National Aeronautics and Space Administration

ARSET

Applied Remote Sensing Training

http://arset.gsfc.nasa.gov

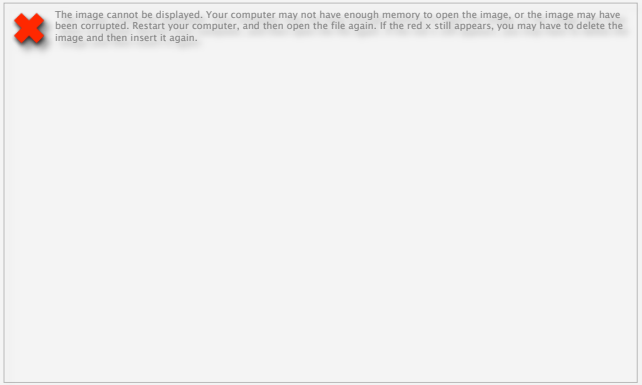
Creating and Using Normalized Difference Vegetation Index (NDVI) from Satellite Imagery

Instructors: Cindy Schmidt and Amber McCullum

Week 4

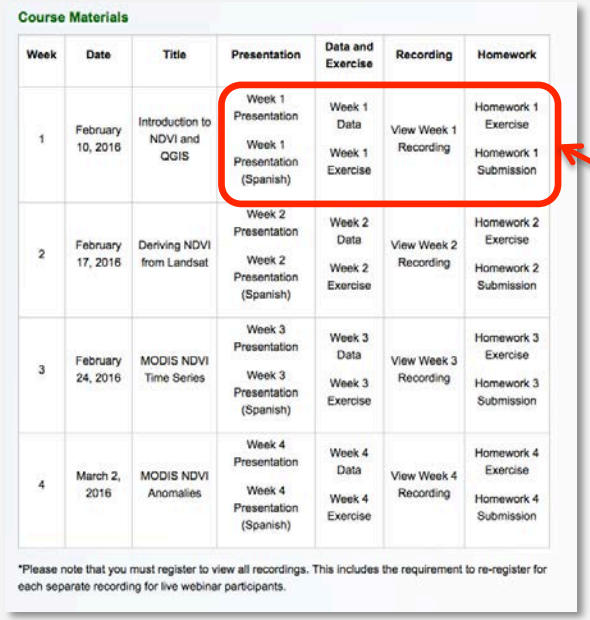
Homework and Certificates

- 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



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

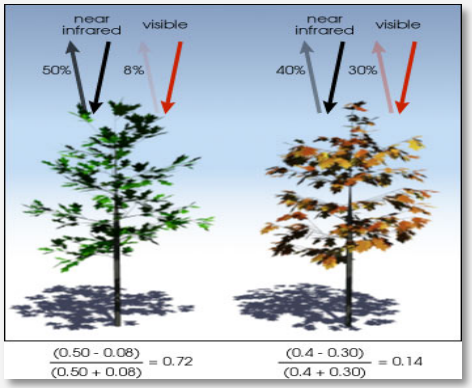
*Please note that you must register to view all recordings. This includes the requirement to re-register for each separate recording for live webinar participants.

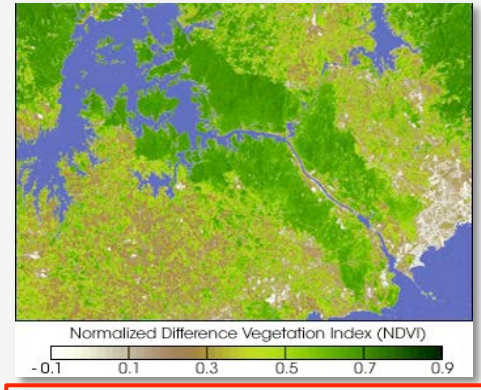
Course materials are provided here using each specified link and will be active after each week

Course Outline

Week 1

Overview of NDVI and QGIS



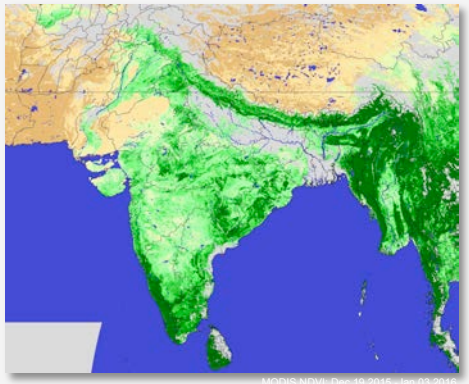


Week 2

NDVI with Landsat

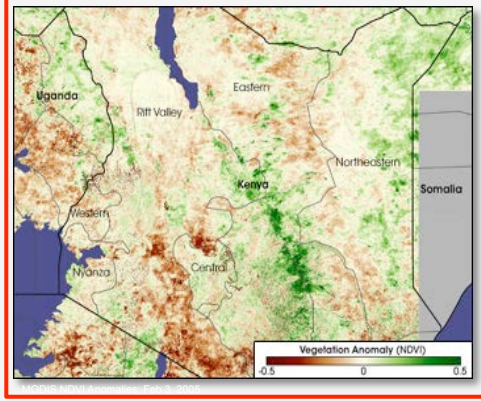
Week 3

MODIS NDVI Time Series



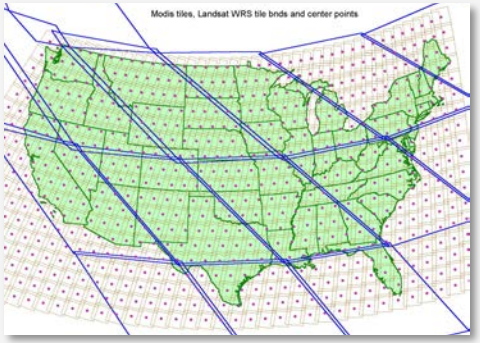
Week 4

MODIS NDVI Anomaly Mapping

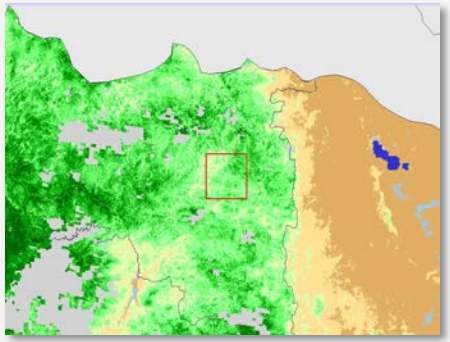


Week 3 Review

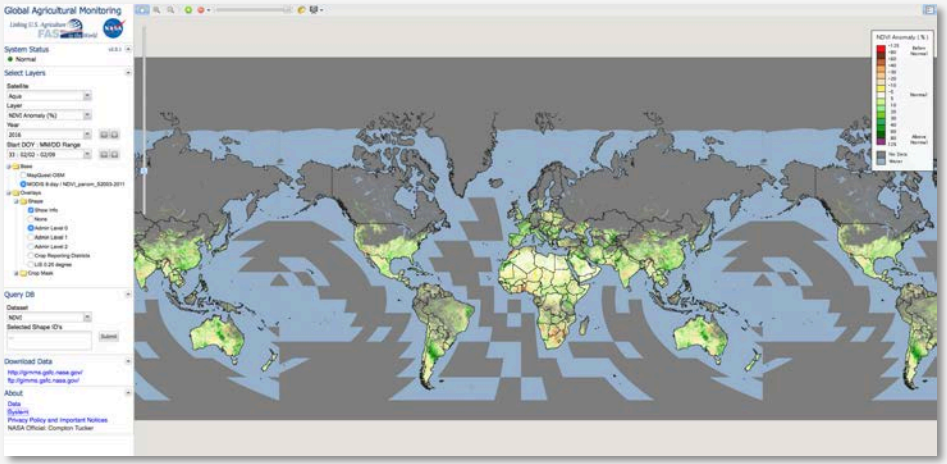
- MODIS data characteristics
- Where to Obtain MODIS Products
- GLAM Websites:
  - Global 16-day 250 m NDVI time series database
  - GIMMS MODIS monitoring system



MODIS scene size



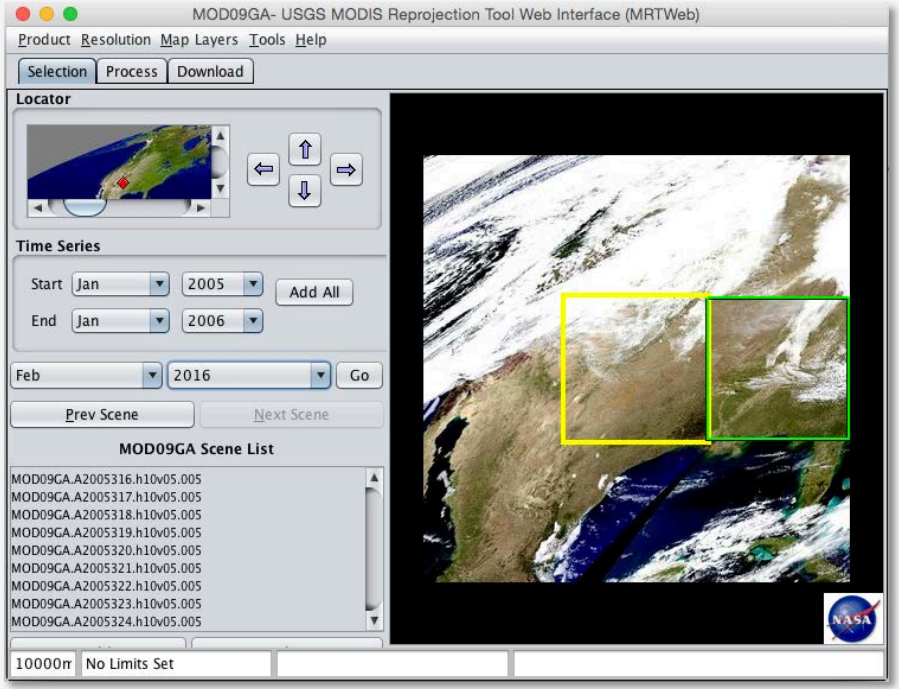
Global 16-day 250 m NDVI time series database



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

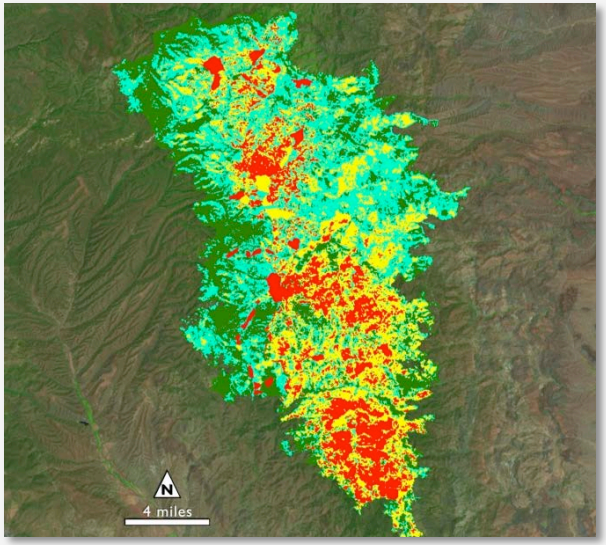


MRT Web User Interface

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)

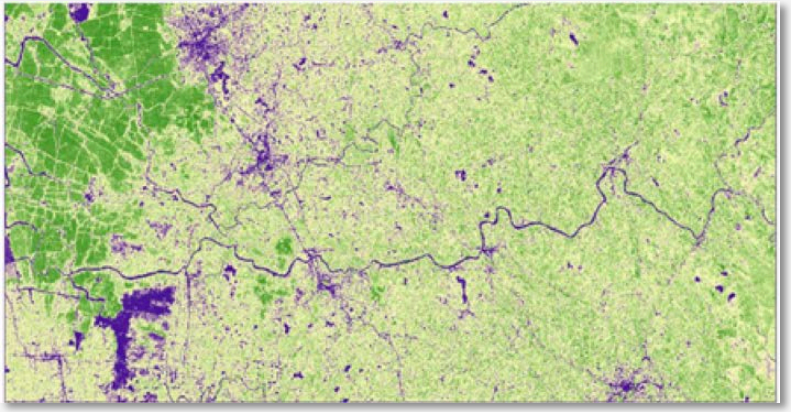


Burn Severity Map from New Mexico Silver Fire:
Image Credit: USFS

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

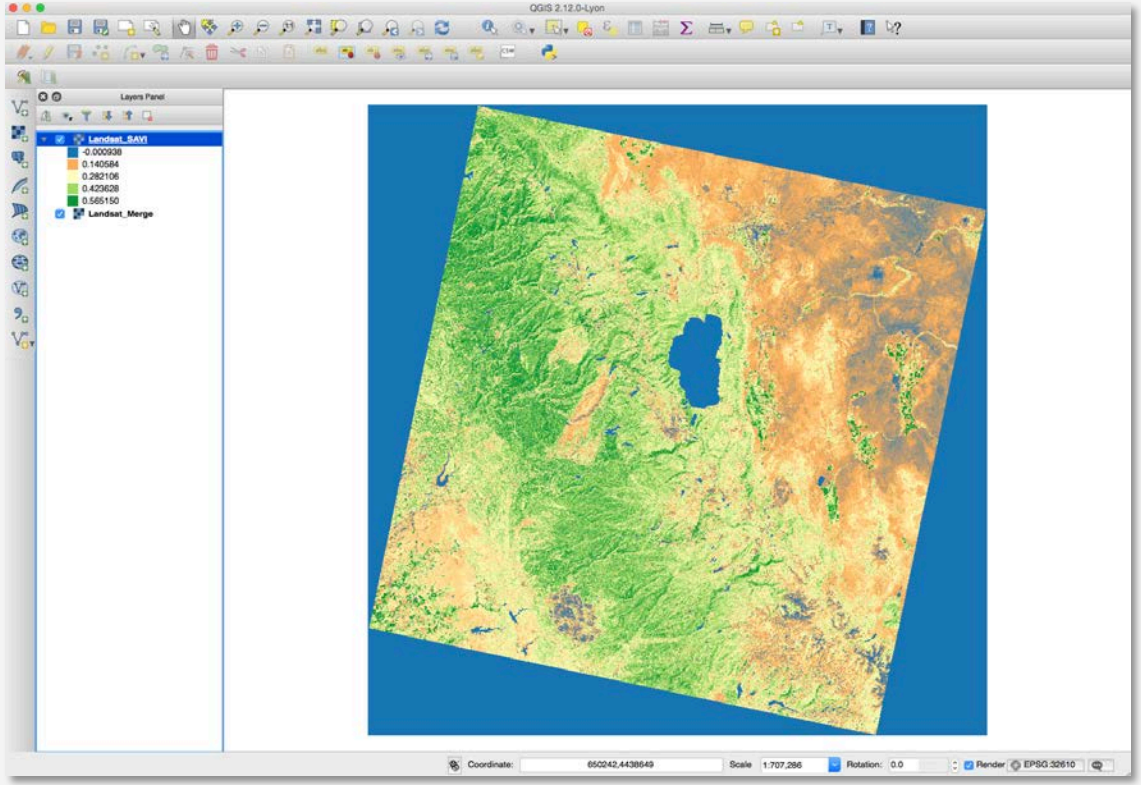
$$SAVI = \left(\frac{(NIR - R)}{(NIR + R + L)} \right) \times (1 + L)$$



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

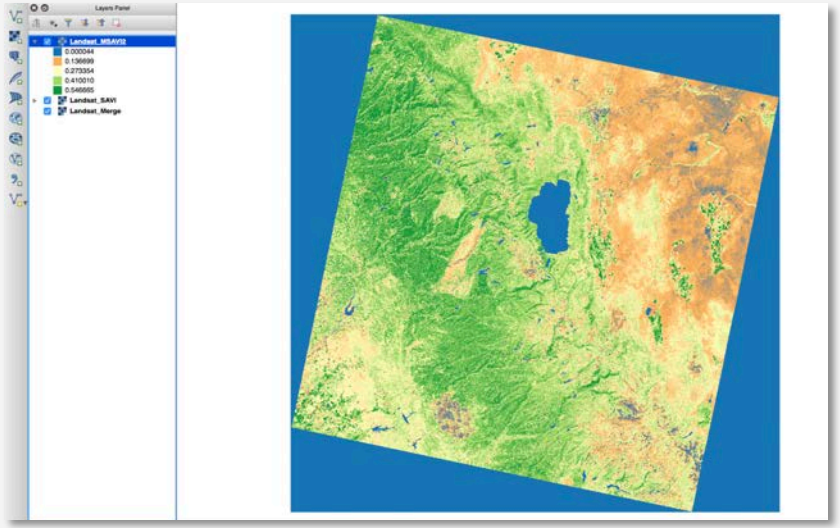


Example of SAVI using the California Landsat scene from week 2 exercise

Modified Soil Adjusted Vegetation Index

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

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

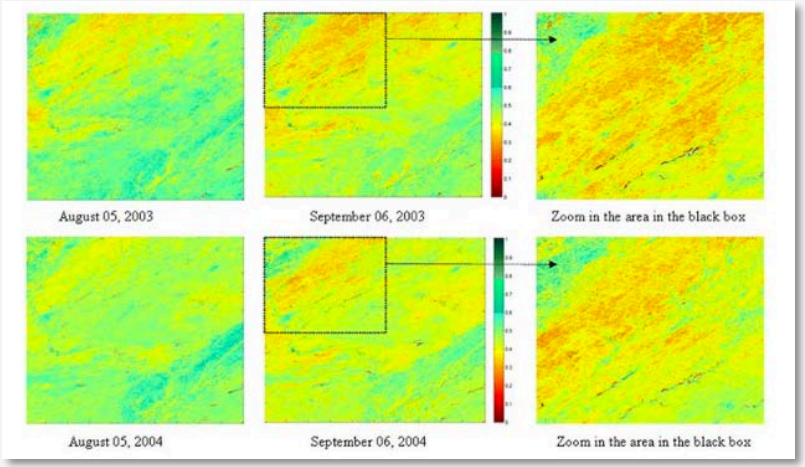


Example of MSAVI using the California Landsat scene from week 2 exercise

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

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



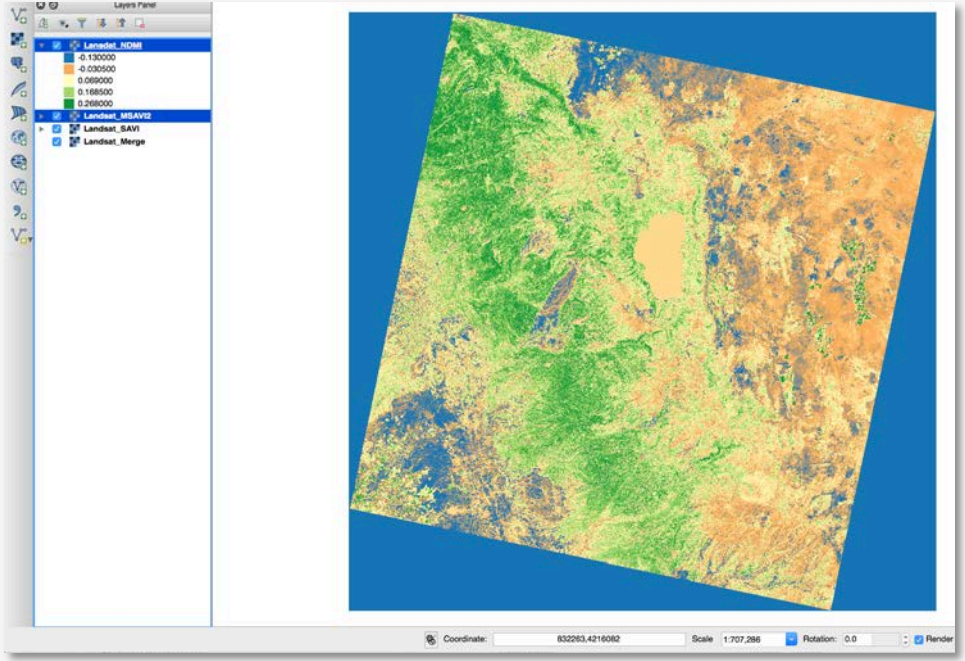
Example of NDMI. Image Credit: Wang and Qu, 2007

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

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

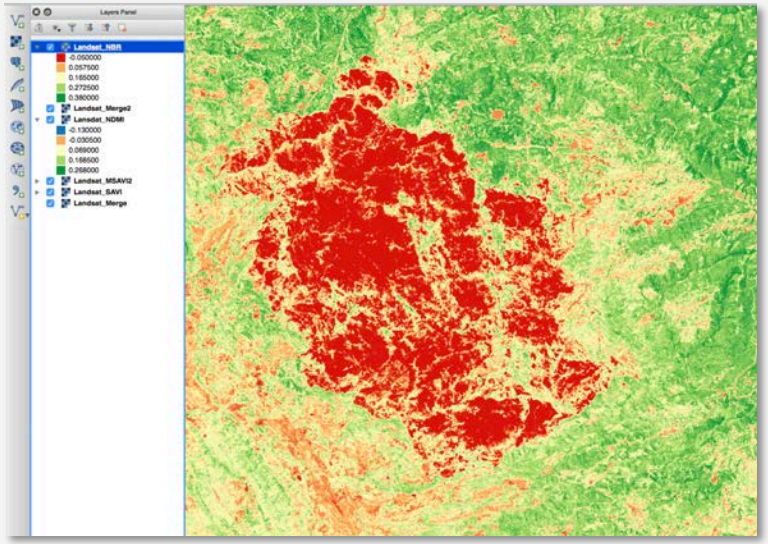
Example of NDMI using the California Landsat scene from week 2 exercise



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

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

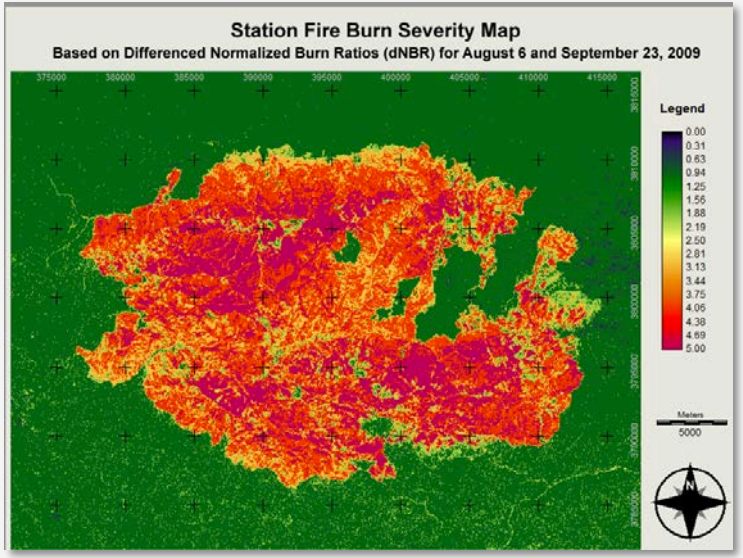


Example of NBR using the California Landsat scene from week 2 exercise: Rim Fire

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

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

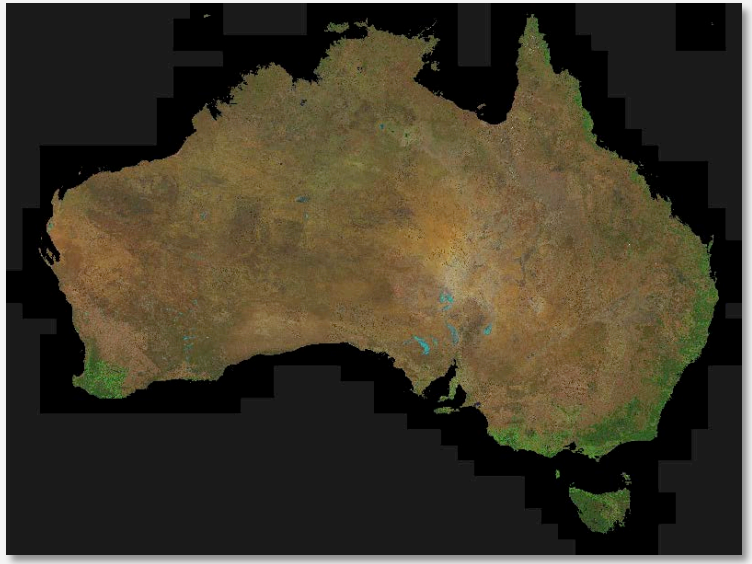


Example of dNBR. Image Credit: Irene Nester

Landsat Surface Reflectance Products

Surface Reflectance Products

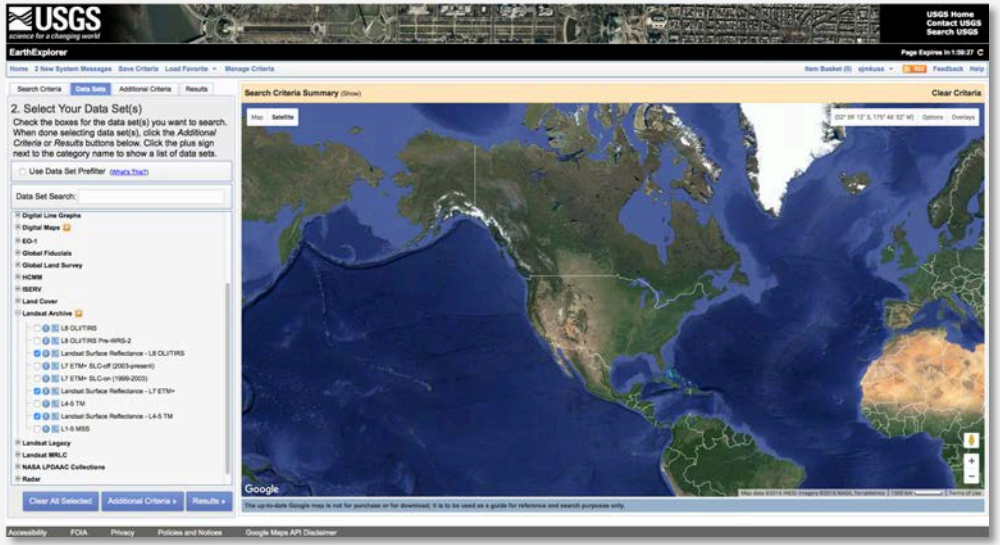
- Standard Landsat 8 imagery provide calibrated scaled digital numbers: no corrections
- Surface Reflectance products apply atmospheric correction for:
  - Water vapor
  - Ozone and aerosol optical thickness
  - Geopotenital height
  - Digital elevation
  - Masks for clouds and cloud shadows



Landsat 8 Surface Reflectance Product: Composite Moasic 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

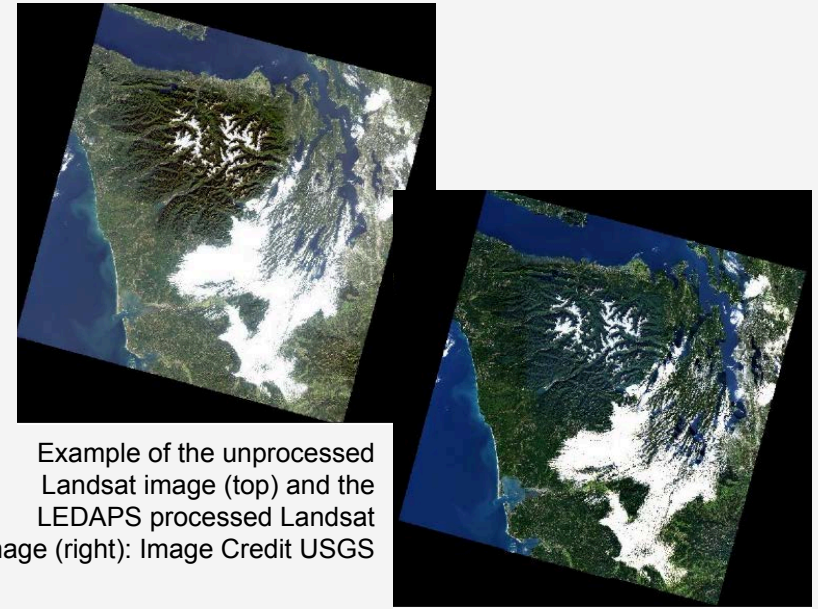
Surface Reflectance Products: Specifications

- 30 meter spatial resolution
- Universal Transverse Mercator (UTM) or Polar Steregoraphic (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

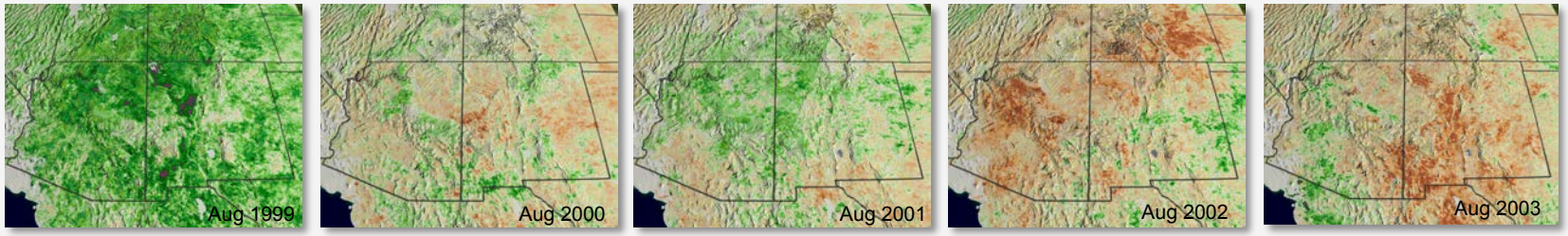


Example of the unprocessed Landsat image (top) and the LEDAPS processed Landsat image (right): Image Credit USGS

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

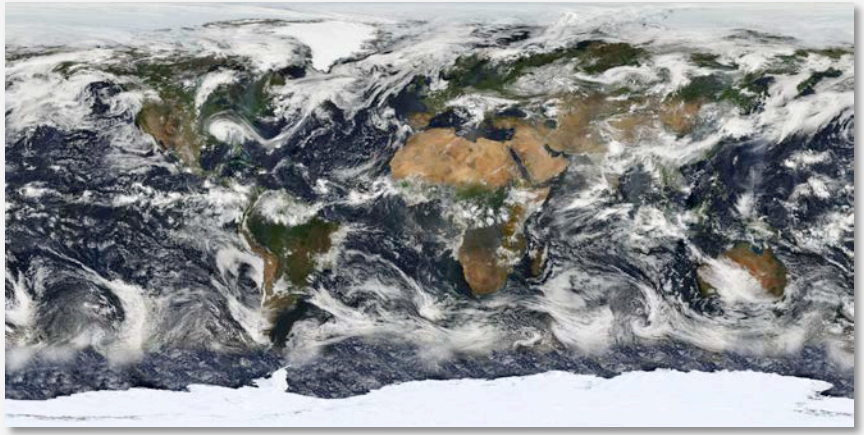


Image Credit: NASA Earth Observatory

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!