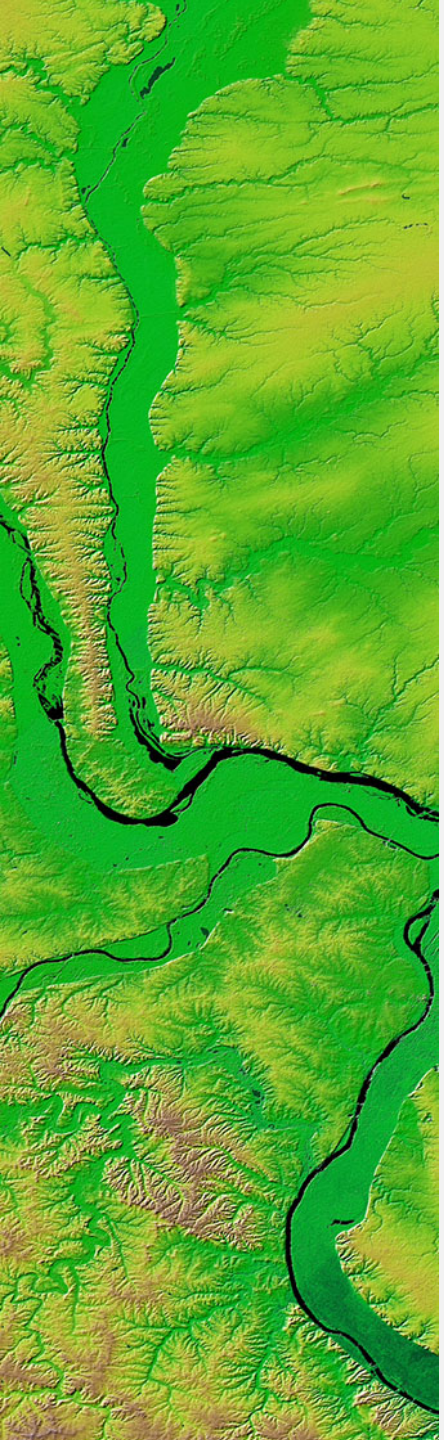


National Aeronautics and
Space Administration

ARSET

Applied Remote Sensing Training

http://arset.gsfc.nasa.gov

@NASAARSET

Overview of Digital Elevation from Shuttle Radar Topography Mission (SRTM) and Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER)

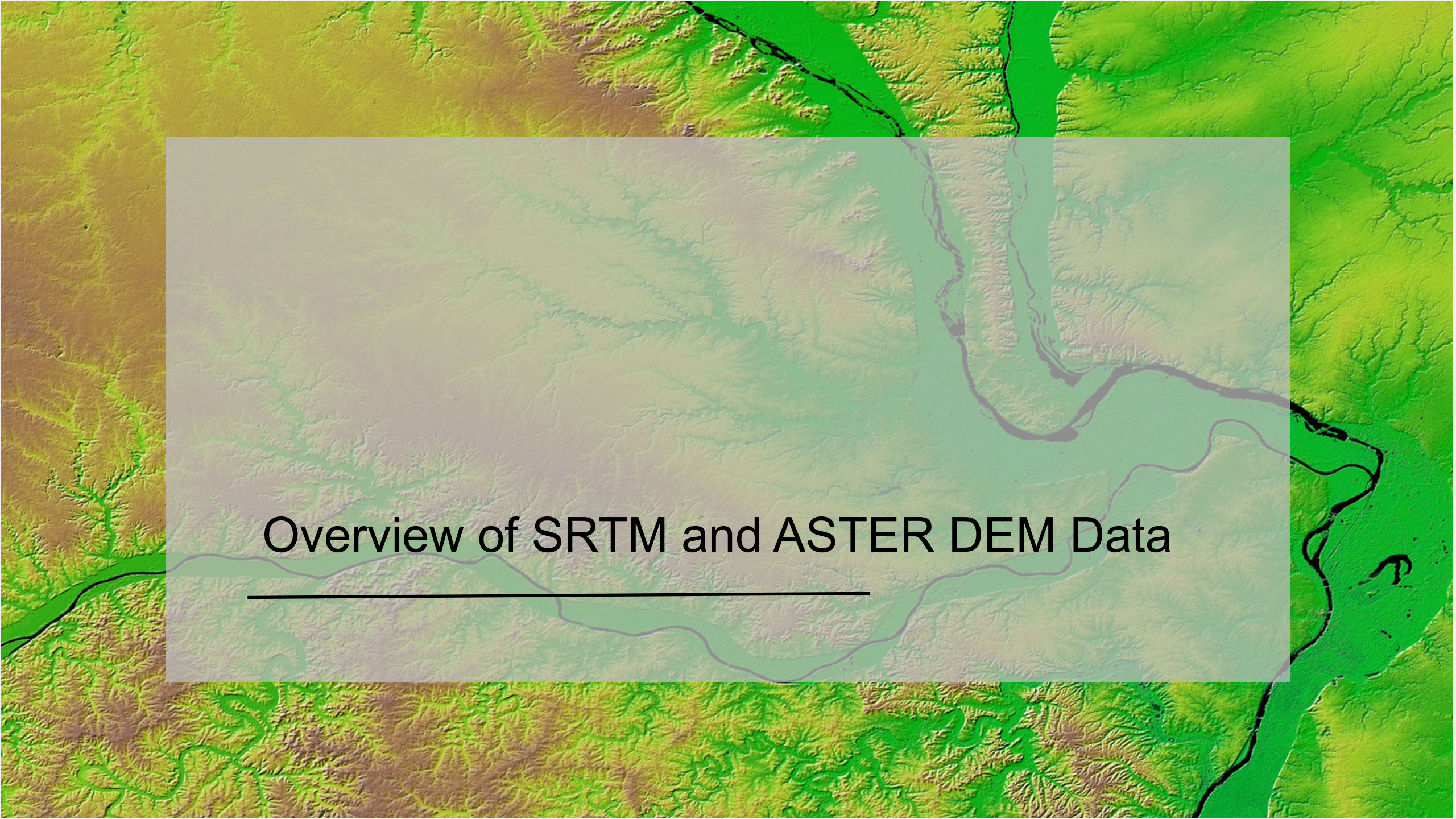
Learning Objectives

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

- Understand SRTM and ASTER Digital Elevation Modeling (DEM) data
- Access DEM for Flood Management Applications

Outline

- Overview of SRTM and ASTER DEM Data
- SRTM and ASTER DEM Data Access
  – Global Data Explorer (GDEx)
  – Consultative Group for International Agricultural Research (CIGAR)
- Demonstration of GDEx

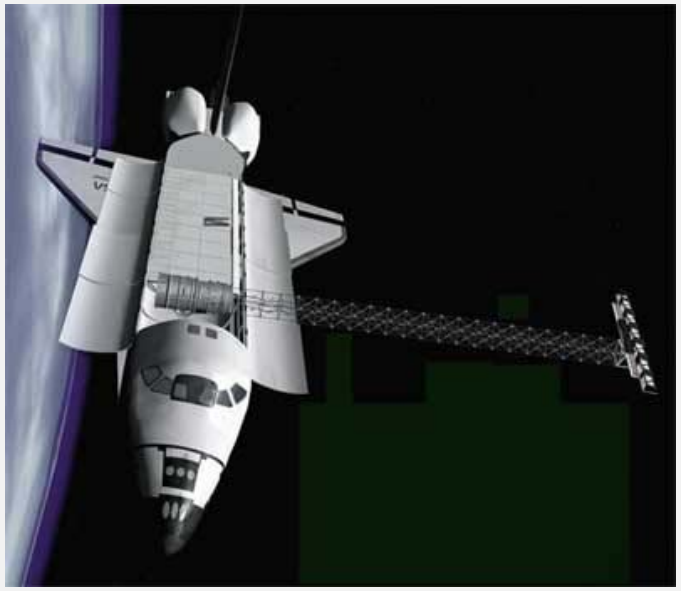


Overview of SRTM and ASTER DEM Data

What is SRTM?

http://www2.jpl.nasa.gov/srtm/mission.htm

- A c-band (5.6 cm) radar mission
- On NASA Space Shuttle Endeavour
- Completed February 2000
- 176 orbits around Earth in 11 days
- Acquired digital terrain elevation data of all land between 60°N- 56°S latitude
  – ~80% of Earth's total land mass



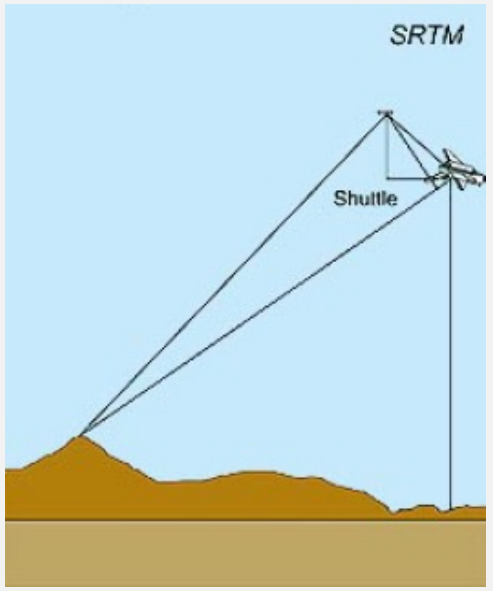
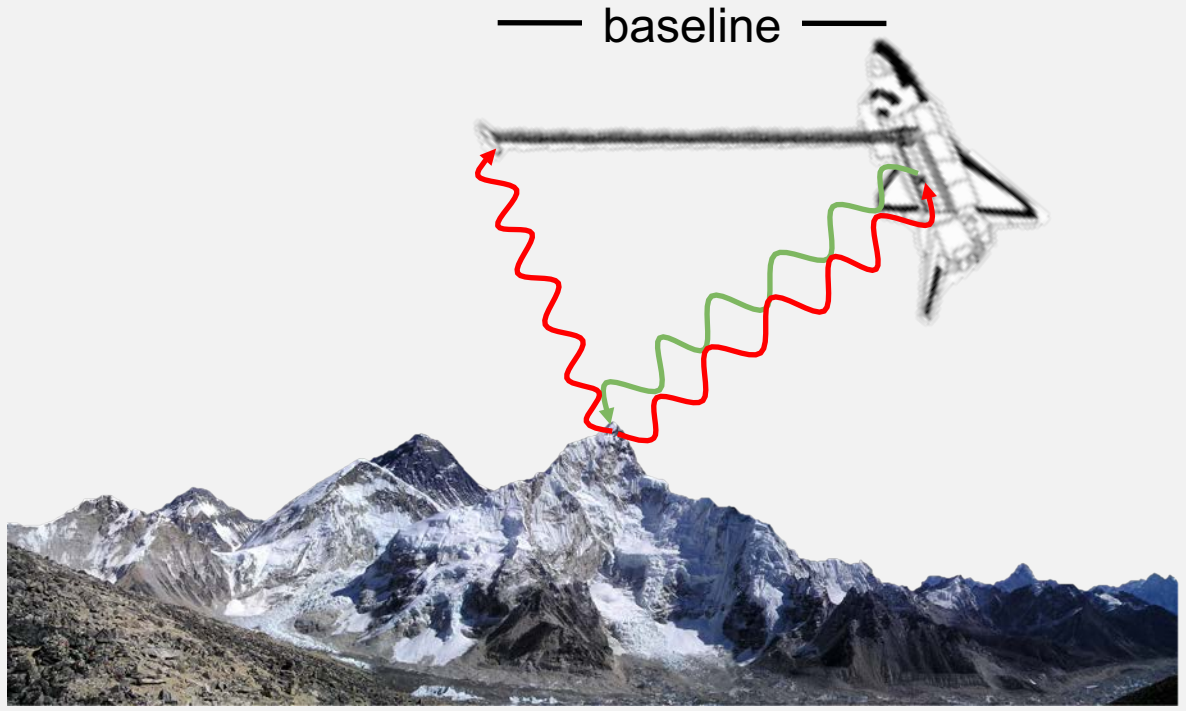


Image Credit (Right): DLR

SRTM Digital Terrain Data

http://www2.jpl.nasa.gov/srtm/instr.htm

- SRTM used interferometry to gather topographic (elevation) data
- Interferometry:
  - two radar images of the same area are taken from different views
  - the difference in the two images determines the height of the surface in the digital elevation model (DEM)

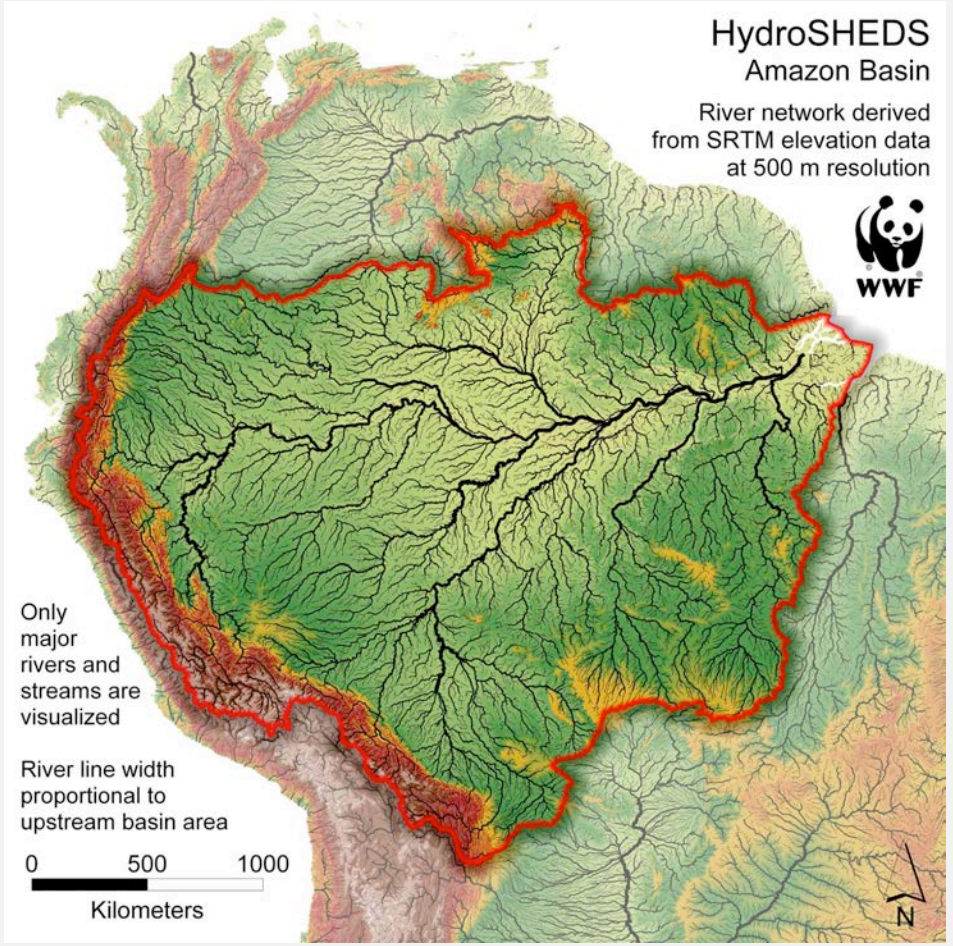


Radar signals being transmitted and received on the SRTM mission (not to scale)

Based on a JPL graphic: http://www2.jpl.nasa.gov/srtm/instrumentinterferometry.html

NASA SRTM Version 3.0 (SRTM Plus)

- As of 2015, terrain data are available at 1 arc second or 30 m spatial resolution
- Eliminated voids in SRTM data by filling with:
  - ASTER GDEM2
  - USGS GMTED2010
  - USGS National Elevation Dataset (NED)

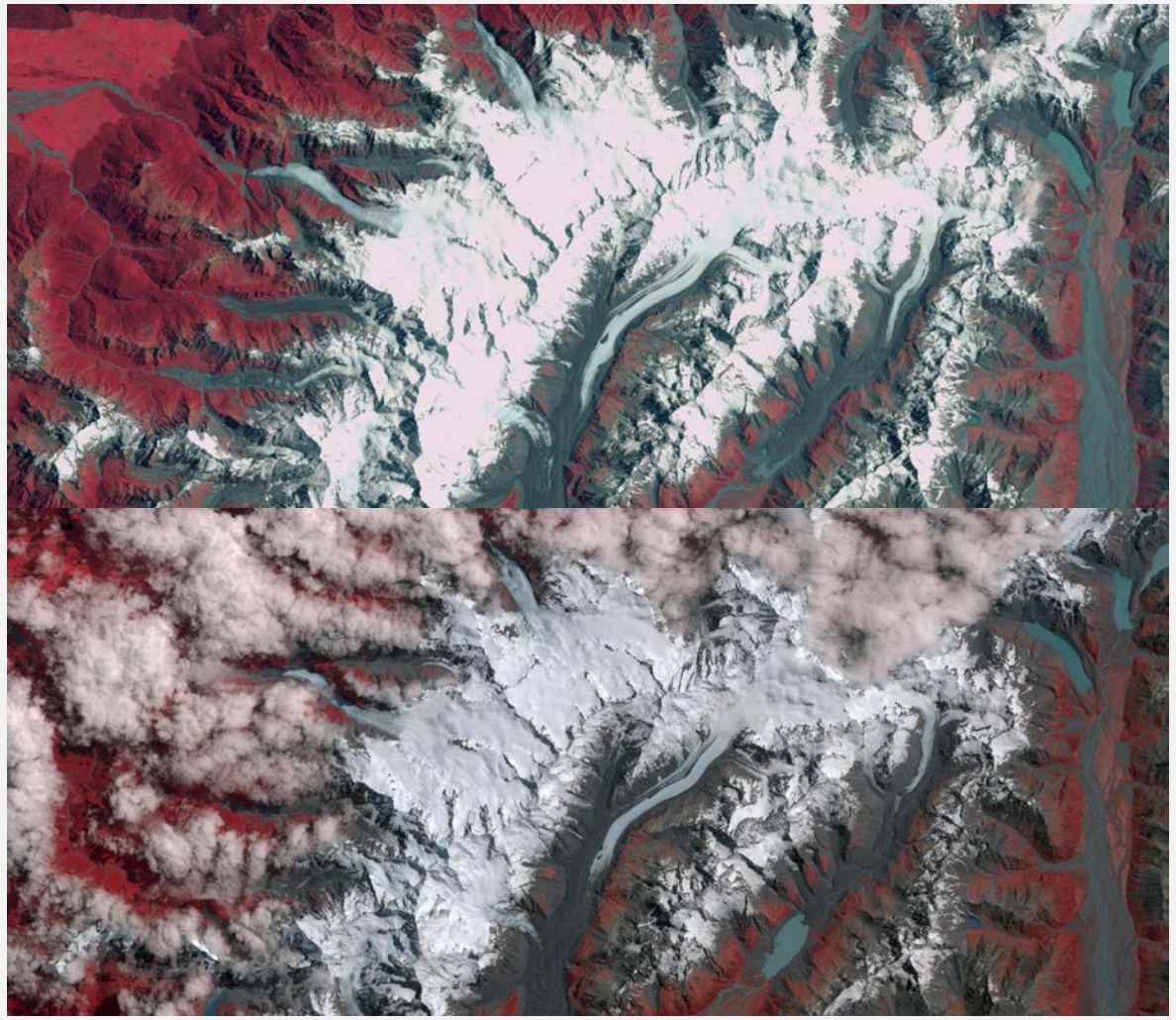


mage Credit: WWF

Advanced Spaceborne Thermal and Reflection Radiometer (ASTER)

http://asterweb.jpl.nasa.gov/

- Onboard Terra
  - Polar orbiting satellite launched Dec 1999
- Spatial Coverage and Resolution
  - Global
  - Swath Width: 60 km
  - Spatial Resolution Varies:
    - 15 m
    - 30 m
    - 90 m

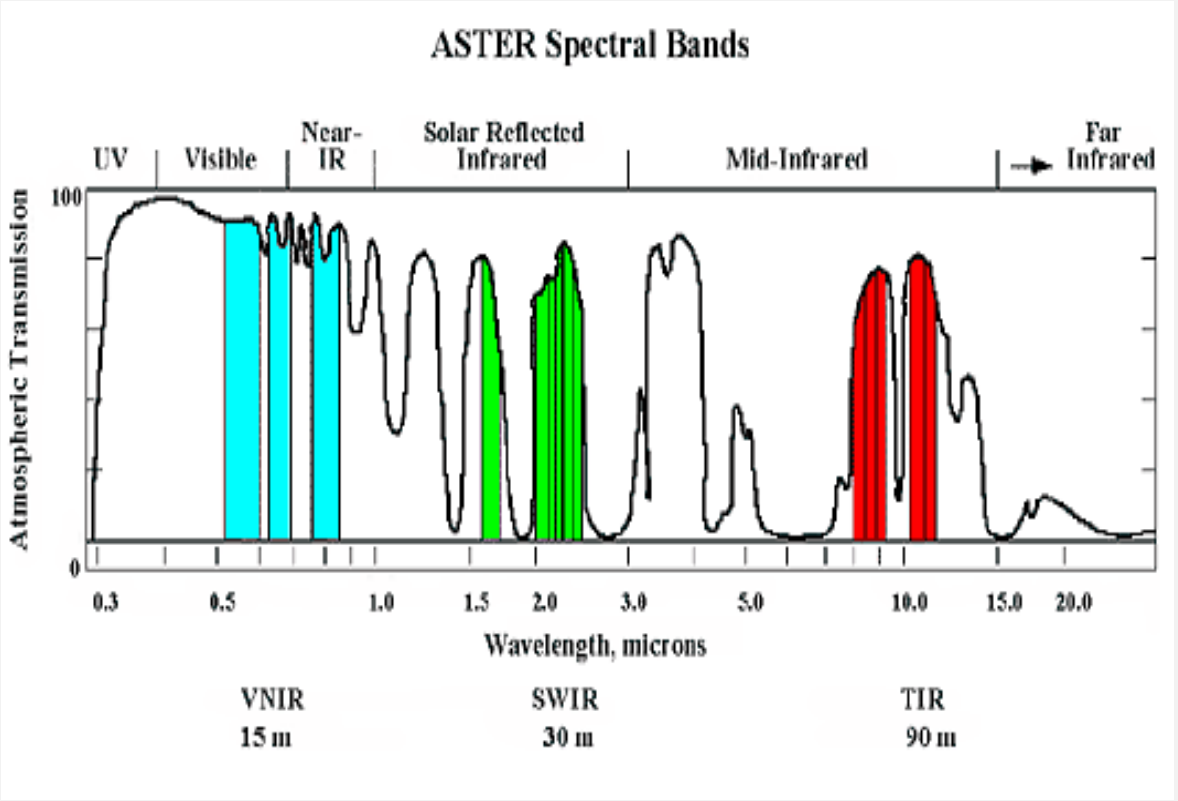


Images of New Zealand glaciers in 1990 (Landsat, top) and 2017 (ASTER, bottom)

Advanced Spaceborne Thermal and Reflection Radiometer (ASTER)

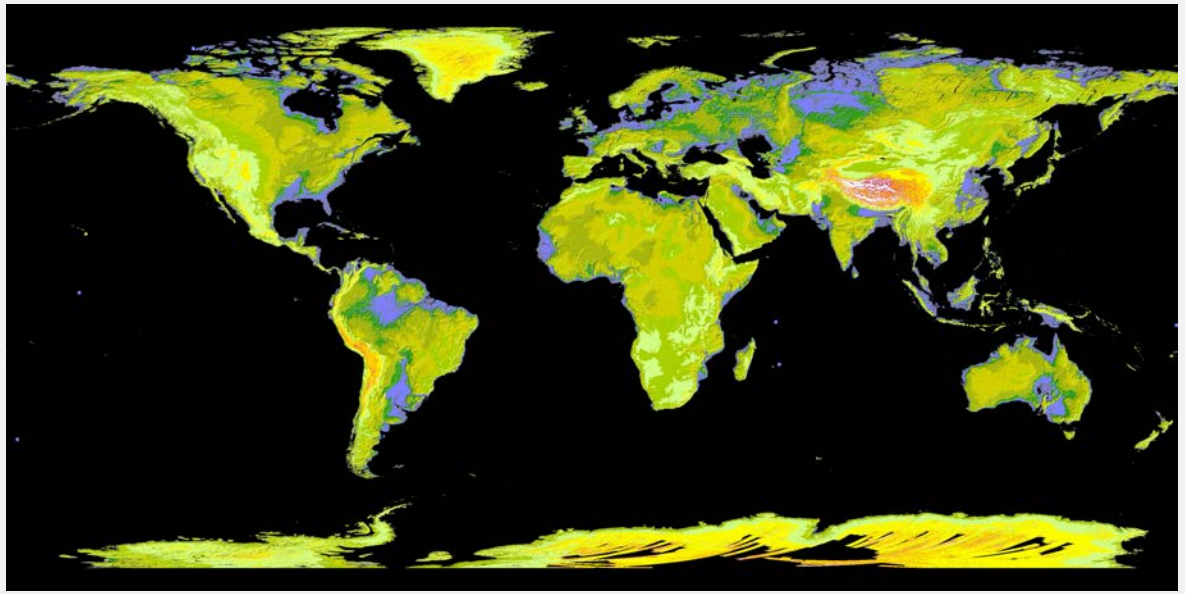
http://asterweb.jpl.nasa.gov/

- Spectral Bands
  - **14 bands** (visible to thermal IR bands)
    - Bands 1-3: 15 m (VNIR)
    - Bands 4-9: 30 m (SWIR)
    - Bands 10-14: 90 m (TIR)
- Status alert: ASTER SWIR data acquired since Apr 2008 not usable



ASTER Global Digital Elevation Model (GDEM V2)

http://asterweb.jpl.nasa.gov/gdem.asp



- A joint product developed and by NASA and the Ministry of Economy, Trade, and Industry (METI) of Japan
- Uses ASTER VNIR stereo pair images to derive DEM
- GDEM version 2 is available since 2011, based all available ASTER stereo images
- Covers land surfaces between 83°N and 83°S and is composed of 22,600 1°- by -1° tiles of 30 m resolution

SRTM and GDEM2 Accuracy

Results from the CONUS absolute vertical accuracy assessment (in meters)

DEM	Minimum	Maximum	Mean	Standard Deviation	RMSE	LE95
GDEM2	-137.37	64.80	-0.20	8.68	8.68	17.01
NED	-46.21	16.42	-0.33	1.81	1.84	3.61
SRTM	-28.67	28.58	0.73	3.95	4.01	7.86
GDEM1	-127.74	105.41	-3.69	8.58	9.34	18.31

- Based on comparison with 18000 geodetic points over the U.S.
- "…the GDEM validation team recommends the release of the GDEM2 to the public, acknowledging that, while vastly improved, some artifacts still exist which could affect its utility in certain application" - ASTER GDEM team [https://pubs.er.usgs.gov/publication/70005960]

SRTM and GDEM2 Accuracy

- DEM data accuracy depends on location and land cover categories

Land Cover	SRTM (rmse m)	GDEM2 (rmse m)
Grass & Shrub	12.36	16.6
Deciduous	25.49	20.79
Evergreen	24.76	22.23
Mixed	18.81	10.03

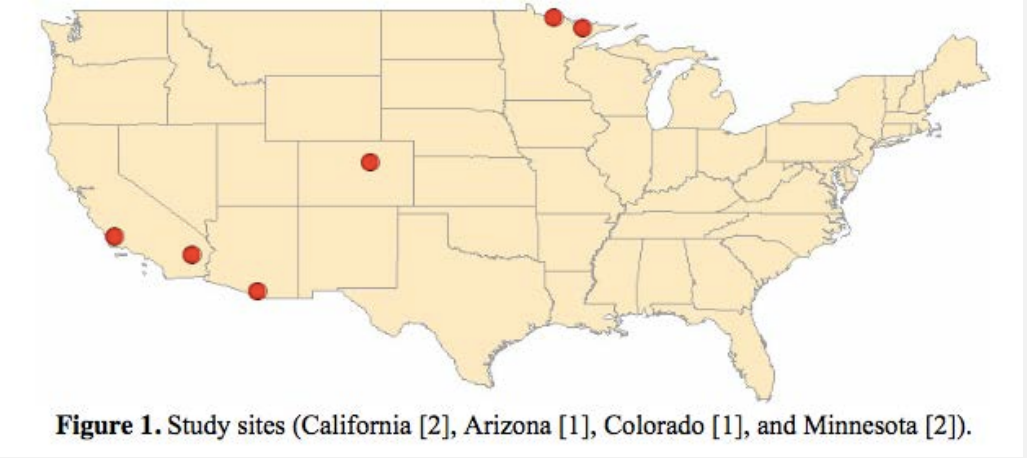
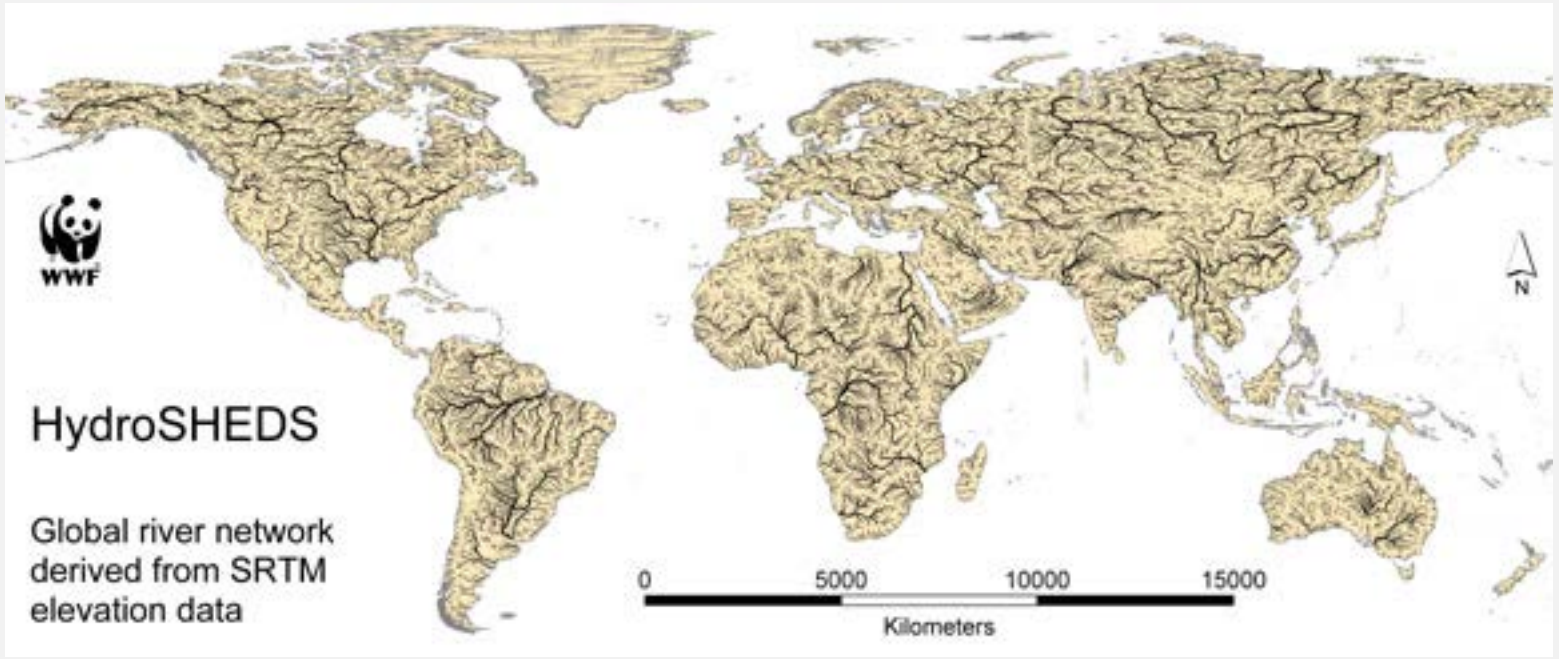


Figure 1. Study sites (California [2], Arizona [1], Colorado [1], and Minnesota [2]).

Tighe, M. L., & Chamberlain, D. (2009). Accuracy Comparison of the SRTM, ASTER, NED, NEXTMAP USA Digital Terrain Model Over Several USA Study Sites. In *ASPRS/MAPPS 2009 Conference Proceedings*. San Antonio, TX. Retrieved from http://www.asprs.org/a/publications/proceedings/sanantonio09/Tighe_2.pdf

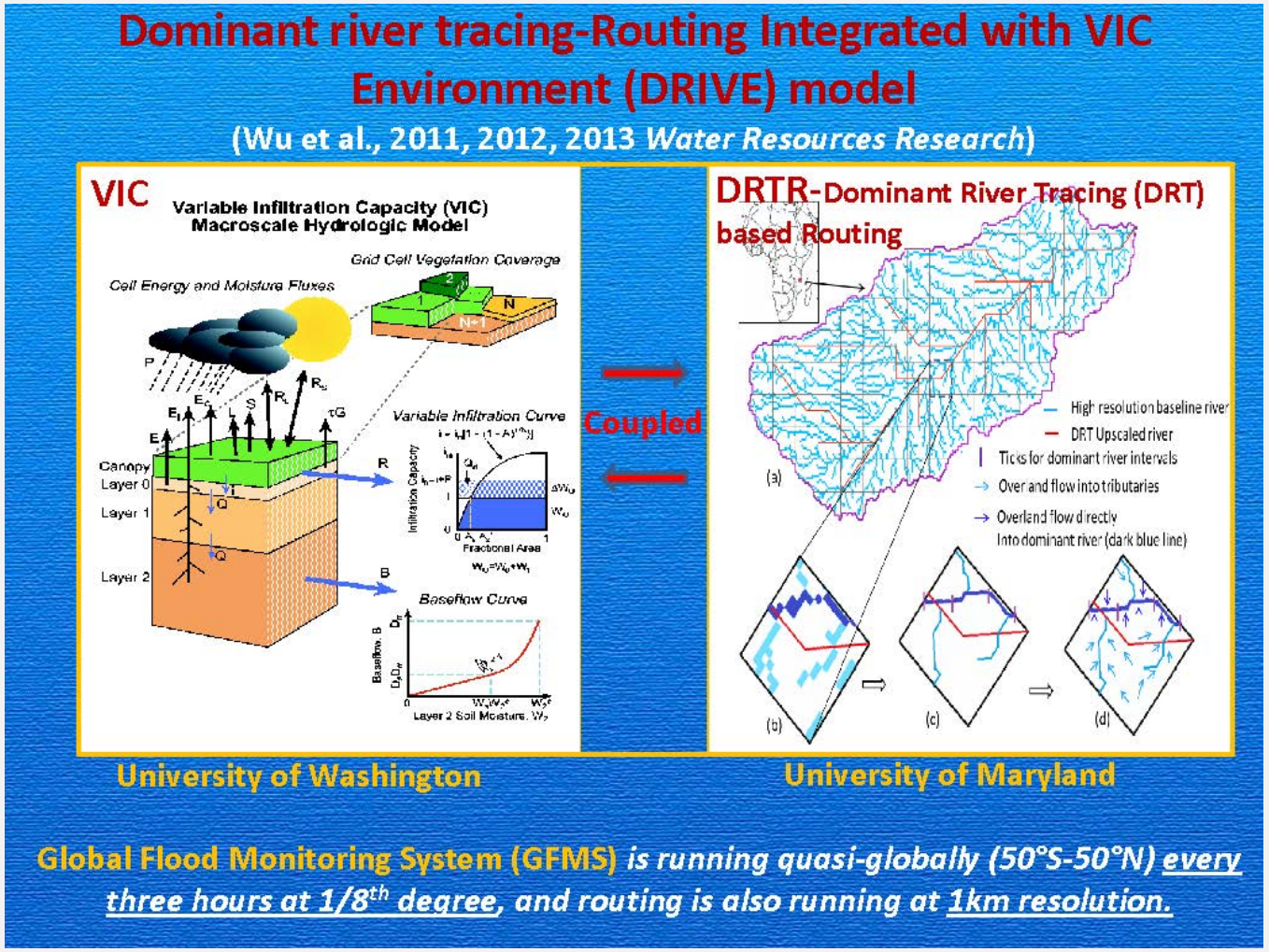
DEM Applications

- Useful for mapping hazardous terrain
- Calculate:
  - slope and aspect
  - catchment area
  - forest canopy height
- Models:
  - runoff
  - stream networks
  - landslides



USGS HydroSHEDS

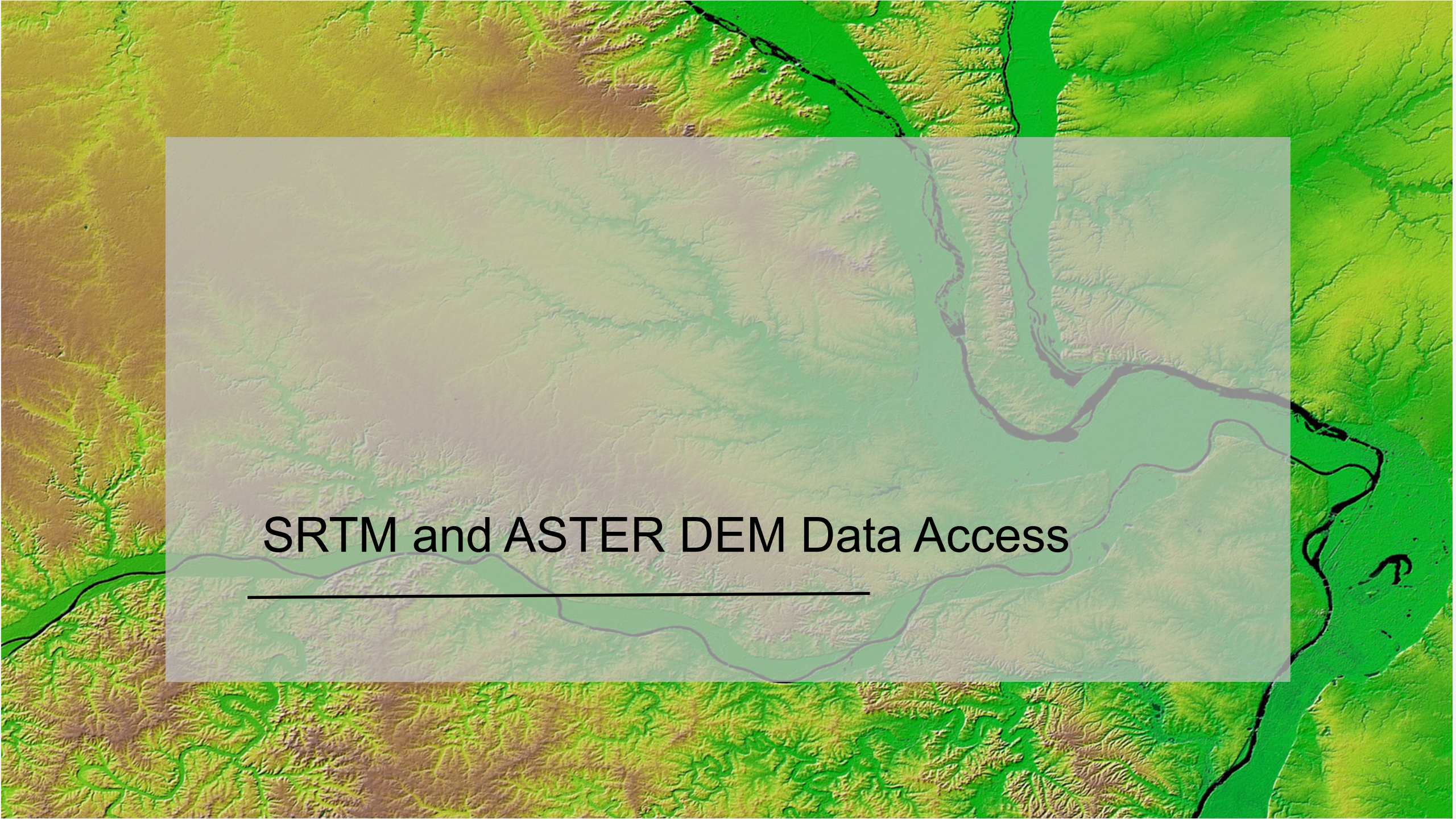
SRTM DEM Application in Flood Modeling



The Global Flood Monitoring System (GFMS) uses HydroSHEDS* derived from SRTM DEM is used in for identifying river networks for routing models

*(http://hydrosheds.org/)

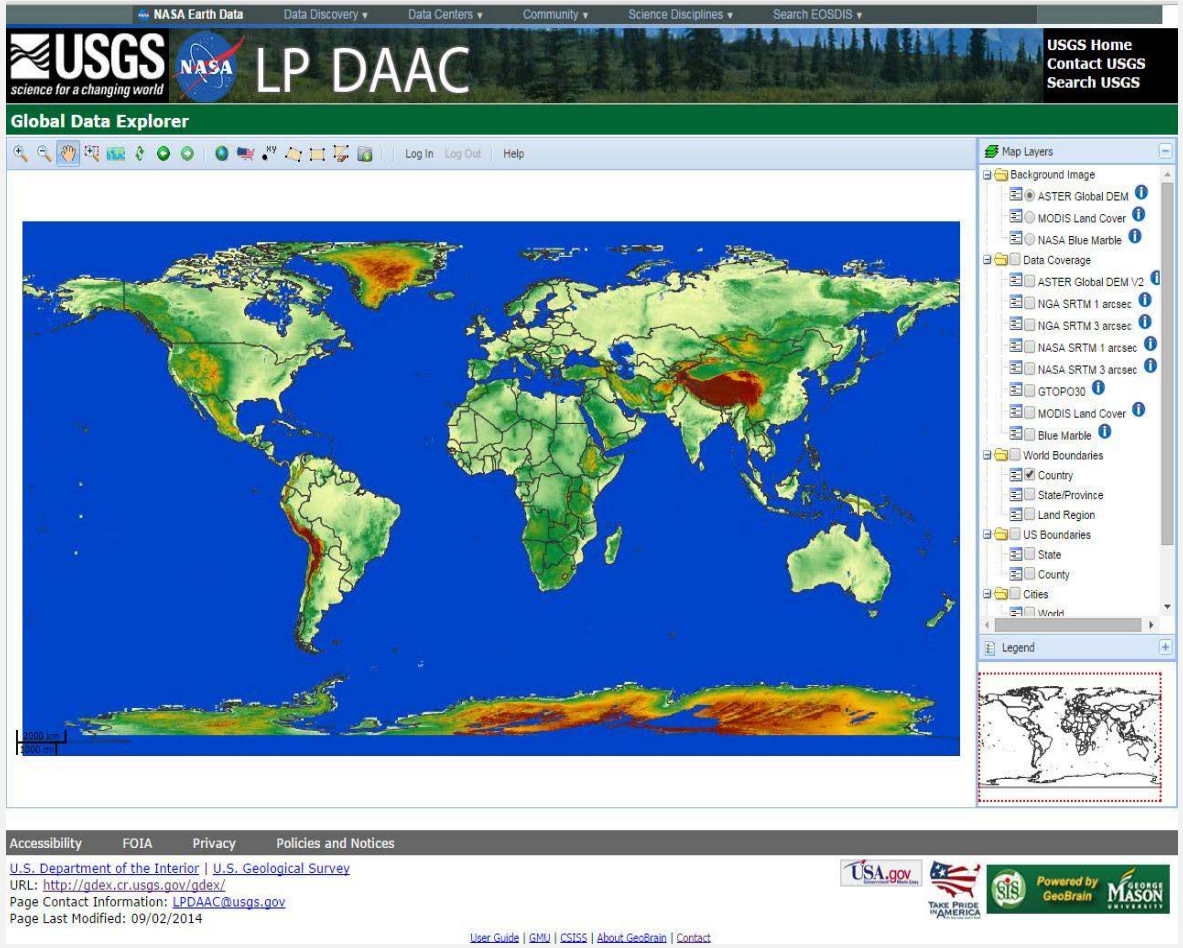
Wu et al., *Real-time Global Flood Monitoring and Forecasting using an Enhanced Land Surface Model with Satellite and NWP model based Precipitation*. GFMS. http://flood.umd.edu/GFMS_conference.pdf


SRTM and ASTER DEM Data Access

Global Data Explorer (GDEx)

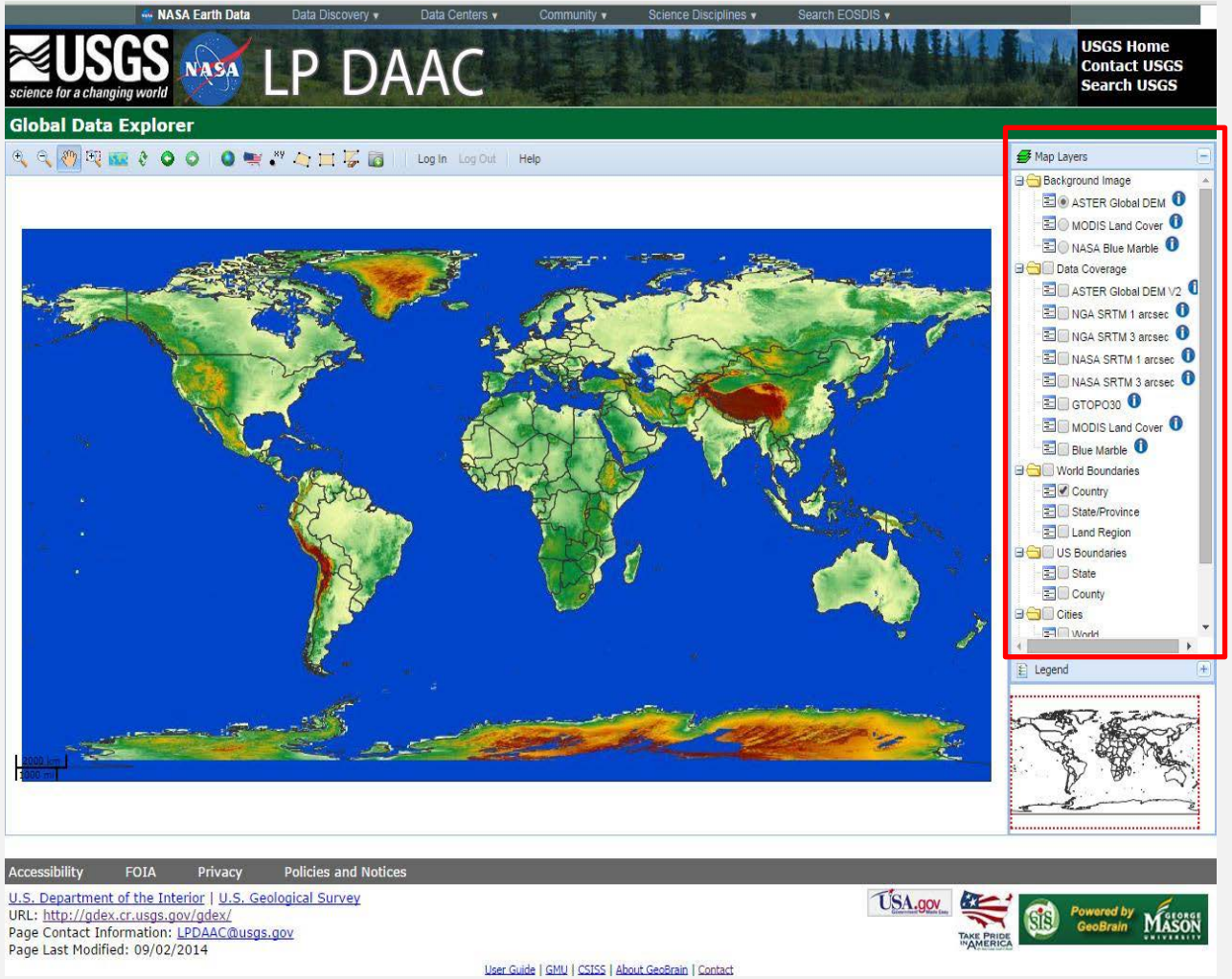
http://gdex.cr.usgs.gov/

- Seamless data viewer that provides access to multiple sources of digital elevation data sets
- Users can subset and download data by area of interest in multiple formats and projections
- Requires user registration via http://urs.earthdata.nasa.gov
- Data can be previewed before downloading

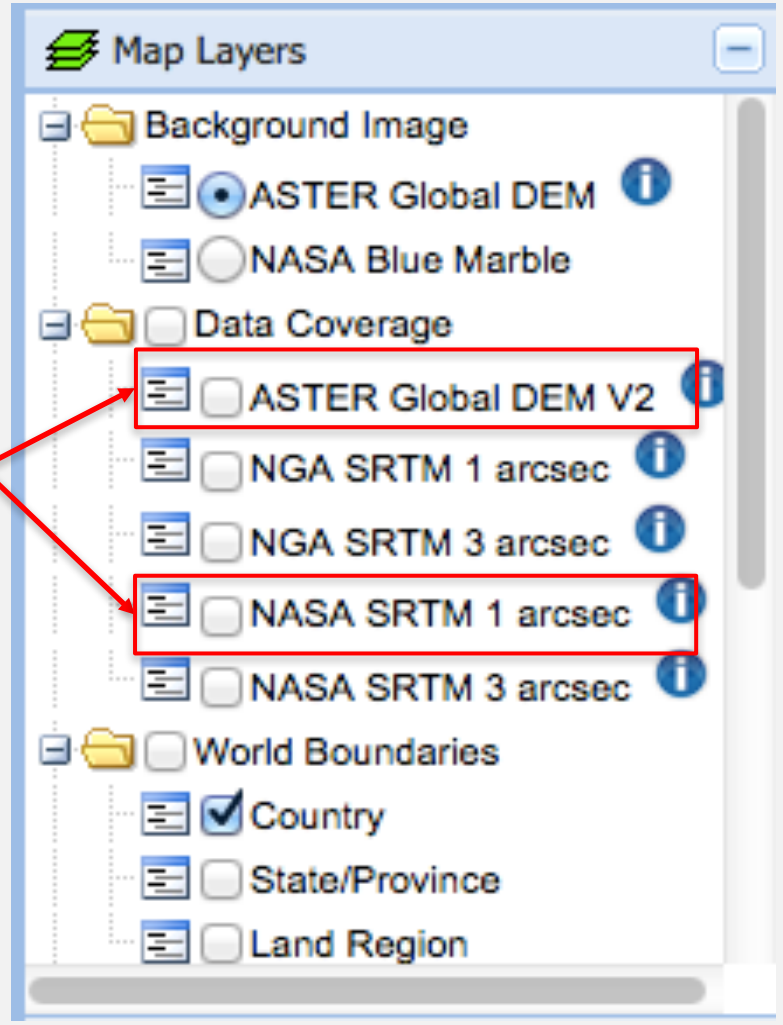


SRTM V3 and ASTER DEM from GDEx

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

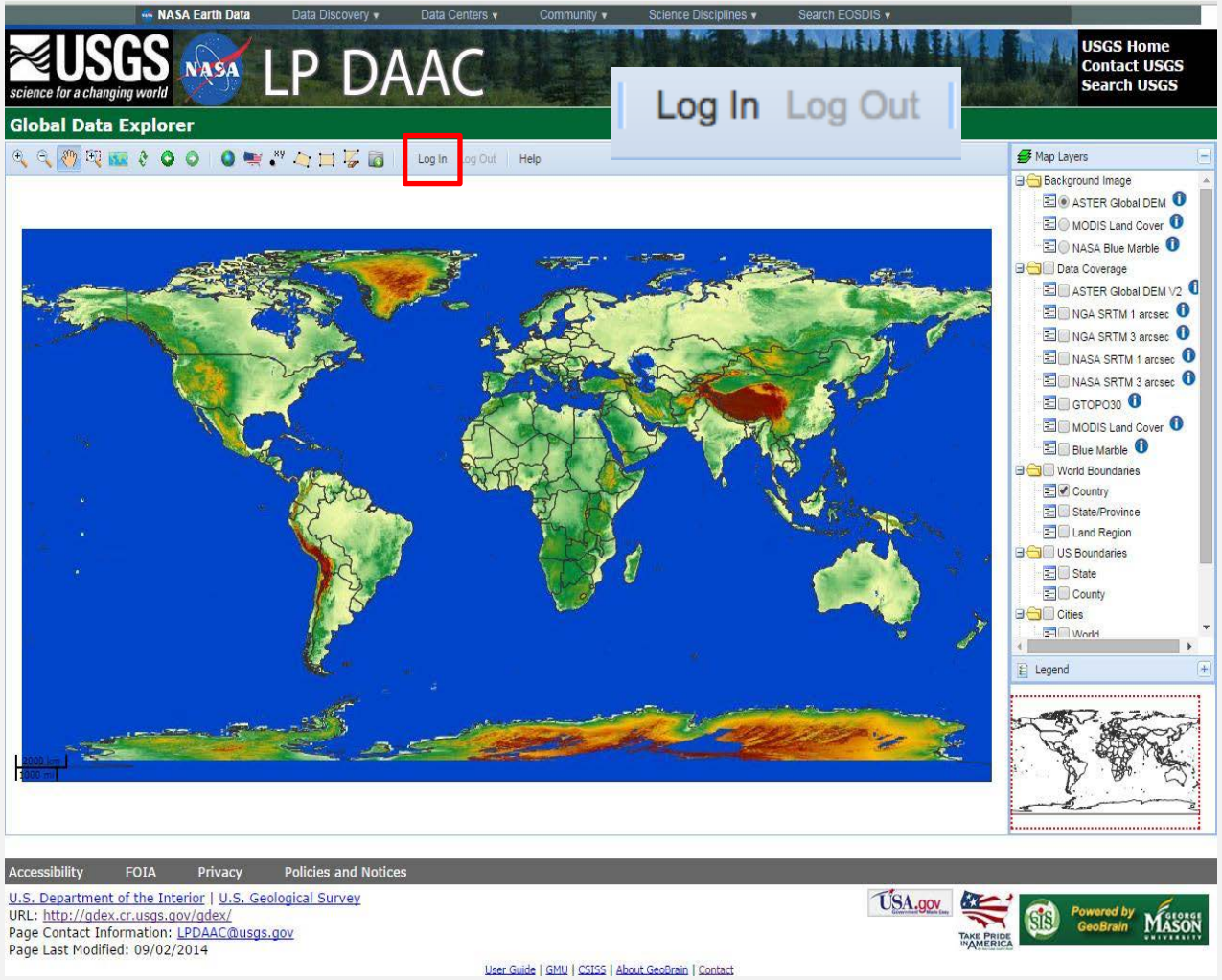


30 m data



SRTM V3 and ASTER DEM from GDEx

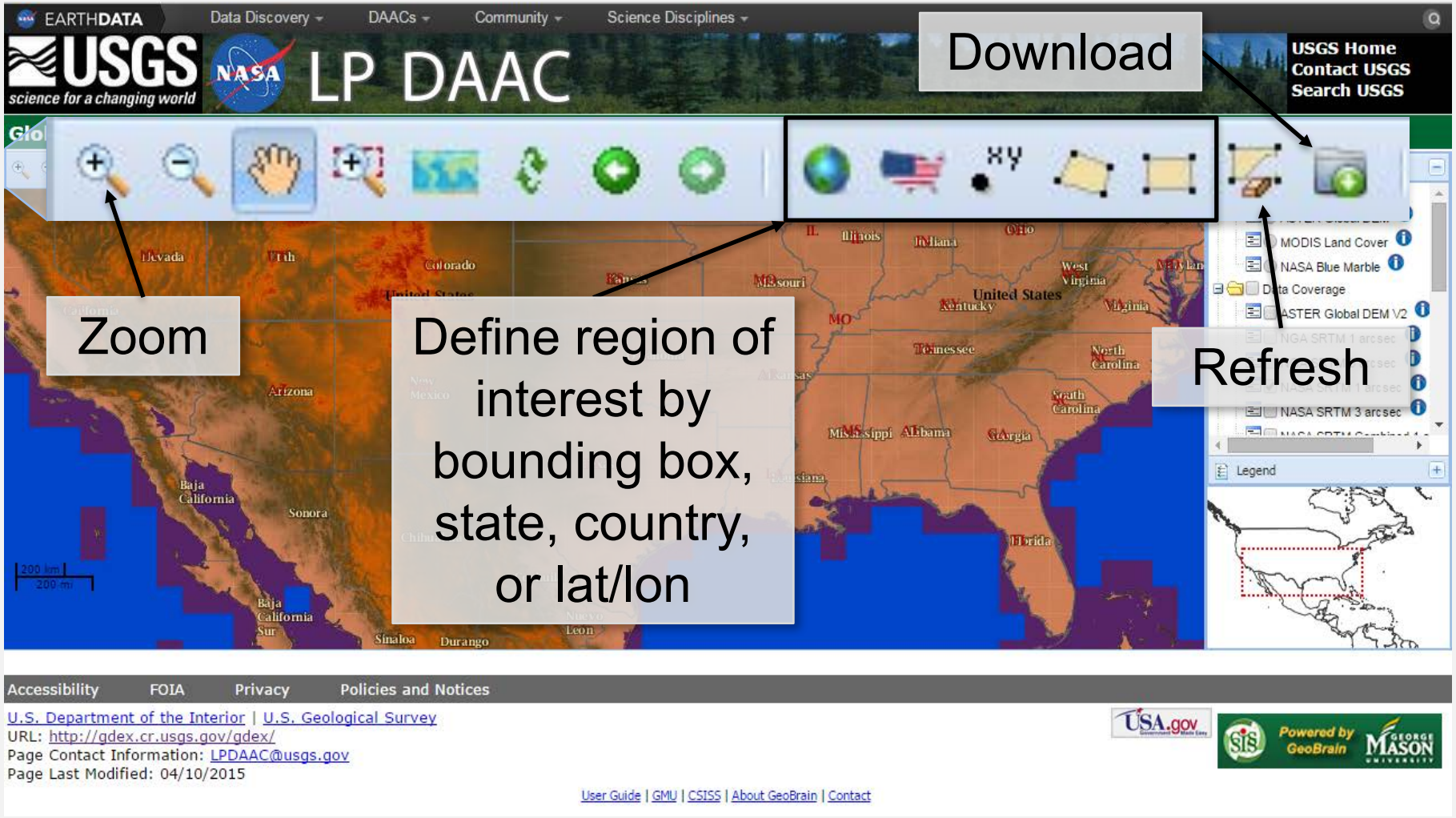
http://gdex.cr.usgs.gov/



Login with your NASA Earthdata username and password

GDEx: SRTM Data Selection

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

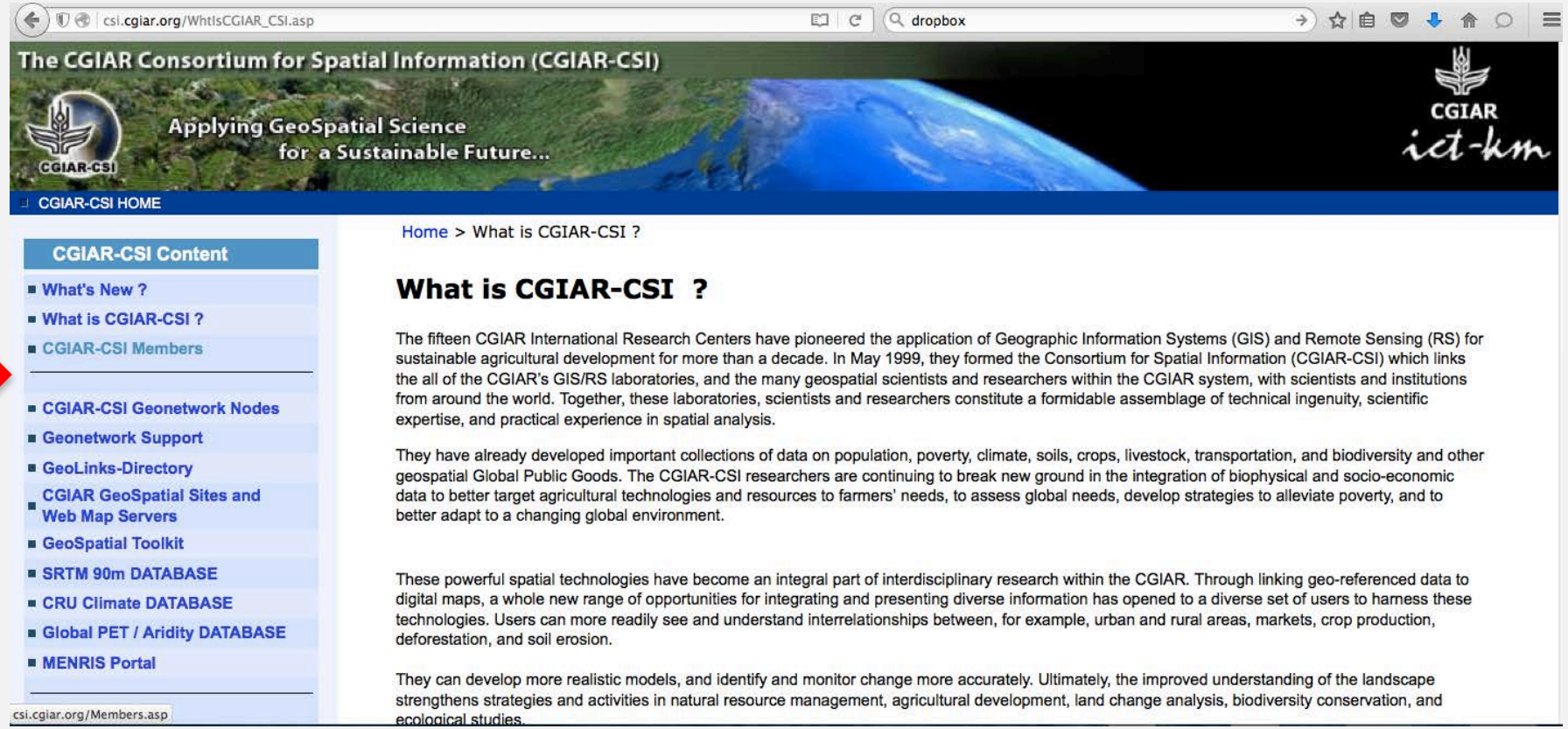


SRTM Data from CGIAR-CSI

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

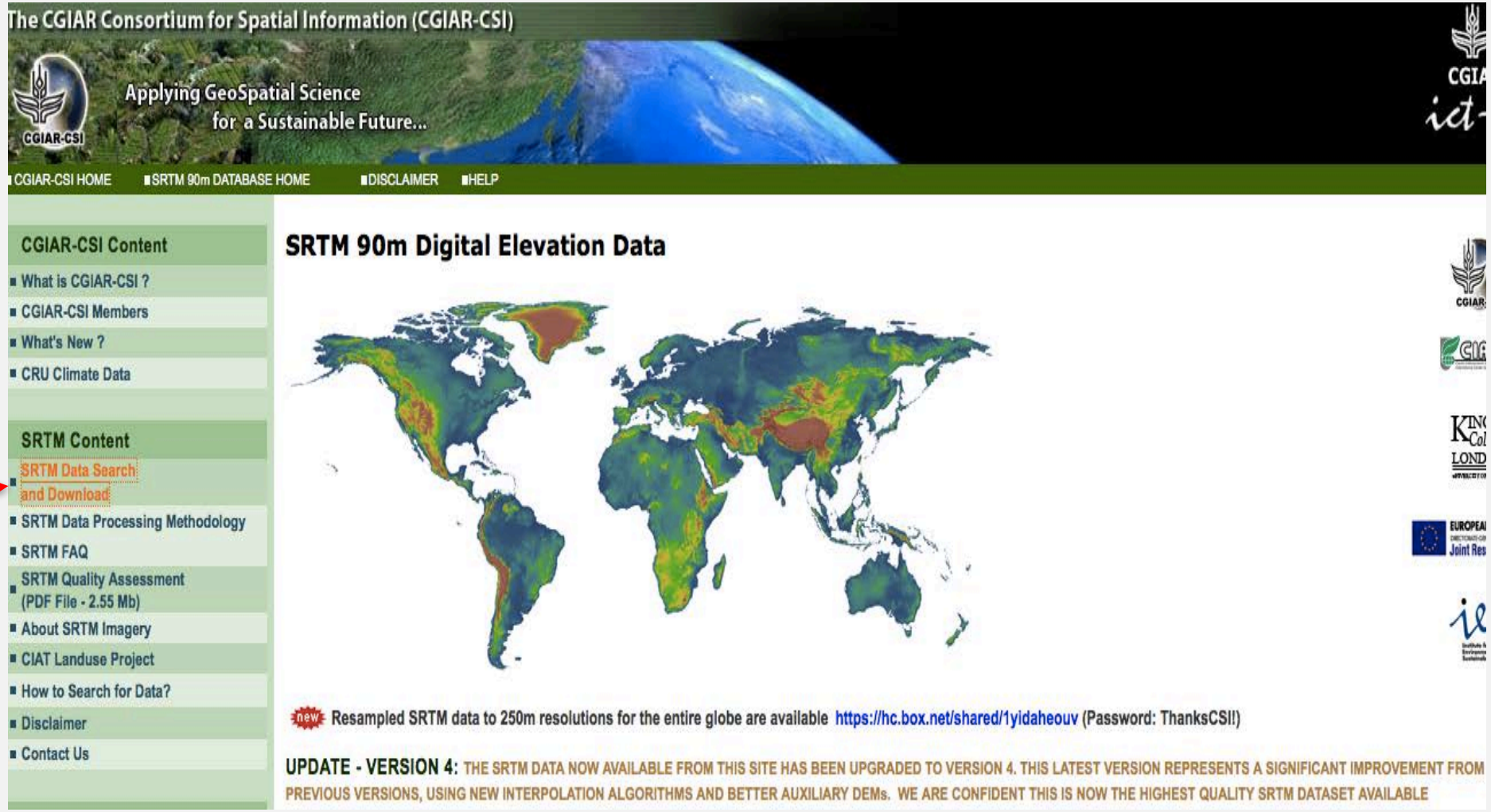
CGIAR-CSI: Consultative Group for International Agricultural Research Consortium of Spatial Information

SRTM data (90 m)



CGIAR-CSI: SRTM Data Access

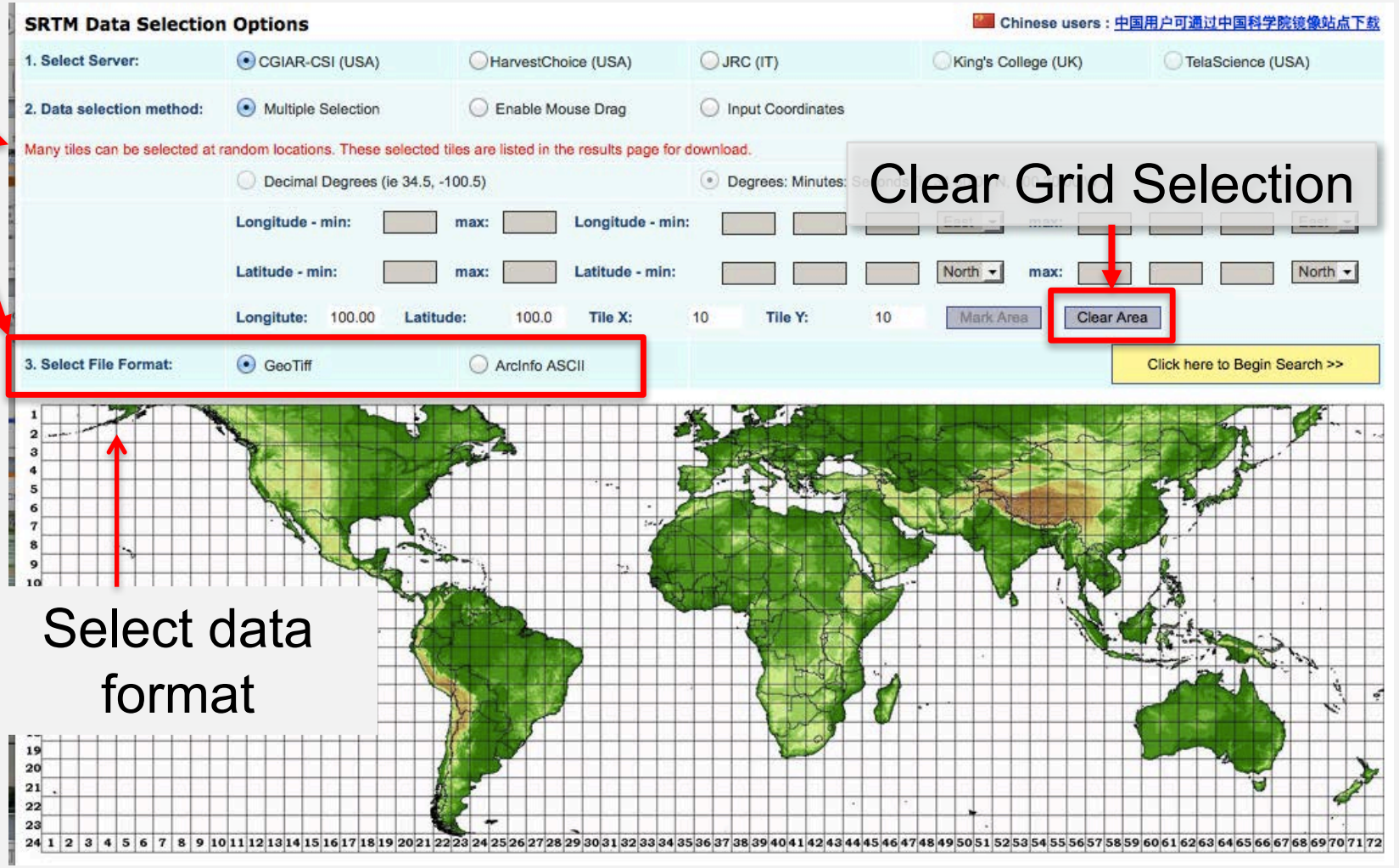
Click to select and download data



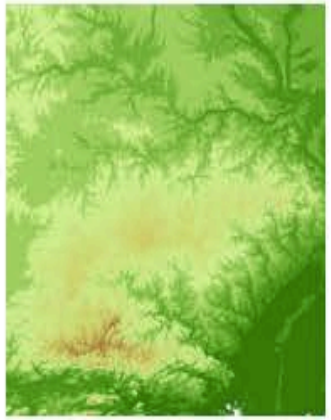
CGIAR-CSI: SRRTM Data Selection

Spatial selection can be by lat/lon

or by clicking on the grid(s)



CGIAR-CSI: SRTM Data Download

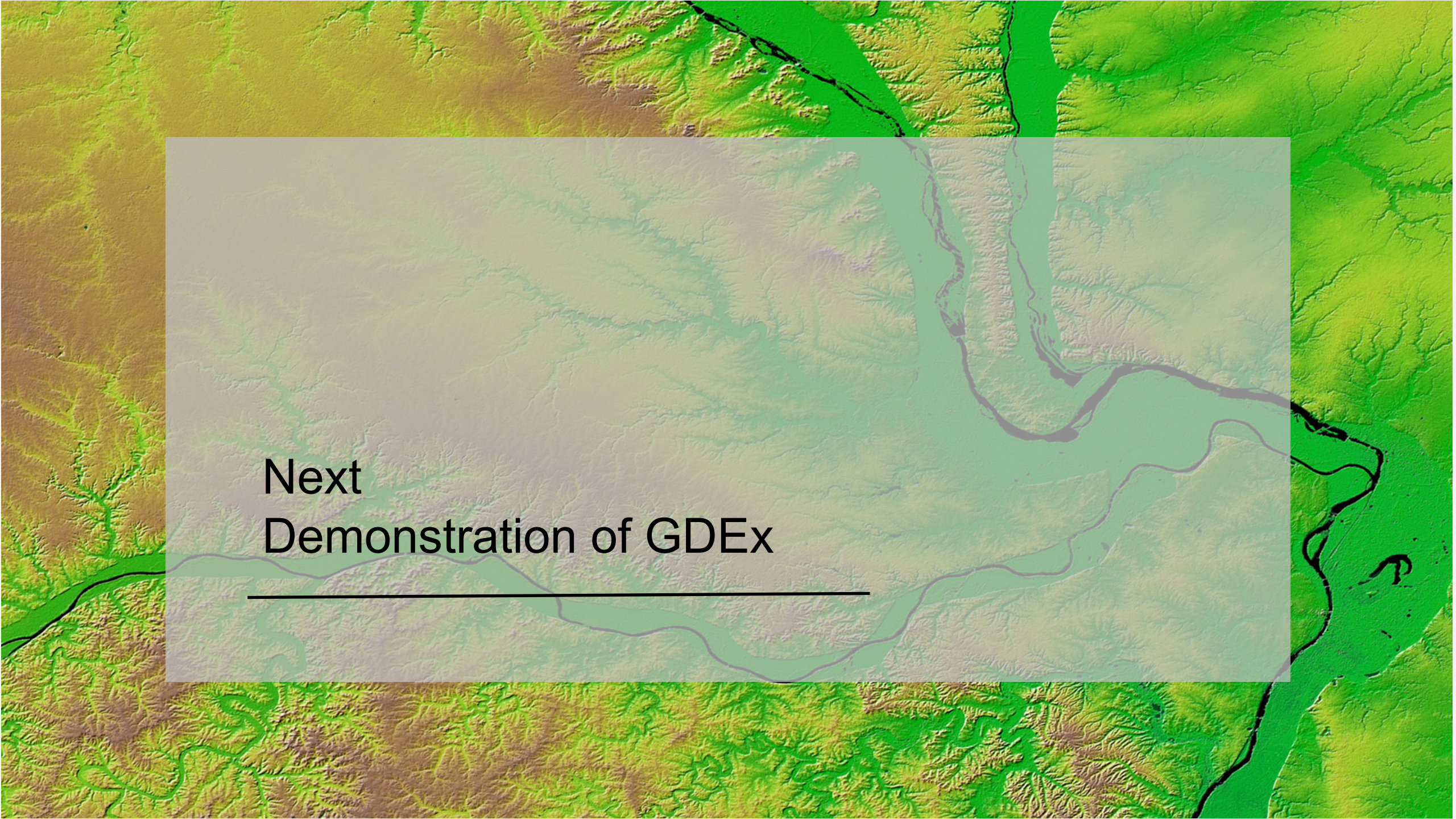
Description	Location	Image
Product : SRTM 90m DEM version 4 **Data File Name :** srtm_18_05.zip **Mask File Name:** srtm_mk_18_05.zip **Latitude min:** 35 N **max:** 40 N **Longitude min:** 95 W **max:** 90 W **Center point :** Latitude 37.50 N Longitude 92.50 W		

CSI Server : Data Download (FTP) Data Download (HTTP) Data Mask Download (FTP) Data Mask Download (HTTP) ^TOP^

- Download options
- Digital elevation data can be downloaded as GeoTIFF

GDEx and CGIAR-CSI

- Both tools are easy to use with spatial subsetting
- Data can be downloaded as GeoTIFF to import in GIS
- GDEx SRTM is 30 m whereas CGIAR-CSI is 90 m
- CGIR-CSI provides combined multiple tiles whereas GDEx provides a series of individual tiles
- GDEx also provides access to ASTER GDEM2 and other DEM data
- GDEx requires user registration and login through **NASA Earthdata**


Next
Demonstration of GDEx