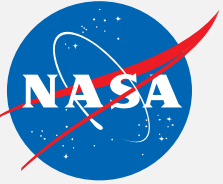


National Aeronautics and
Space Administration



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

A topographic map showing a river system. The map uses a color gradient from green (low elevation) to brown (high elevation) to represent terrain. A large river flows from the top right towards the bottom right, with several tributaries. A semi-transparent white rectangular box is overlaid on the map, containing the title text and a horizontal line.

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

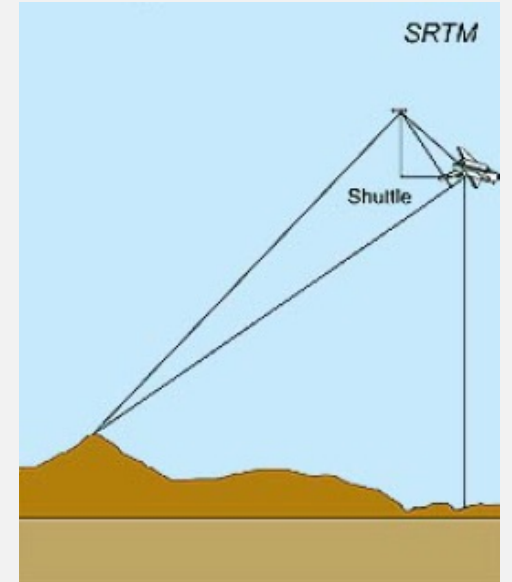
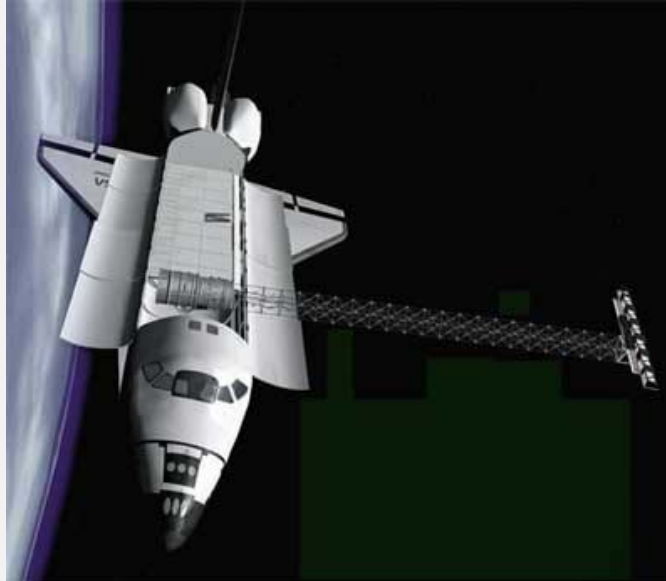
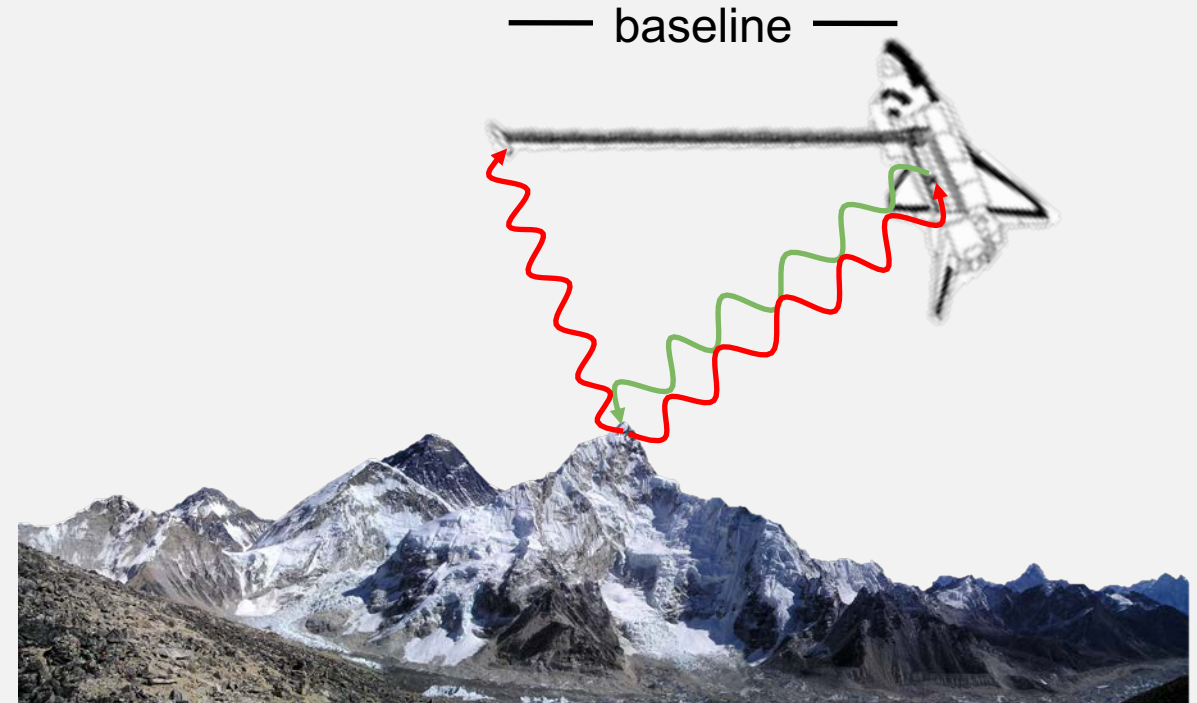


Image Credit (Right): DLR

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)



~~~~~ Transmitted Wave  
~~~~~ Received Wave

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)

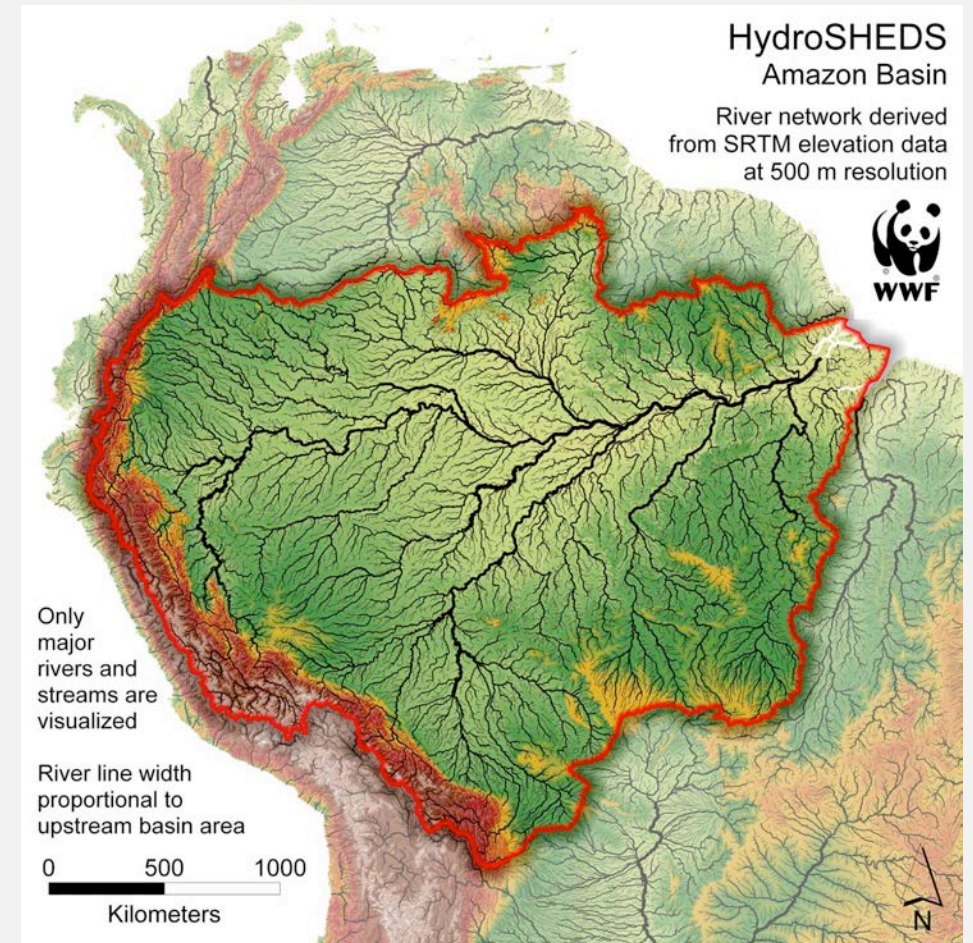


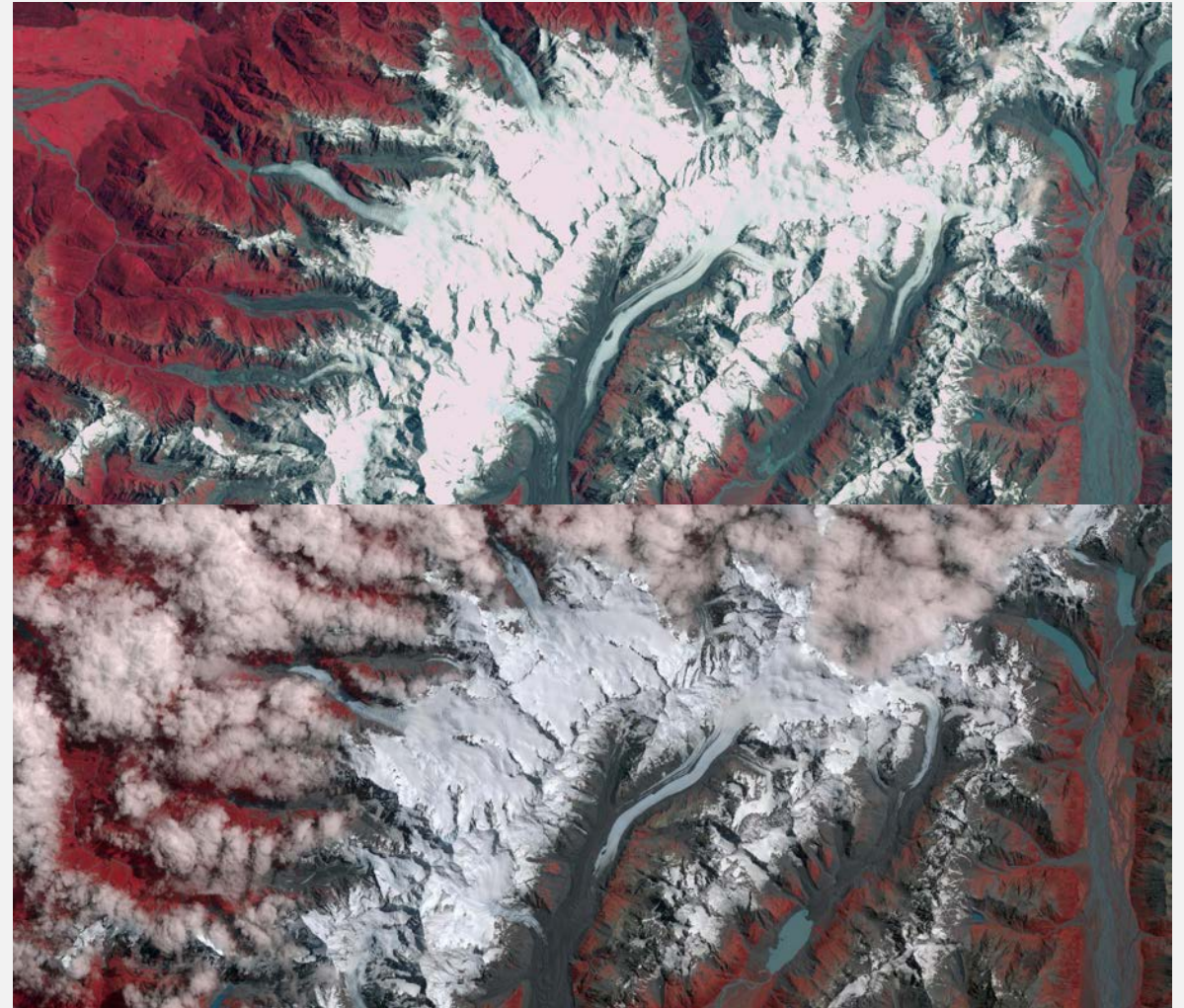
Image Credit: WWF

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

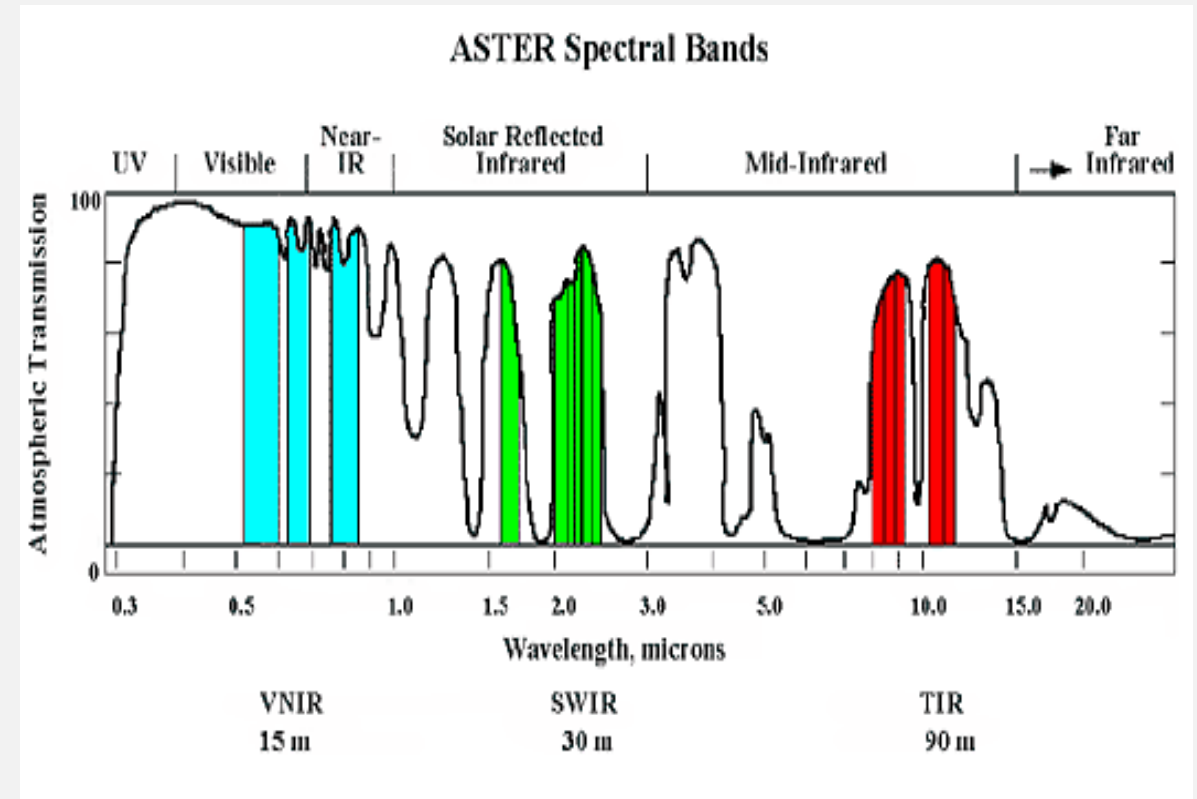
Images of New Zealand glaciers in 1990 (Landsat, top) and 2017 (ASTER, bottom)



Advanced Spaceborne Thermal and Reflection Radiometer (ASTER)

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

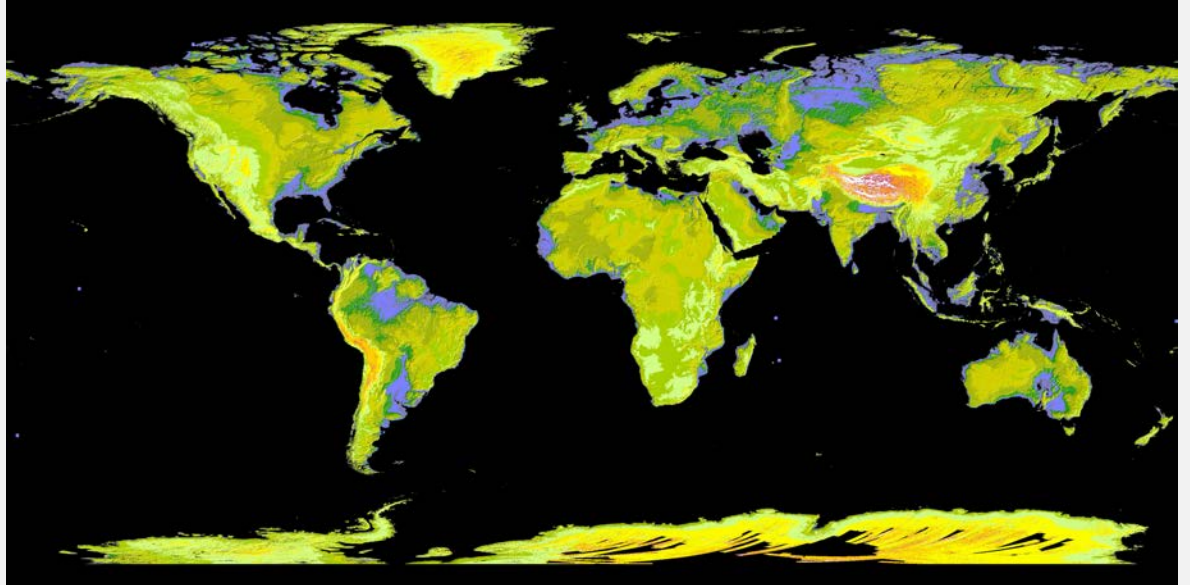
- Spectral Bands
 - **14 bands** (visible to thermal IR bands)
 - Bands 1-3: 15 m (VNIR)
 - Bands 4-9: 30 m (SWIR)
 - Bands 10-14: 90 m (TIR)
- Status alert: ASTER SWIR data acquired since Apr 2008 not usable



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 |

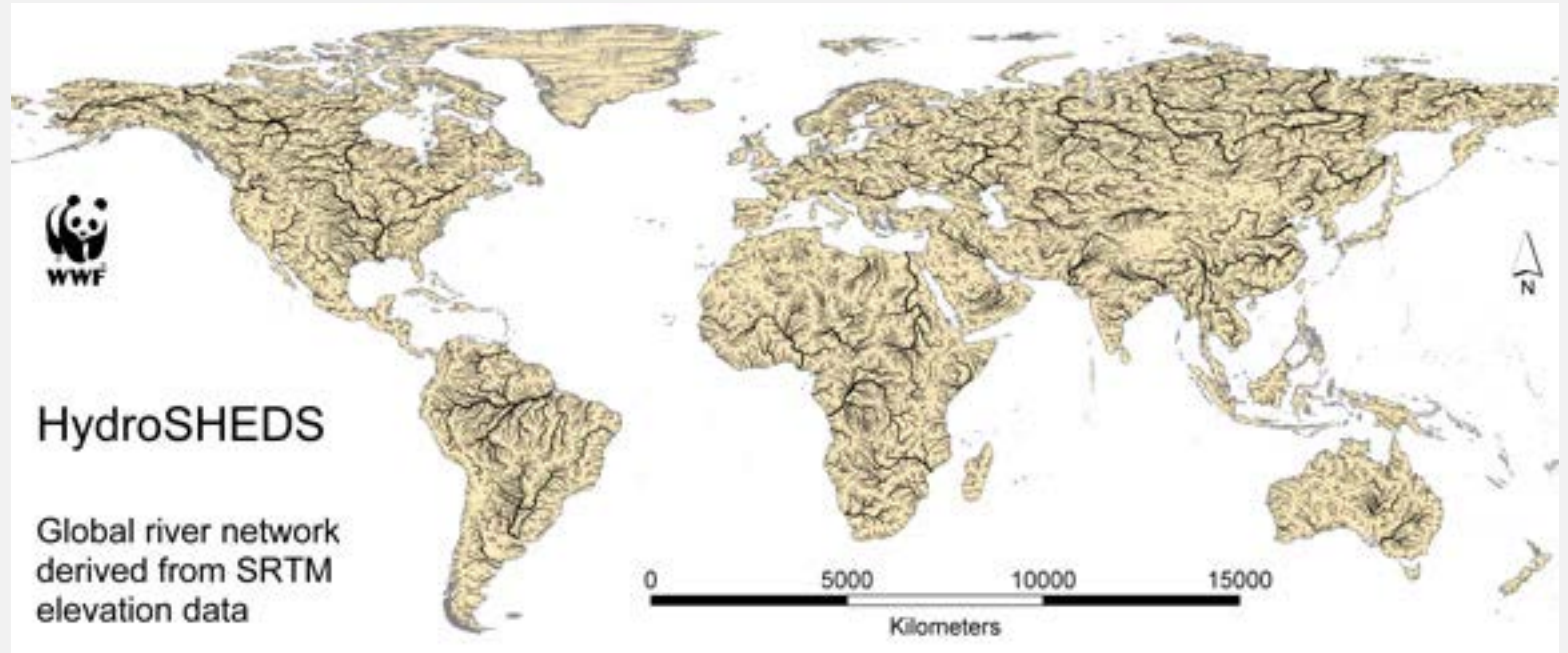


Figure 1. Study sites (California [2], Arizona [1], Colorado [1], and Minnesota [2]).

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

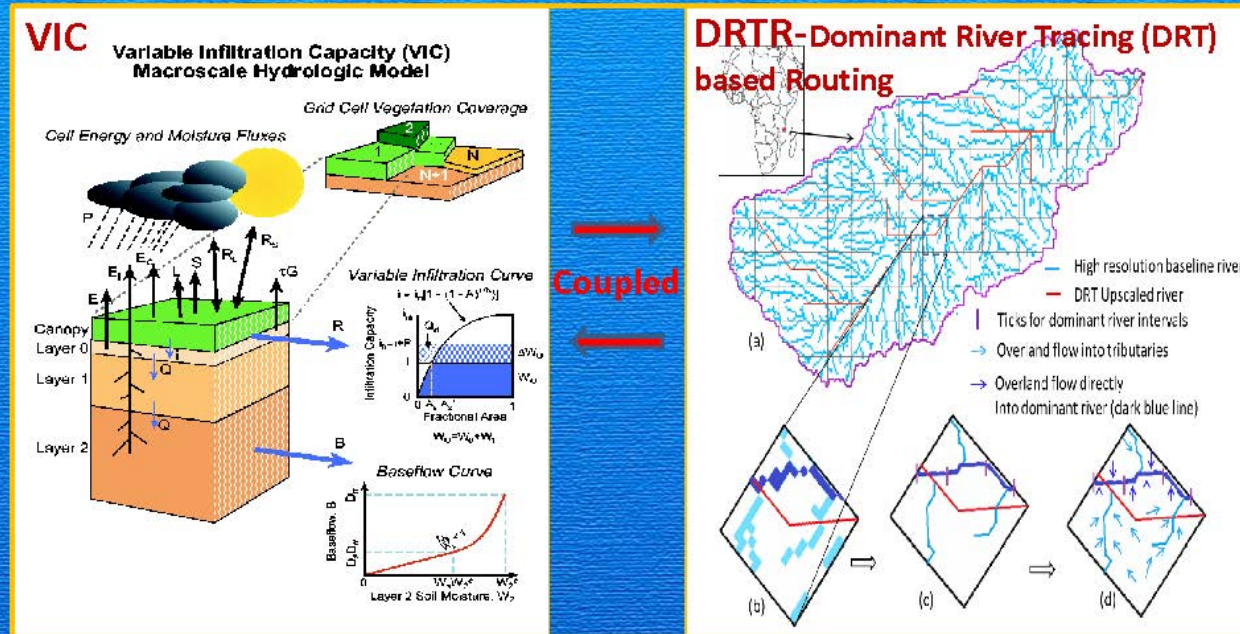


USGS HydroSHEDS

SRTM DEM Application in Flood Modeling

Dominant river tracing-Routing Integrated with VIC Environment (DRIVE) model

(Wu et al., 2011, 2012, 2013 *Water Resources Research*)



University of Washington

University of Maryland

Global Flood Monitoring System (GFMS) is running quasi-globally (50°S-50°N) every three hours at 1/8th degree, and routing is also running at 1km resolution.

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

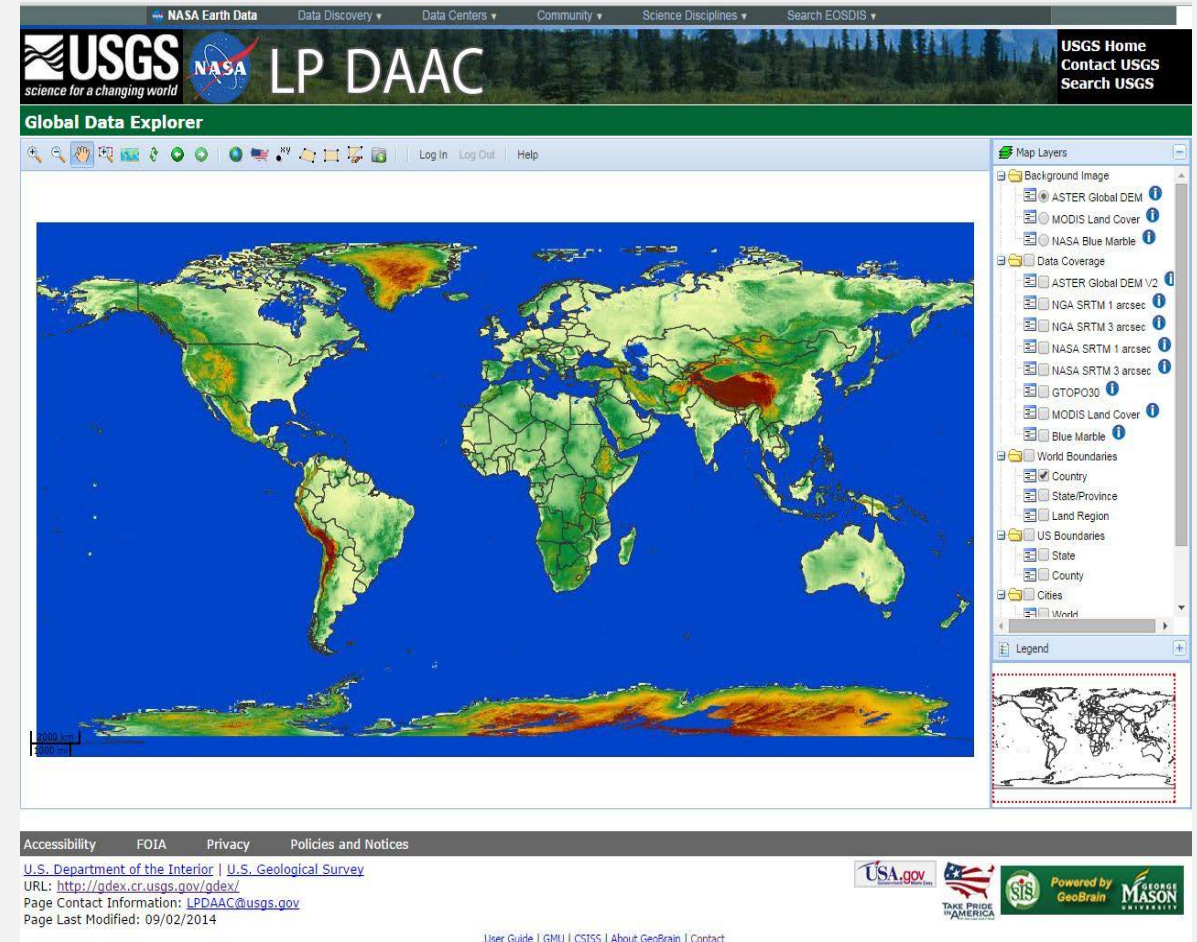
A topographic map showing a river system. The map uses a color gradient from green (low elevation) to brown (high elevation). A semi-transparent white rectangular box is overlaid on the map, containing the title text. The river is depicted as a dark line winding through the landscape.

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/>

The screenshot shows the Global Data Explorer (GDEx) interface. The main map displays a world map with a color-coded elevation or data overlay. The 'Map Layers' panel on the right is highlighted with a red box. The layers listed include:

- Background Image
 - ASTER Global DEM
 - MODIS Land Cover
 - NASA Blue Marble
- Data Coverage
 - ASTER Global DEM V2
 - NGA SRTM 1 arcsec
 - NGA SRTM 3 arcsec
 - NASA SRTM 1 arcsec
 - NASA SRTM 3 arcsec
 - GTOPO30
 - MODIS Land Cover
 - Blue Marble
- World Boundaries
 - Country
 - State/Province
 - Land Region
- US Boundaries
 - State
 - County
- Cities
 - Wwrtk

A red arrow points from the text '30 m data' to the 'ASTER Global DEM V2' layer in the 'Map Layers' panel.

30 m
data

This is a close-up view of the 'Map Layers' panel. The layers listed are:

- ASTER Global DEM
- NASA Blue Marble
- Data Coverage
 - ASTER Global DEM V2
 - NGA SRTM 1 arcsec
 - NGA SRTM 3 arcsec
 - NASA SRTM 1 arcsec
 - NASA SRTM 3 arcsec
- World Boundaries
 - Country
 - State/Province
 - Land Region

A red arrow points from the text '30 m data' to the 'ASTER Global DEM V2' layer.

SRTM V3 and ASTER DEM from GDEx

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

NASA Earth Data | Data Discovery | Data Centers | Community | Science Disciplines | Search EOSDIS

USGS science for a changing world | NASA LP DAAC | USGS Home | Contact USGS | Search USGS

Global Data Explorer | Log In | Log Out | Help

Map Layers

- Background Image
 - ASTER Global DEM
 - MODIS Land Cover
 - NASA Blue Marble
- Data Coverage
 - ASTER Global DEM V2
 - NGA SRTM 1 arcsec
 - NGA SRTM 3 arcsec
 - NASA SRTM 1 arcsec
 - NASA SRTM 3 arcsec
 - GTOPO30
 - MODIS Land Cover
 - Blue Marble
- World Boundaries
 - Country
 - State/Province
 - Land Region
- US Boundaries
 - State
 - County
- Cities
 - World

Legend

Accessibility | FOIA | Privacy | Policies and Notices

U.S. Department of the Interior | U.S. Geological Survey
URL: <http://gdex.cr.usgs.gov/gdex/>
Page Contact Information: LPDAAC@usgs.gov
Page Last Modified: 09/02/2014

USA.gov | TAKE PRIDE IN AMERICA | Powered by GeoBrain | GEORGE MASON UNIVERSITY

User Guide | GMU | CSISS | About GeoBrain | Contact

Login with your NASA Earthdata username and password

GDEx: SRTM Data Selection

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

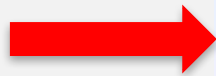
The screenshot displays the GDEx web application interface. At the top, there is a navigation bar with links for "EARTHDATA", "Data Discovery", "DAACs", "Community", and "Science Disciplines". The main header features the "USGS" logo with the tagline "science for a changing world" and the "NASA LP DAAC" logo. A "Download" button is visible in the top right corner. Below the header is a toolbar with various icons for map navigation and data selection. A "Zoom" callout points to the zoom-in (+) and zoom-out (-) icons. A "Define region of interest by bounding box, state, country, or lat/lon" callout points to the bounding box and state/country selection icons. A "Refresh" callout points to the refresh icon in the toolbar. The main content area shows a map of the United States with a red dashed bounding box over the central region. On the right side, there is a layer list with items like "MODIS Land Cover", "NASA Blue Marble", "Data Coverage", "ASTER Global DEM V2", "NASA SRTM 1 arcsec", "NASA SRTM 3 arcsec", and "NASA SRTM Custom". A legend and a small inset map of the United States are also visible. At the bottom, there is a footer with links for "Accessibility", "FOIA", "Privacy", and "Policies and Notices", along with contact information for the U.S. Department of the Interior and U.S. Geological Survey. Logos for "USA.gov" and "Powered by GeoBrain" are also present.

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)



The screenshot shows the CGIAR-CSI website interface. The browser address bar displays 'csi.cgiar.org/WhtisCGIAR_CSI.asp'. The main header features the CGIAR-CSI logo and the tagline 'Applying GeoSpatial Science for a Sustainable Future...'. Below the header is a navigation menu with the following items:

- CGIAR-CSI HOME
- CGIAR-CSI Content
 - What's New ?
 - What is CGIAR-CSI ?
 - CGIAR-CSI Members
 - CGIAR-CSI Geonetwork Nodes
 - Geonetwork Support
 - GeoLinks-Directory
 - CGIAR GeoSpatial Sites and Web Map Servers
 - GeoSpatial Toolkit
 - SRTM 90m DATABASE**
 - CRU Climate DATABASE
 - Global PET / Aridity DATABASE
 - MENRIS Portal

The main content area is titled 'What is CGIAR-CSI ?' and contains the following text:

Home > What is CGIAR-CSI ?

What is CGIAR-CSI ?

The fifteen CGIAR International Research Centers have pioneered the application of Geographic Information Systems (GIS) and Remote Sensing (RS) for sustainable agricultural development for more than a decade. In May 1999, they formed the Consortium for Spatial Information (CGIAR-CSI) which links the all of the CGIAR's GIS/RS laboratories, and the many geospatial scientists and researchers within the CGIAR system, with scientists and institutions from around the world. Together, these laboratories, scientists and researchers constitute a formidable assemblage of technical ingenuity, scientific expertise, and practical experience in spatial analysis.

They have already developed important collections of data on population, poverty, climate, soils, crops, livestock, transportation, and biodiversity and other geospatial Global Public Goods. The CGIAR-CSI researchers are continuing to break new ground in the integration of biophysical and socio-economic data to better target agricultural technologies and resources to farmers' needs, to assess global needs, develop strategies to alleviate poverty, and to better adapt to a changing global environment.

These powerful spatial technologies have become an integral part of interdisciplinary research within the CGIAR. Through linking geo-referenced data to digital maps, a whole new range of opportunities for integrating and presenting diverse information has opened to a diverse set of users to harness these technologies. Users can more readily see and understand interrelationships between, for example, urban and rural areas, markets, crop production, deforestation, and soil erosion.

They can develop more realistic models, and identify and monitor change more accurately. Ultimately, the improved understanding of the landscape strengthens strategies and activities in natural resource management, agricultural development, land change analysis, biodiversity conservation, and ecological studies.

CGIAR-CSI: SRTM Data Access

Click to select and download data



The CGIAR Consortium for Spatial Information (CGIAR-CSI)

Applying GeoSpatial Science for a Sustainable Future...

CGIAR-CSI HOME ■ SRTM 90m DATABASE HOME ■ DISCLAIMER ■ HELP

CGIAR-CSI Content

- What is CGIAR-CSI ?
- CGIAR-CSI Members
- What's New ?
- CRU Climate Data

SRTM Content

- **SRTM Data Search and Download**
- SRTM Data Processing Methodology
- SRTM FAQ
- SRTM Quality Assessment (PDF File - 2.55 Mb)
- About SRTM Imagery
- CIAT Landuse Project
- How to Search for Data?
- Disclaimer
- Contact Us

SRTM 90m Digital Elevation Data

new Resampled SRTM data to 250m resolutions for the entire globe are available <https://hc.box.net/shared/1yidaheouv> (Password: ThanksCSI!)

UPDATE - VERSION 4: THE SRTM DATA NOW AVAILABLE FROM THIS SITE HAS BEEN UPGRADED TO VERSION 4. THIS LATEST VERSION REPRESENTS A SIGNIFICANT IMPROVEMENT FROM PREVIOUS VERSIONS, USING NEW INTERPOLATION ALGORITHMS AND BETTER AUXILIARY DEMs. WE ARE CONFIDENT THIS IS NOW THE HIGHEST QUALITY SRTM DATASET AVAILABLE

CGIAR-CSI: SRRTM Data Selection

Spatial selection can be by lat/lon

or by clicking on the grid(s)

SRTM Data Selection Options Chinese users : [中国用户可通过中国科学院镜像站点下载](#)

1. Select Server: CGIAR-CSI (USA) HarvestChoice (USA) JRC (IT) King's College (UK) TelaScience (USA)

2. Data selection method: Multiple Selection Enable Mouse Drag Input Coordinates

Many tiles can be selected at random locations. These selected tiles are listed in the results page for download.

Decimal Degrees (ie 34.5, -100.5) Degrees: Minutes: Seconds

Longitude - min: max: Longitude - min:

Latitude - min: max: Latitude - min: North max: North

Longitude: 100.00 Latitude: 100.0 Tile X: 10 Tile Y: 10

3. Select File Format: GeoTiff ArcInfo ASCII

1
2
3
4
5
6
7
8
9
10

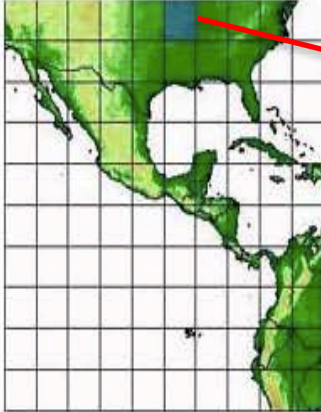
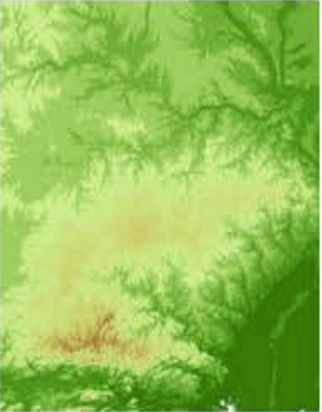
19
20
21
22
23
24

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 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72

Clear Grid Selection

Select data format

CGIAR-CSI: SRTM Data Download

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

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
- CGIAR-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**

A topographic map showing a river system. The map uses a color gradient from green (low elevation) to brown (high elevation). A prominent river flows from the top right towards the bottom right, with several meanders. A semi-transparent white rectangular box is overlaid on the map, containing the text "Next Demonstration of GDEx".

Next
Demonstration of GDEx
