



National Aeronautics and
Space Administration



ARSET

Applied Remote Sensing Training

<http://arset.gsfc.nasa.gov>

Creating and Using Normalized Difference Vegetation Index (NDVI) from Satellite Imagery

Instructors: Cindy Schmidt and Amber McCullum

Week 4

Homework and Certificates

- Homework
 - Hands-on exercise each week
 - Answers must be submitted via Google Form
- Certificate of Completion:
 - Attend all 4 webinars
 - Complete all 4 homework assignments by the deadline (access from ARSET website)
 - **Week 4 Deadline: Wednesday March 16th**
 - You will receive certificates in approximately 2 months from:
marines.martins@ssaihq.com



Accessing Course Materials

- <http://arset.gsfc.nasa.gov/ecoforecasting/webinars/advanced-webinar-creating-and-using-normalized-difference-vegetation-index>

The screenshot shows the ARSET website header with navigation tabs for Earth Sciences Division, Applied Sciences, and ASP Water Resources. The main content area features a sidebar with 'Eco Forecasting' and 'Fundamentals of Remote Sensing' sections. The central content displays the title 'Advanced Webinar: Creating and Using Normalized Difference Vegetation Index (NDVI) from Satellite Imagery' with a date range of 02/10/2016 to 03/02/2016. Below the title is a world map showing NDVI data from October 2015. The text indicates the webinar is held on Wednesdays from 12:00PM-1:00PM EST (UTC -05:00) on February 10, February 17, February 24, and March 2, 2016. A course description at the bottom states: 'In this advanced webinar, participants will learn how to acquire, use, and derive'.

Course Materials

Week	Date	Title	Presentation	Data and Exercise	Recording	Homework
1	February 10, 2016	Introduction to NDVI and QGIS	Week 1 Presentation Week 1 Presentation (Spanish)	Week 1 Data Week 1 Exercise	View Week 1 Recording	Homework 1 Exercise Homework 1 Submission
2	February 17, 2016	Deriving NDVI from Landsat	Week 2 Presentation Week 2 Presentation (Spanish)	Week 2 Data Week 2 Exercise	View Week 2 Recording	Homework 2 Exercise Homework 2 Submission
3	February 24, 2016	MODIS NDVI Time Series	Week 3 Presentation Week 3 Presentation (Spanish)	Week 3 Data Week 3 Exercise	View Week 3 Recording	Homework 3 Exercise Homework 3 Submission
4	March 2, 2016	MODIS NDVI Anomalies	Week 4 Presentation Week 4 Presentation (Spanish)	Week 4 Data Week 4 Exercise	View Week 4 Recording	Homework 4 Exercise Homework 4 Submission

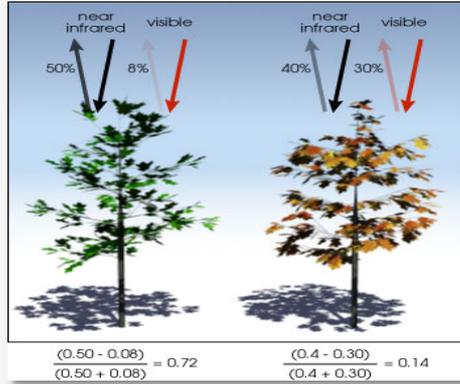
*Please note that you must register to view all recordings. This includes the requirement to re-register for each separate recording for live webinar participants.

Course materials are provided here using each specified link and will be active after each week

Course Outline

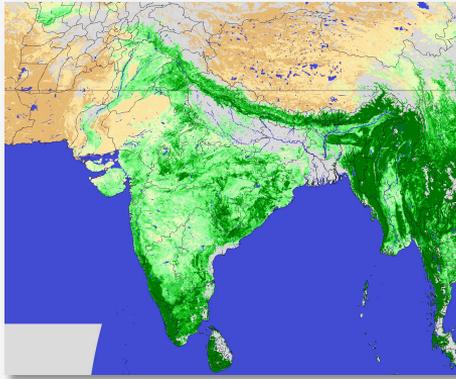
Week 1

Overview of
NDVI and
QGIS



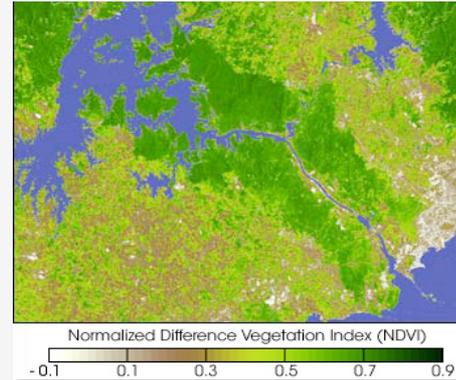
Week 3

MODIS
NDVI Time
Series



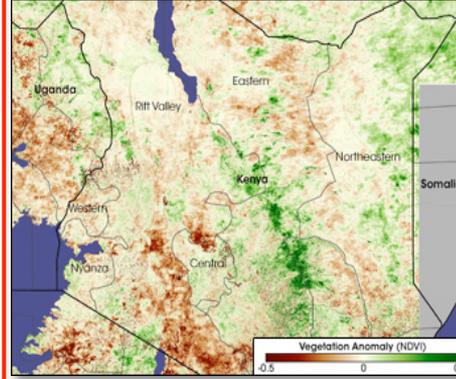
Week 2

NDVI with
Landsat



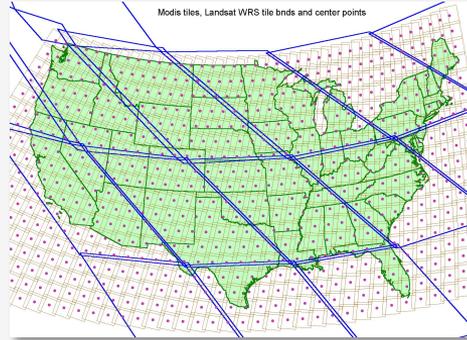
Week 4

MODIS
NDVI
Anomaly
Mapping

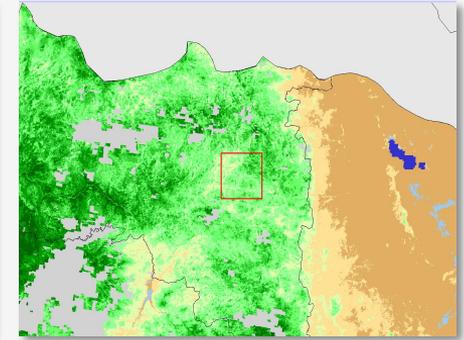


Week 3 Review

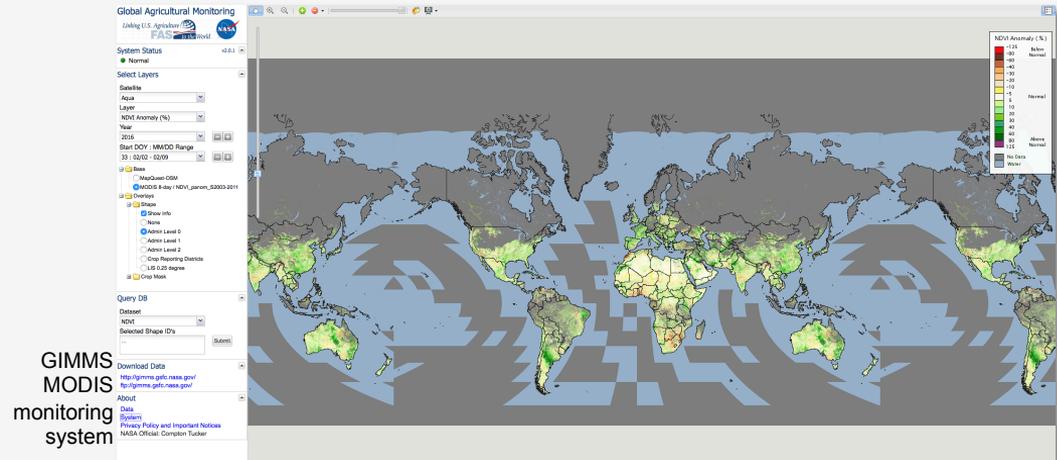
- MODIS data characteristics
- Where to Obtain MODIS Products
- GLAM Websites:
 - Global 16-day 250 m NDVI time series database
 - GIMMS MODIS monitoring system



MODIS scene size



Global 16-day 250 m NDVI time series database



Global Agricultural Monitoring
Loading U.S. Agriculture Data

System Status v0.8.1

Select Layers

Satellite: Aqua

Layer: NDVI Anomaly (%)

Year: 2015

Start DOY / M/M/D Range: 151 / 5/20 / 22/09

Download Data

<http://gimms.gfc.nasa.gov/>
<ftp://gimms.gfc.nasa.gov/>

ABOUT

Data

System

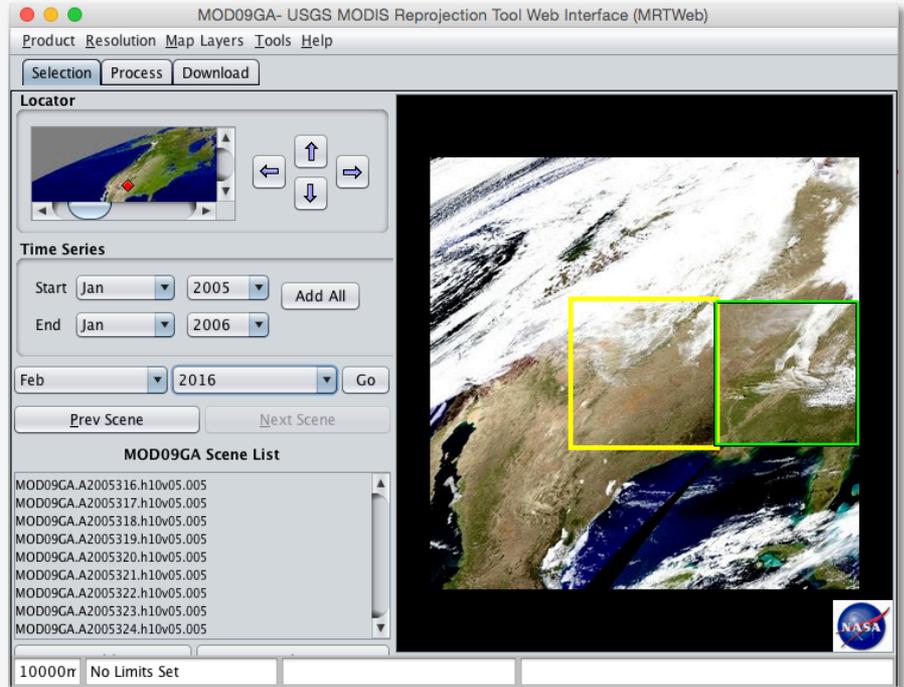
Privacy Policy and Important Notices

NASA Official: Compton Tucker

GIMMS MODIS monitoring system

Week 4 Agenda

- Overview of additional Landsat indices
- Overview of MODIS scaling factor
- Overview of MODIS NDVI Mapping
- Exercise: Creating a MODIS NDVI Anomaly Map
- Q&A
- Survey



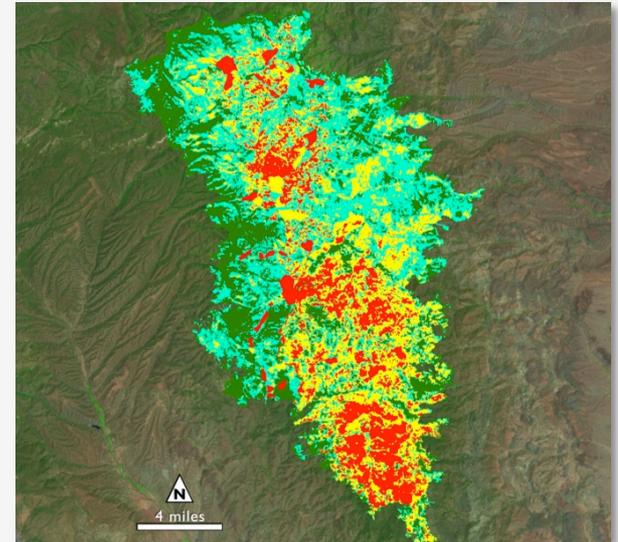
MRT Web User Interface

An aerial satellite image of a forested landscape. A large river flows from the top right towards the bottom right. In the lower center, there is a large reservoir or dam structure. The surrounding area is densely forested with various shades of green. A semi-transparent white rectangular box is overlaid on the center of the image, containing the title text.

Additional Spectral Indices for Landsat

Landsat Spectral Indices

- Enhanced Vegetation Index (EVI- reviewed last week)
- Soil Adjusted Vegetation Index (SAVI)
- Modified Soil Adjusted Vegetation Index (MSAVI)
- Normalized Difference Moisture Index (NDMI)
- Normalized Burn Ratio (NBR) and Difference Normalized Burn Ratio (dNBR)

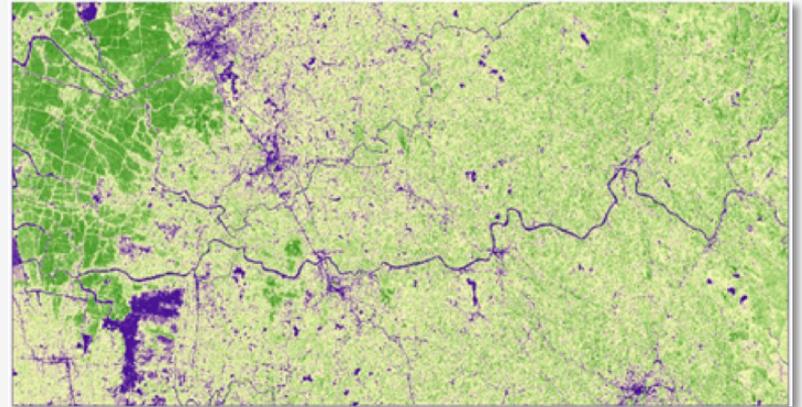


Burn Severity Map from New Mexico Silver Fire:
Image Credit: USFS

Soil Adjusted Vegetation Index

- Minimizes soil brightness influences
- Useful in areas with greater soil cover
 - Contains a soil brightness correction factor (L)
 - 0.5 typically used
 - Lower for areas with greater canopy cover
 - Higher for areas with less canopy cover

$$SAVI = \left(\frac{(NIR - R)}{(NIR + R + L)} \right) \times (1 + L)$$

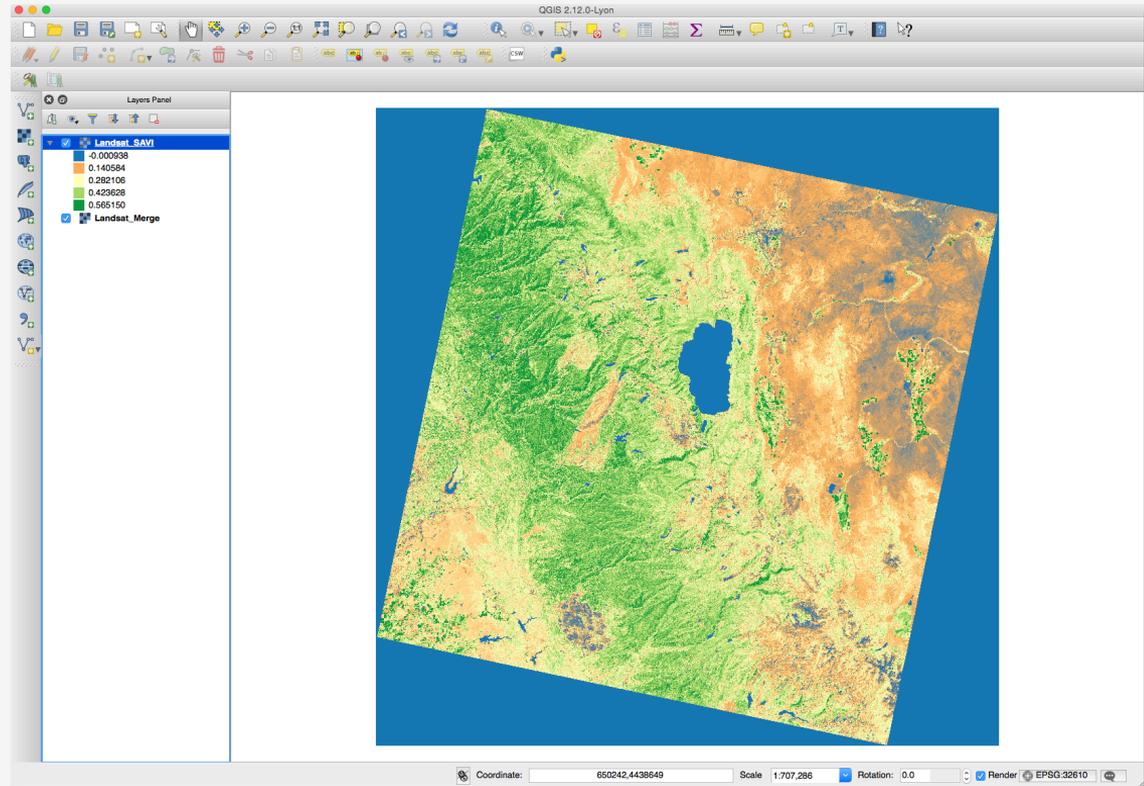


SAVI: Image Credit: Grind GIS

Soil Adjusted Vegetation Index

- Remember: Landsat Bands
 - Landsat 4-7
 - NIR = Band 4
 - R = Band 3
 - Landsat 8
 - NIR = Band 5
 - R = Band 4

Example of
SAVI using the
California
Landsat scene
from week 2
exercise

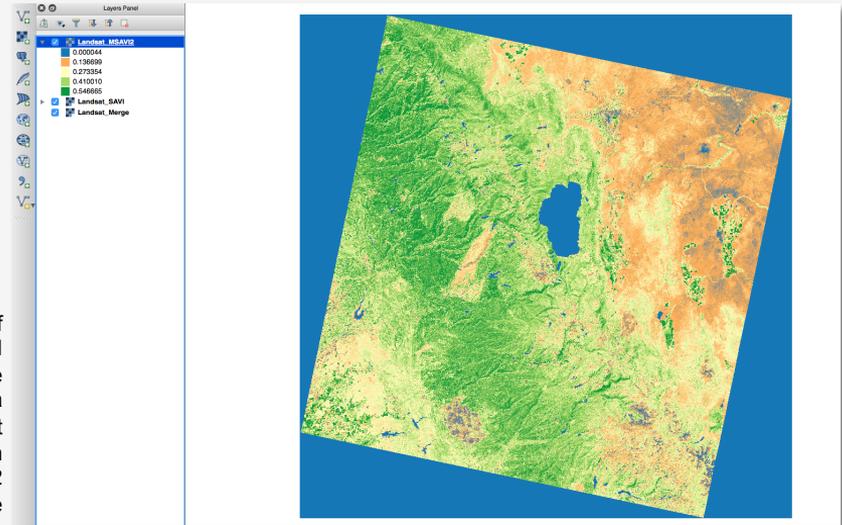


Modified Soil Adjusted Vegetation Index

$$MSAVI = \frac{\left(2 \times NIR + 1 - \sqrt{(2 \times NIR + 1)^2 - 8 \times (NIR - R)}\right)}{2}$$

- Inductive L function
 - Do not need to specify soil correction factor
- Designed to maximize reduction of soil effects on the vegetation signal

Example of MSAVI using the California Landsat scene from week 2 exercise

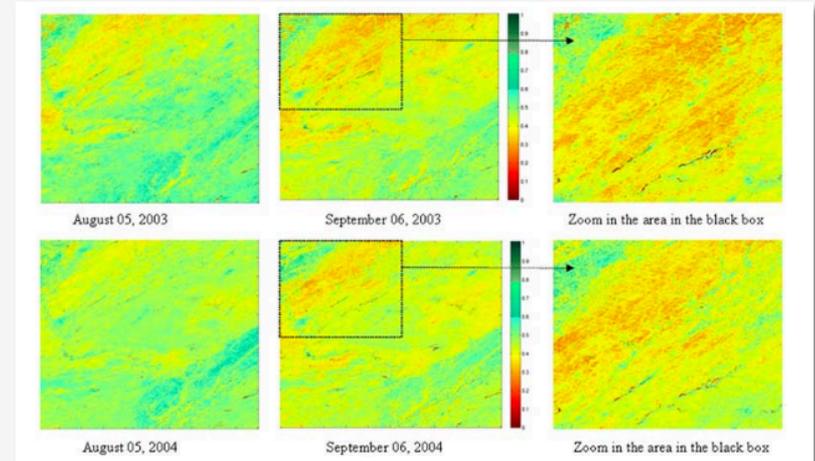


Normalized Difference Moisture Index (NDMI)

- Measure of vegetation moisture
- Frequently used in drought monitoring
 - Detects more subtle changes in vegetation moisture
- Used in wildfire hazard potential

$$NDMI = \frac{(NIR - SWIR)}{NIR + SWIR}$$

Example of
NDMI.
Image
Credit:
Wang and
Qu, 2007

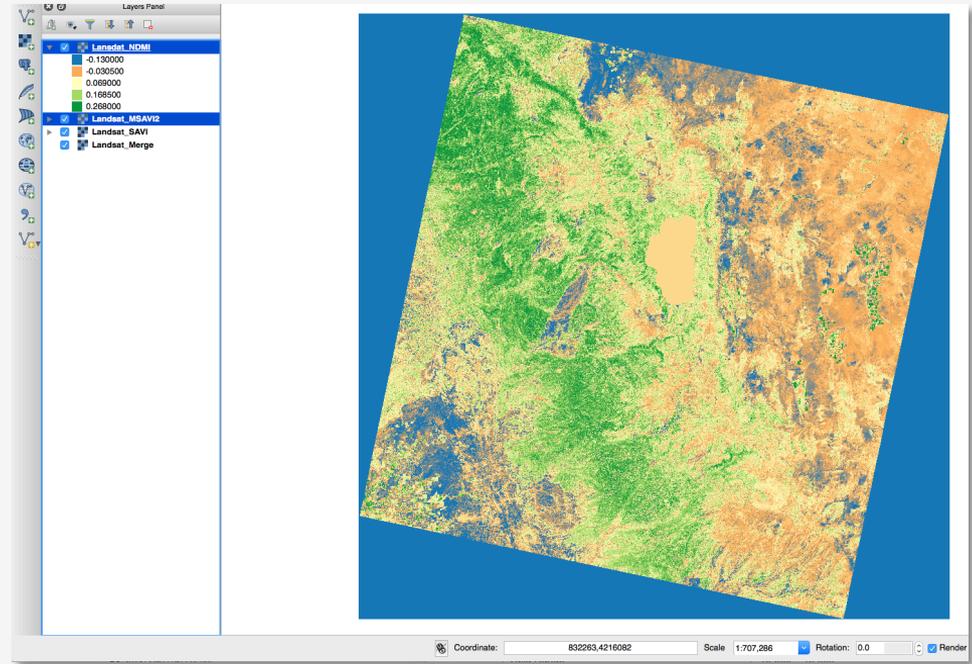


Normalized Difference Moisture Index (NDMI)

- Remember: Landsat Bands
 - Landsat 4-7
 - NIR = Band 4
 - SWIR = Band 5
 - Landsat 8
 - NIR = Band 5
 - SWIR = Band 6

$$NDMI = \frac{(NIR - SWIR)}{NIR + SWIR}$$

Example of
NDMI using the
California
Landsat scene
from week 2
exercise

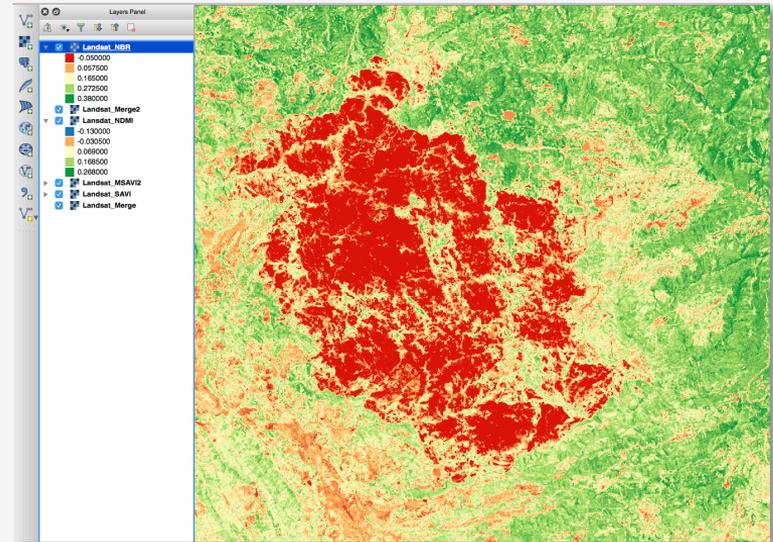


Normalized Burn Ratio

- Used to identify burned areas
- Compare pre and post-burn to identify burn extent and severity
- Use Band 7 for SWIR in Landsat images

$$NBR = \frac{(NIR - SWIR)}{NIR + SWIR}$$

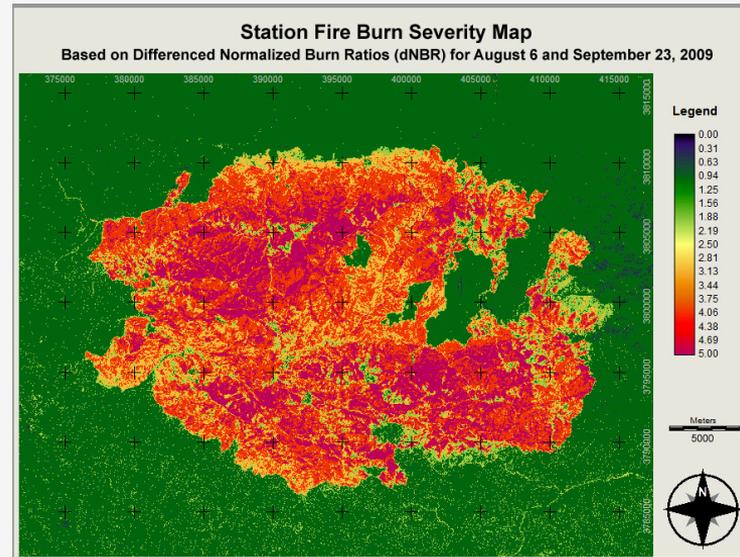
Example of NBR using the California Landsat scene from week 2 exercise: Rim Fire



Normalized Burn Ratio Difference Map

- Need at least 2 images:
 - One pre-burn
 - One post-burn
- 1. Create NBR for each image
- 2. Subtract post-fire image from pre-fire image
- 3. Evaluate differenced map

$$dNBR = NBR_{prefire} - NBR_{postfire}$$



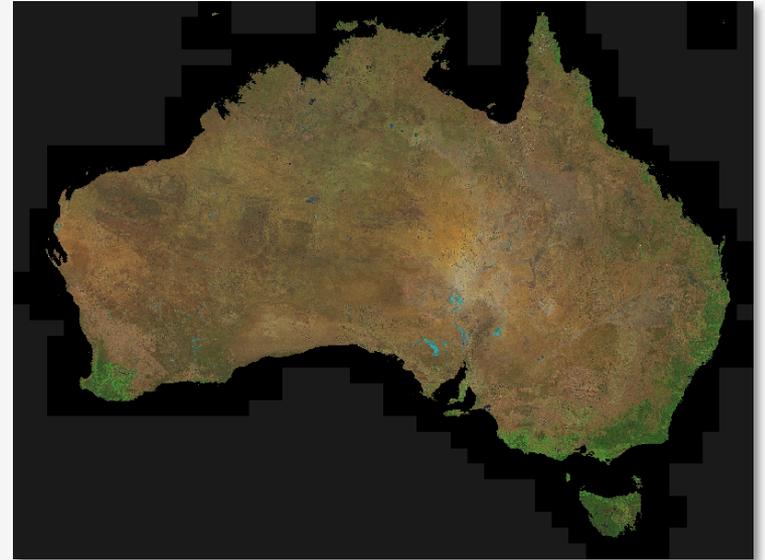
Example of dNBR. Image Credit: Irene Nester

An aerial satellite image of a forested landscape. A large river flows through the center, with a dam visible in the lower right. The terrain is covered in dense green vegetation, with some lighter green patches indicating different types of vegetation or land use. The image is overlaid with a semi-transparent white rectangle containing the title text.

Landsat Surface Reflectance Products

Surface Reflectance Products

- Standard Landsat 8 imagery provide calibrated scaled digital numbers: no corrections
- Surface Reflectance products apply atmospheric correction for:
 - Water vapor
 - Ozone and aerosol optical thickness
 - Geopotential height
 - Digital elevation
 - Masks for clouds and cloud shadows



Landsat 8 Surface Reflectance Product: Composite Mosaic for Australia: Image Credit USGS

Surface Reflectance Products

- Surface Reflectance products generated from the Landsat Ecosystem Disturbance Adaptive Processing System (LEDAPS)
 - Originally developed by NASA
- Available from EarthExplorer:
 - <http://earthexplorer.usgs.gov/>

Landsat 4-7 and 8 Surface Reflectance Products Available from EarthExplorer

The screenshot shows the USGS EarthExplorer interface. At the top, there's a navigation bar with 'USGS Home', 'Contact USGS', and 'Search USGS'. Below that, the 'EarthExplorer' logo and a search criteria summary are visible. The main content area is titled '2. Select Your Data Set(s)' and includes instructions on how to select data sets. A 'Data Set Search' field is present, followed by a list of categories. The 'Landsat Archive' category is expanded, showing a list of data sets including 'L8 OLI/TIRS', 'L7 ETM+ SLC-off (2005-present)', 'Landsat Surface Reflectance - L8 OLI/TIRS', 'L7 ETM+ SLC-on (1999-2003)', 'Landsat Surface Reflectance - L7 ETM+', 'L4-5 TM', and 'Landsat Surface Reflectance - L4-5 TM'. A map of North America is displayed on the right side of the interface.

Surface Reflectance Products: Specifications

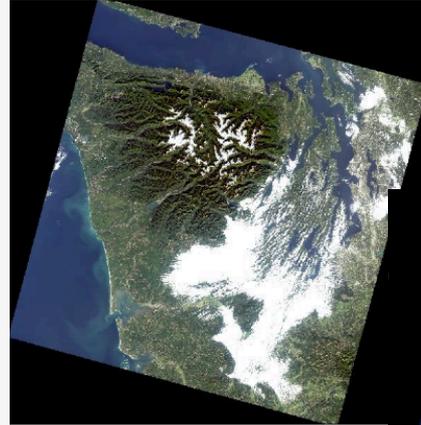
- 30 meter spatial resolution
- Universal Transverse Mercator (UTM) or Polar Stereographic (PS) grid
- Download as GeoTIFF
- Original scene name with “_sr_” followed by band designation
- More information: http://landsat.usgs.gov/CDR_LSR.php



Example of the unprocessed Landsat image (left) and the LEDAPS processed Landsat image (right)

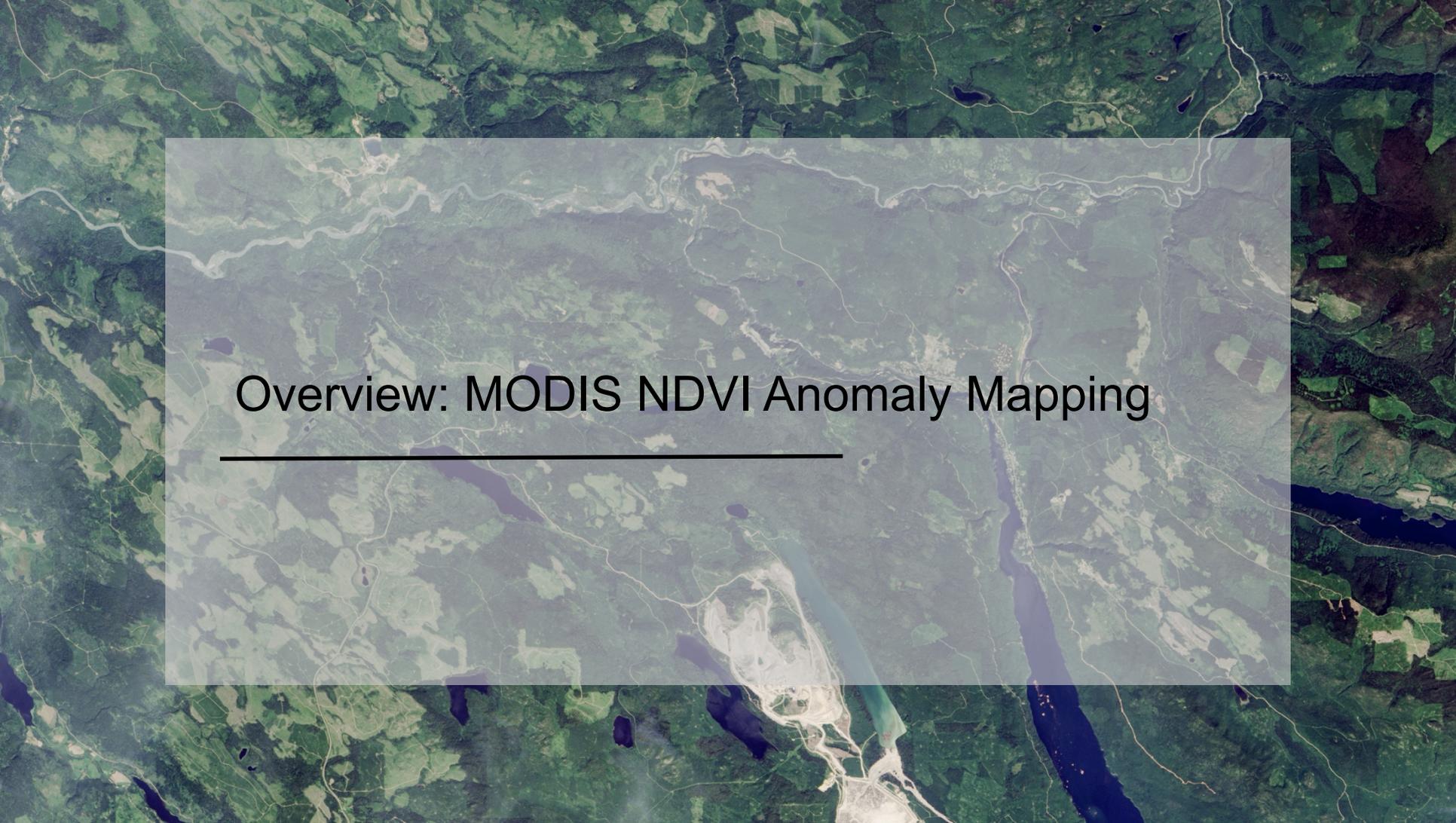
Surface Reflectance Products: Caveats

- Products considered provisional
- Landsat 7 images not gap-filled
- Usefulness of surface reflectance products reduced in:
 - Hyper-arid or snow-covered regions
 - Low sun angle conditions
 - Coastal regions
 - Areas with extensive clouds
- Panchromatic band (ETM+ Band 8) not processed
- Specific date ranges for Landsat 4,5,7



Example of the unprocessed Landsat image (top) and the LEDAPS processed Landsat image (right): Image Credit USGS

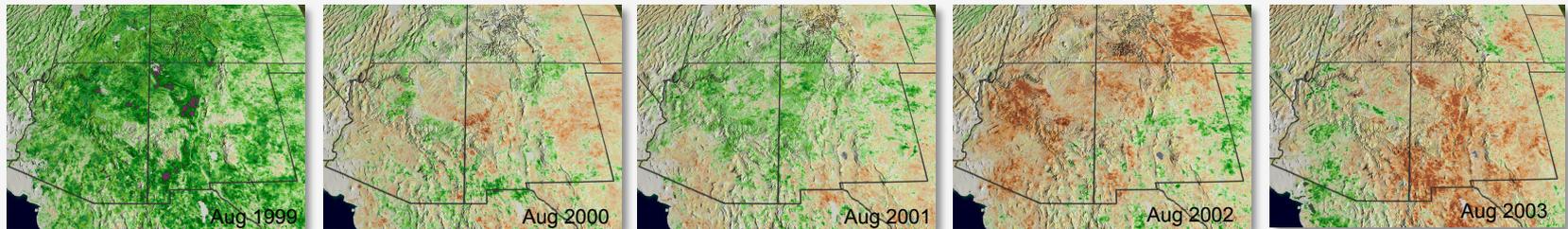


An aerial satellite image of a forested landscape, likely a river valley. The terrain is covered in dense green vegetation, with a network of roads and a prominent river system visible. A semi-transparent rectangular box is overlaid on the center of the image, containing the title text. Below the text is a horizontal line.

Overview: MODIS NDVI Anomaly Mapping

Reminder: NDVI Anomalies

- Departure of NDVI from the long-term average, normalized by long-term variability
- Generated by subtracting the long-term mean from the current value for that month of the year for each grid cell.
- Indicates if vegetation greenness at a particular location is typical for that period or if the vegetation is more or less green



NDVI Anomalies in the southwestern United States. Image Credit: NASA/Goddard Space Flight Center Scientific Visualization Studio.

Reminder: MODIS Scaling Factor

- Before calculating NDVI anomalies we must multiple by the MODIS scaling factor
- Data Storage: less storage needed if pixel values do not contain decimals.
 - Thus, before we conduct processing to the image, a scaling factor is used:

**MODIS SCALING
FACTOR: 0.0001**

- Must multiple entire image by 0.0001

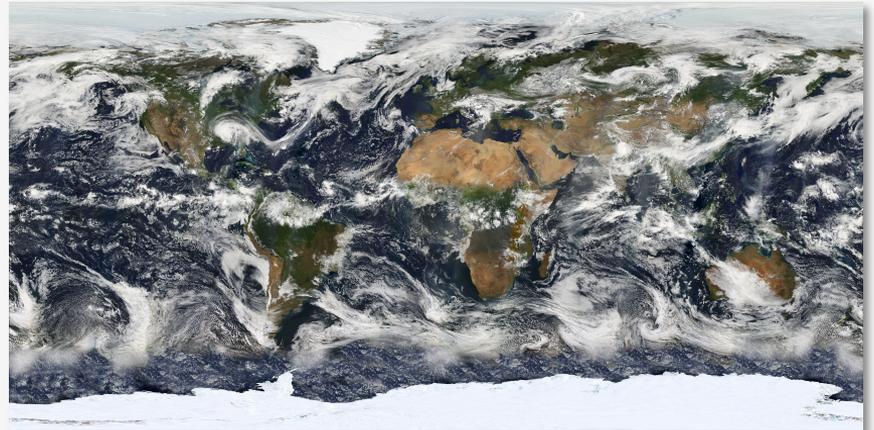
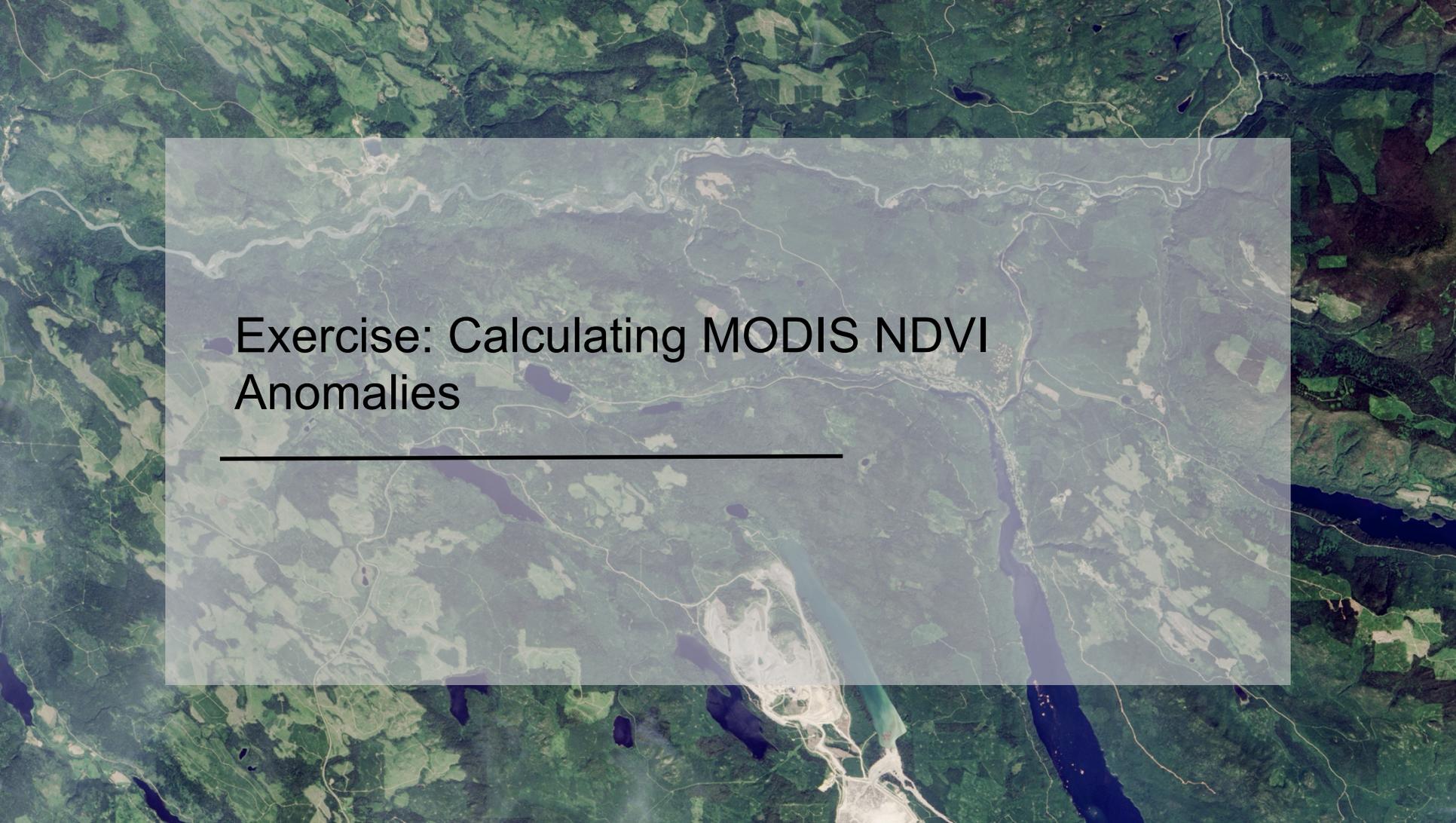


Image Credit: NASA Earth Observatory

A satellite image of a river delta, likely the Amazon, showing a complex network of channels and floodplains. A semi-transparent white rectangular box is overlaid on the center of the image, containing the title text. The background shows various shades of green, brown, and blue, representing different land and water features.

Exercise: Calculating MODIS NDVI Anomalies

Contacts

- ARSET Land Management and Wildfire Contacts
 - Cynthia Schmidt: Cynthia.L.Schmidt@nasa.gov
 - Amber McCullum: AmberJean.Mccullum@nasa.gov
- General ARSET Inquiries
 - Ana Prados: aprados@umbc.edu
- ARSET Website:
 - <http://arset.gsfc.nasa.gov/>

Survey

- Thank you for your participation in our webinar series. We would appreciate it if you could take a few minutes to complete our end-of-course survey.
- The link will be provided in the chat box.



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Thank You

**Remember: Complete homework
assignments!**