 PM	ISRO Flood Monitoring and Modeling Tools (Altimeter & Hydro models)	Presentation	Praveen K. Thakur
3:30-3:45 PM	**Break**		
	Session 6		
3:45-5:00 PM	Flood Monitoring Case Study GFMS, MODIS NRT Flood Mapping, IIRS/NRSC flood cases from ISRO	**Hands-on Exercise**	Amita, Erika, Praveen
5:00-5:45 PM	**Presentation by Participants**		
5:45-6:30 PM	Summary, Q/A, & Survey		

Remote Sensing-Based Flood Detection

There are three approaches to using remote sensing observations for flood monitoring:

1. Detecting flood water on previously dry land surfaces using satellite-derived land cover observations
2. Hydrology models that derive streamflow and runoff using precipitation and weather data from satellites and models
3. Inferring flooding conditions using satellite-derived precipitation

Note: Each flooding tool also uses model and/or surface-based data in addition to satellite data

Overview of Flood Monitoring and Mapping Based on Remote Sensing of Land Cover

Learning Objectives

By the end of this presentation, you will be able to:

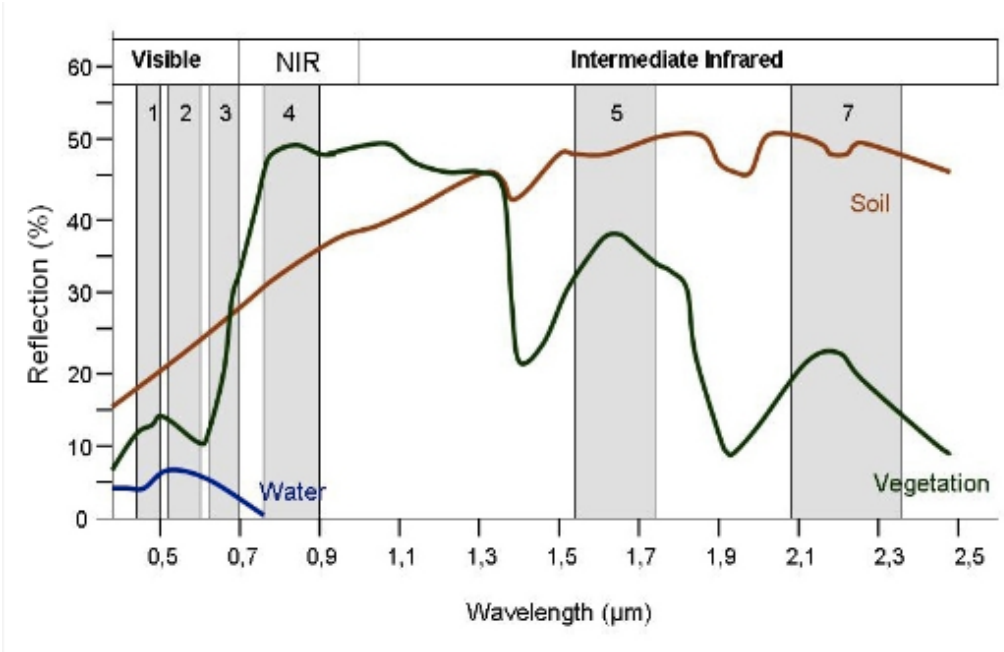
- Understand inundation tools based on remote sensing of land cover observations

Outline

- Flooding Tools Based on Land Cover Observations
  - MODIS Near Real-Time (NRT) Flood Mapping
  - Dartmouth Flood Observatory (DFO, DFO River Watch)
  - Global Flood detection System 2 (GFDS2) for Global Disaster Alert and coordination System (GDACS)
- Demonstration of MODIS NRT Flood Mapping

Land Cover Monitoring for Flood Detection

Optical Radiation: reflected by the surface and depends on the surface type

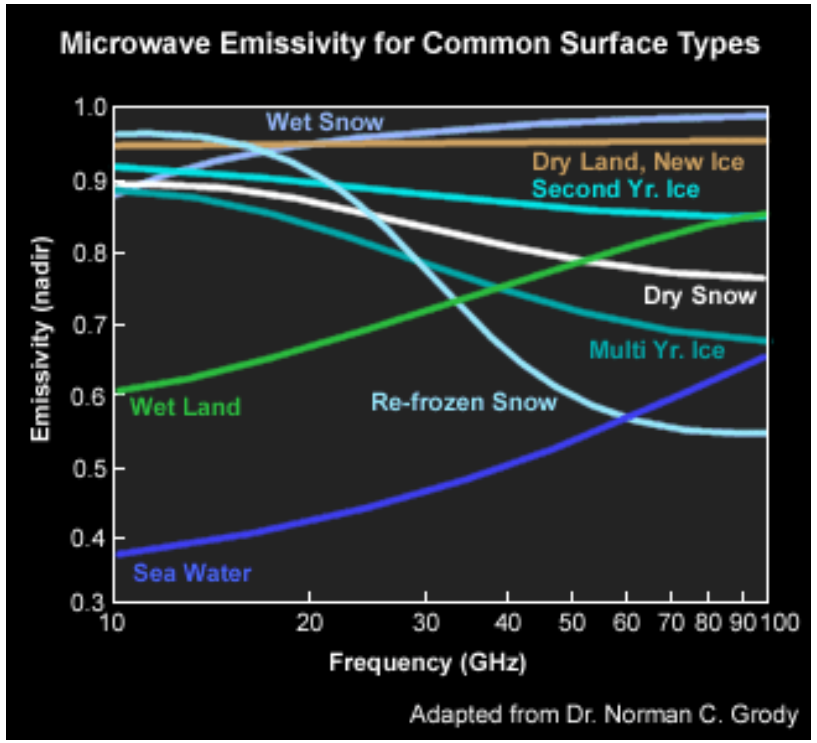


Optical Radiation

- Used for flood detection:
  - Terra/Aqua MODerate Resolution Imaging Spectroradiometer (MODIS) reflectance changes
- Used by:
  - MODIS NRT Flood Mapping
  - Dartmouth Flood Observatory(DFO)
- Used to observe land cover changes:
  - Reflectance from Landsat
- Used by: DFO

Land Cover Monitoring for Flood Detection

Passive Microwave Radiation: emitted by the surface and influenced by the presence of water

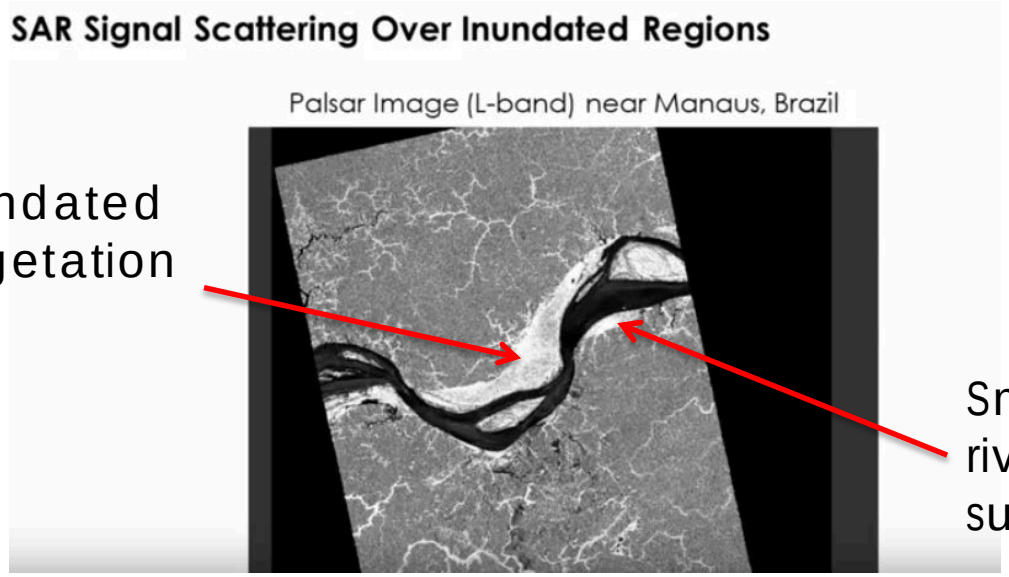


Passive Microwave Radiation

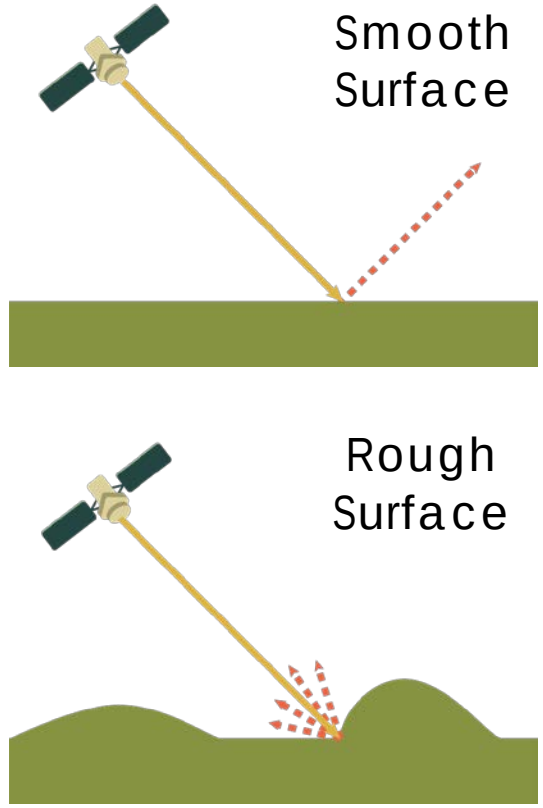
- Sources:
  - Microwave (37 GHz) brightness temperatures from TRMM Microwave Imager (TMI)
  - GPM Microwave Imager (GMI)
  - GCOM-W based Advanced Microwave Scanning Radiometer 2 (AMSR2)
- Tools:
  - GFDS2 (GDACS)
  - DFO River Watch

Land Cover Monitoring For Flood detection

- **Active Microwave Radar (Synthetic Aperture Radar)** : The backscatter signal is primarily sensitive to surface structure



Backscattering Mechanisms

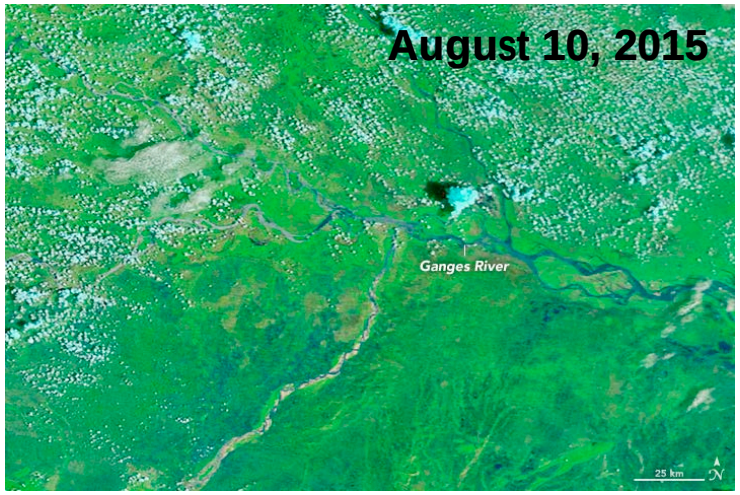


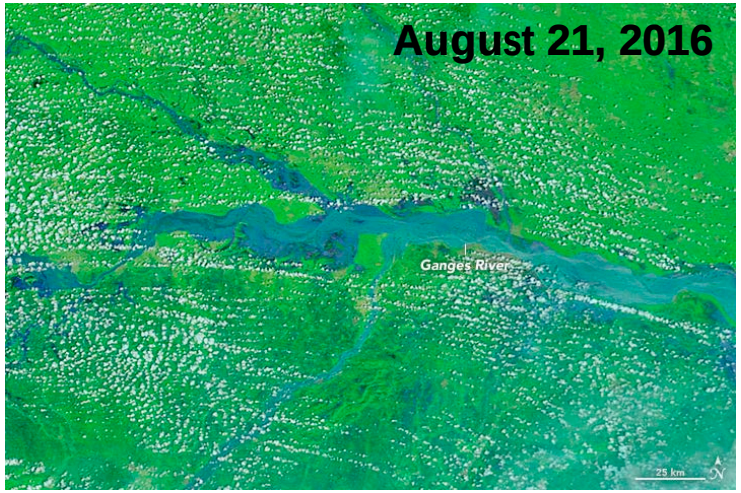
Details in next presentation

MODIS-Based Inundation Mapping [Optical Radiation]

- MODIS provides observations 1-2 times per day
- Certain bands indicate water on previously dry surfaces:
  - Band 1: 620-670 nm
  - Band 2: 841-876 nm
  - Band 7: 2105-2155 nm
- Mapped with respect to a global reference database of water bodies
- MODIS cannot see the surface in the presence of clouds

Flooding in the Ganges-- Aug 2016



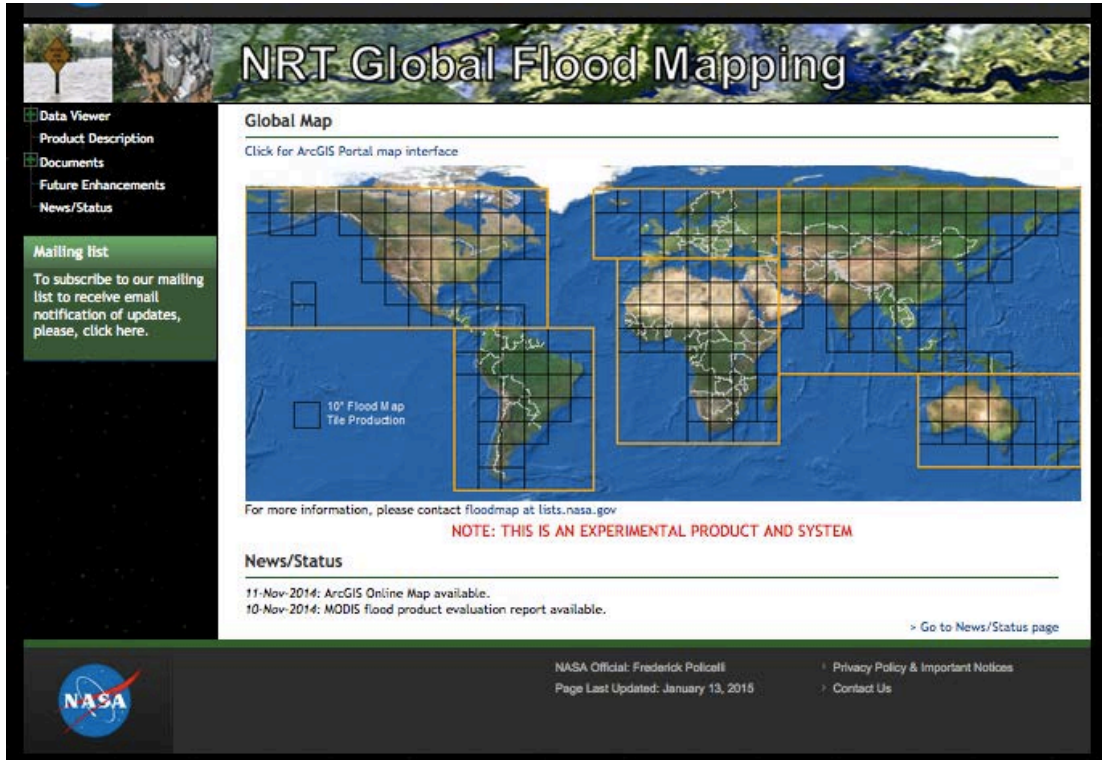


https://earthobservatory.nasa.gov/images/88624/flooding-on-the-ganges-river

MODIS NRT Global Flood Mapping Web-Tool

http://oas.gsfc.nasa.gov/

- Based on MODIS reflectance at 250 m resolution composited on 2, 3, and 14 days
- Flood maps available on 10°x10° tile
- Permanent and surface flood water data available
- Cloud or terrain shadows can be misinterpreted as surface water
- Provides near real-time flood mapping and archived flood mapping since Jan 2013



https://earthobservatory.nasa.gov/images/88624/flooding-on-the-ganges-river

MODIS NRT Global Flood Mapping: Available Quantities

http://oas.gsfc.nasa.gov/

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.

https://earthobservatory.nasa.gov/images/88624/flooding-on-the-ganges-river

MODIS NRT Global Flood Mapping: Filename Convention

https://floodmap.modaps.eosdis.nasa.gov/readme.php

Filename Convention (3-day composite)

product_date_tile_composite_xtra.ext

For Example:

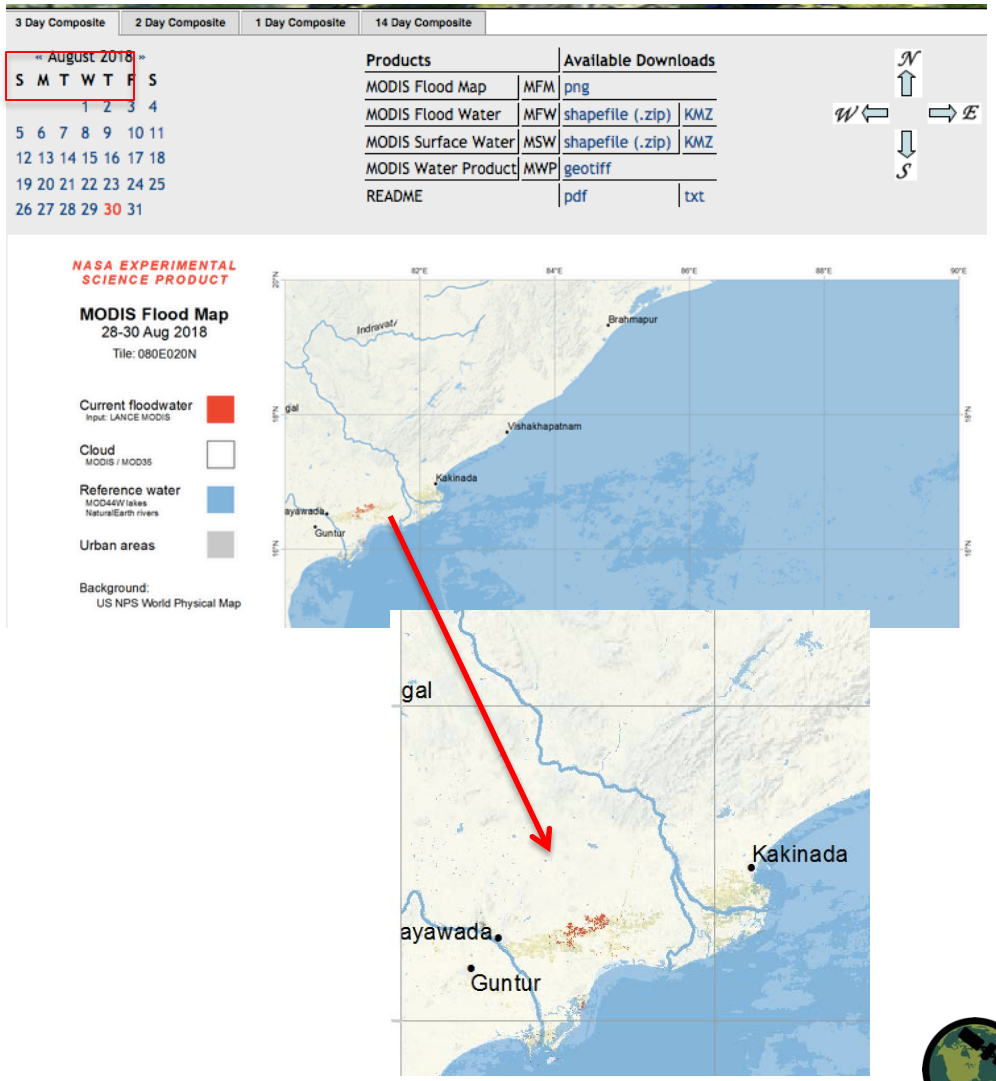
MSW_2018242_080E020N_3D3O_V.shp

MFM_2018009_080E020N_2D2O.png

yyyydoy (year, day of year)

lon-lat

2 or 3 day observations

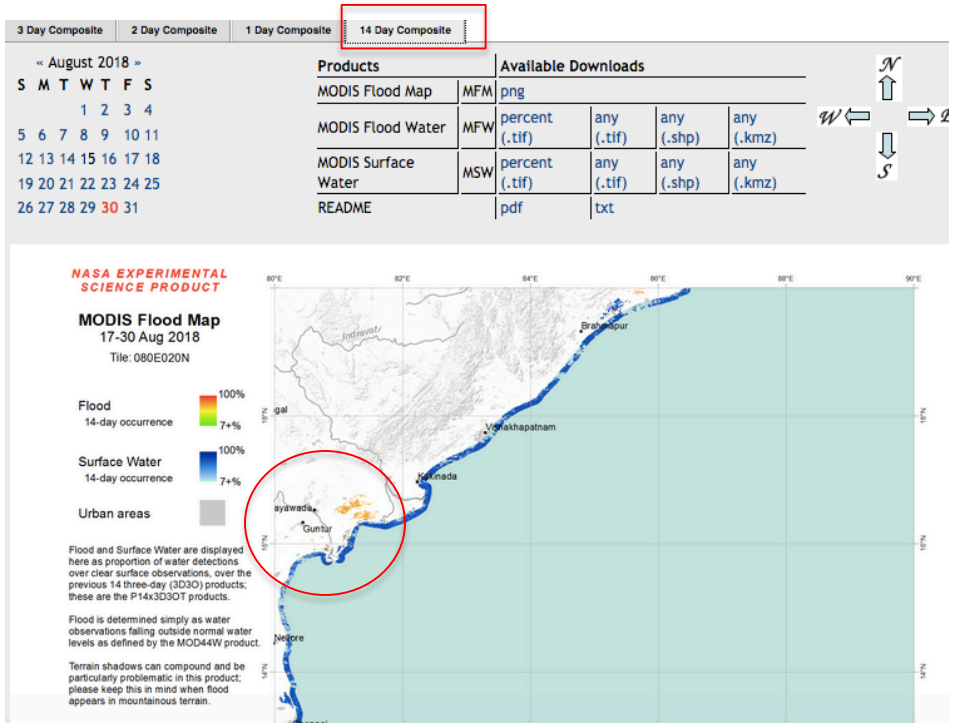


MODIS NRT Global Flood Mapping: Filename Convention

https://floodmap.modaps.eosdis.nasa.gov/readme.php

Filename Convention (14-day composite)

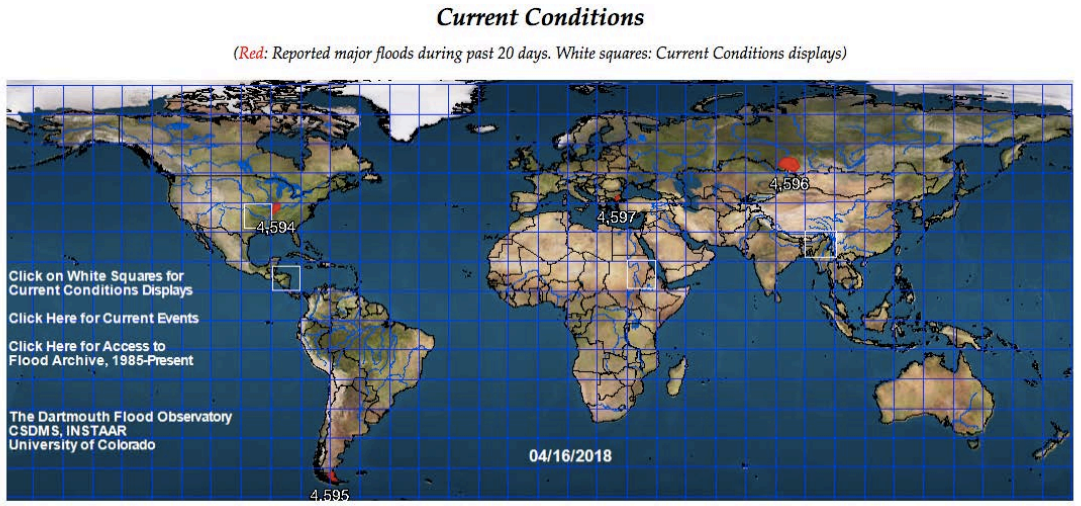
- Similar filename convention with additional processing for composite field
  - N: no shadow masking
  - T: terrain shadow masking
  - S: both terrain & shadow masking
- e.g. **2D2OT**
  - 2 days imagery, 2 observations required, terrain shadow masking applied
- Provides occurrence of water as percent clear observation over the last 14 days' products
- GeoTIFF are 0-1 images (1 if % water > 0)



Dartmouth Flood Observatory (DFO) [Optical and Microwave Observations]

http://floodobservatory.colorado.edu/

- Uses flood mapping based on MODIS reflectance
  - same as MODIS NRT
- Also uses Landsat 8, EO-1, and ASTER images
  - uses COSMO-SkyMed and Sentinel-1 synthetic aperture radar (SAR) when available)
- Current flood events are analyzed with multiple data sources, including media reports



- Provides near real-time, current, and past flood event mapping
- Red areas (above) indicate inundated surfaces

Flood Detection Based on Passive Microwave Radiation

http://www.gdacs.org/flooddetection/

- Microwave (37 GHz) brightness temperatures from TRMM Microwave Imager (TMI)
- GPM Microwave Imager (GMI)
- GCOM-W based Advanced Microwave Scanning Radiometer 2 (AMSR2)

- Used by:
  - GFDS2 (a part of Global Disaster Coordination and Alert System -- GDACS)
  - DFO River Watch

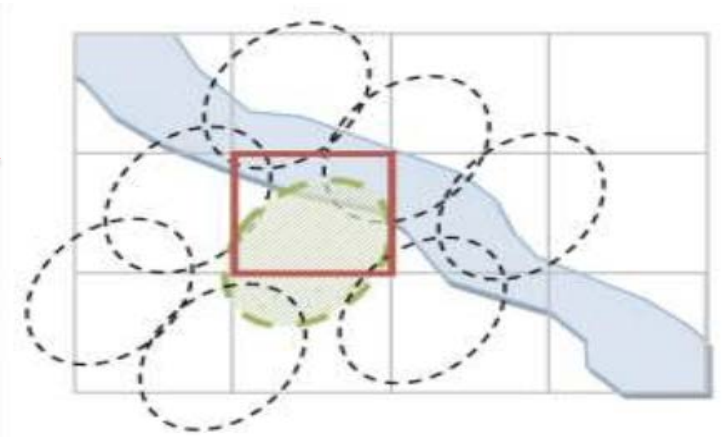
- GFDS2 and DFO River Watch are collaborative programs

Developed for GDACS in collaboration with DFO

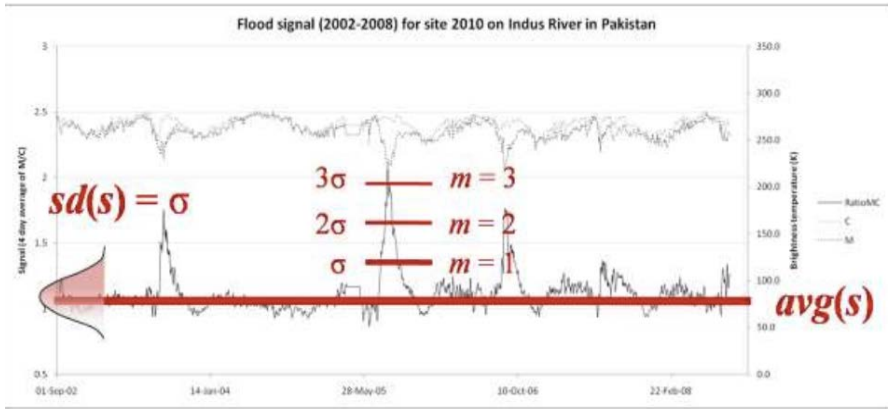
Flood Detection Based on Passive Microwave Radiation-GFDS2

http://bit.ly/GFDS_specs_15

- Joint Research Center (JRC) from the European Commission produces daily, 10 km grids of satellite signal (S) to be used by GFDS2 and DFO River Watch



- GFDS2 derives flood magnitude based on the anomalies of the ratio (S) compared to its value averaged over 7 years (records start in June 2002)



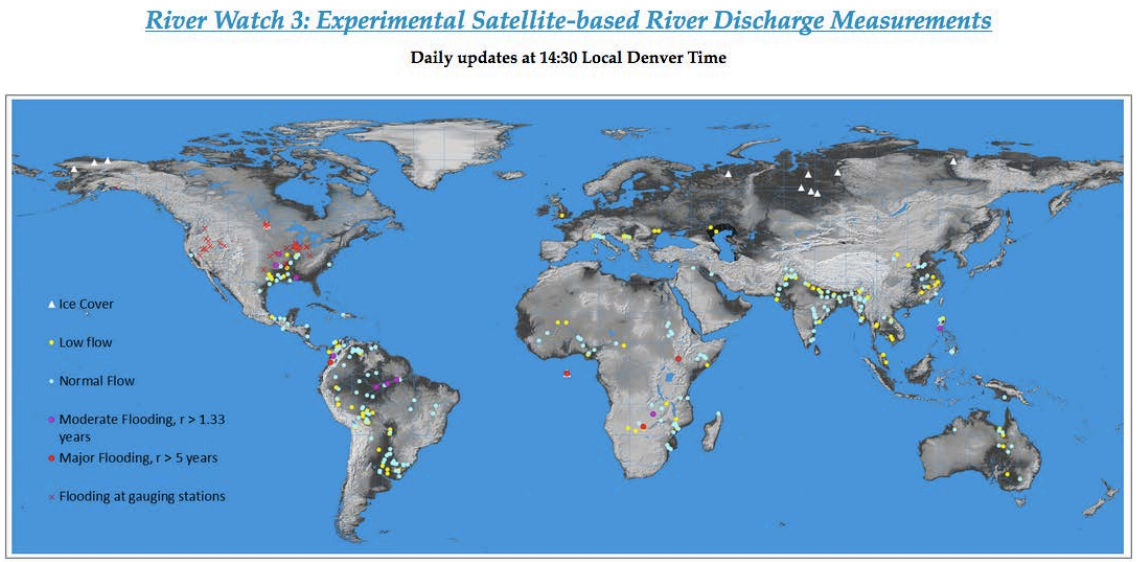
- GFDS2 flood magnitudes are used by GDACS to provide near real-time alerts

http://bit.ly/GFDS_specs_15

Flood Detection Based on Passive Microwave Radiation-GFDS2 DFO River Watch

http://floodobservatory.colorado.edu/GlobalRunoff.html

- DFO River Watch system uses the JRC-powered satellite signal (S – microwave brightness T_b ratio) at specific surface river gauging locations
- S values are converted to river discharge by combining them with surface discharge measurements and then converted to runoff by using a Water Balance Model (WBM)



Demonstration of DFO, GFDS2/ GDACS in Next Session

http://floodobservatory.colorado.edu/GlobalRunoff.html

Demonstration : MODIS NRT Flood Mapping

http://oas.gsfc.nasa.gov/

Next: Overview and Applications of Synthetic Aperture Radar (SAR)