National Aeronautics and
Space Administration

ARSET

Applied Remote Sensing Training

http://arset.gsfc.nasa.gov

@NASAARSET

Advanced Webinar on using NASA Remote Sensing for Flood Monitoring and Management

Instructors:

- Amita Mehta (ARSET)
- Kyle Peterson (ARSET)

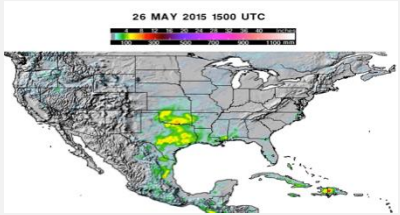
Guest Speaker:

- Sang-Ho Yun (NASA-JPL)

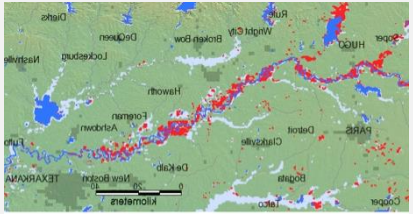
Week-3

Course Outline

Week 1: Demonstration of Flood Mapping Web Tools Based on NASA Remote Sensing Observations of Rainfall

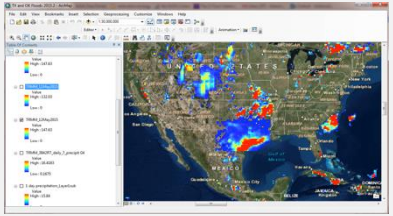


Week 2: Demonstration of Flood Mapping Web Tools Based on NASA Remote Sensing Observations of Land Cover



Week 3: Overview & Access to Ancillary NASA Data for Flood Management

Week 4: Flooding Case Studies Using NASA Web Tools and GIS



Acknowledgements

- **Training Set-up, Coordination, and Website Help**

  Tim Sough
  Brock Blevins
  Elizabeth Hook

- **QGIS Exercise**

  Kyle Peterson

Spanish Translation

  David Barbato

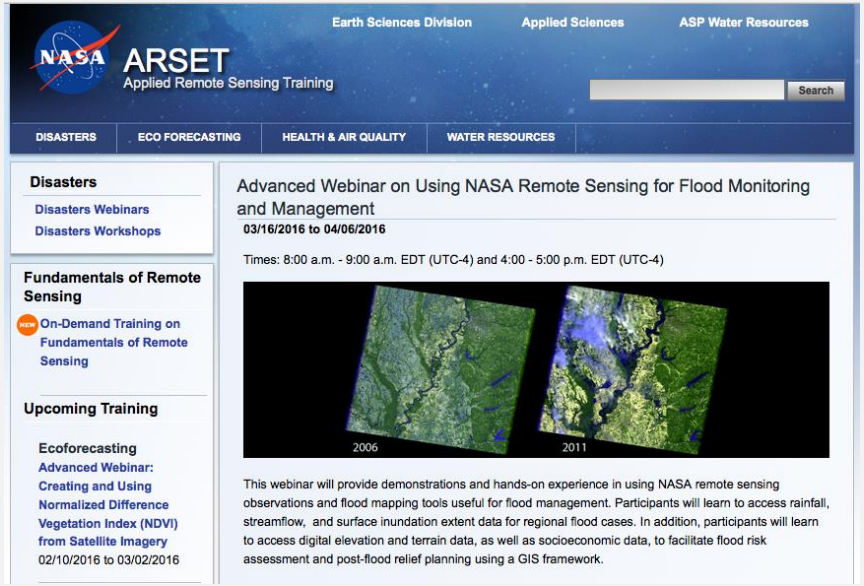
- **ARSET Manager**

  Ana Prados

Course Material

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

Webinar presentations, exercises, homework assignments, and recordings



Links will be available here

Course Materials

Date	Title	Materials
March 15, 2016	View **Week 1**, **Week 2**, and **Week 3** of **NASA Remote Sensing Observations for Flood Management**	**Homework** - due March 15
March 16, 2016	Demonstration of Flood Mapping Web Tools Based on NASA Remote Sensing Observations of Rainfall	Recording Slides Homework
March 23, 2016	Demonstration of Flood Mapping Web Tools Based on NASA Remote Sensing Observations of Land Cover	Recording Slides Homework
March 30, 2016	Overview and Access to Ancillary NASA Data for Flood Management	Recording Slides Homework
April 6, 2016	Flooding Case Studies Using NASA Web Tools and GIS	Recording Slides Homework

Homework and Certificate

- **Homework**
  - Hands-on exercises
  - Answers to homework questions via Google form
  - Available at http://arset.gsfc.nasa.gov/disasters/webinars/advfloodwebinar
- **Certificate of Completion**
  - Attend all 4 webinar sessions
  - Complete all 4 homework assignments
  - Certificates will be emailed approx. 2 months after the course finishes by Marines Martins (marines.martins@ssaihq.com)

Agenda: Week 3

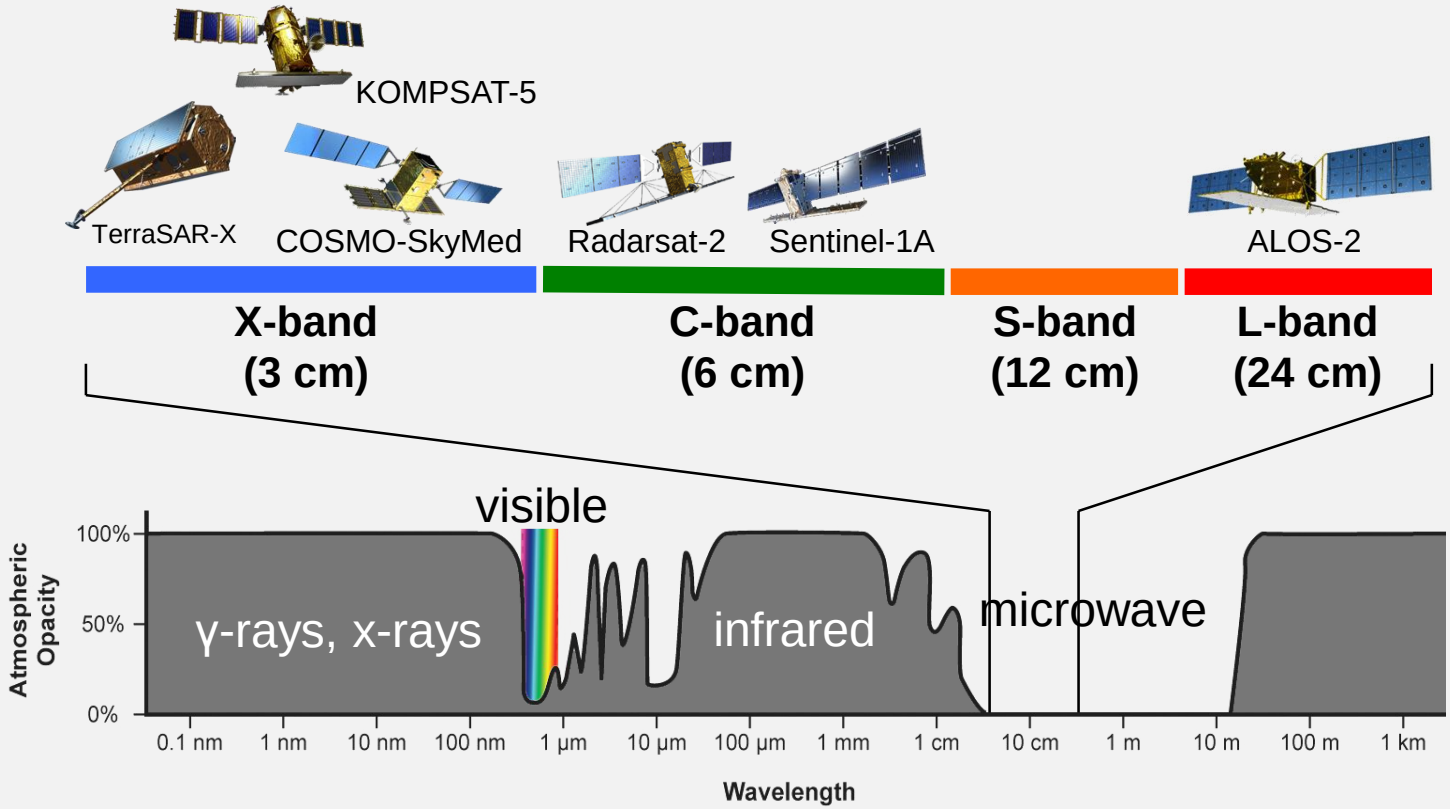
- Synthetics Aperture Radar data and application for flood monitoring
- Overview and Demonstration of Data Access and import into QGIS:
  - Shuttle Radar Topography Mission terrain data access relevant for flood plain identification
  - NASA Socio-economics data access useful for flood preparedness and relief planning

Synthetic Aperture Radar for Rapid Flood Extent Mapping

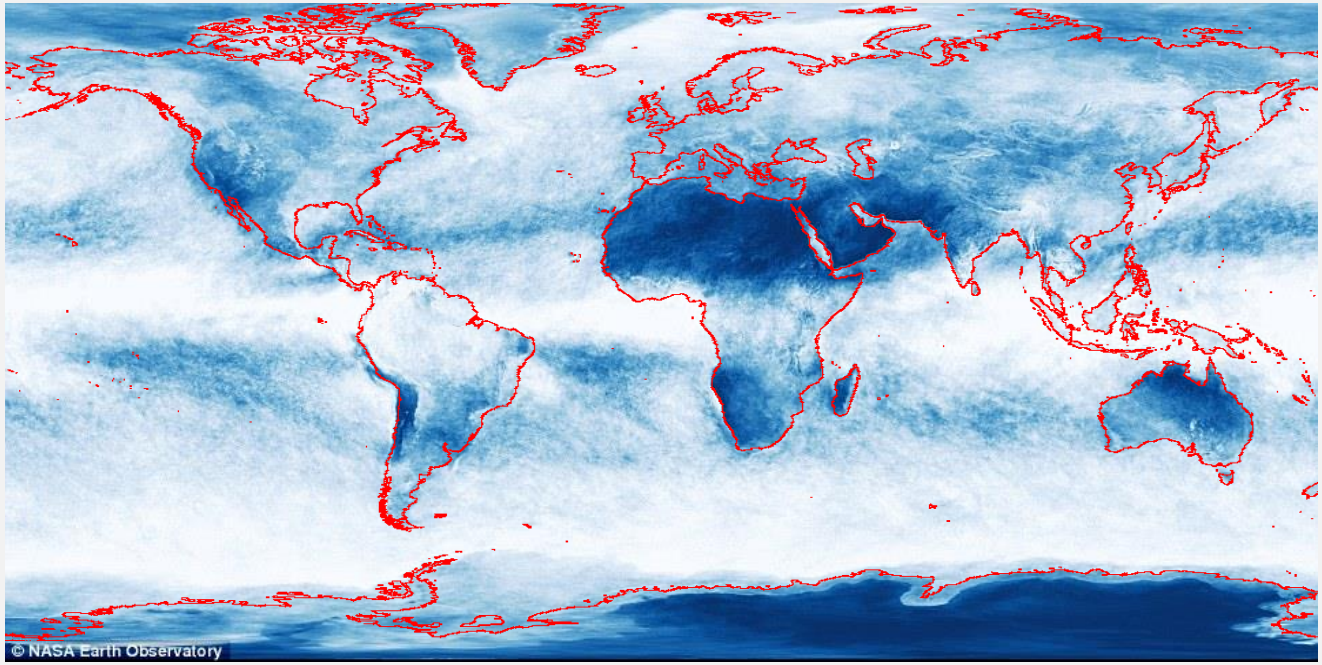
Sang-Ho Yun
ARIA Team
Jet Propulsion Laboratory
California Institute of Technology

Image Credit: Terra MODIS/Worldview; 17 Jan 2016

Atmospheric Windows & Current SAR Missions

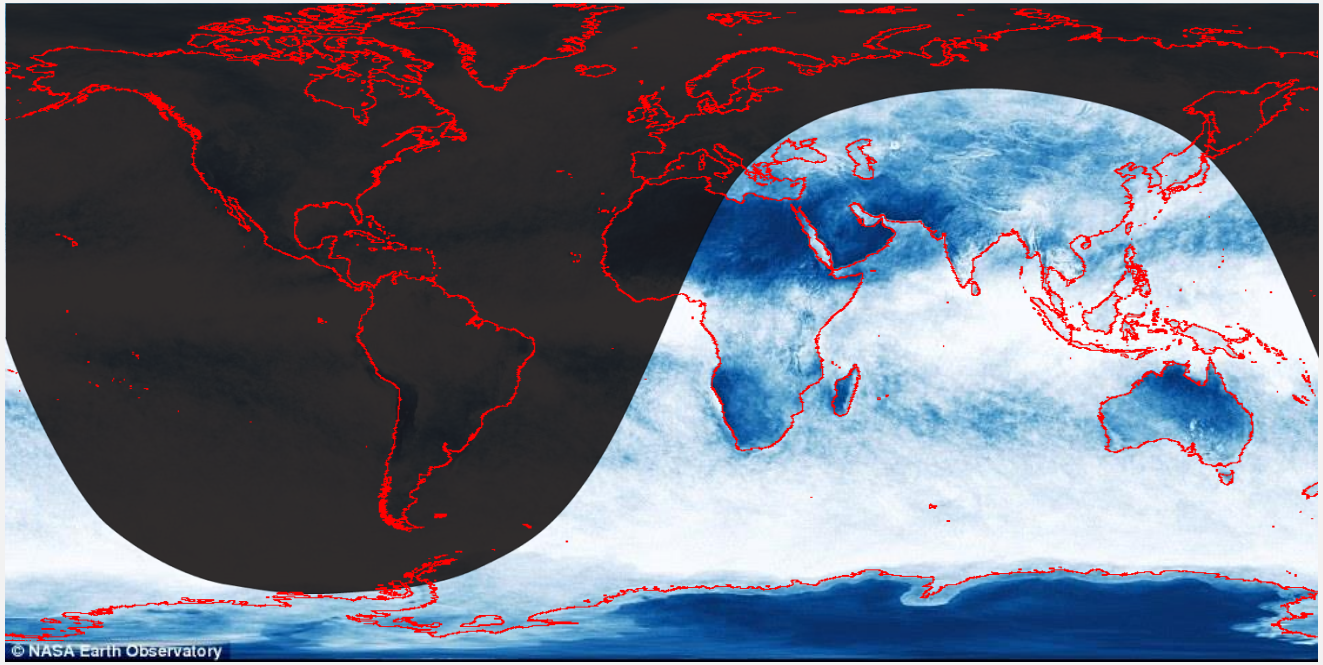


Earth is Mostly Cloudy



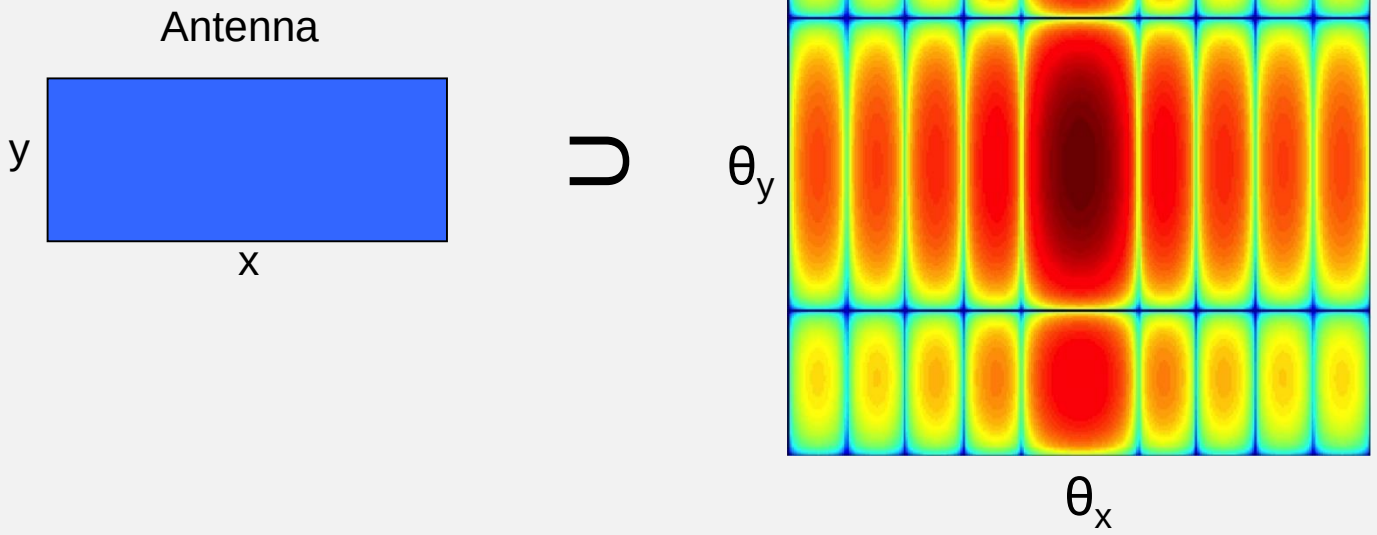
Average cloudiness over Earth in April 2015 seen from Aqua Satellite. At any given time, around 70% of the Earth is covered by clouds.

And Half Dark

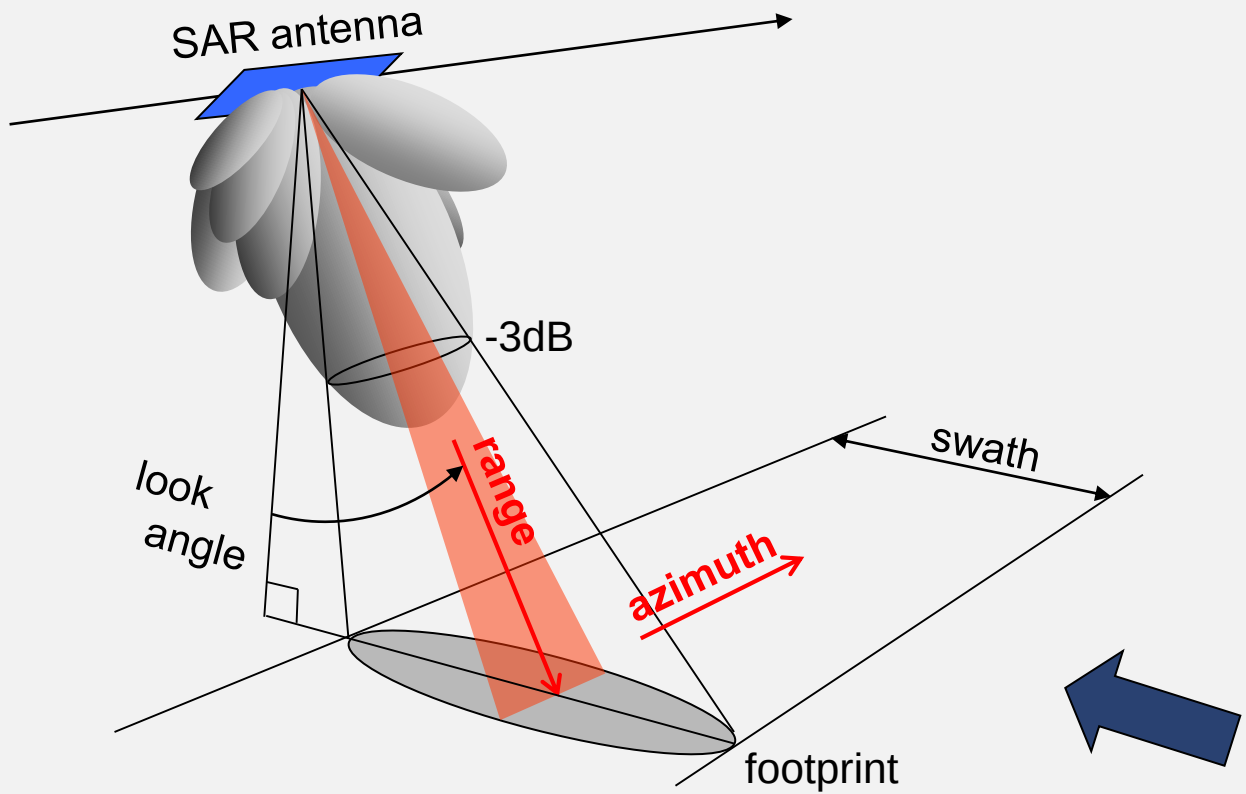


At any given time, 50% of the earth is dark.

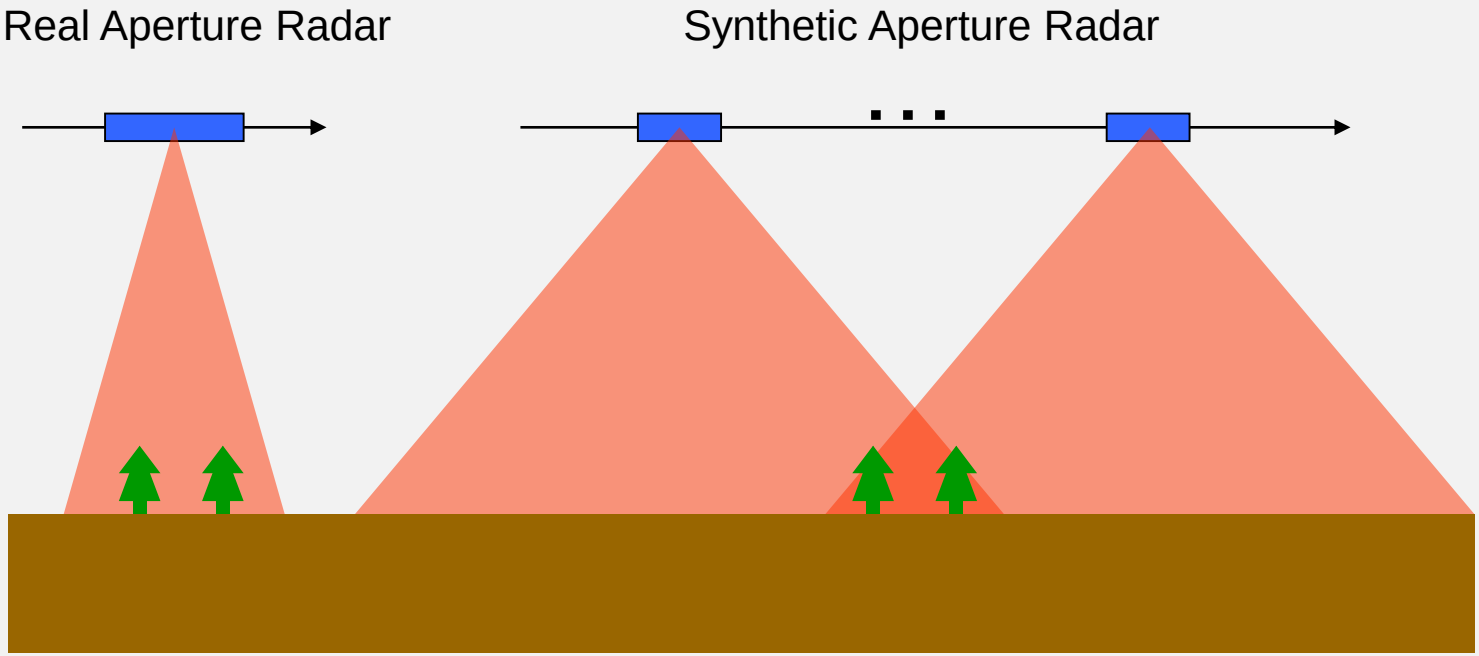
Radiation Pattern



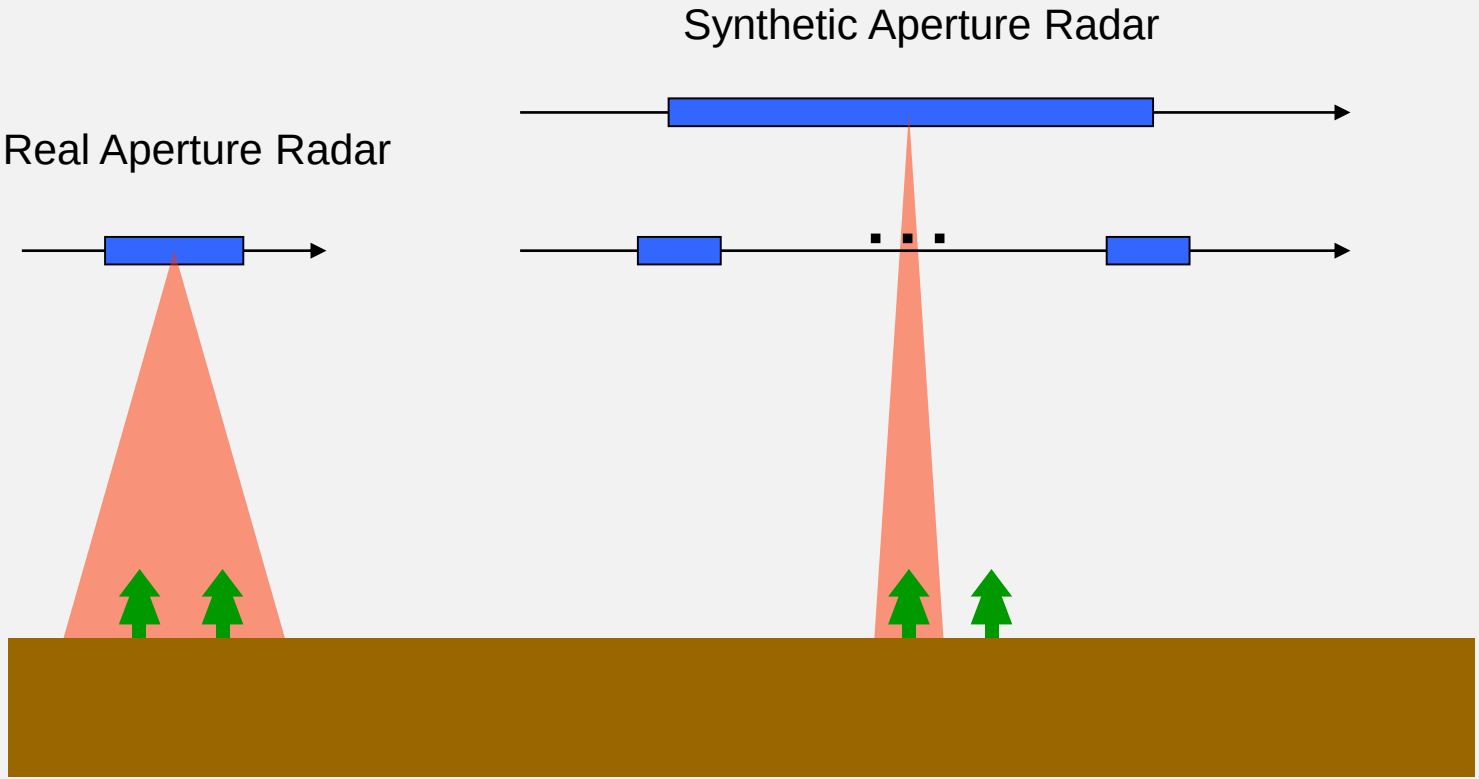
Some Imaging Radar Jargon



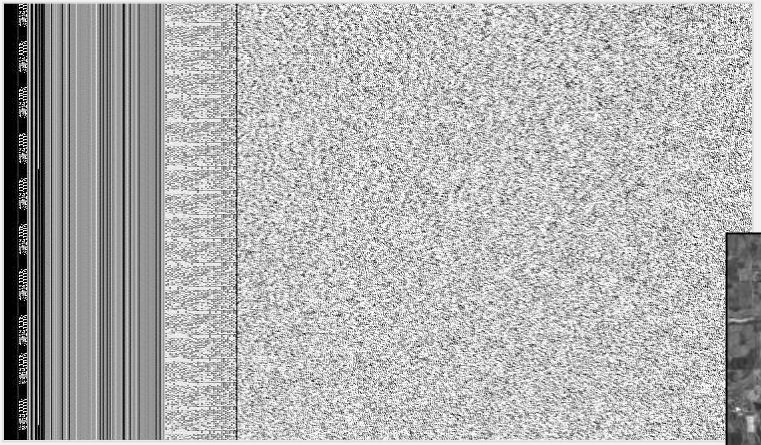
Synthetic Aperture Radar (SAR)



Synthetic Aperture Radar (SAR)

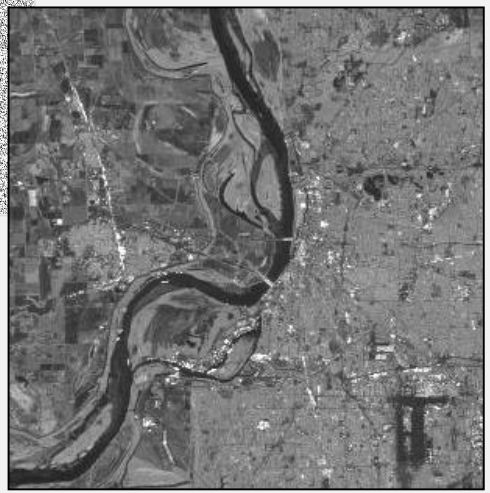


SAR image (amplitude)

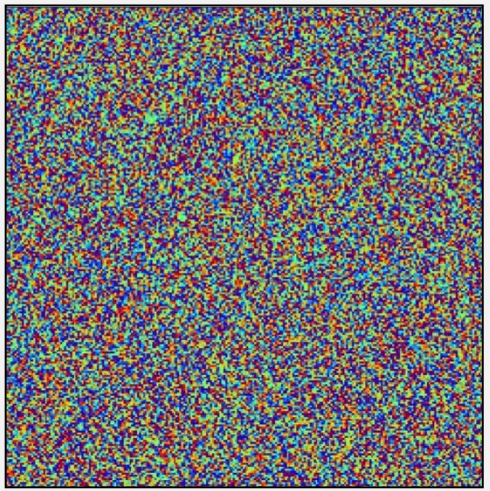


Raw data (complex)

SAR processing

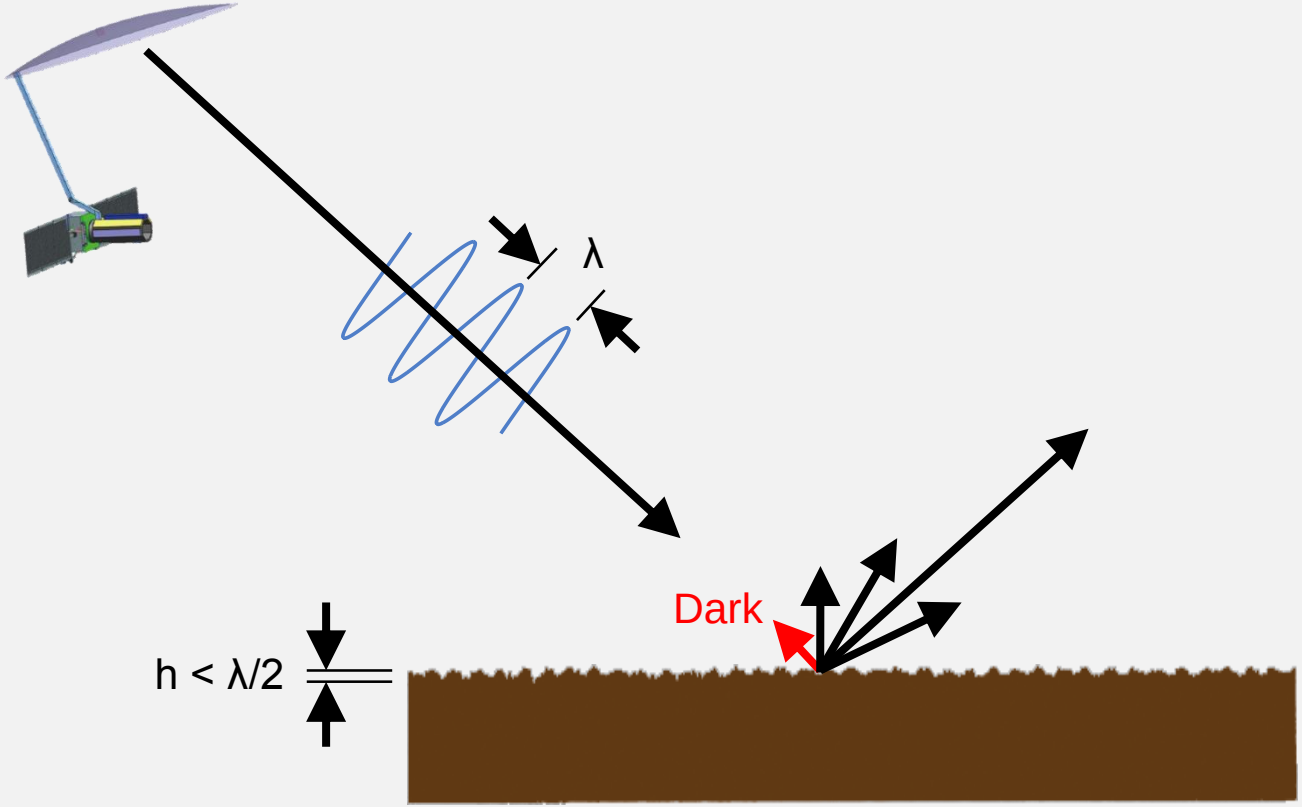


Amplitude

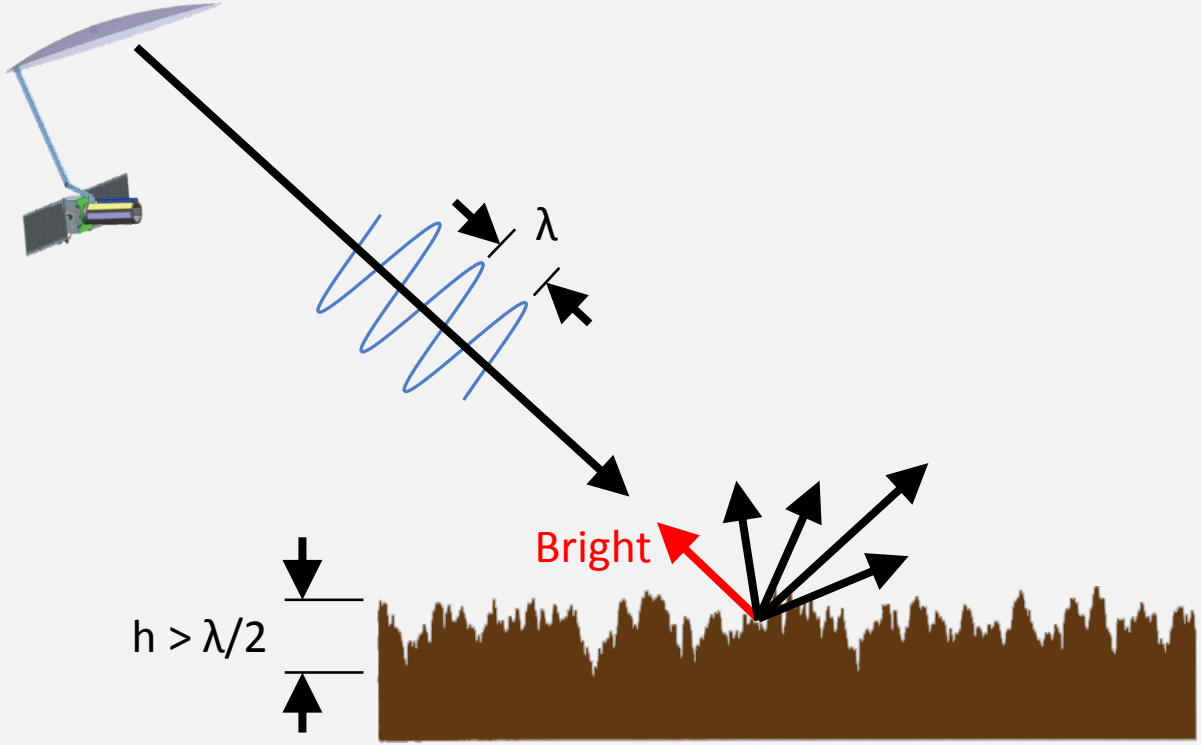


Phase

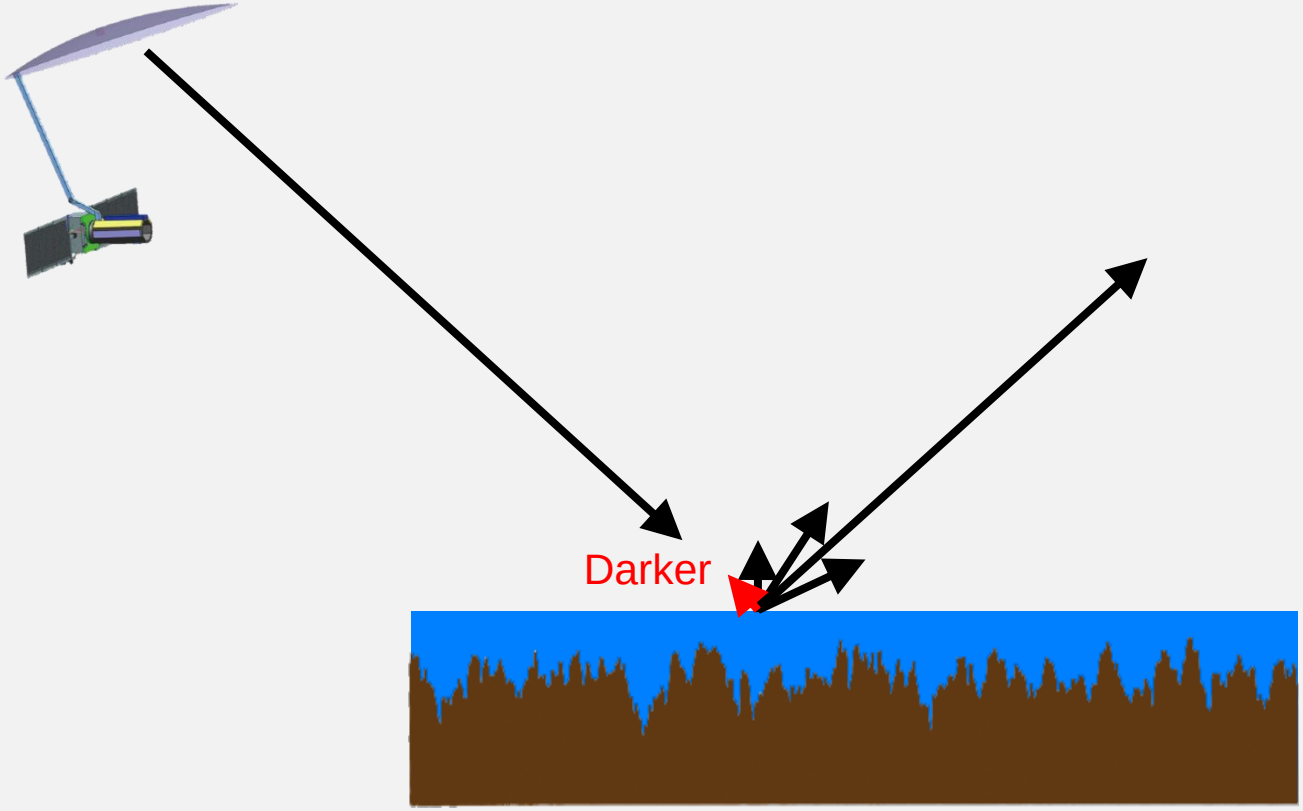
Microwave Scattering (Smooth)



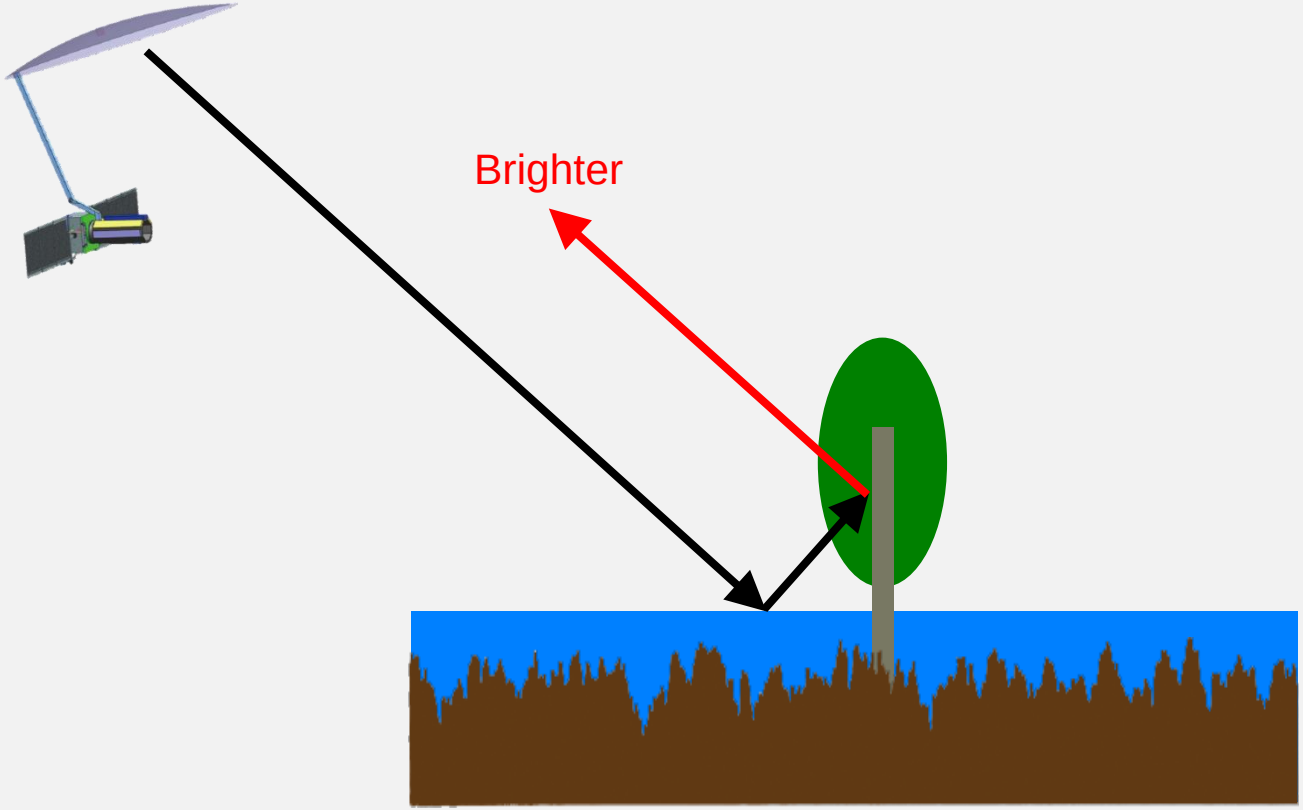
Microwave Scattering (Rough)



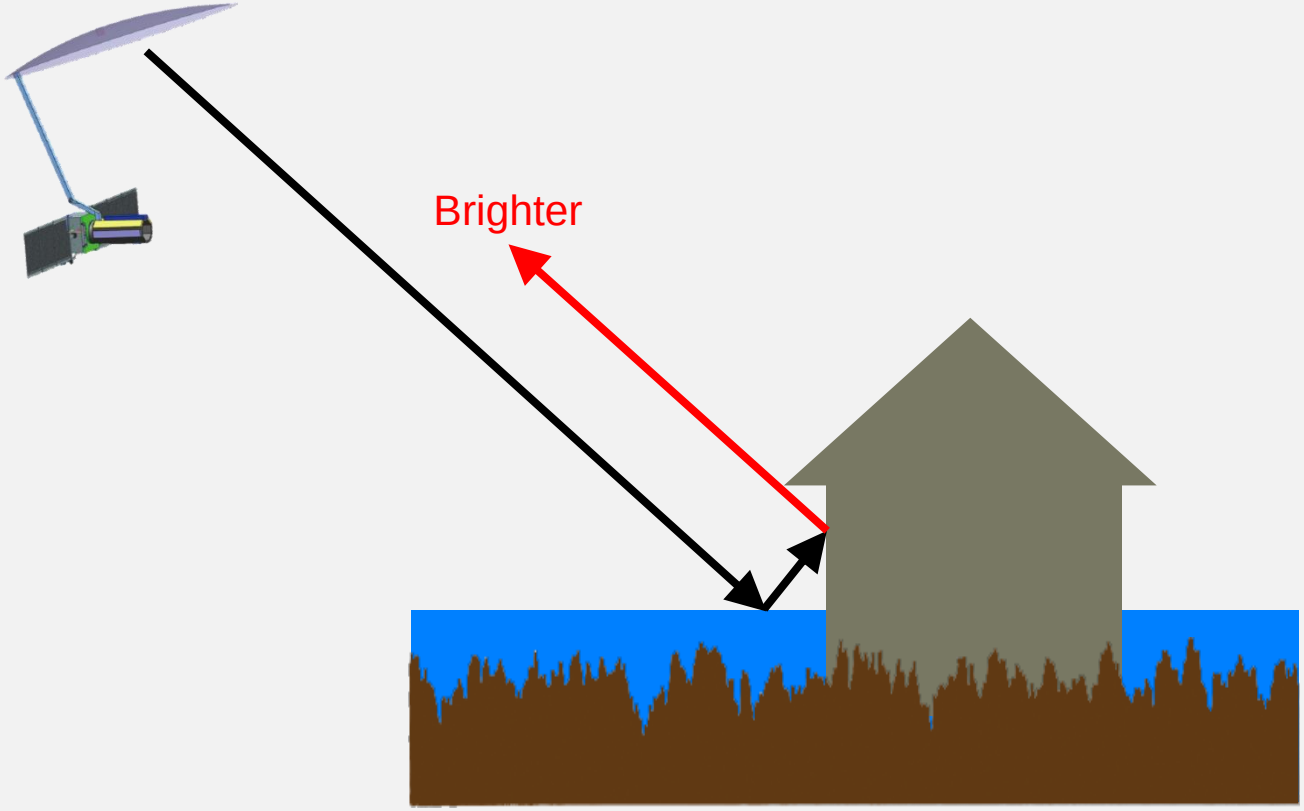
Floods Form Smooth Surface



Floods with Tall Vegetation

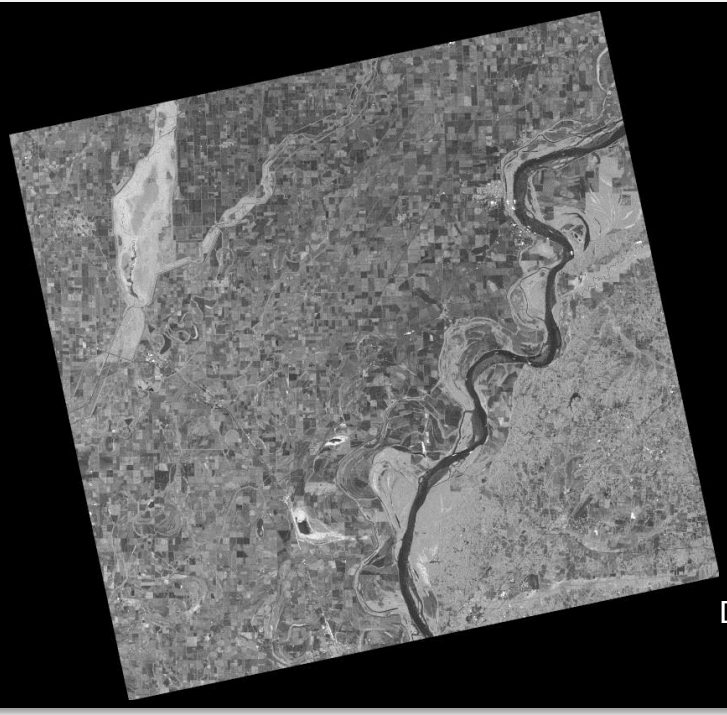


Floods with Artificial Structure



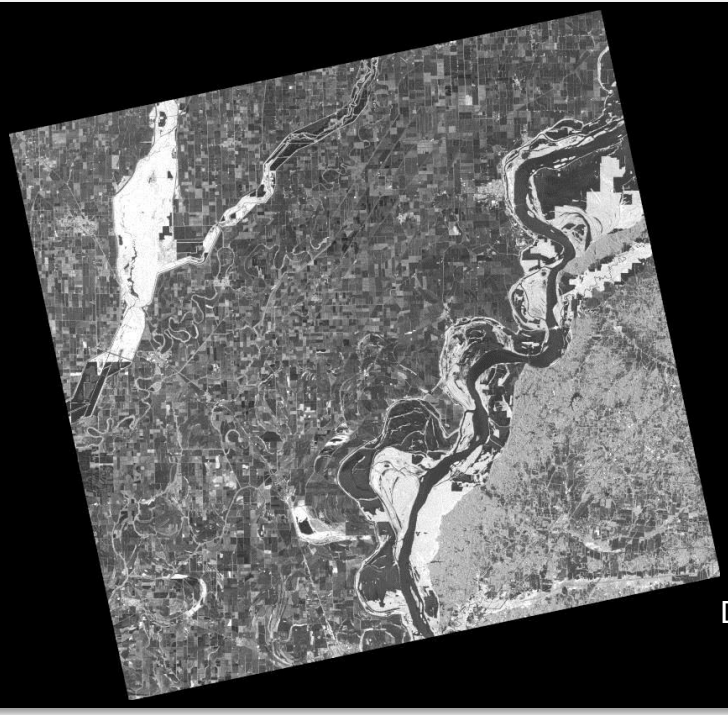
SAR Image (Before)

ALOS-2
2015-09-30



SAR Image (After)

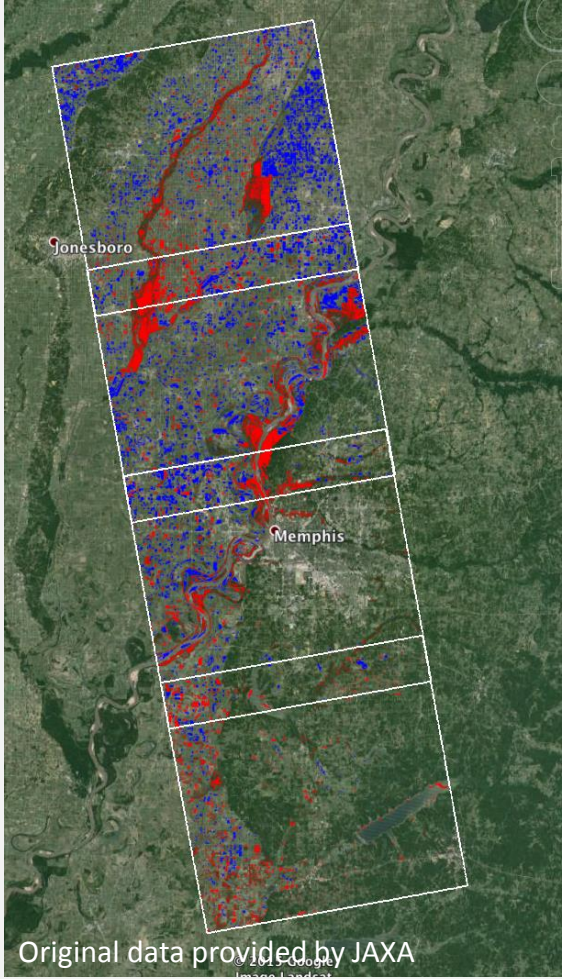
ALOS-2
2016-01-06



Flood Extent Maps

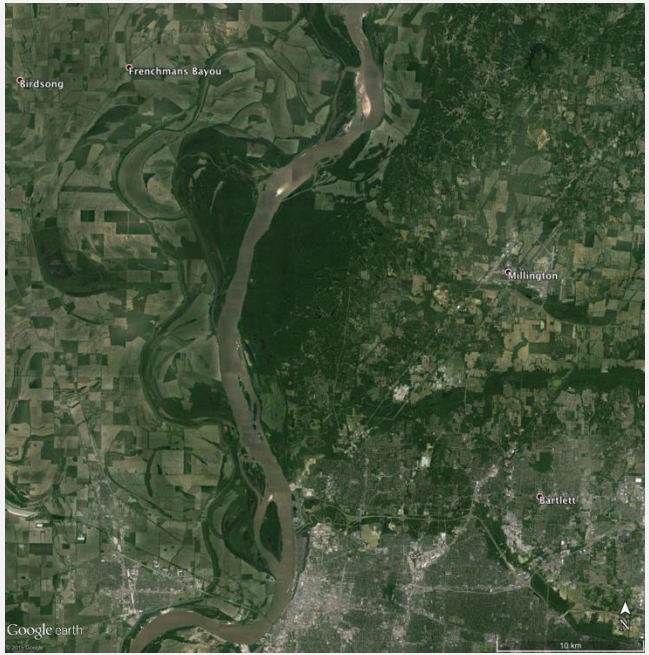
- Derived from ALOS-2 SAR Data
- 2016-01-06 data compared to 2015-09-30
- Processing Level: 1.5
- Coverage: 70 km x 240 km
- Resolution: ~12 m
- Area of potential floods: Blue + Red
- Blue polygons: Floods with smooth surface
- Red polygons: Floods with tall vegetation

- Product formats
  - KMZ (Polygons)
  - KMZ (PNG image)
  - GeoTiff
  - Shapefile
- Available to download at http://aria-share.jpl.nasa.gov/events/20160111-US_Midwest_Floods/

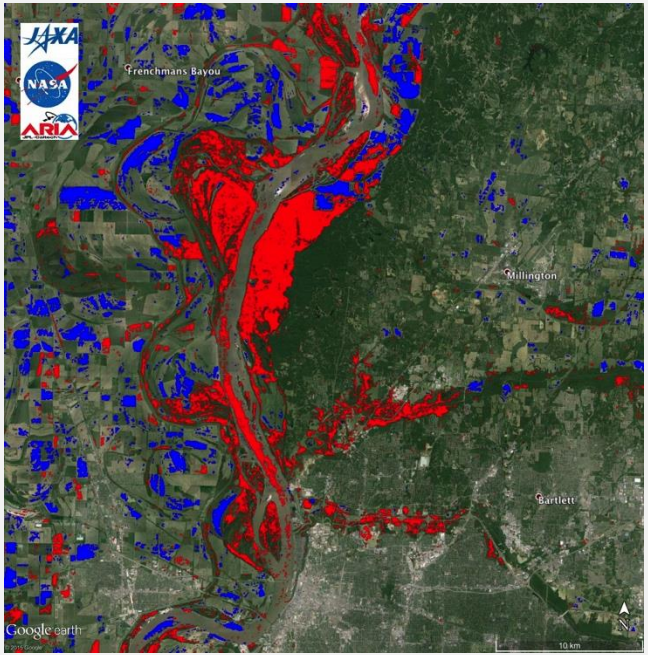


Flood Extent Map

Google Earth

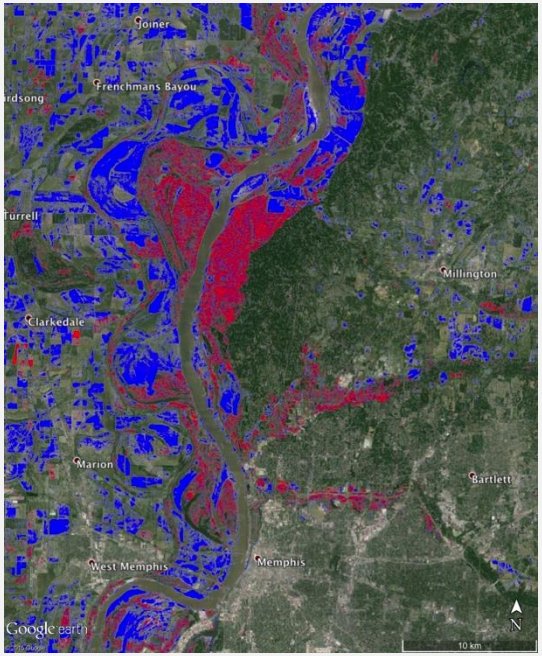


NASA Flood Map

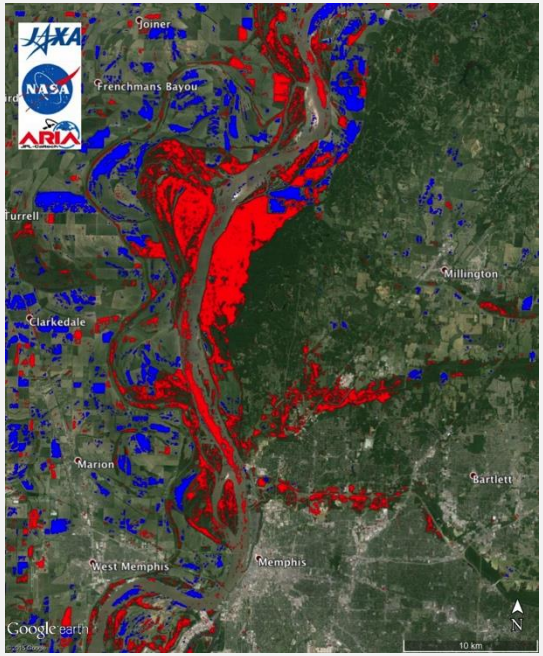


Flood Extent Map

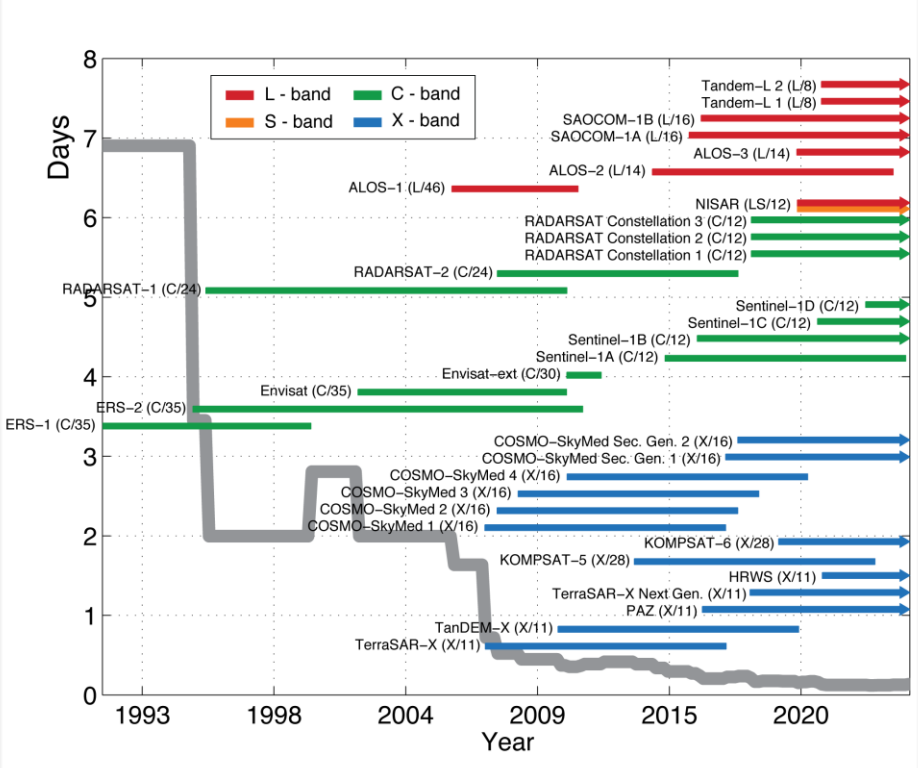
JAXA Flood Map



NASA Flood Map



SAR Data Acquisition Latency



Summary

- Radar sensors see through clouds day and night.
- Synthetic Aperture Radar achieves high resolution (3 – 20 m) over a wide swath (50 – 250 km).
- SAR amplitude is sensitive to floods, with pixel values becoming either darker or brighter.
- Achievable SAR data acquisition latency is already less than a day

Shuttle Radar Topography Mission (SRTM)

Courtesy: Cynthia Schmidt (NASA-ARSET)
Lindsey Harriman (USGS), Kelly Lemig (USGS)

Image Credit: Terra MODIS/Worldview; 17 Jan 2016

What is SRTM?

- A Radar mission, carried by NASA Space Shuttle Endeavour, Was completed in February 2000
- Consisted of 176 orbits around Earth in 11 days
- Acquired Digital Elevation Model (DEM) of all land between 60^{o}N and 56^{o}S latitude, about 80% of Earth's total land mass

Useful for Mapping

Hazardous terrain

Calculating

Slope and aspect
Catchment area
Forest canopy height

Modeling

Runoff
Stream networks
Landslides

SRTM v3 Data Product

Tile size	1º by 1º
Pixel size	1 arc second (~30 meters) or 3 arc seconds (~90 meters)
Geographic coordinates	Geographic latitude and longitude
Output format	DEMS: .HGT, 16-bit signed integer, in units of vertical meters Number: .NUM
Geoid reference	WGS84/EGM96
Special DN values	N/A - No voids in v3
Coverage	60ºN to 56ºS latitude U.S. and Territories Africa

New version released in 2014 has high resolution

How to Access SRTM v3 Terrain data

- Reverb: http://reverb.echo.nasa.gov/reverb

- GDEx: http://gdex.cr.usgs.gov/gdex/
- CGIAR-CSI http://srtm.csi.cgiar.org

Interactive Data Access Tools

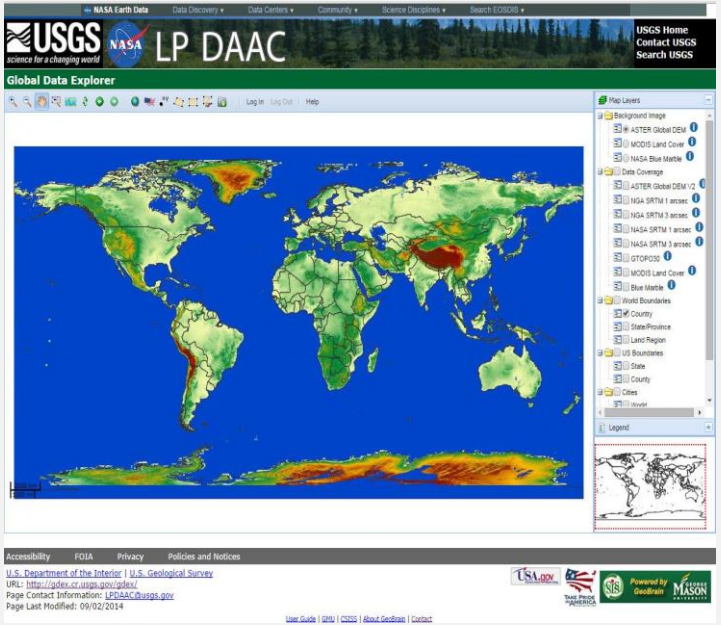
- Data Pool and DAAC2Disk: https://lpdaac.usgs.gov/data_access/data_pool

- More information: SRTM v3 User Guide https://lpdaac.usgs.gov/sites/default/files/public/measures/docs/NASA_SRTM_V3.pdf

GDEx

http://gdex.cr.usgs.gov/gdex/

- A seamless data viewer providing access to multiple sources of digital elevation data sets
- Users can subset and download data by area of interest in multiple formats and projections
- NASA ECHO/Reverb user account required to download data
- Product documentation and User Guide
- Square or polygonal area of interest
- Pre-defined areas of interest (state, county)
  - A dvanced, on-the-fly processing
  - Mosaic tiles coverage clipped to area of interest
  - Reformat to GeoTIFF, ArcASCII, or JPEG
    universal transverse Mercator (UTM) or LAT/LON projection



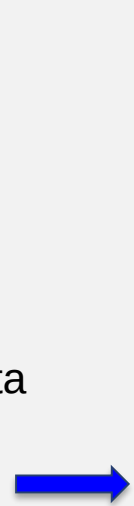
Data can be previewed before download

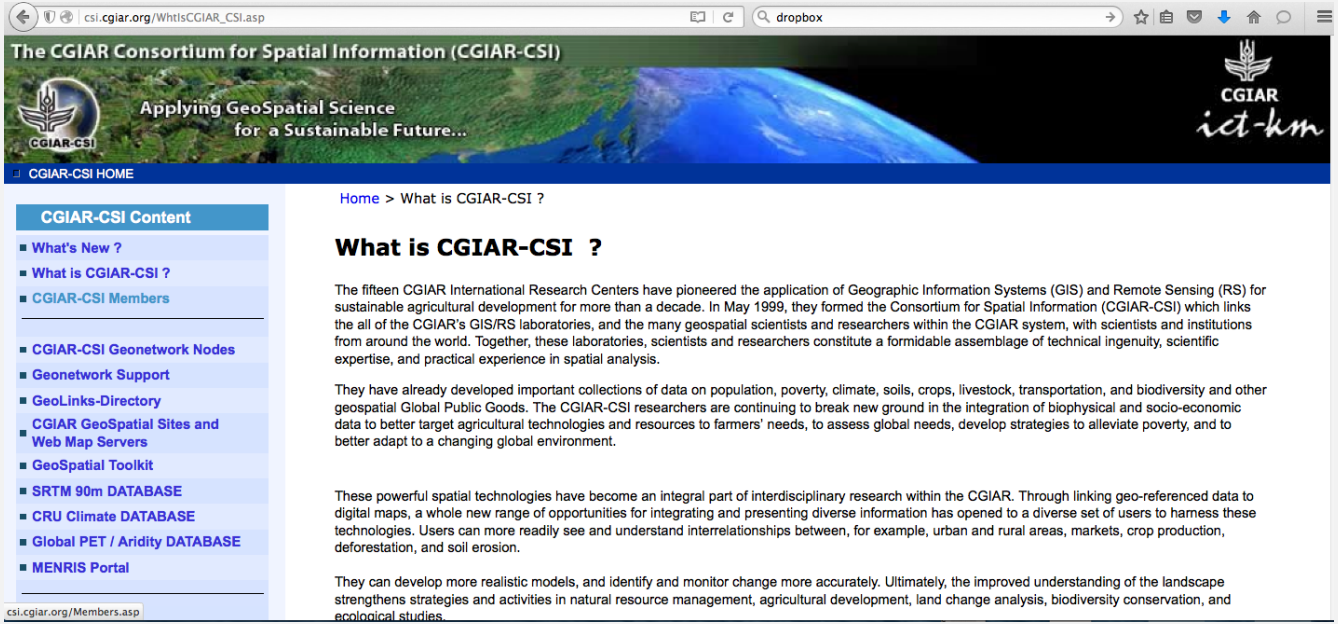
CGIAR-CSI

http://csi.cgiar.org/WhtIsCGIAR_CSI.asp

Consultative Group for International Agricultural Research/Consortium of Spatial Information

SRTM Data





Overview of NASA Socioeconomic Data

http://sedac.ciesin.columbia.edu/

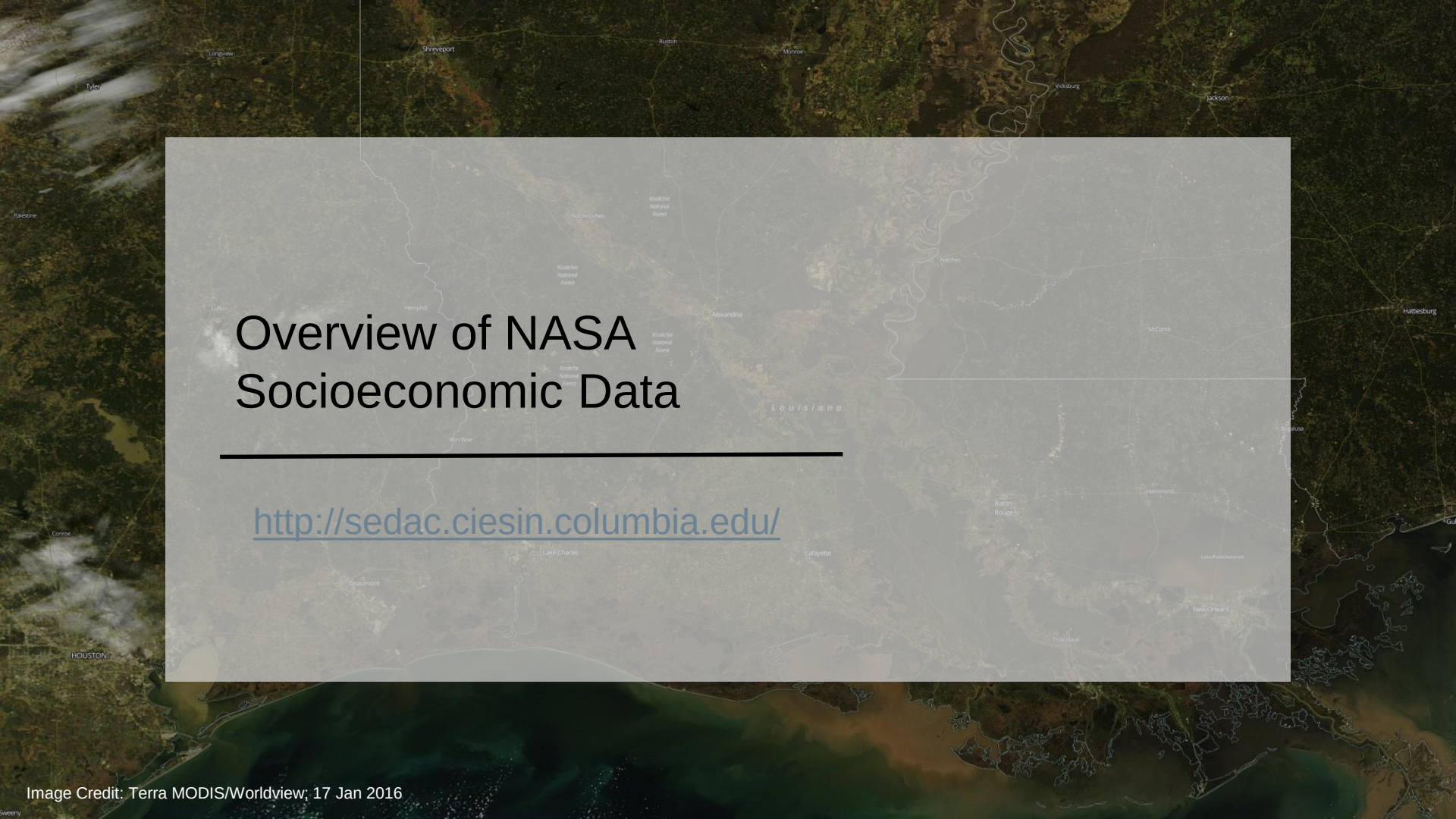
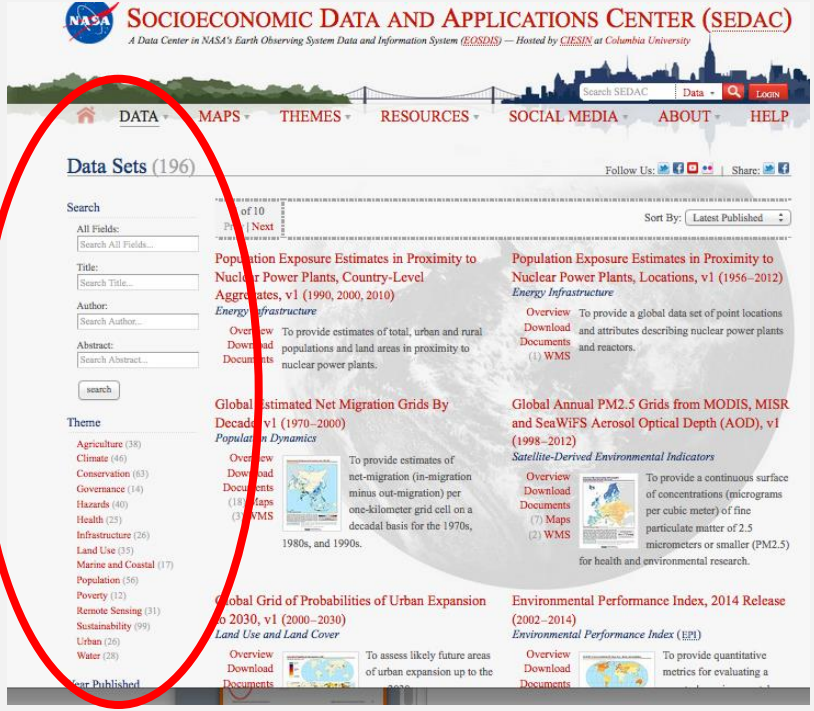


Image Credit: Terra MODIS/Worldview; 17 Jan 2016

Socioeconomic Data and Applications Center (SEDAC)

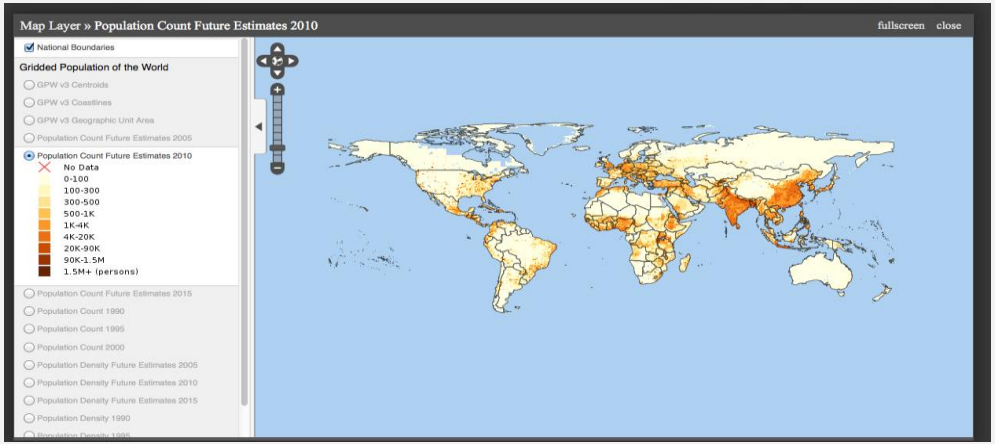
http://sedac.ciesin.columbia.edu/



- User registration required
- There are 196 data sets from 16 thematic areas
- Information and documents about the data sets available on-line
- Multiple options for data formats and download
- Interactive mapping and visualization possible

Socioeconomic Data and Applications Center (SEDAC)

http://sedac.ciesin.columbia.edu/



- A number of socioeconomic data available that be used along with the flood monitoring tools to facilitate the post-flooding rescue and recovery phases such as:
- Global Urban Areas and Population Density
- Global Roads and Dams
- Nuclear Power Plant Locations and Population Exposure Estimates in the Proximity

Demonstration of SRTM and SEDAC Data Analysis in QGIS

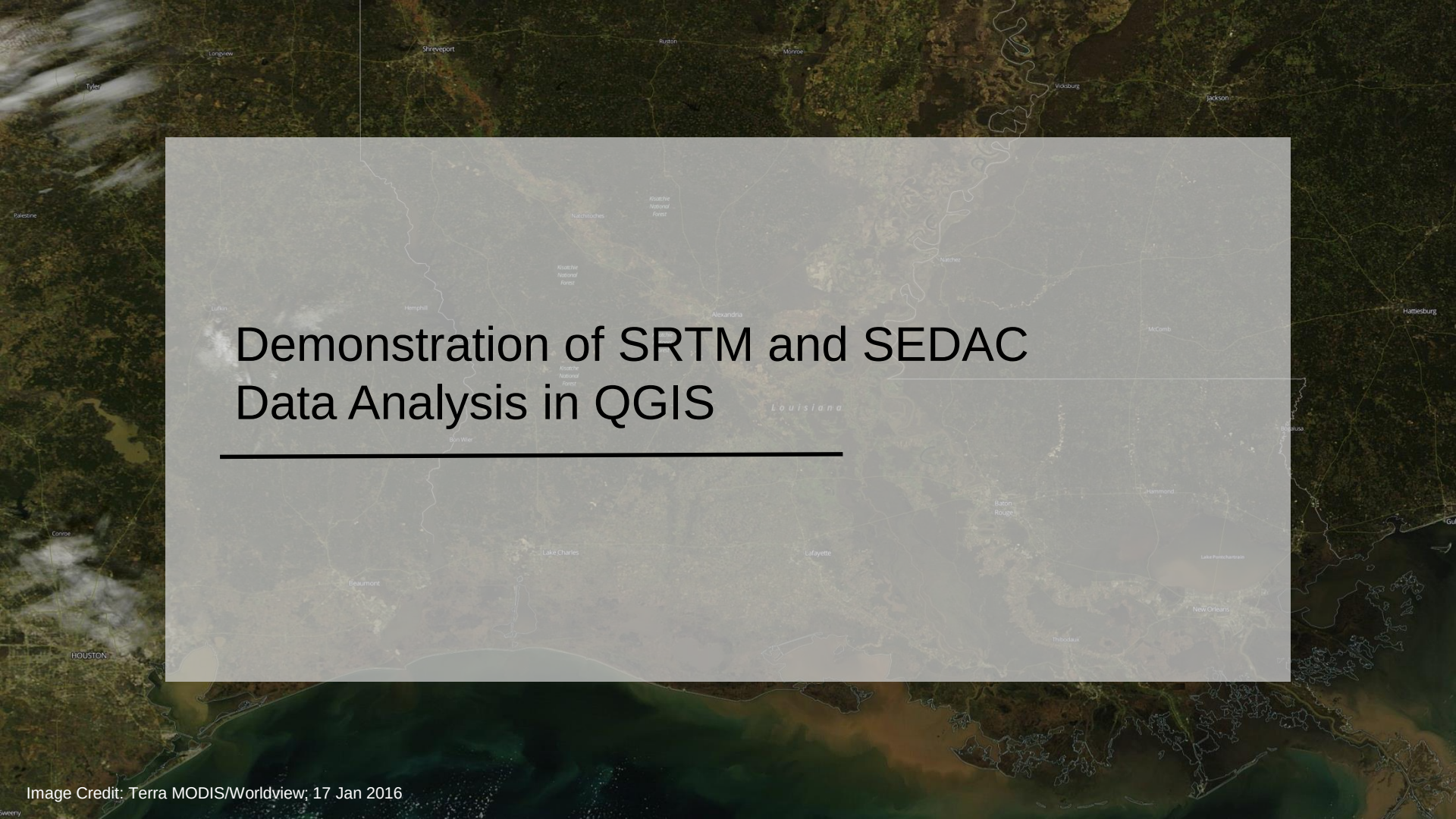


Image Credit: Terra MODIS/Worldview; 17 Jan 2016

Coming Up Next Week

Flooding Case Studies

- Flood Monitoring and Mapping Using GFMS, ERDS, MODIS NRT, DFO
- Using SRTM and SEDAC data for Flood Management and Relief Planning
  - Mississippi Flooding January 2016
  - India Flooding November 2015
- Course Summary

Thank You

The recording of today's session will be available shortly at
http://arset.gsfc.nasa.gov/disasters/webinars/advfloodwebinar