Welcome to NASA Applied Remote Sensing Training (ARSET) Webinar Series

INTRODUCTION TO REMOTE SENSING FOR WILDFIRE APPLICATIONS

Course Dates: Every TUESDAY, March 31- April 28
Time: 11:30 AM-12:30 pm EST

Important Information

- Week 5: final webinar
  - One lecture per week – every Tuesday from March 31 to April 28 (11:30 AM – 12:30 PM EST)
- Webinar recordings, PowerPoint presentations, and homework assignments can be found after each session at: https://arset.gsfc.nasa.gov/disasters/webinars/introduction-remote-sensing-wildfire-applications
- Certificate of Completion
  - Attend 4 out of 5 webinars
  - Assignment 1 and 2 – access from the ARSET wildfire webinar website (above)
  - Reminder to complete homework by **May 12th**
  - You will receive certificates in approximately mid- June: marines.martins@ssaihq.com
- Q/A: 15 minutes following each lecture and/or by email (cynthia.l.schmidt@nasa.gov)

ARSET Wildfire Management

http://arset.gsfc.nasa.gov/eco/webinars/land-management

Registration: **https://arset.adobeconnect.com/wildfire/event/registration.html**
Agenda: **NASA_ARSET_Wildfire_Webinar_Agenda.pdf**
Keywords: **Ecosystems**, **Fires and Smoke**, **Satellite Imagery**, **Vegetation Indices**
Instruments/Missions: **Landsat**, **MODIS**, **NPP**, **SMAP**, **VIIRS**

Presentations and Recordings

Week	Date	Title	Presentation	Recording	Assignment
1	March 31, 2015	Overview of remote sensing	**Week 1 Presentation** **Week 1 Presentation (Spanish)**	View Week 1 Recording	N/A
2	April 7, 2015	Satellite sensors and data products for wildfire applications	Week 2 Presentation Week 2 Presentation (Spanish)	View Week 2 Recording	**Assignment 1**
3	April 14, 2015	Remote sensing products for pre- and post-fire wildfire planning and assessment	Week 3 Presentation Week 3 Presentation (Spanish)	View Week 3 Recording	N/A

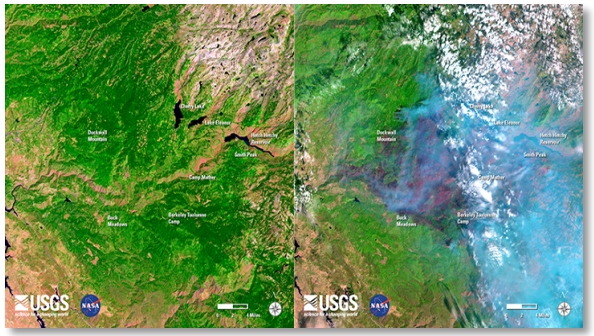
Your Course Instructors

- Cindy Schmidt (ARSET): cynthia.l.schmidt@nasa.gov
- Amber Kuss (ARSET): amberjean.m.kuss@nasa.gov
- Guest Speakers:
  - Tony Guay – USDA Forest Service Remote Sensing Applications Center (week 3)
  - Keith Weber – Idaho State University (week 3)
  - Dale Hamilton – Northwest Nazarene University (week 4)
  - Amita Mehta– NASA Goddard (week 4)
  - Lindsey Harriman – LP DAAC (week 5) lharriman@usgs.gov

General inquiries about ARSET: Ana Prados (ARSET) aprados@umbc.edu

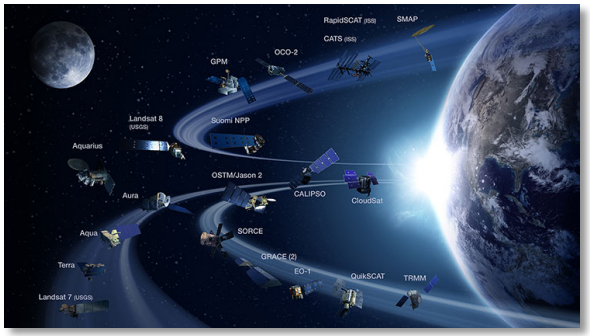
Course Outline

Week 1



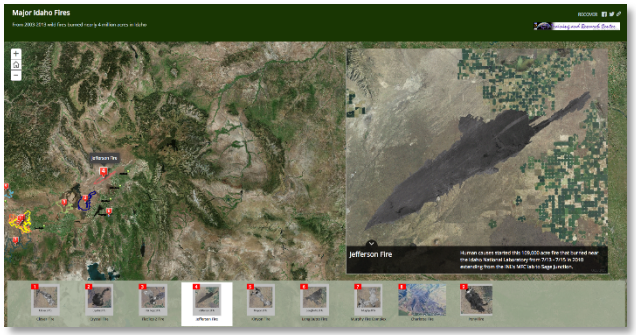
Overview of satellite remote sensing

Week 2



Platforms and sensors for wildfire applications

Week 3

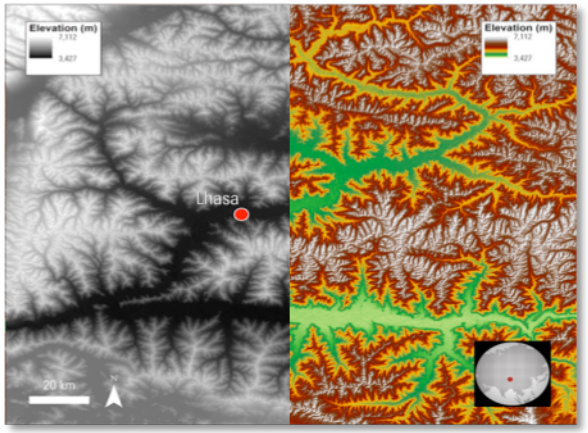


Products and tools for pre and post-wildfire

Week 4

New techniques and technologies

Week 5



Terrain data applications

Week 5 Agenda

- Brief review of last week
- Guest Speaker: *Lindsey Harriman,* Science Communication Lead from the Land Processes Distributed Active Archive Center (LP DAAC)
  - Terrain data for wildfire applications
  - LP DAAC data availability
  - Case studies of terrain data uses
  - Live Demo: Global Data Explorer (GDEx)

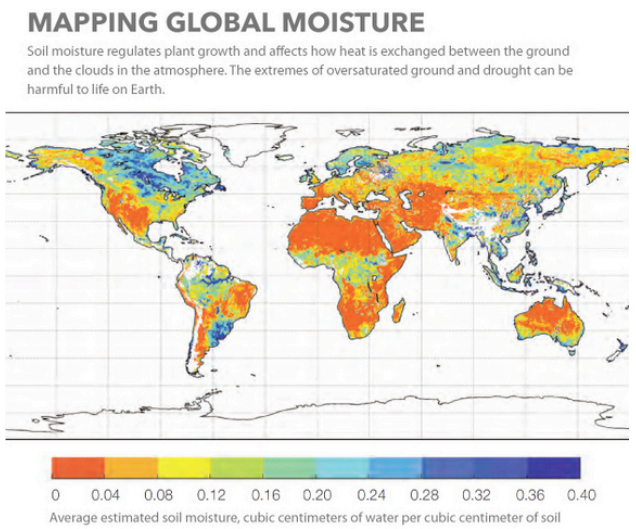
Review of Week 4

Week 4

- Unmanned Aircraft Systems (UAS)
  - Overview
  - Benefits and constraints
  - UAS imagery for wildfire applications

UAS aircraft examples

- Soil Moisture Active Passive (SMAP)
  - Overview of sensor
  - Data resolution and availability
  - Acquisition and processing
  - Data applications for wildfire applications



Guest Speaker: Lindsey Harriman

Terrain Data at the LP DAAC

Lindsey Harriman, Innovate! Inc.
Contractor to the U.S. Geological Survey (USGS) Earth Resources Observation and Science (EROS) Center Sioux Falls, South Dakota

***Work performed under USGS contract G10PC00044**

U.S. Department of the Interior
U.S. Geological Survey

Outline

- Overview of terrain data for fire applications
- Introduction to terrain data at the LP DAAC
- Using terrain data
- Demonstration of Global Data Explorer (GDEx)

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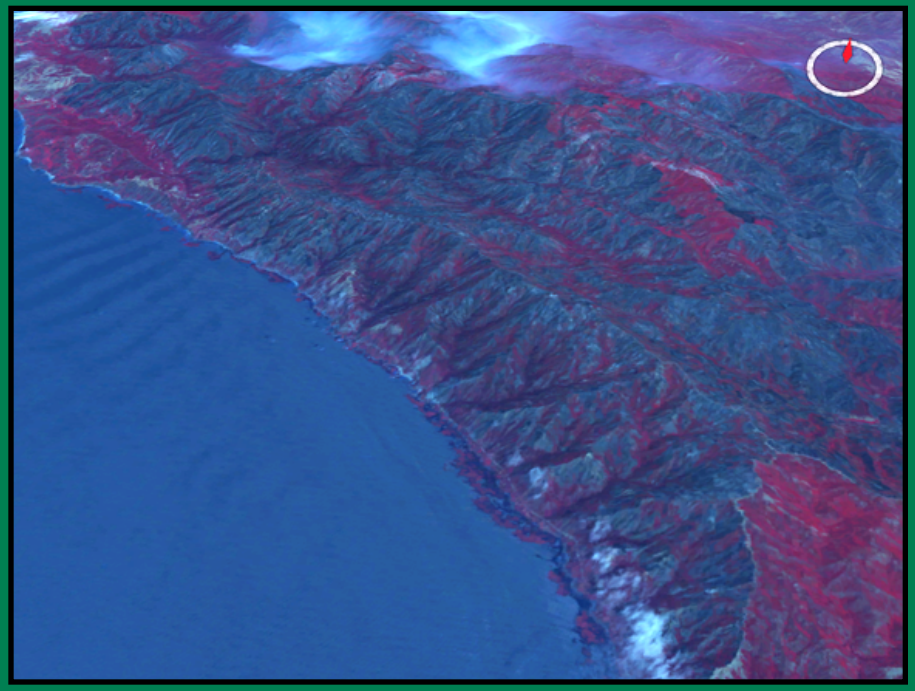
Terrain Data and Wildfire

- Visualize satellite data in 3D
- Calculate
  - Slope and aspect
  - Burn area
  - Forest canopy height
  - Elevation
- Model
  - Fire fuel and gradient
  - Fire behavior and effects



Scars from the Basin Complex Fire, California.
ASTER image from July 15, 2008.

LANDFIRE, n.d., Topographic, accessed March 20, 2015, at http://www.landfire.gov/topographic.php.

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Sources of Land Terrain Data

- Field Methods
  - Surveys
  - GPS collection
- Passive systems (stereo-photogrammetry)
  - Aerial imagery
  - Spaceborne optical imagery
    - Terra Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER)
- Active systems
  - Radar (interferometry)
    - Shuttle Radar Topography Mission (SRTM)
  - Light Detection and Ranging (lidar)

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NASA LP DAAC

- Land Processes (LP) Distributed Active Archive Center (DAAC)
  - https://lpdaac.usgs.gov
- One of 12 of NASA's discipline-oriented DAAC's
- Located in Sioux Falls, SD at the USGS Earth Resources Observation Science (EROS) Center
- Processes, archives, and distributes remotely sensed land data products to the civilian remote sensing community

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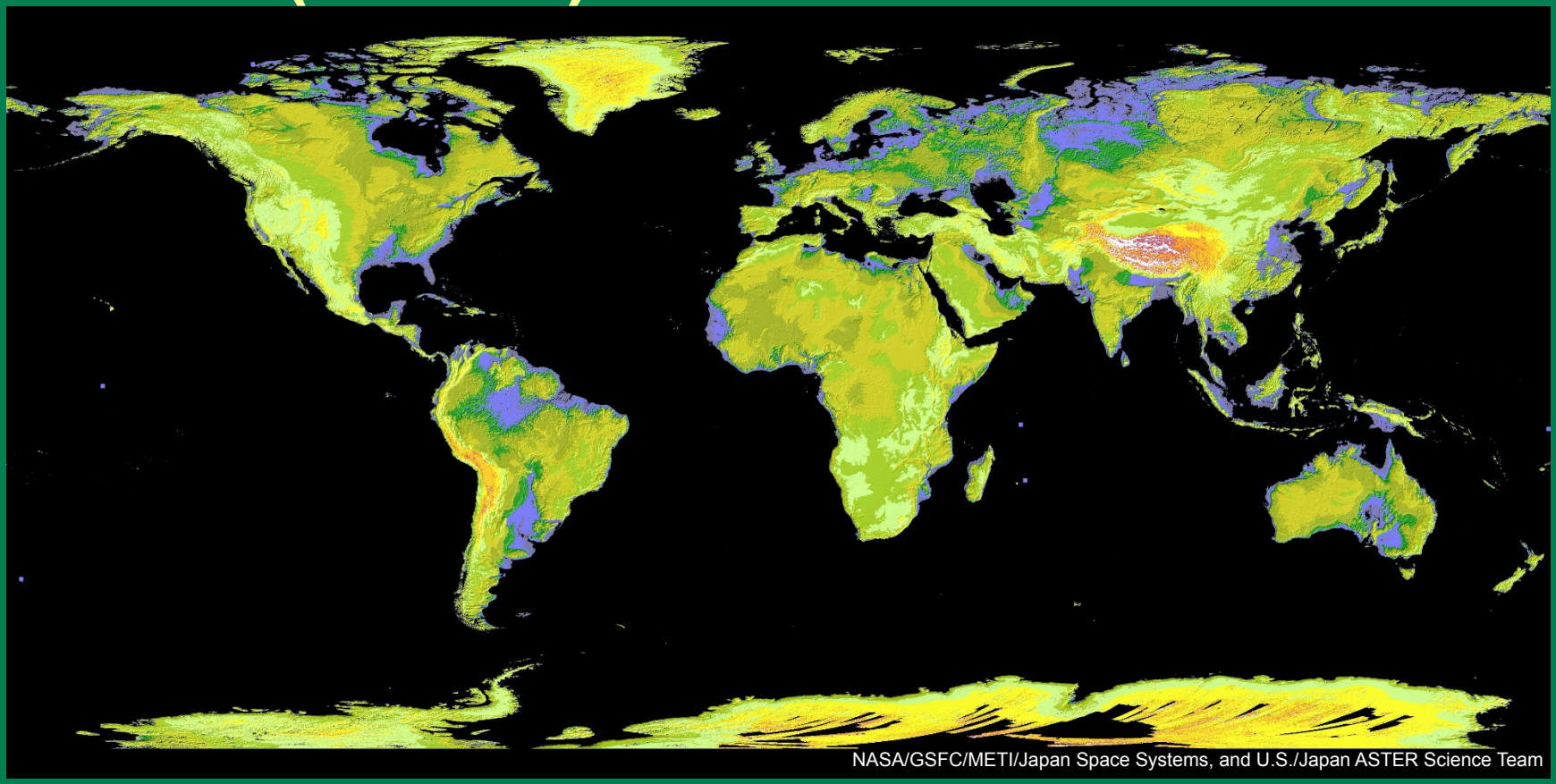
ASTER Global Digital Elevation Model (GDEM)



https://lpdaac.usgs.gov/products/aster_products_table/astgtm

USGS NASA

What is ASTER?

- ASTER
  - Advanced Spaceborne Thermal Emission and Reflection Radiometer
  - Onboard NASA's Terra satellite
  - Developed jointly by NASA and Japan's Ministry of Economy, Trade, and Industry (METI)
- Bands
  - 3 – 15 m bands in Visible & Near-infrared (VNIR)
  - 6 – 30 m Shortwave Infrared (SWIR)*
  - 5 – 90 m Thermal Infrared (TIR)

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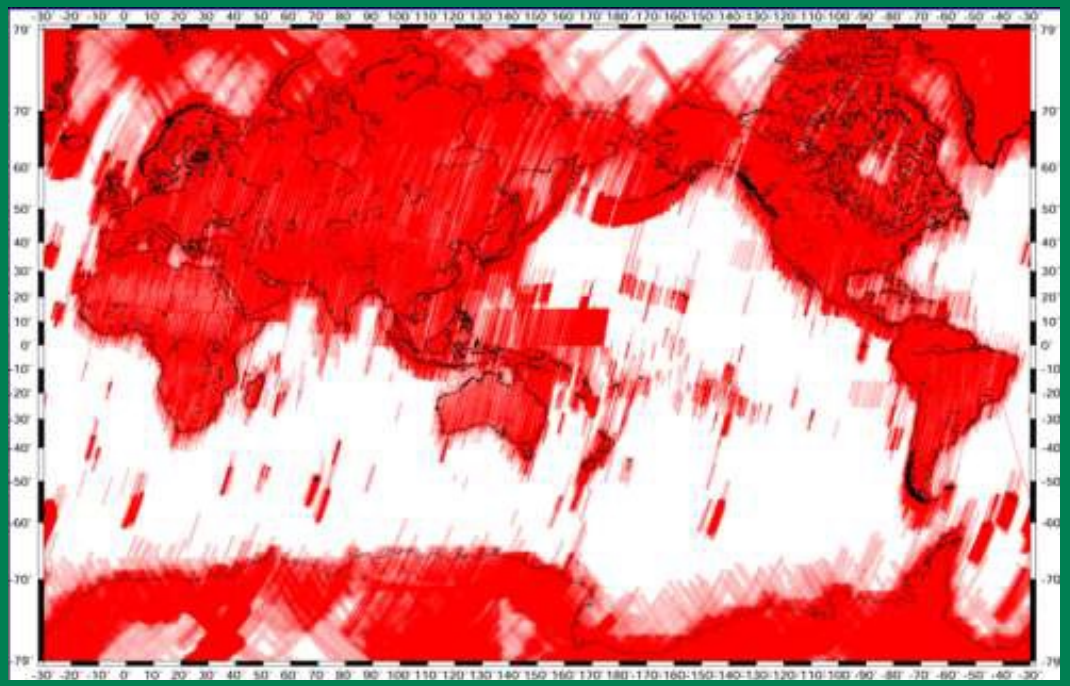
ASTER Acquisition and Coverage

- Data has been collected since 2000
- ~2.5 million scenes
- ~515 scenes/day
- Global coverage
  - Taskable
  - Pointable
  - Expedited



Spatial and temporal coverage may vary

- ASTER can collect in stereo (3D)
  - Uses nadir- and aft-looking near infrared cameras

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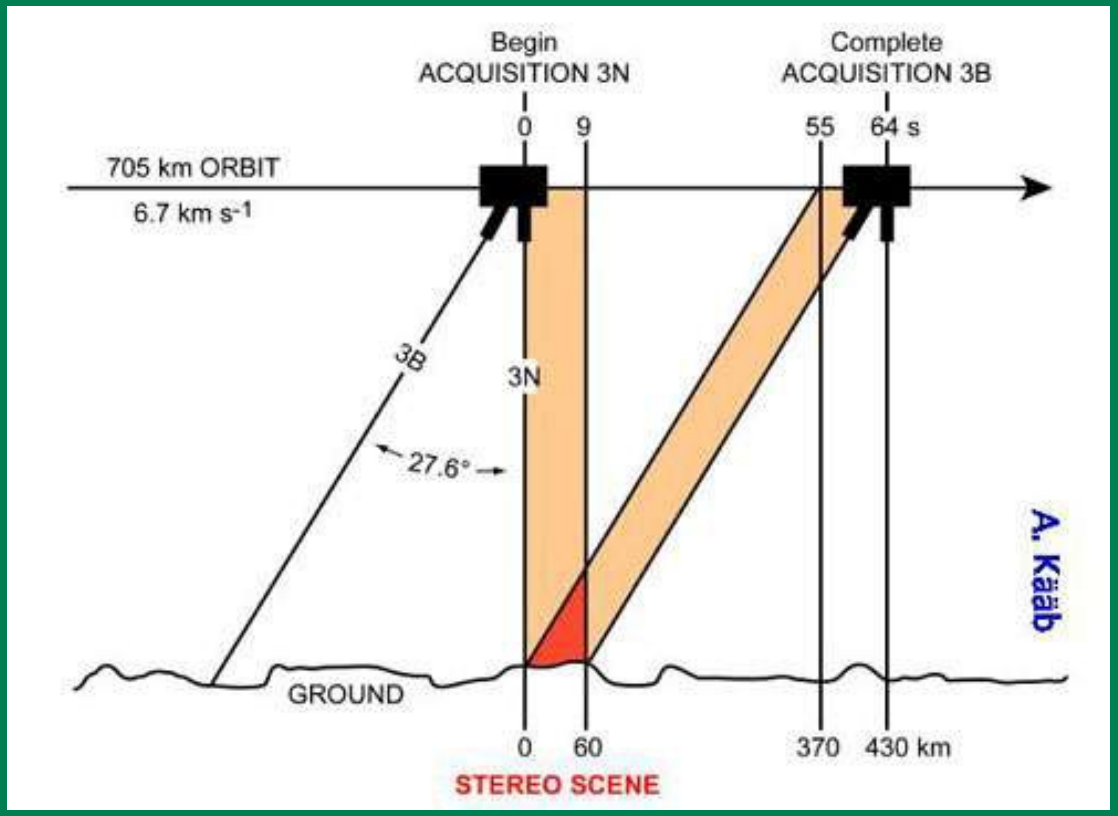
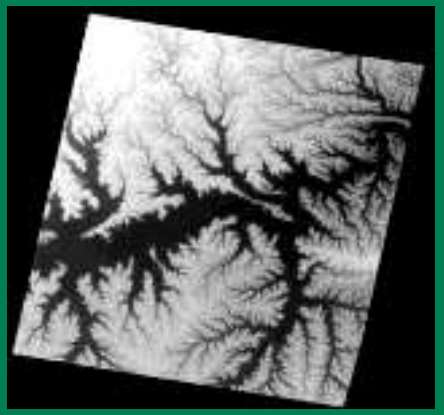
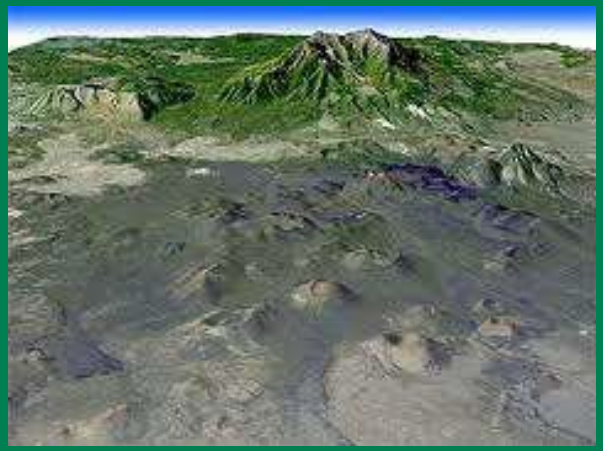
Stereo Vision in the NIR



Courtesy: Global Land Ice Measurements from Space (GLIMS Switzerland).
http://www.geo.unizh.ch/~kaeaeb/glims/glims.html



AST_14DEM

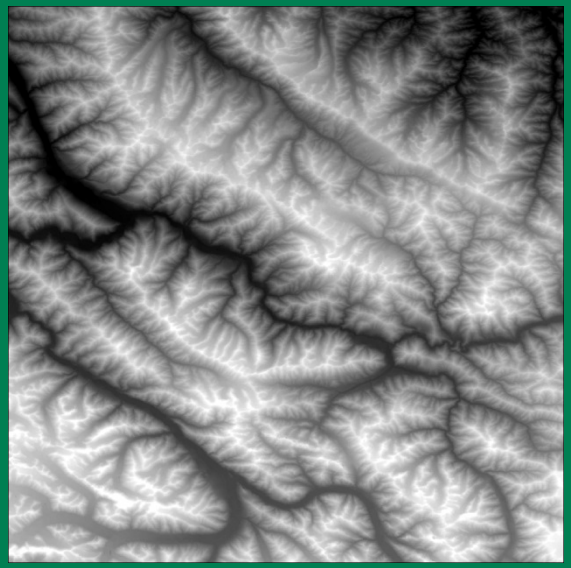


Courtesy: NASA & USGS

USGS NASA

What is ASTER GDEM?

- Global Digital Elevation Model (GDEM)
- Product of METI and NASA
- Version 1 released June 29, 2009
  - 1.3 million ASTER VNIR scenes (as stereo-pairs) were used to produce single scene DEMs
  - Data from 2000 - 2008
- Improved Version 2 released October 17, 2011
  - Incorporated 260,000 more stereo-pairs from ASTER images collected after September 2008
- Freely available; redistribution restricted



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ASTER GDEM Characteristics

- **Short name: ASTGTM**

Data Set Characteristics

Tile Size	3601 x 3601 (1 degree by 1 degree)
Pixel Size	1 arc-second
Geographic coordinates	Geographic latitude and longitude
DEM output format	GeoTIFF, signed 16 bits in units of vertical meters
Geoid reference	WGS84/EGM96
Special DN values	-9999 for void pixels, and 0 for sea water body
Tile volume	25 MB uncompressed, 4–5 MB compressed
Coverage	North 83 degrees to south 83 degrees, 22,702 tiles

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ASTER GDEM Layers

Output format	File extension	Units	Data Type	Description
DEMs	.DEM	meters	16-bit signed integer	Elevation information
Number	.NUM	none	16-bit signed integer	QA/Void-fill information

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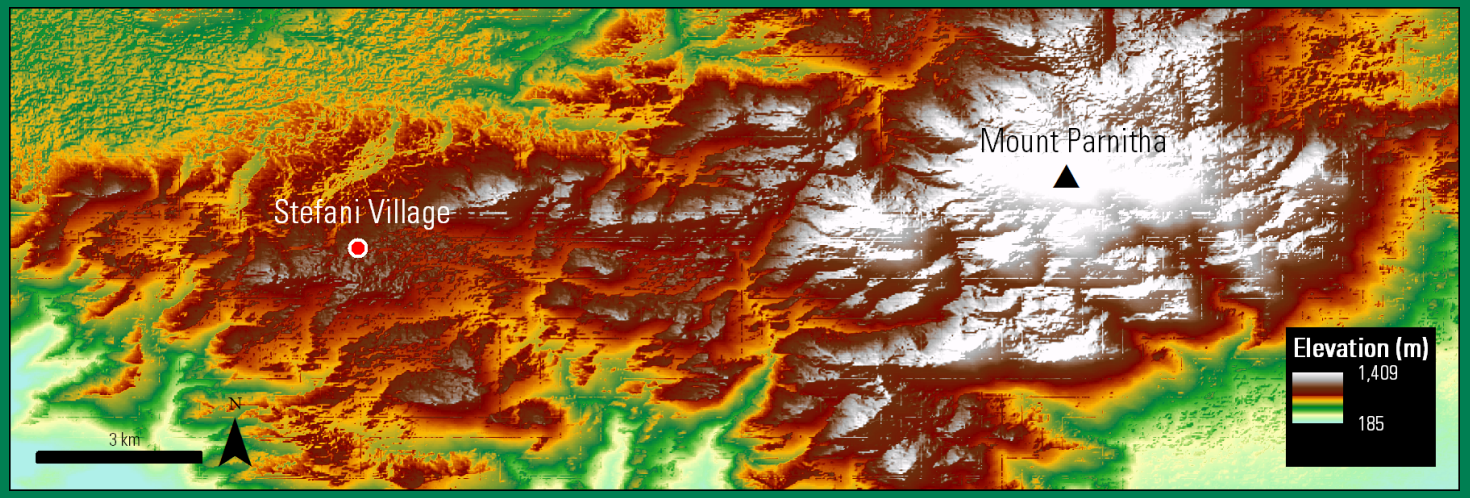
Use Case: Mount Parnitha

- Fire occurred on June 27, 2007
  - Started near the village of Stefani and spread to Mount Parnitha National Park, Greece
  - Elevation ranges from 200 meters to 1,413 meters (above sea level)
  - Three days to contain; burned 45 km^2



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Use Case: Mount Parnitha

- **Objectives**
  - **Determine the spatial and temporal characteristics of vegetation re-growth over a 4 year period over a burn scar**
  - **Analyze the influence of topography on the re-growth**

Petropoulos, G.P., Griffiths, H.M., Kalivas, D.P., 2014, Quantifying spatial and temporal vegetation recovery dynamics following a wildfire event in a Mediterranean landscape using EO data and GIS, Applied Geography v. 50, p. 120-131. Also available at [http://dx.doi.org/10.1016/j.apgeog.2014.02.006].

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Use Case: Mount Parnitha

- Data used
  - Slope and aspect were calculated from ASTER GDEM
    - Aspect
      - North-facing slopes (NW (315°) to NE (45°))
      - South-facing slopes (SE (135°) to SW (225°))
    - Slope
      - Varies from 3% to 90%
- Normalized Difference Vegetation Index (NDVI) calculated from Landsat 5 TM

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Use Case: Mount Parnitha

- **Findings:**
  - **North-facing slopes had greater loss of vegetation than south-facing slopes**
  - **North-facing slopes recovered faster than south-facing slopes**

	Mean NDVI				
	Pre-fire (May 2007)	July 2007	July 2009	Aug 2010	August 2011
North-facing	0.515	0.085	0.300	0.302	0.340
South-facing	0.478	0.087	0.218	0.224	0.253

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How to Access ASTER GDEM

- **Reverb:**
  http://reverb.echo.nasa.gov/reverb
- **GDEx (demo today):**
  http://gdex.cr.usgs.gov/gdex/
- **Japan Space Systems GDEM:**
  http://gdem.ersdac.jspacesystems.or.jp/

- **More information:**
  https://lpdaac.usgs.gov/products/aster_products_table/aster_gdem_version_2_validation

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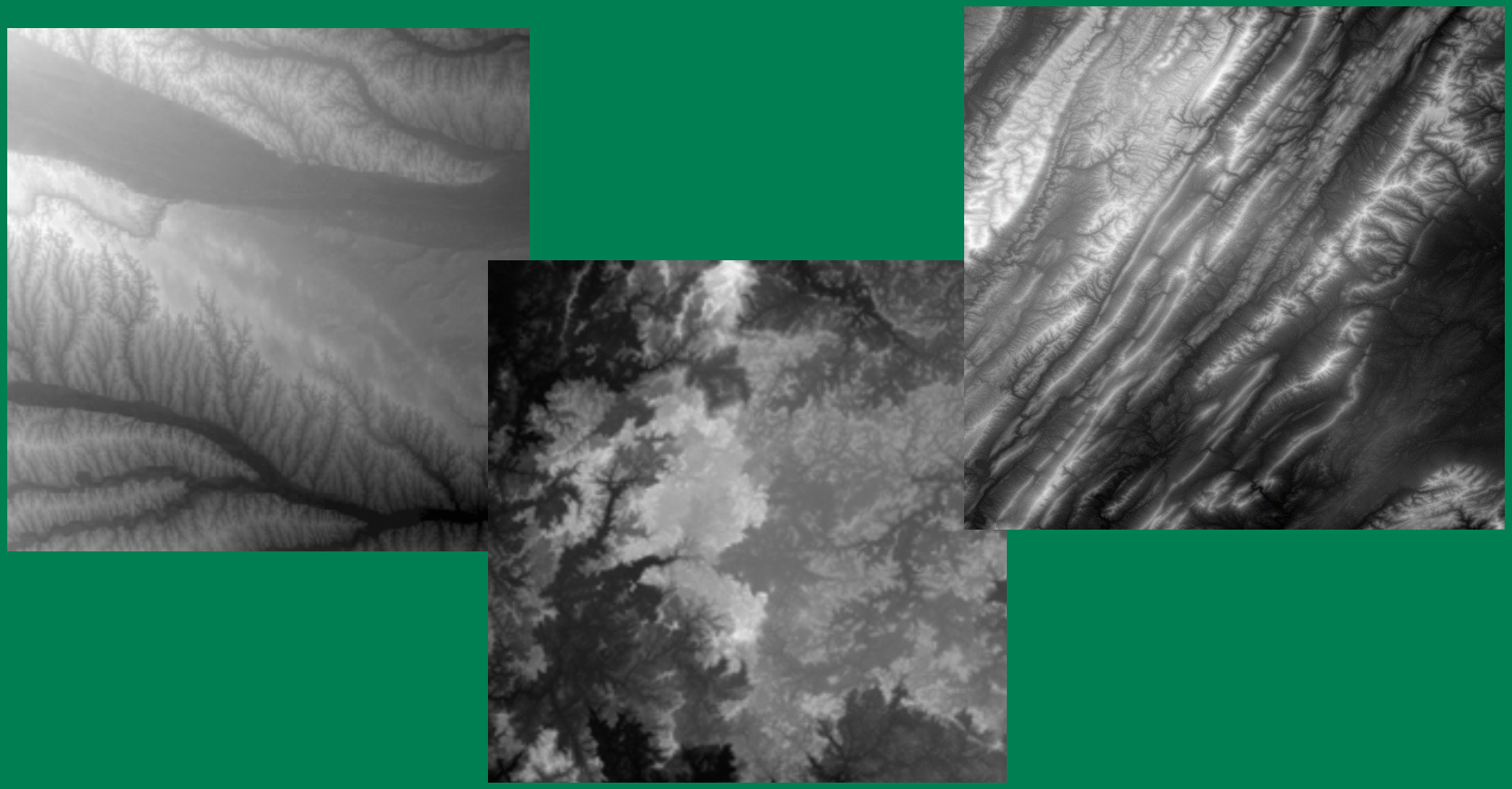
NASA SRTM Version 3.0 (SRTM Plus)



https://lpdaac.usgs.gov/products/measures_products_table

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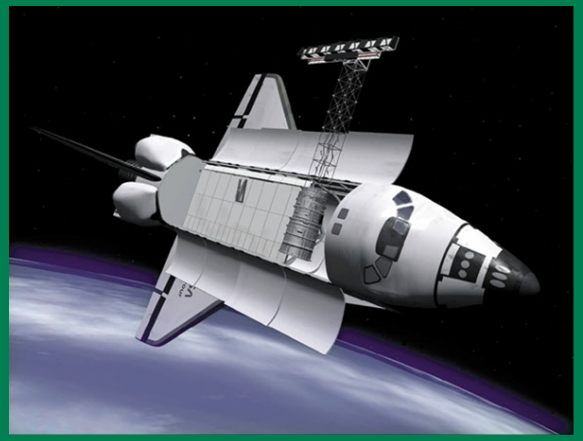
What is SRTM?

- Shuttle Radar Topography Mission (SRTM)
- NASA mission completed in February 2000
- Consisted of 176 orbits around Earth in 11 days
- Acquired DEM of all land between 60ºN and 56ºS latitude, about 80% of Earth's total landmass
- Collected at 1 arc-second and resampled to 3 arc-seconds



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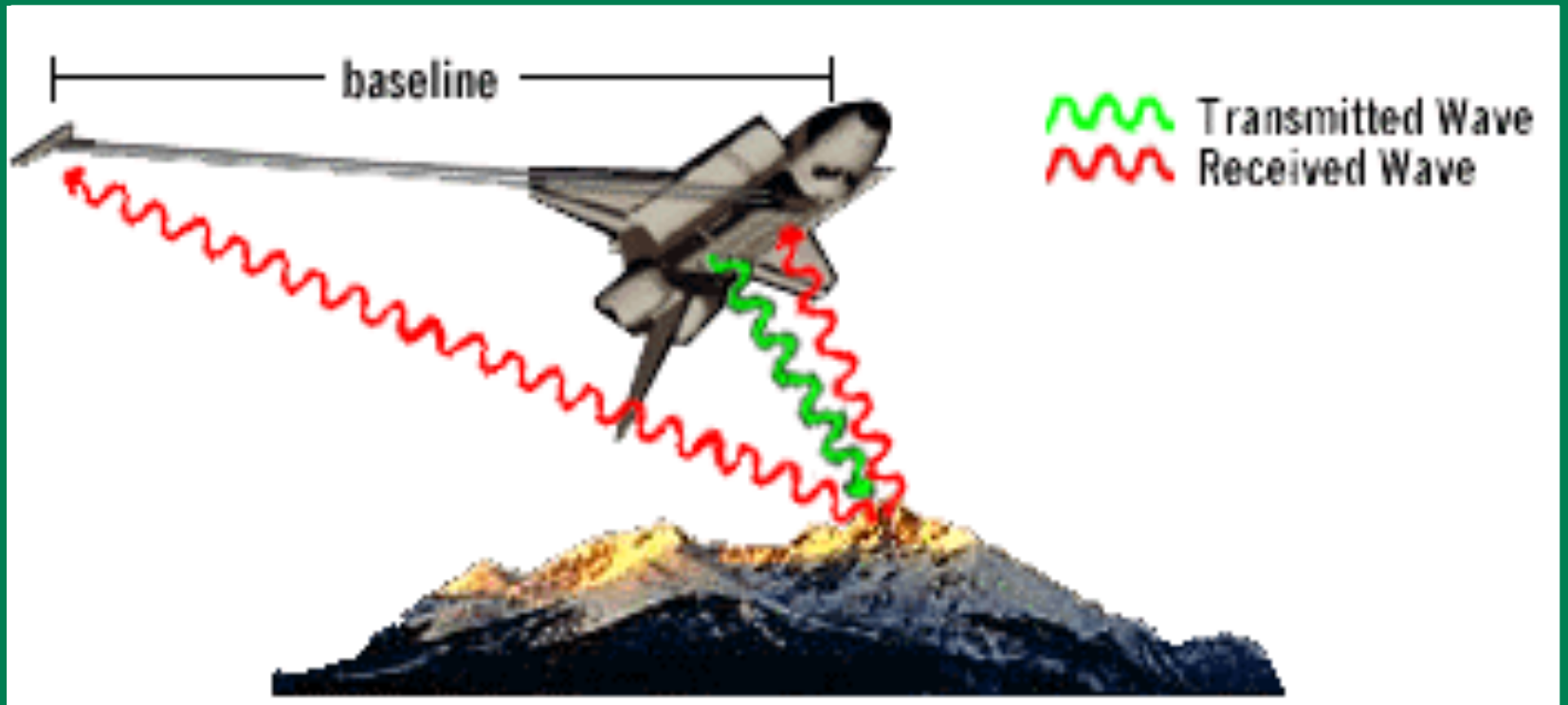

Radar signals being transmitted and recieved in the SRTM mission (image not to scale).

http://srtm.usgs.gov/data/interferometry.php

NASA SRTM Version 3.0 (SRTM Plus)

- Created by the Jet Propulsion Laboratory (JPL) as part of the NASA MEaSUREs program
- Principal Investigator: Michael Kobrick, JPL
- Eliminated voids in the SRTM data by filling with ASTER GDEM2, USGS GMTED2010, or USGS National Elevation Dataset (NED)
- 1 arc-second
  - U.S. & Territories, Africa, Asia, Australia, Europe
- 3 arc-second
  - 60°N to 56°S

USGS NASA

NASA SRTM v3 Products

Short Name	Collection	MEaSUREs Data Product	Spatial Resolution
SRTMGL1	SRTM	SRTM Global 1 arc second	1 arc-second
SRTMGL1N	SRTM	SRTM Global 1 arc second number	1 arc-second
SRTMGL3	SRTM	SRTM Global 3 arc second	3 arc-second
SRTMGL30	SRTM	SRTM Global 30 arc second	30 arc-second
SRTMGL3N	SRTM	SRTM Global 3 arc second number	3 arc-second
SRTMGL3S	SRTM	SRTM Global 3 arc second sub-sampled	3 arc-second
SRTMIMGM	SRTM	SRTM Combined Image Data Set	1 arc-second
SRTMIMGR	SRTM	SRTM Swath Image Data	1 arc-second
SRTMSWBD	SRTM	SRTM Water Body Data Shapefiles & Raster Files	1 arc-second

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NASA SRTM v3 Characteristics

Characteristic	Description
Tile size	1° by 1°
Pixel size	1 arc-second (~30 meters) or 3 arc-seconds (~90 meters)
Geographic coordinates	Geographic latitude and longitude
Geoid reference	WGS84/EGM96
Special DN values	N/A - No voids in v3
Coverage	1 arc-second U.S. & Territories, Africa, Asia, Australia, Europe 3 arc-second 60°N to 56°S

USGS NASA

NASA SRTM v3 Output Formats

Output format	File extension	Units	Data Type	Description
DEMs	.HGT	meters	16-bit signed integer	Elevation information
Number	.NUM	none	8-bit unsigned integer	QA/Void-fill information

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NASA SRTM v3
3 arc-second Products

Short Name	Collection	MEaSUREs Data Product	Spatial Resolution
SRTMGL1	SRTM	SRTM Global 1 arc second	1 arc-second
SRTMGL1N	SRTM	SRTM Global 1 arc second number	1 arc-second
SRTMGL3	SRTM	SRTM Global 3 arc second	3 arc-second
SRTMGL30	SRTM	SRTM Global 30 arc second	30 arc-second
SRTMGL3N	SRTM	SRTM Global 3 arc second number	3 arc-second
SRTMGL3S	SRTM	SRTM Global 3 arc second sub-sampled	3 arc-second
SRTMIMGM	SRTM	SRTM Combined Image Data Set	1 arc-second
SRTMIMGR	SRTM	SRTM Swath Image Data	1 arc-second
SRTMSWBD	SRTM	SRTM Water Body Data Shapefiles & Raster Files	1 arc-second

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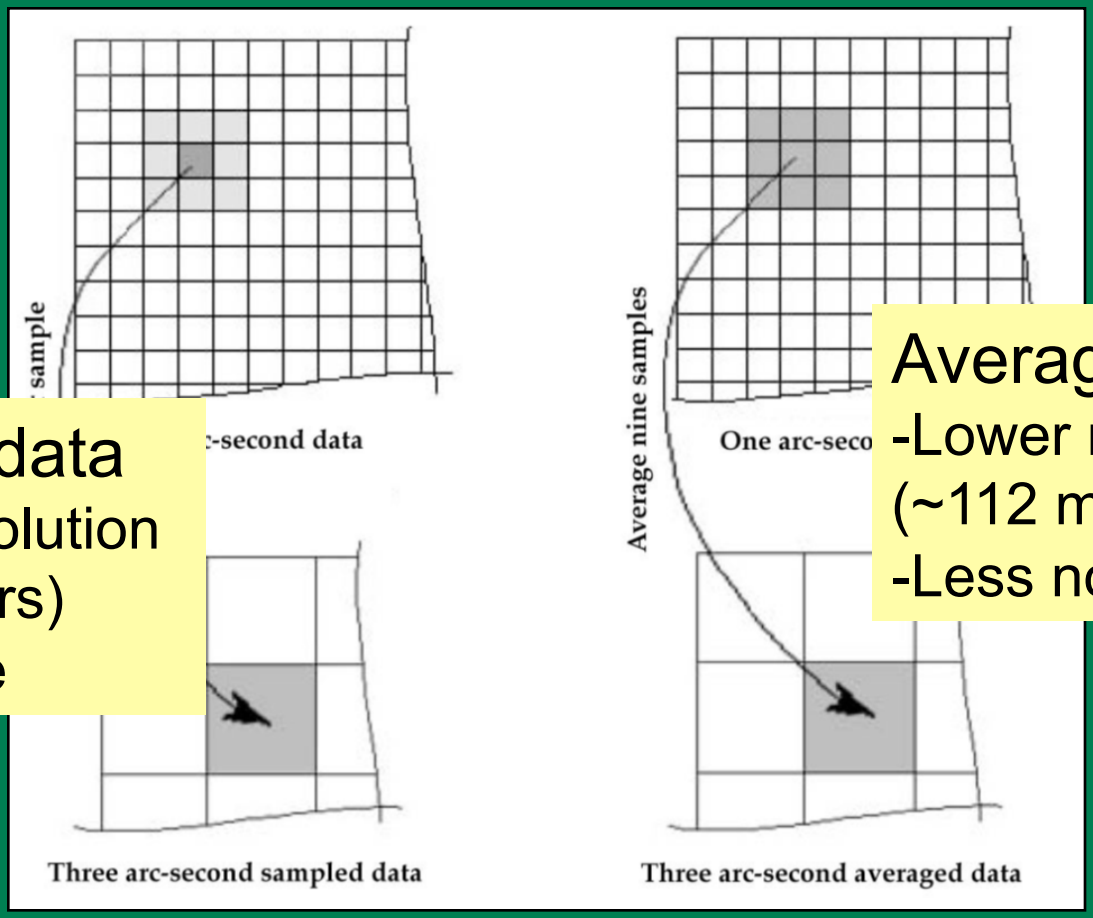
Sampling Methods: Global 3 arc second data

SRTMGL3S **SRTMGL3**



Sampled data
-Higher resolution (~100 meters)
-More noise

Averaged data
-Lower resolution (~112 meters)
-Less noise

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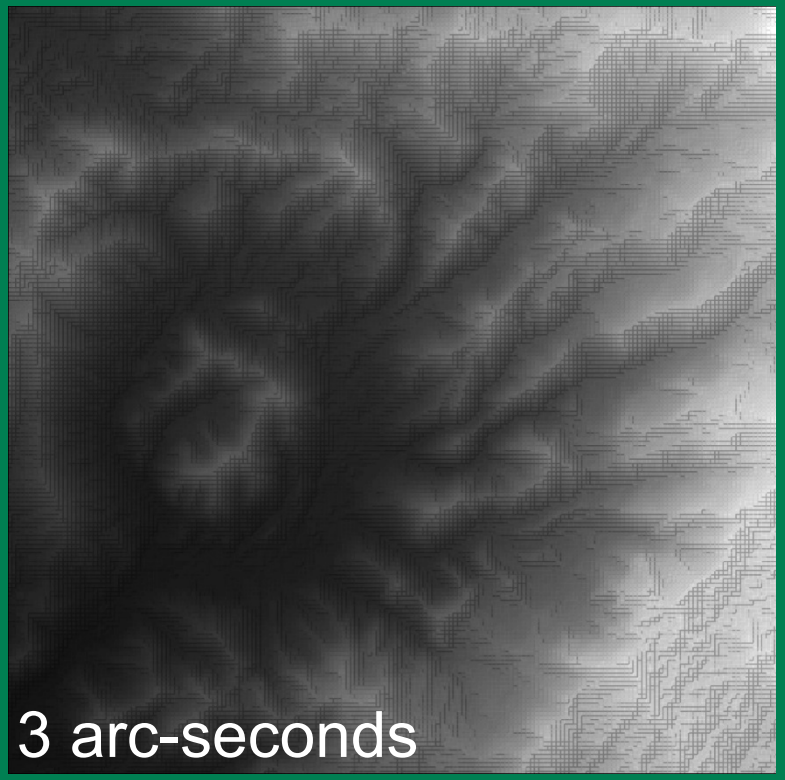
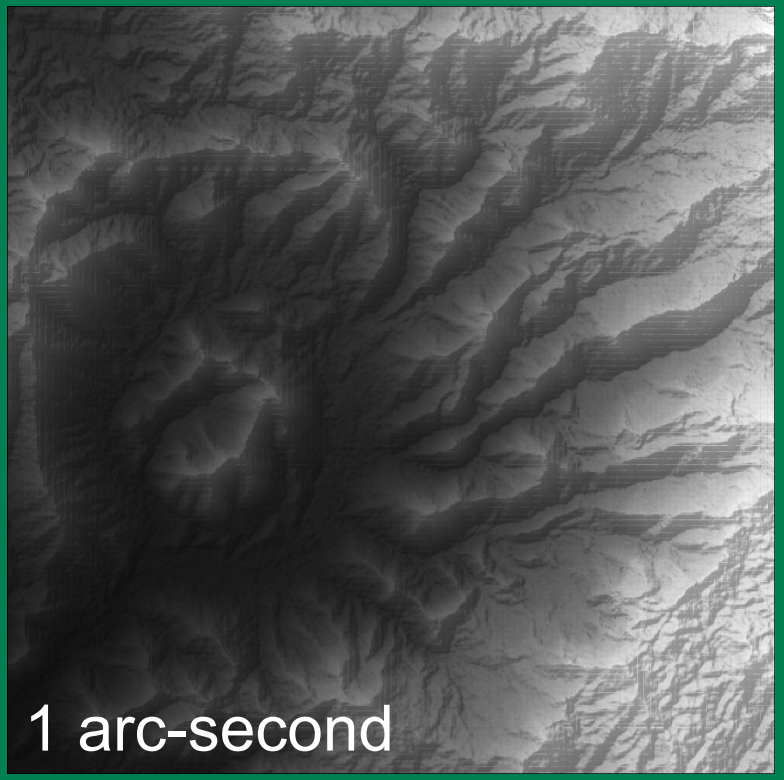
NASA SRTM v3

Mount Elgon, Uganda



http://dx.doi.org/10.5067/MEaSUREs/SRTM/SRTMGL3.003



http://dx.doi.org/10.5067/MEaSUREs/SRTM/SRTMGL1.003

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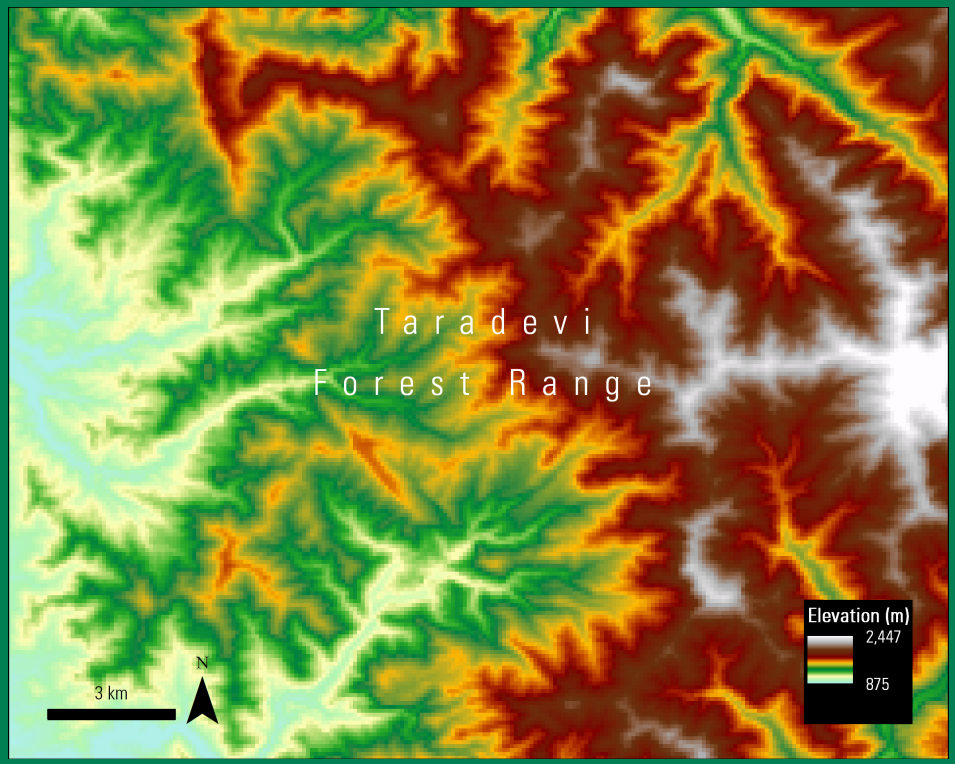
Use Case: Taradevi Forest Range

- Model forest fire risk as component of forest management, land use planning, and sustainable natural resource management
- Taradevi forest range of the Shimla Forest Division in Himachal Pradesh, India



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Use Case: Taradevi Forest Range

- Objectives
  - Model fire risk to aid fire managers, land managers
  - Use knowledge-based and analytic hierarchy process (AHP) approach to modeling
  - Investigate forest fire risk factors: fuel type, slope, aspect, elevation, and distance from roads and settlements

Sharma, L.K., Kanga, S., Nathawat, M.S., Sinha, S., and Pandey, P.C., 2012, Fuzzy AHP for forest fire risk modeling: Disaster Prevention and Management, v. 21, n. 2, p. 160-171. [Also available at http://doi.org/10.1108/09653561211219964.]

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Use Case: Taradevi Forest Range

- Data
  - SRTM 90 meter (3 arc-second) data used to calculate slope, elevation, and aspect
  - IRS-P6 LISS-III imagery used for determining distances to roads and settlements
- Process
  - Defined six parameters
    - Fuel type, elevation, slope, aspect, distance from road, distance from settlement
  - Each parameter weighted and assigned classes, index values, and fire rating class
  - Compare knowledge-based, Fuzzy AHP and Crisp AHP methods

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Use Case: Taradevi Forest Range

- **Findings**

Risk	% of Study Area (Crisp AHP)	% of Study Area (Fuzzy AHP)
Very high	8.74	8.72
High	22.68	22.61
Moderate	30.97	30.87
Low	35.90	35.98
Very low	1.71	1.82

- **Slightly more percentage of land is at a higher risk of fire under Crisp AHP**
  - **Slope and elevation were ranked higher with this method**

USGS NASA

How to Access NASA SRTM v3

- **Reverb:**
  http://reverb.echo.nasa.gov/reverb
- **GDEx (demo today):**
  http://gdex.cr.usgs.gov/gdex/
- **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

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Choosing data: What to consider

- Topographical features
  - Mountainous areas
  - Desert areas or areas with a lot of snow cover
  - Hydrologic networks
  - Forested areas – Top of canopy vs. middle-to-bottom of forest area

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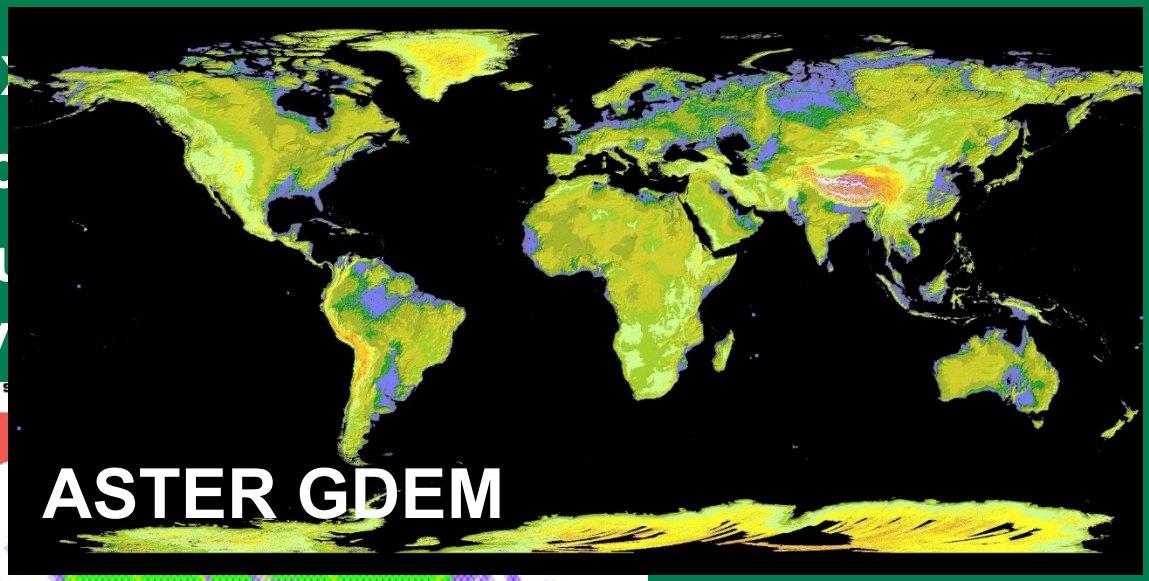
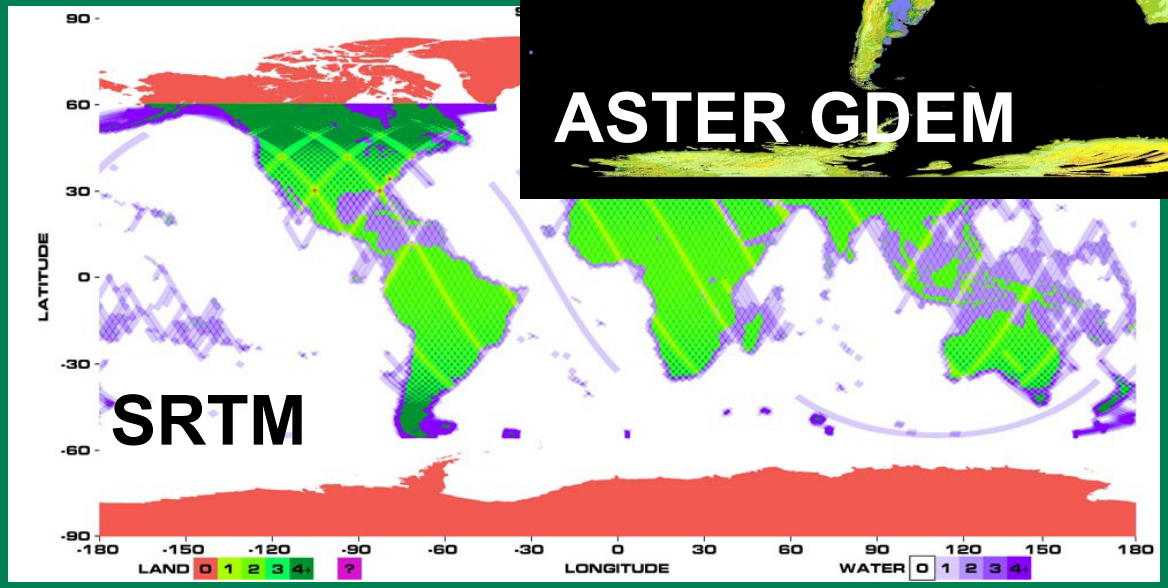
Choosing data: What to consider

- Geographic ex
  - Areas with co
  - Extreme latitu
    some data av





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Sources and Additional Reading

- ESRI, 2012. Types of source data supported in terrain datasets, http://resources.arcgis.com/en/help/main/10.1/index.html#//005v00000009000000
- JPL, 2005. SRTM: Frequently Asked Questions, www2.jpl.nasa.gov/srtm/faq.html
- JSS, n.d. ASTER Global Digital Elevation Model, https://www.jspacesystems.or.jp/ersdac/GDEM/E/2.html
- LP DAAC, 2012. ASTER: Advanced Spaceborne Thermal Emission and Reflection Radiometer. Land Remote Sensing Data Access Workshop, March 13-14, 2012, https://lpdaac.usgs.gov/sites/default/files/public/user_community/docs/02%2BData%2BTalk%2BASTER.pdf
- LP DAAC, 2013, SRTM Collection, https://lpdaac.usgs.gov/sites/default/files/public/measures/docs/NASA_SRTM_V3.pdf
- NASA JPL, 2009. Global Digital Elevation Model, http://asterweb.jpl.nasa.gov/gallery-detail.asp?name=gdem
- Tachikawa, T., Hato, M., Kaku, M., Iwasaki, A., 2011, Characteristics of ASTER GDEM Version 2, IGARRS 2011, Canada. https://lpdaac.usgs.gov/sites/default/files/public/aster/docs/Tachikawa_etal_IGARSS_2011.pdf

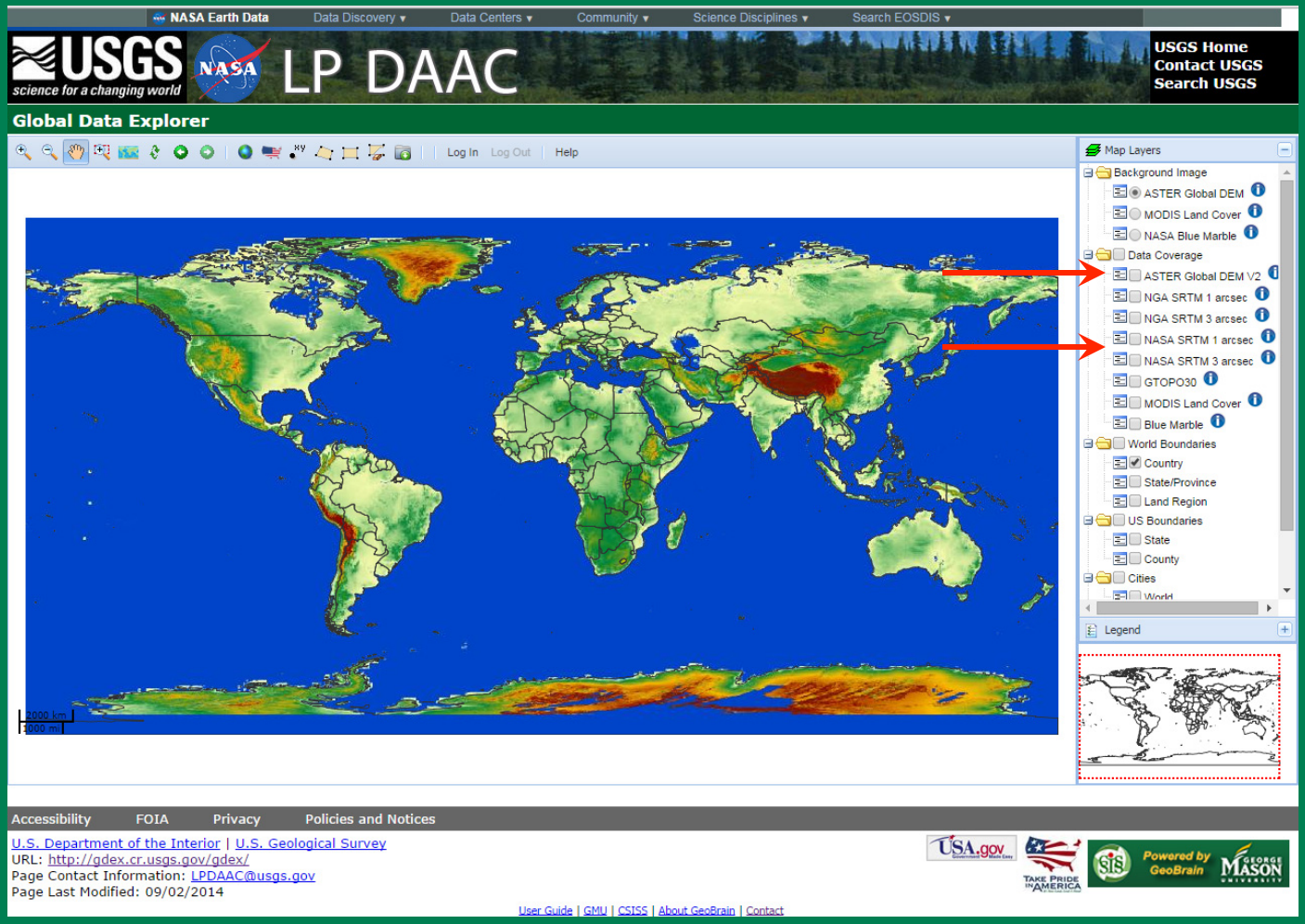
USGS NASA

Global Data Explorer (GDEX)

- Funded through NASA ROSES 2005 ACCESS Program
- A collaboration between the LP DAAC and George Mason University's Center for Spatial Information Science and Systems
- 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
- http://gdex.cr.usgs.gov/gdex/

USGS NASA

GDEx



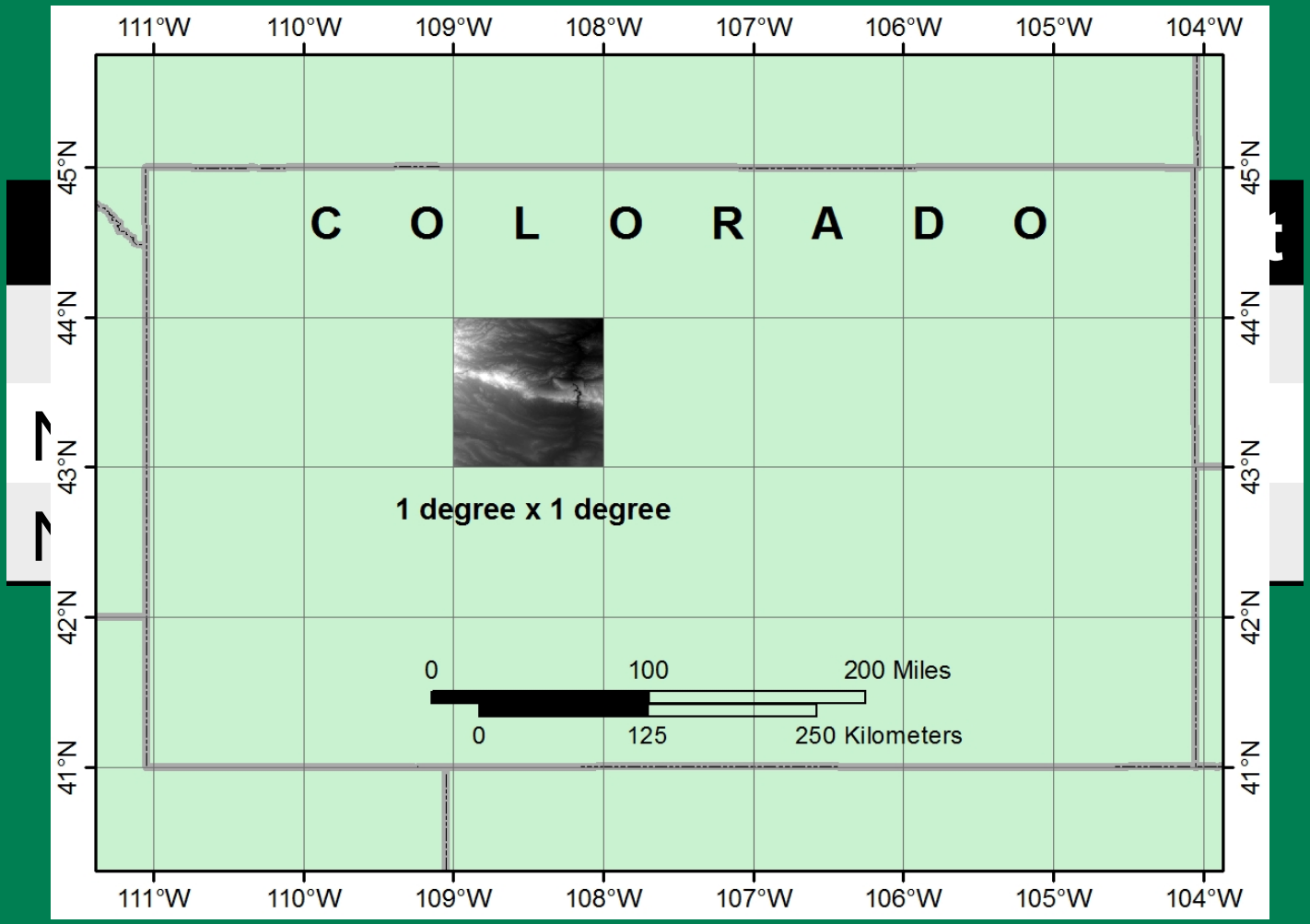
USGS NASA

GDEx Features and Functions

- 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)
- Advanced, on-the-fly processing
  - Mosaic tiles into coverage clipped to AOI
  - Reformat to GeoTIFF, ArcASCII, or JPEG
  - UTM or LAT/LON projection
- Preview data before download

USGS NASA

GDEx Tile Limits



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Live Demo

Global Data Explorer (GDEx):

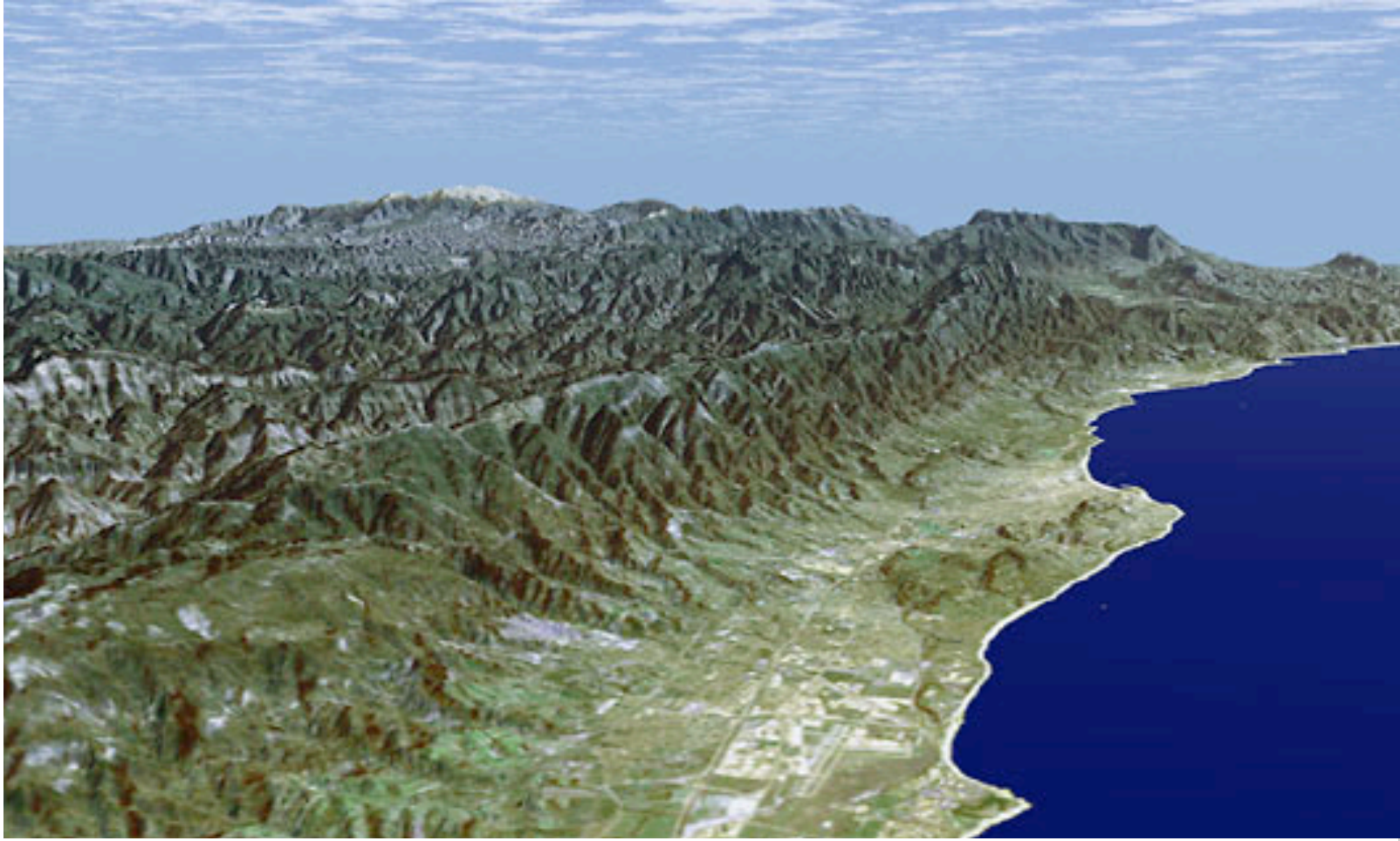
http://gdex.cr.usgs.gov/gdex/

Important Information

- Thank you for your participation in the ARSET webinar series Introduction to Remote Sensing for Wildfire Applications.
- Webinar recordings, PowerPoint presentations, and homework assignments can be found after each session at: https://arset.gsfc.nasa.gov/disasters/webinars/introduction-remote-sensing-wildfire-applications
- Certificate of Completion
  - Attend 4 out of 5 webinars
  - Assignment 1 and 2 – access from the ARSET wildfire webinar website (above)
  - Reminder to complete homework by **May 12th**
  - You will receive certificates in approximately mid- June: marines.martins@ssaihq.com
- Q/A: 15 minutes following each lecture and/or by email (cynthia.l.schmidt@nasa.gov)

This perspective view of the Santa Barbara region was generated using data from the Shuttle Radar Topography Mission (SRTM) and an enhanced Landsat satellite image.

(February 2000)



Thank You!!

Cindy Schmidt
Cynthia.L.Schmidt@nasa.gov