LAND and WATER ASSESSMENTS: GIS and REMOTE SENSING TOOLS

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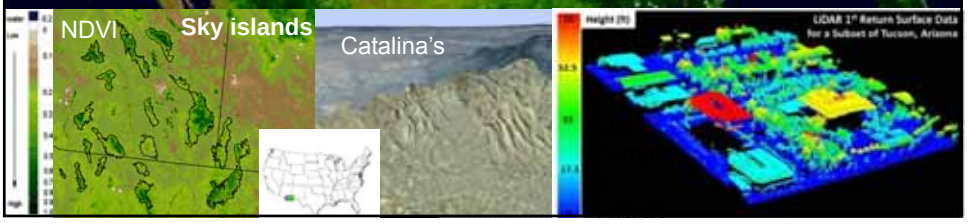
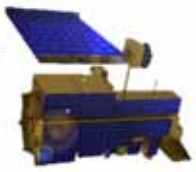
SNRE – Arizona Remote Sensing Center

1. Natural Resource & Urban Remote Sensing, Monitoring and Assessment
2. Global/Regional/Urban Land Use Change, Wildfire, Drought and Phenology
3. Multiple Sensors, Temporal, Spatial, and Organizational Scales



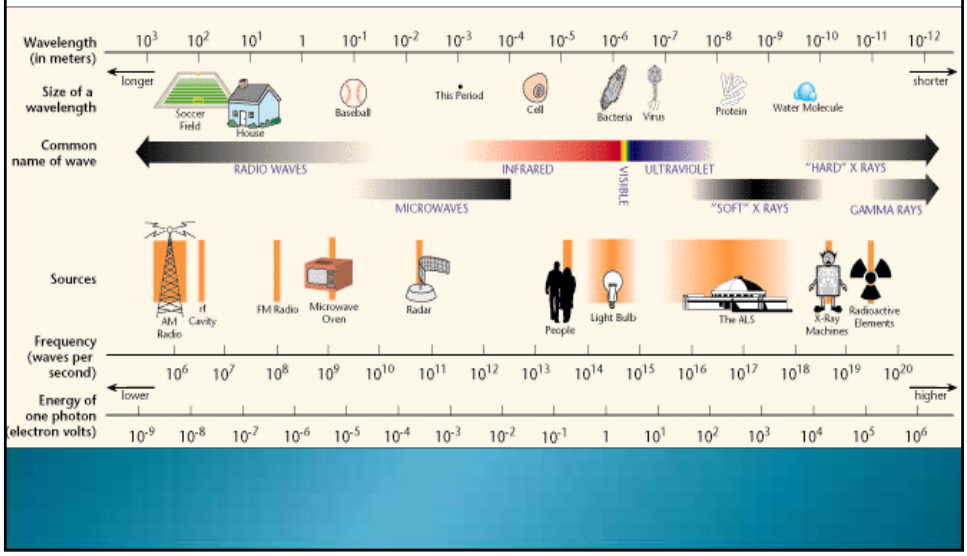
LAND and WATER ASSESSMENTS: GIS and REMOTE SENSING TOOLS

- Remote Sensing Data and Products
- Remote Sensing Scale and Data Selection
- A Hierarchical Landscape Inventory, Monitoring, Assessment and Modeling Framework: Impact of Scales on Land Use and Land Cover
- GIS and Remote Sensing Tools – Demonstrations
- Synthesis – Decision Support Systems



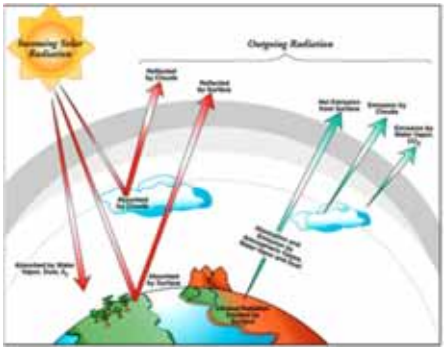
The Electromagnetic Spectrum

- The electromagnetic spectrum can be expressed in terms of **wavelength**, **frequency** or **energy**,



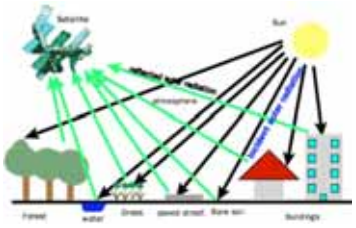
Radiation at the Top of Atmosphere

Parameters influencing the amount of radiation at the top of earth-atmosphere systems:



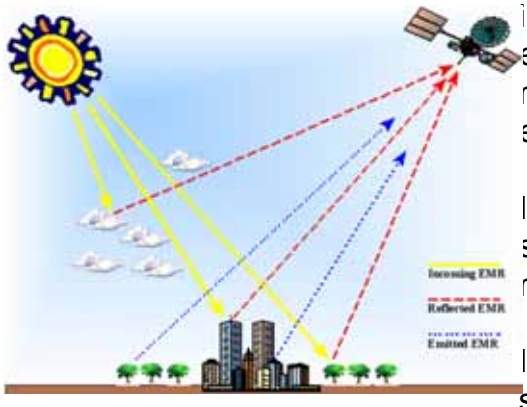
Solar radiation
surface type – e.g. vegetation, soil, snow/ice, clouds, aerosols

Infrared radiation
surface temperature, greenhouse gases (water vapor, carbon dioxide, methane, ozone) and clouds



Microwave radiation
Surface temperature and type (snow/ ice, soil moisture), rain, water vapor, clouds

Principles of Remote Sensing



Satellites carry a variety of instruments to measure electromagnetic radiation reflected or emitted by the earth-atmosphere system

In **'passive'** remote sensing satellites measure naturally reflected or emitted radiation

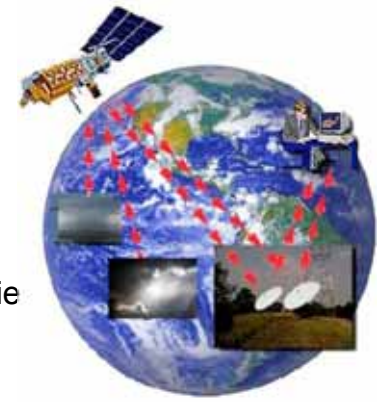
In **'active'** remote sensing satellites 'throw' beams of radiation on the earth-atmosphere system and measure 'back-scattered' radiation

Principles of Remote Sensing

The measured radiant energy by satellites is recorded typically as digital counts on-board and transmitted to ground stations

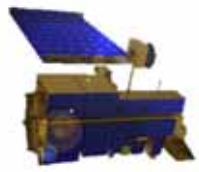
The counts are processed and converted to appropriate geophysical quantities by using complex procedures (algorithms)

These 'retrieved' geophysical quantitie are validated for accuracy by comparing them with ground-based and/or aircraft-based measurements



Remote Sensing Data and Products

Data processing



Level 0 to 4

1. Electromagnetic Radiation
2. Voltage
3. Digital Number
4. Radiance
5. Apparent Reflectance or Temperature
6. Surface reflectance/Temperature
7. Vegetation Index
8. Land cover
9. Evapotranspiration

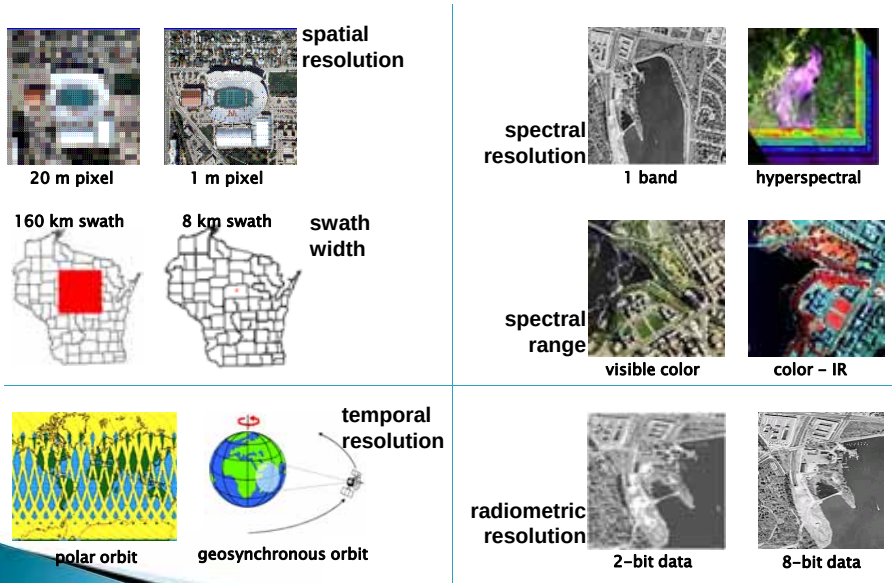
Remote Sensing Data and Products

Data processing

1. Electromagnetic Radiation (λ; Active or Passive)
2. Voltage (A/D conversion)
3. Digital Number (Calibration)
4. Radiance (Radiative transfer models)
5. Apparent Reflectance or Temperature
6. Surface reflectance/Temperature and Δ
7. Vegetation Index and Δ (NIR/red)
8. Land cover and Δ (algorithm)
9. Evapotranspiration and Δ(model)

Level 0 to 4

Dimensions of Remotely Sensed Imagery



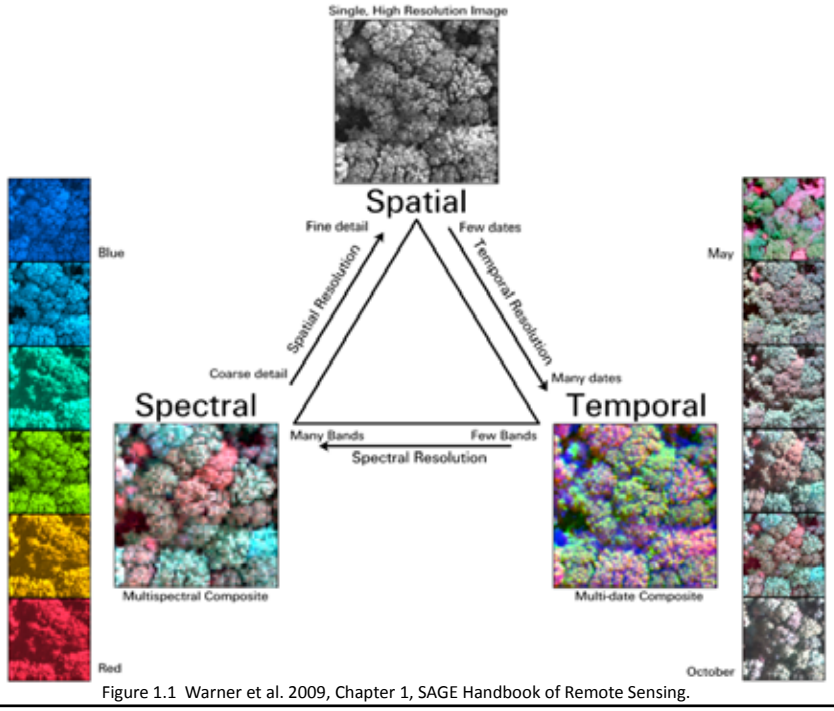
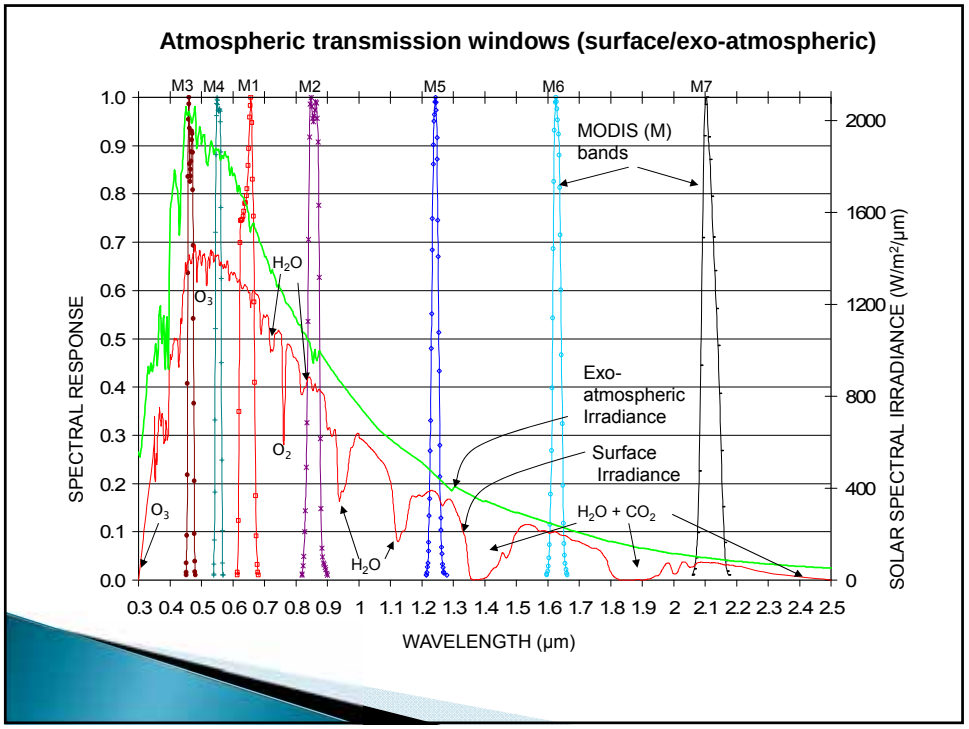
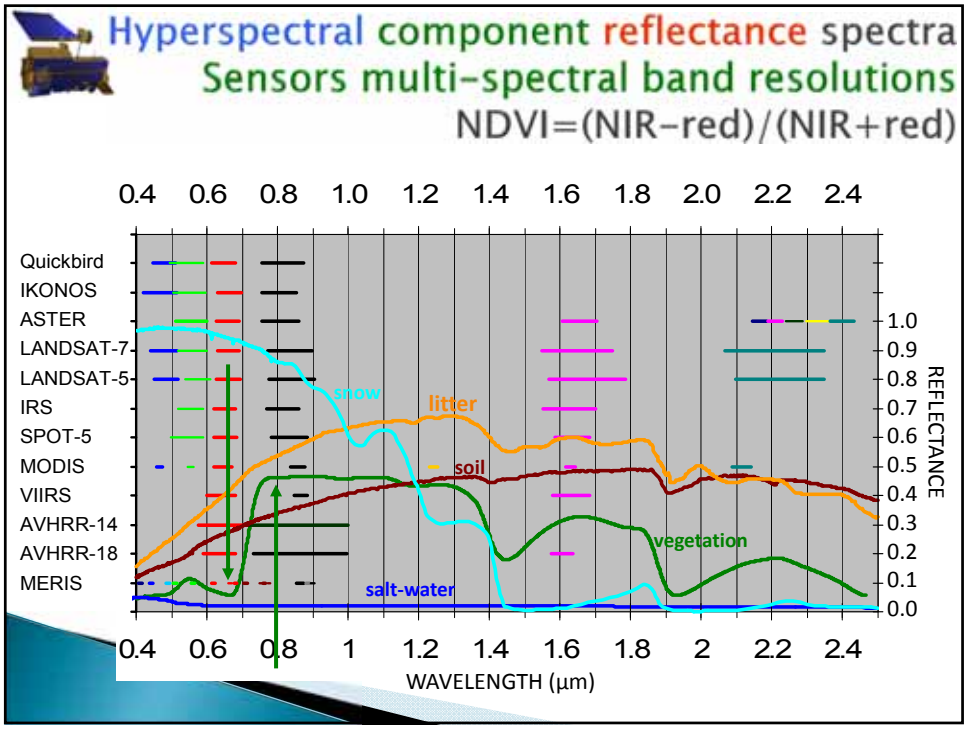


Figure 1.1 Warner et al. 2009, Chapter 1, SAGE Handbook of Remote Sensing.

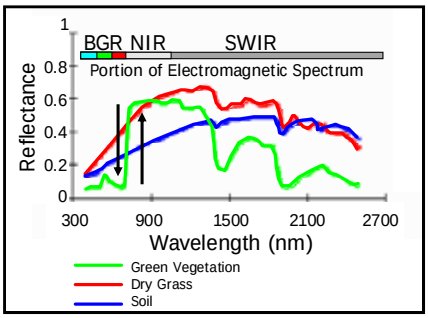
Ikonos images showing the impact of improving radiometric resolution. In the upper part of the figure, different roofs can only be discriminated when enough radiometric resolution is available, while in the lower part, the same applies to the darker areas

(Courtesy Indra Espacio).


Atmospheric transmission windows (surface/exo-atmospheric)
M3 M4 M1 M2 M5 M6 M7
MODIS (M) bands
SPECTRAL RESPONSE
SOLAR SPECTRAL IRRADIANCE (W/m²/μm)
WAVELENGTH (μm)
Exo-atmospheric Irradiance
Surface Irradiance
H2O
O3
O2
H2O + CO2

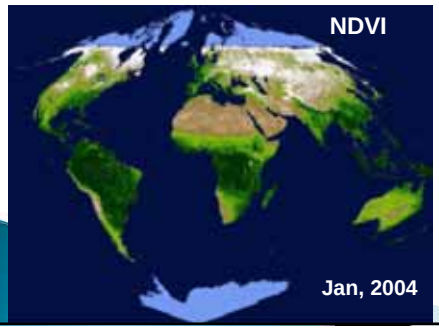

Hyperspectral component reflectance spectra
Sensors multi-spectral band resolutions
NDVI=(NIR−red)/(NIR+red)
Quickbird
IKONOS
ASTER
LANDSAT-7
LANDSAT-5
IRS
SPOT-5
MODIS
VIIRS
AVHRR-14
AVHRR-18
MERIS
snow
litter
soil
vegetation
salt-water
REFLECTANCE
WAVELENGTH (μm)

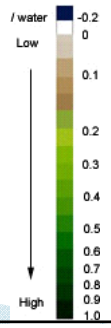
MODIS NDVI 16-day Composite Image

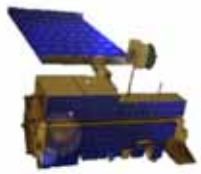


Normalized Difference Vegetation Index

$$NDVI = \frac{(NIR - RED)}{(NIR + RED)}$$







MODIS - TERRA

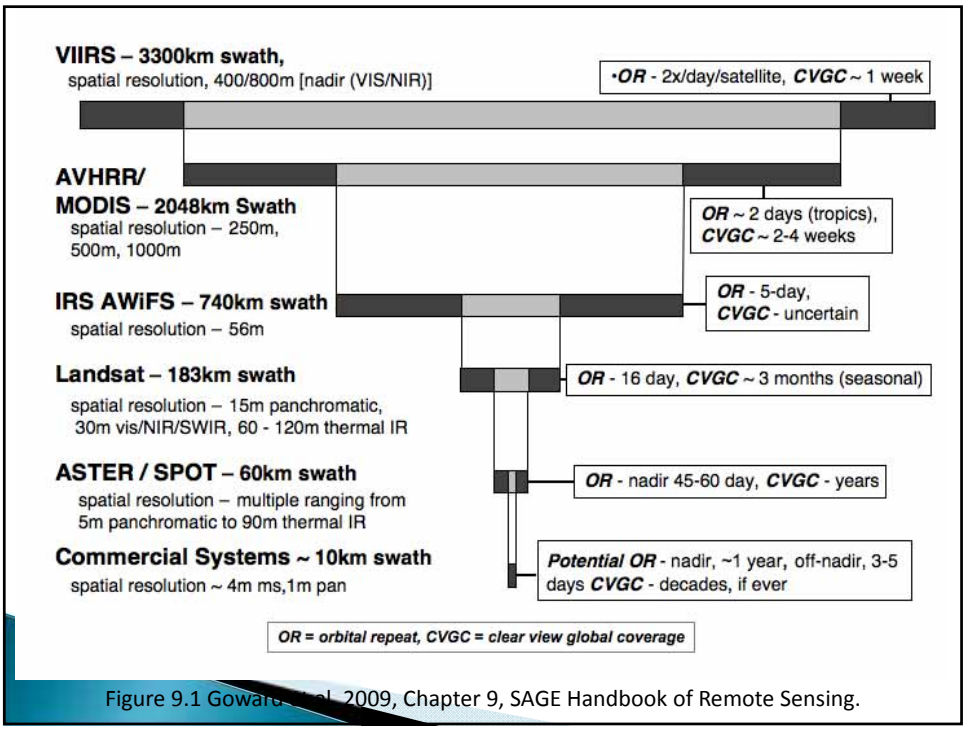


Figure 9.1 Goward et al. 2009, Chapter 9, SAGE Handbook of Remote Sensing.

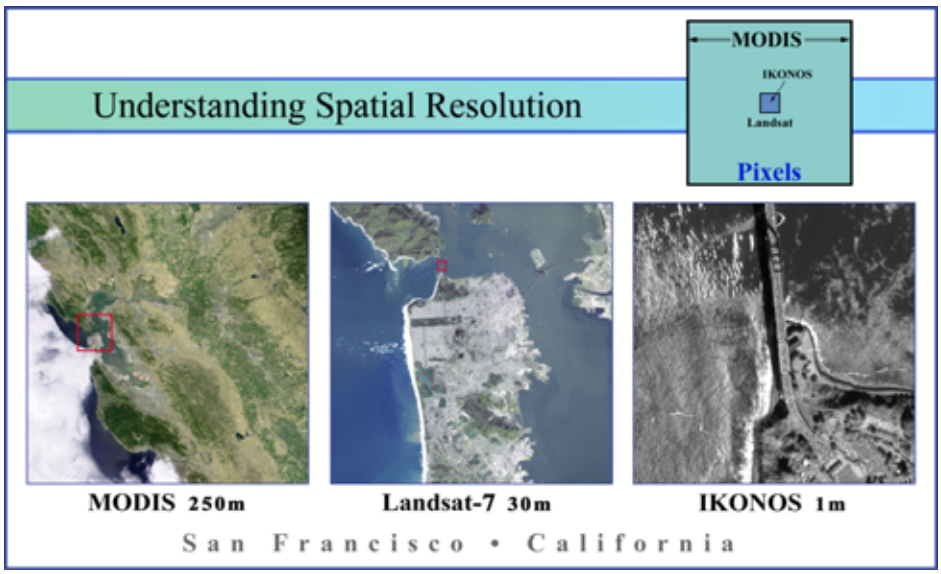


Figure 9.2 Goward et al. 2009, Chapter 9, SAGE Handbook of Remote Sensing.

Consider:

- ✓ Spatial resolution and swath width
- ✓ spectral resolution
- ✓ radiometric resolution
- ✓ temporal resolution
- ✓ cost

(You can't have everything)

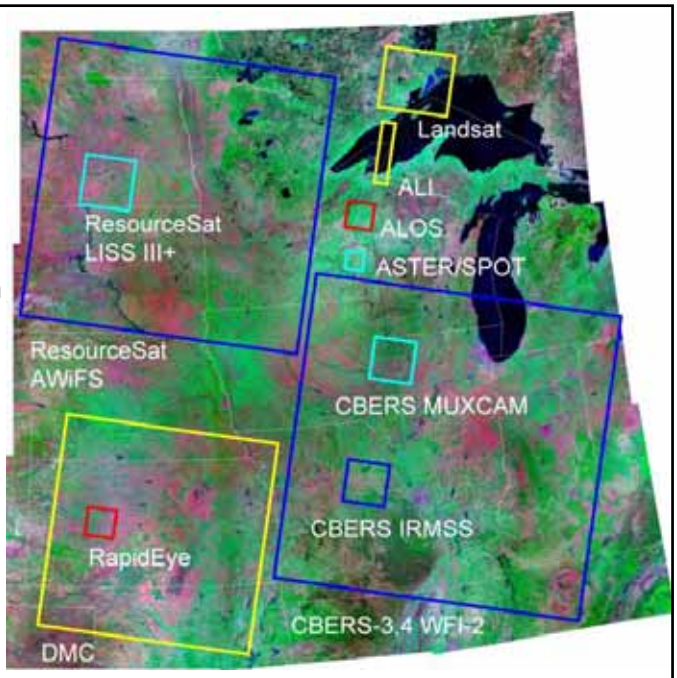
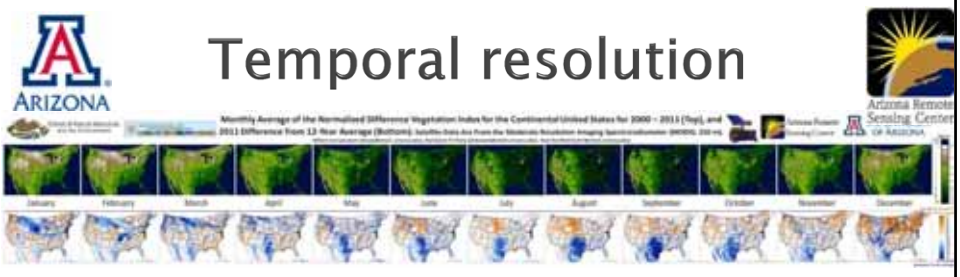
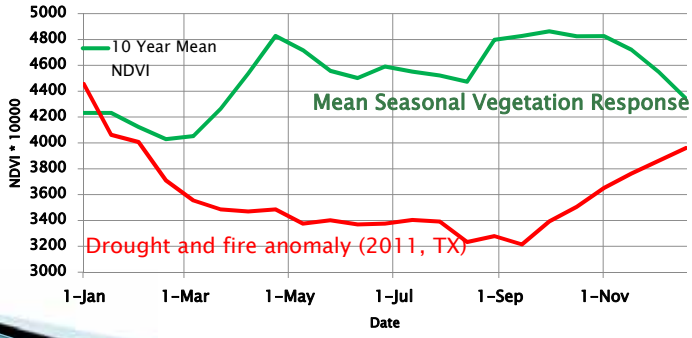


Figure 9.3 Goward et al. 2009, Chapter 9, SAGE Handbook of Remote Sensing.

Temporal resolution



Comparison of 10 Year Mean NDVI and 2011 Mean NDVI – Edwards Plateau (TX)



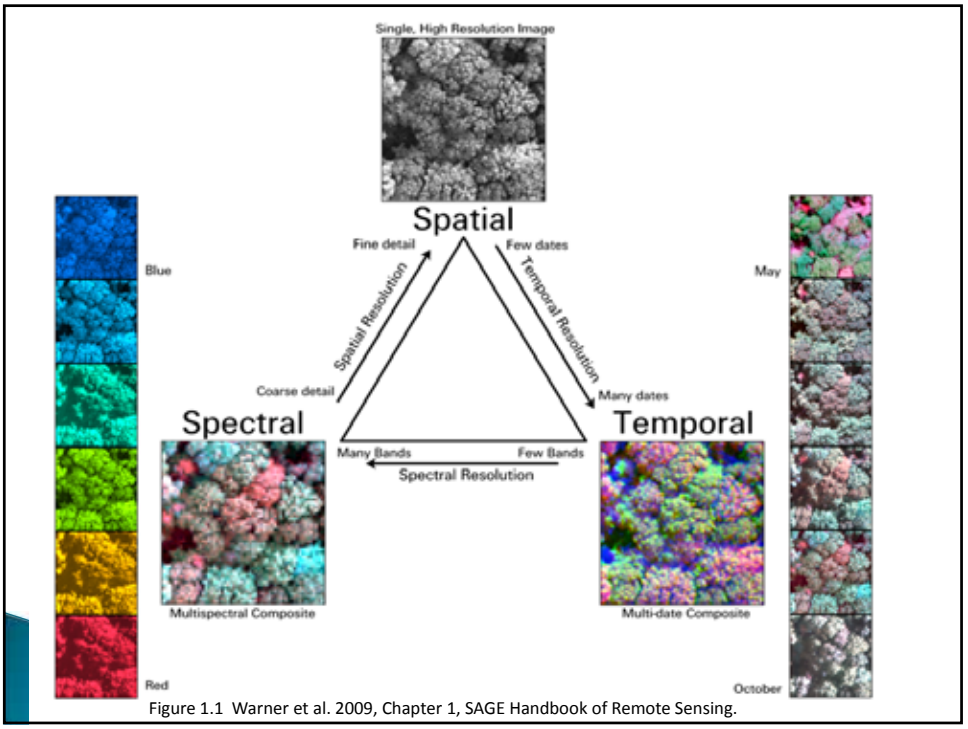
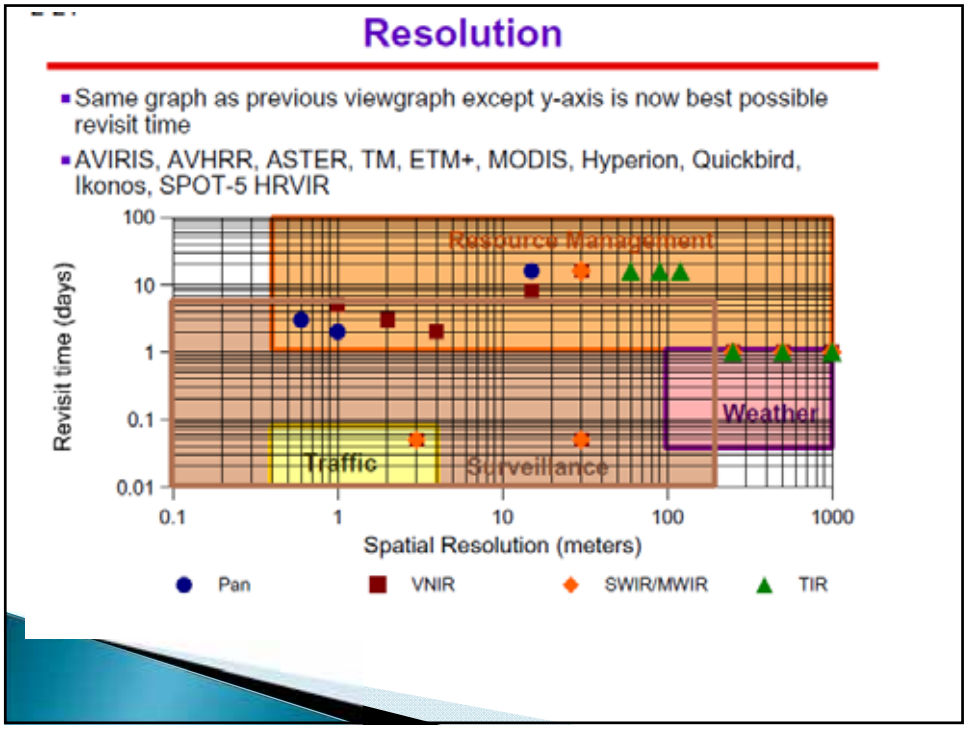


Figure 1.1 Warner et al. 2009, Chapter 1, SAGE Handbook of Remote Sensing.



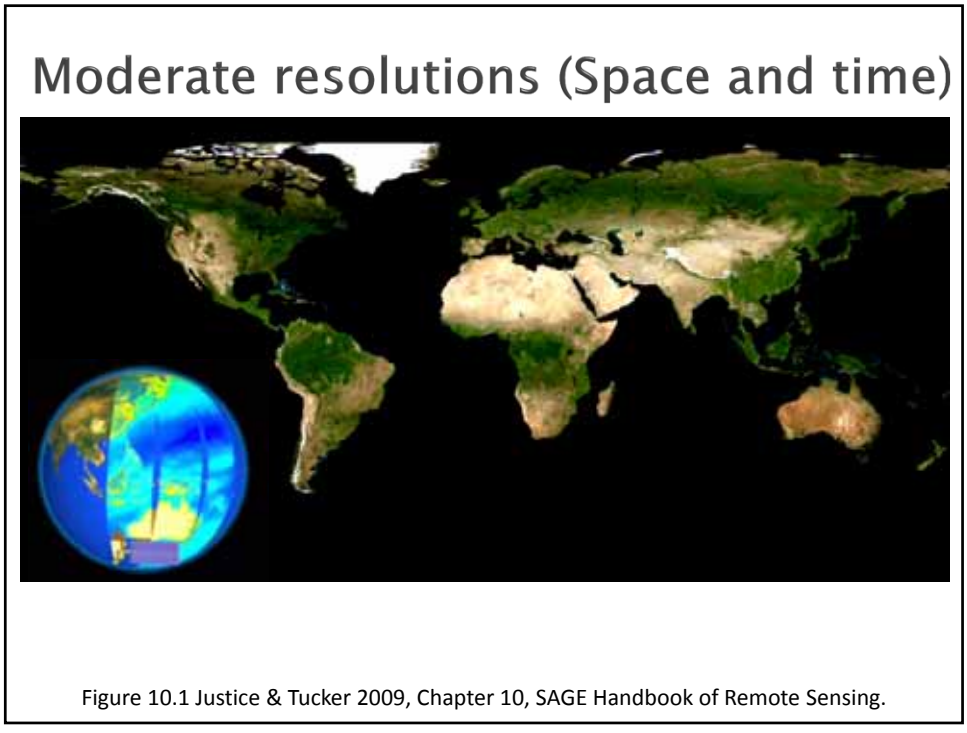
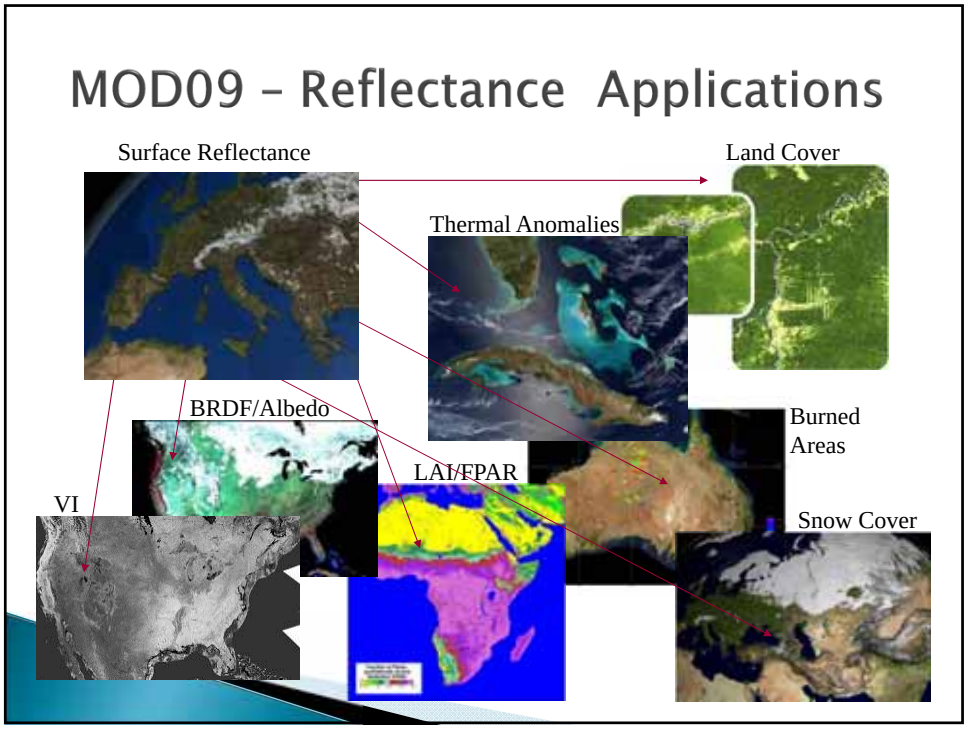
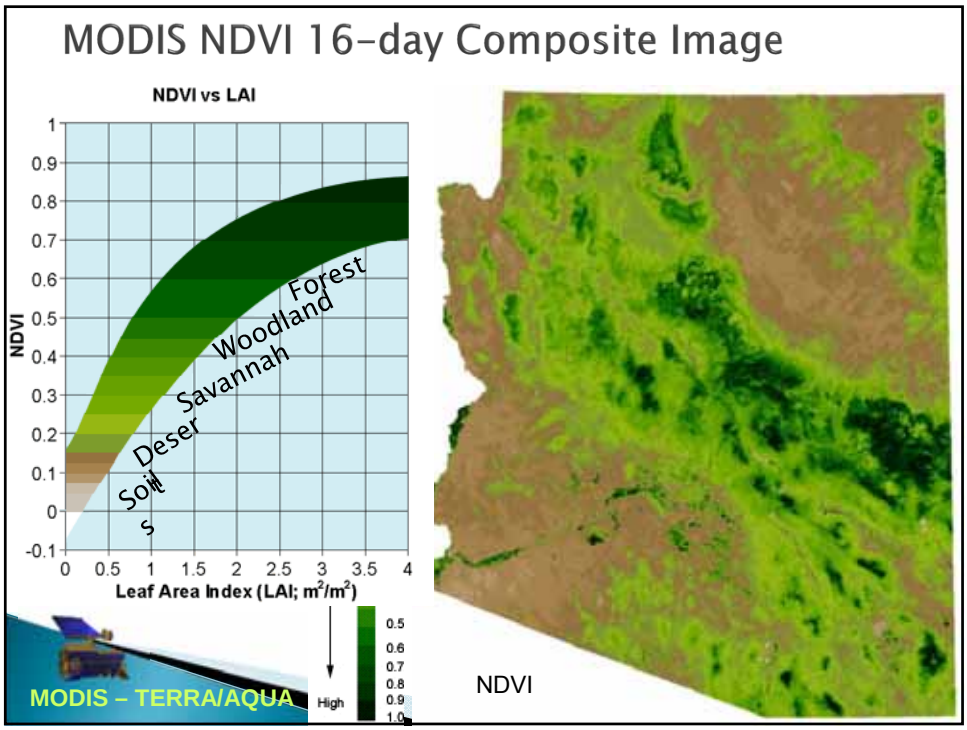
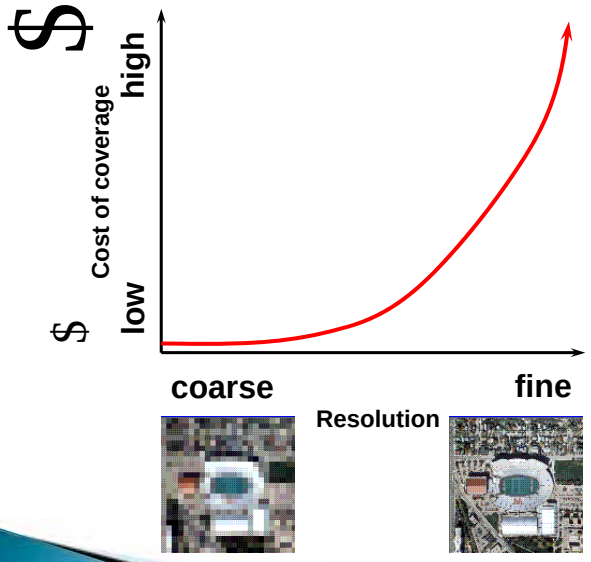


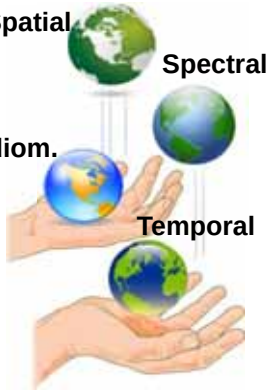
Figure 10.1 Justice & Tucker 2009, Chapter 10, SAGE Handbook of Remote Sensing.

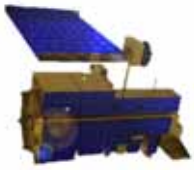

MOD09 – Reflectance Applications
Surface Reflectance
Land Cover
Thermal Anomalies
BRDF/Albedo
Burned Areas
LAI/FPAR
VI
Snow Cover


MODIS NDVI 16-day Composite Image
NDVI vs LAI
NDVI
Leaf Area Index (LAI; m²/m²)
Forest
Woodland
Savannah
Desert
Soils
MODIS – TERRA/AQUA
High
NDVI

Resolutions: Which can you afford?

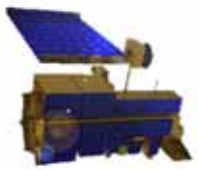






Practical Remote Sensing Needs Assessment

WHAT do you want to do?
mapping, monitoring, animal, vegetable, mineral
WHY do you want to do it (that way)?
strategy, goals, objectives, constraints
WHERE do you want to do it?
global, regional, local
WHEN do you want to do it?
once, repeatedly, seasonally, hourly
WHOM do you want to do it?
government, university, commercial



…and last…

HOW do you want to do it?
airborne, spaceborne, spectral bands, resolution, timing, processing

Interactions among Ecosystem goods and services, management and socio-economic and biophysical drivers take place at multiple spatial, temporal and organizational scales.

Scale refers to the resolution and extent of spatial, temporal and organizational characteristics that govern the interactions among the five spheres of an ecosystem: biosphere, hydrosphere, atmosphere, lithosphere and anthroposphere.

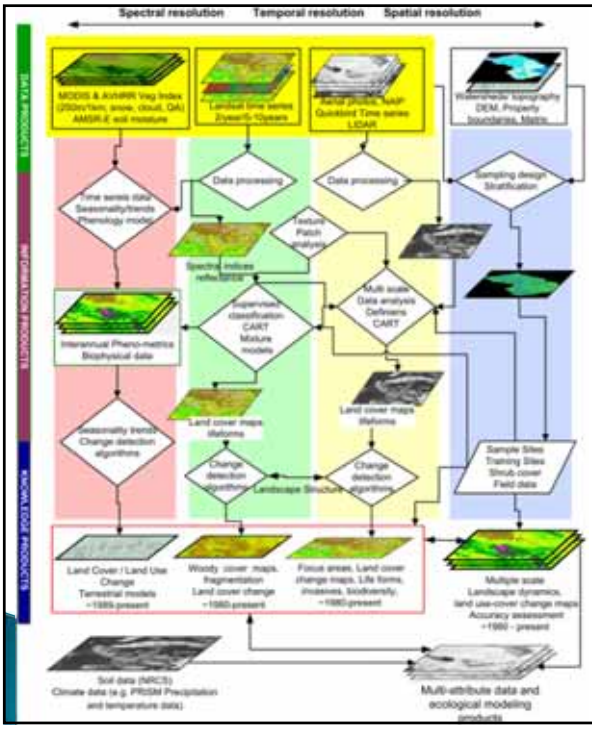
Important Questions: Land Cover & Climate Change

1. What is the impact of climate variability on range (e.g. drought and wildfire)?
2. How does mosquito habitat change in a changing urban environment?
3. Will changing rangeland cover and woody plant encroachment increase or decrease above and/or below ground carbon sequestration?
4. How does woody cover and fragmentation affect species habitat and other ecosystem services?
5. Will changes in management practices affect carbon and nitrogen stocks and what could be the impact of management on carbon sequestration?

How Can Remote Sensing Help Answer Some of These Questions?

What Are We Learning In The Southwest US?

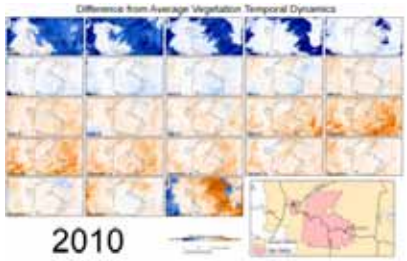
Range and Habitat RS examples

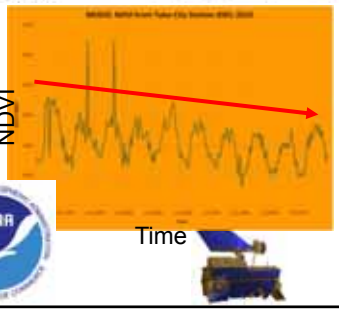


Hierarchical Landscape Inventory, Monitoring, Assessment and Modeling Framework Using Remotely Sensed Data and Products.

These data and product can be used or integrated with climate and soil information to model biogeochemical and ecological processes and possibly verify their results.

Q. How can we monitor and asses drought impacts to inform and manage our natural resources?





Science Issue:

- **Drought and climate change and variability impact vegetation response, land use and management (**Hopi Tribe and Navajo Nation**)**

Tools:

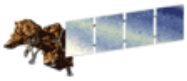
- **AVHRR and MODIS NDVI time series products**
- **Precipitation and temperature data**
- **Contextual GIS**

Approach:

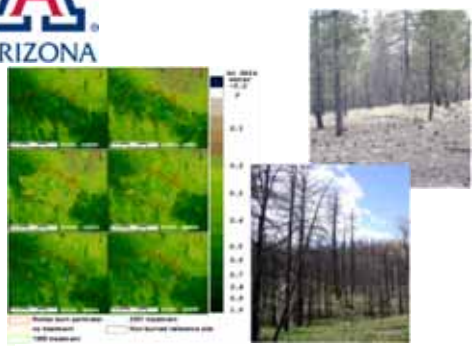
- **NDVI time-series data analysis per range unit**
- **Phenology=f(environmental variables)**
- **Anomaly analysis**
- **Analog years (e.g. wet, dry)**

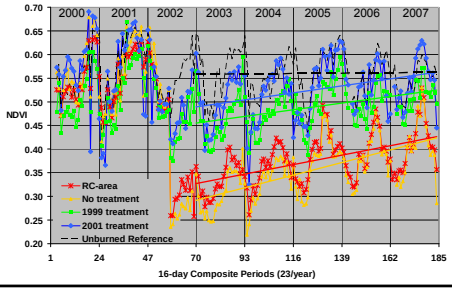
Results:

- **Range assessments**
- **Vegetation Anomaly Maps**



Q. How does wildfire impact phenolology?





Science Issue:

- **Climate, land use and land cover variability and changes impact post-wildfire response.**
- **How can we use satellite data to monitor post –wildfire vegetation response?**

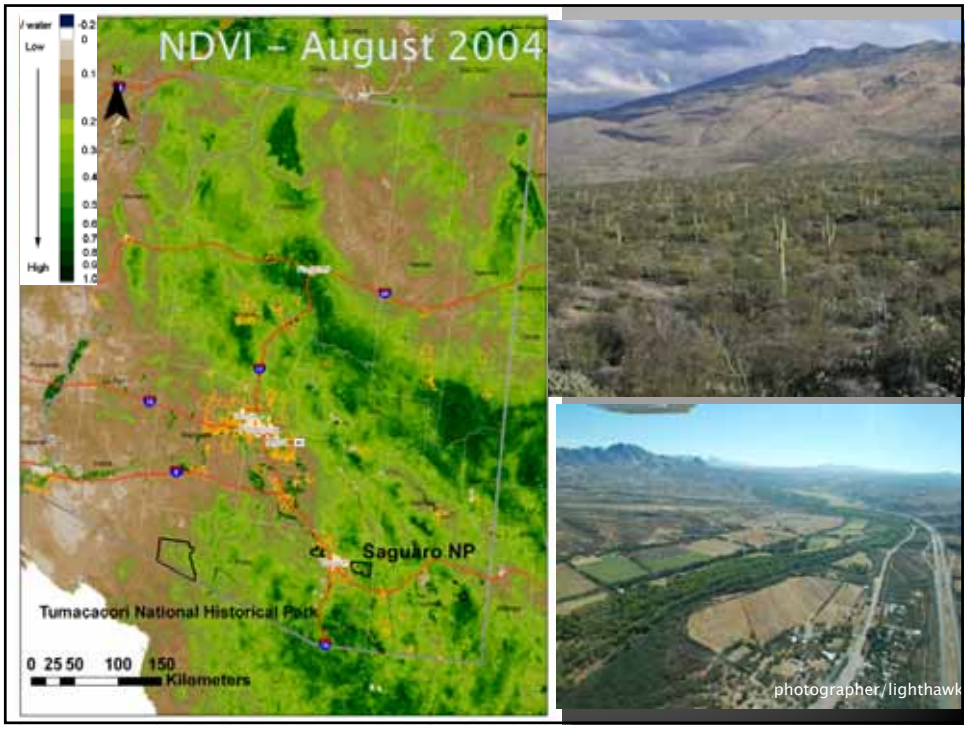
Tools:

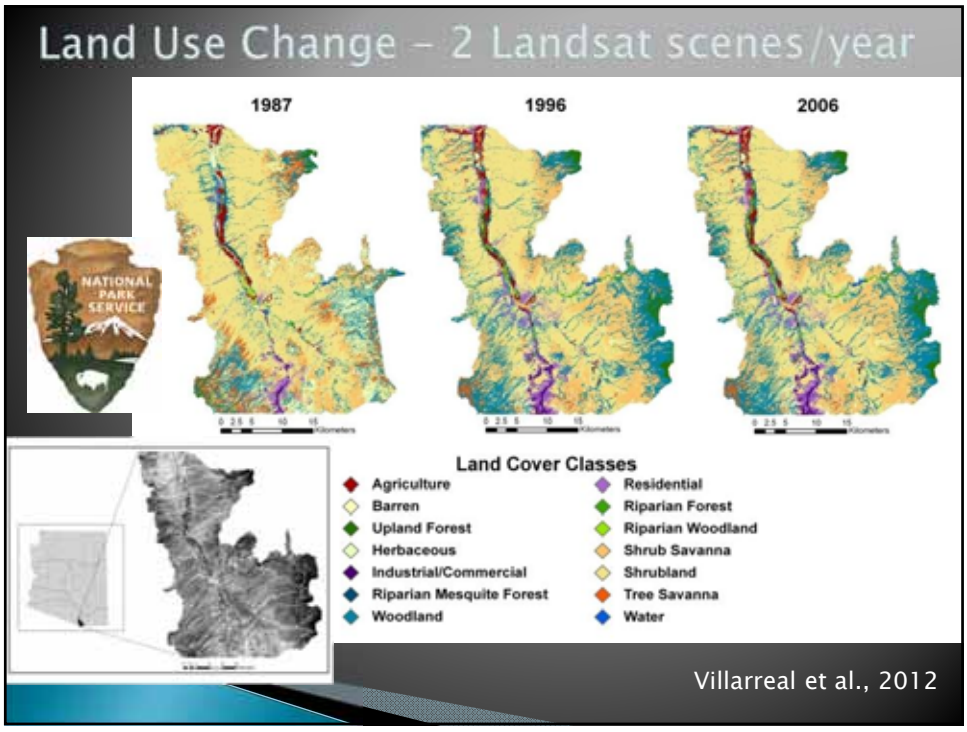
- **Multi-resolution time series of reflectance and NDVI data from MODIS, Landsat, and NAIP.**
- **GIS data integration**

Approach:

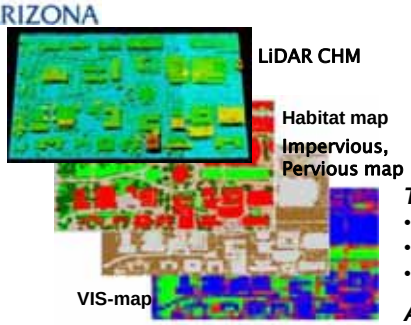
- **Phenological assessments**
- **Quantifying seasonal and interannual variability in vegetation growth patterns for different wildfire severity and management approaches**

van Leeuwen et al., 2008, 2010


NDVI – August 2004
Low
High
Saguaro NP
Tumacacori National Historical Park
0 25 50 100 150
Kilometers
photographer/lighthawk


Land Use Change – 2 Landsat scenes/year
1987
1996
2006
NATIONAL PARK SERVICE
Land Cover Classes
Agriculture
Barren
Upland Forest
Herbaceous
Industrial/Commercial
Riparian Mesquite Forest
Woodland
Residential
Riparian Forest
Riparian Woodland
Shrub Savanna
Shrubland
Tree Savanna
Water
Villarreal et al., 2012

Q. What and where is Tucson mosquito habitat?



Science Issue:

- **Can we characterize high risk mosquito breeding habitat?**
- **What are relationships between mosquitos, microclimates and land use/land cover?**

Tools:

- **Lidar and multispectral data**
- **Mosquito counts**
- **Temperature, precipitation & humidity data**

Approach:

- **Data fusion and land use/cover classification**
- **Mosquito habitat modeling**

Results:

- **Mosquito habitat maps**

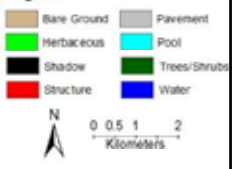
Hartfield, Kyle A., Landau, Katheryn I., Willem J.D. van Leeuwen, 2011. Fusion of High Resolution Aerial Multispectral and LiDAR Data: Land Cover in the Context of Urban Mosquito Habitat. *Remote Sensing*, 3(11): 2364-2383.

Land Cover Classification

NAIP-NDVI | NAIP-Canopy Height Model-NDVI

	NAIP-NDVI	NAIP-CHM-NDVI
Accuracy	85.05%	89.18%
Total Kappa	0.83	0.88

Statistically different at P=0.01



Hartfield, Kyle A., Landau, Katheryn I., Willem J.D. van Leeuwen, 2011. Fusion of High Resolution Aerial Multispectral and LiDAR Data: Land Cover in the Context of Urban Mosquito Habitat. *Remote Sensing*, 3(11): 2364-2383.

Mosquito Collection

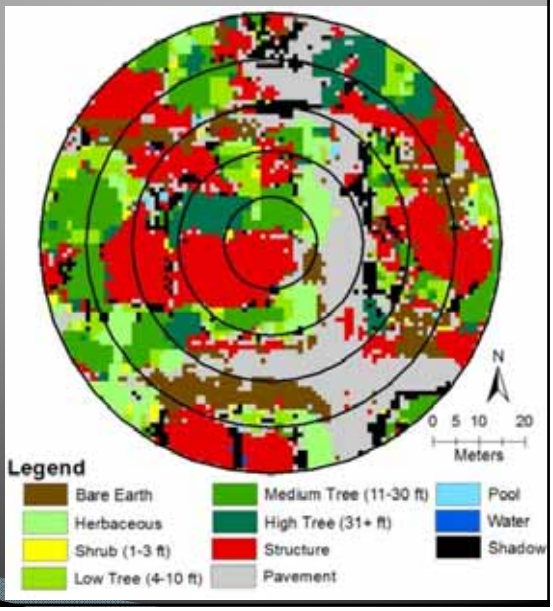
- 2010 – 49 Sites
- 2011 – 30 Sites

- Weekly Trapping
- May–October 2010 and 2011

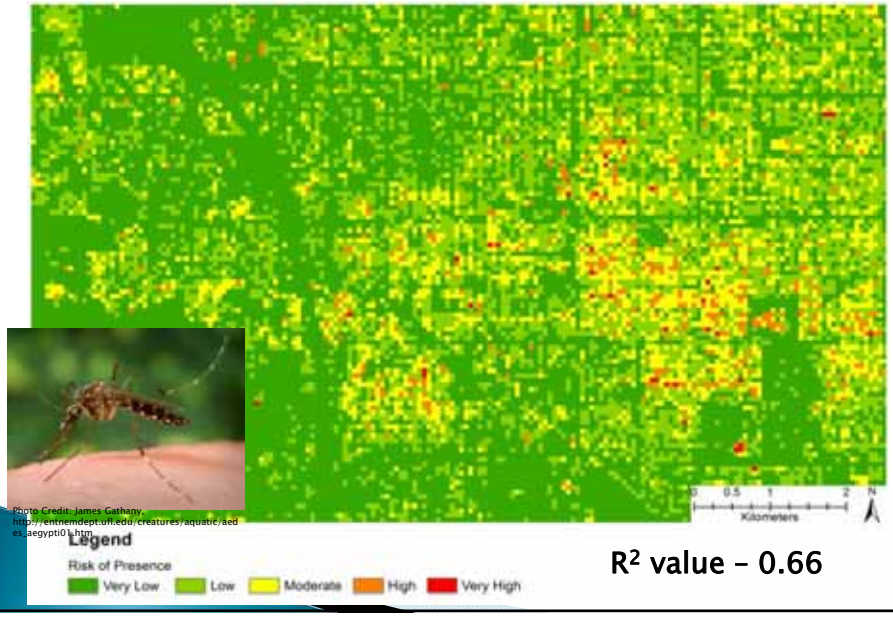
Site Land Cover Characterization

- 5 buffers per site
- Site Characteristics
  - Percent cover 11 LULC classes
  - Distance to waterways

significant predictive land cover variables: percent structure, bare earth, and medium tree.



Ae. aegypti Predicted Seasonal Presence



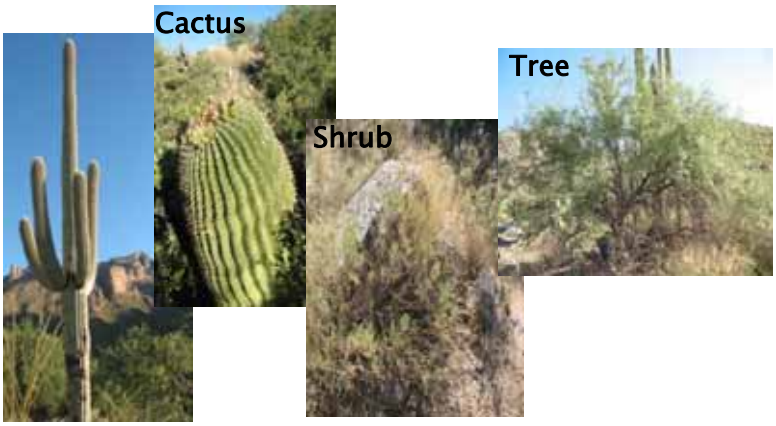
R^2 value – 0.66

Results

- Spatial resolution does matter
  - 30 m buffer has highest R^2
- High spatial resolution inputs needed
- Mosquito control applications
  - Identify high risk areas
  - Focus mitigation practices

Katheryn I. Landau, Willem J.D. van Leeuwen, 2012. FINE SCALE SPATIAL URBAN LAND COVER FACTORS ASSOCIATED WITH ADULT MOSQUITO ABUNDANCE AND RISK IN TUCSON, ARIZONA. *Journal of Vector Ecology.* In Press.

Can LIDAR Help Provide More Accurate Estimates of Rangeland Biomass and Carbon?



Identifying vegetation life forms in the Santa Catalina Mountains using LIDAR and multispectral data

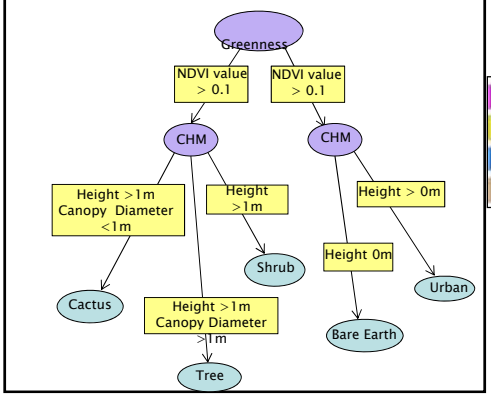
Katheryn Landau, Kyle Hartfield, Willem J.D. van Leeuwen

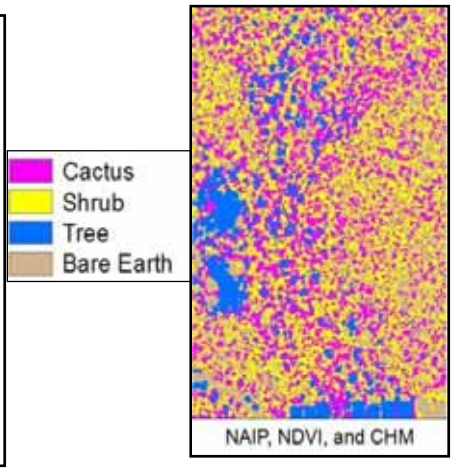
Arizona Remote Sensing Center

Can LIDAR Help Provide More Accurate Estimates of desert lifeforms to improve assessments of Biomass and Carbon?

Results and Discussion

Cart Model





! Co-registration 1m LiDAR and multispectral data; point density !

Q. How accurate can we asses woody cover using multispectral 1m resolution imagery?

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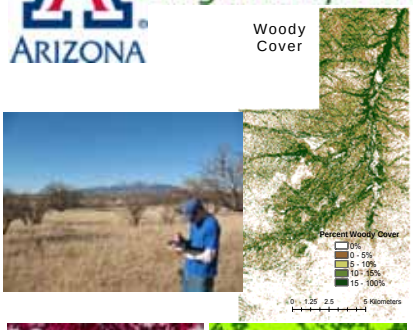
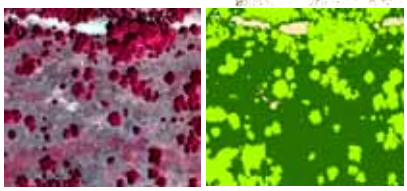




Science Issue:

- **Brush management-Woody encroachment assessment for upper Cienega Creek Basin and Sonoita Plain, AZ**

Tools:

- ***In situ woody cover data***
- ***Timely 1m Visible NIR reflectance data***
- ***ESRI and ERDAS and See5 software***

Approach:

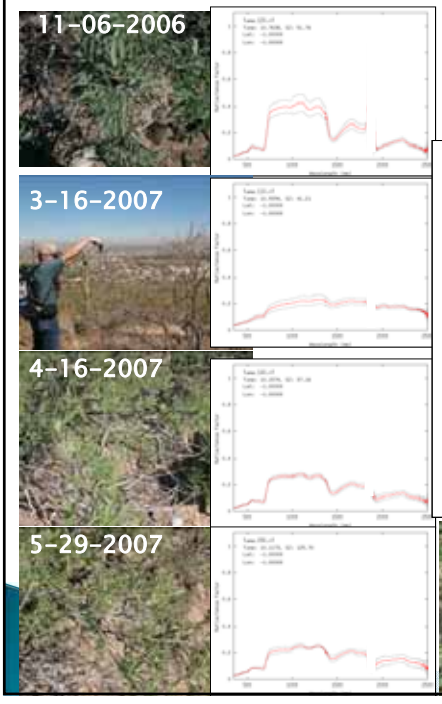
- ***Compare 2 classification approaches***
  - ***Classification and Regression Tree (CART)***
  - ***Feature Analyst***
  - ***Accuracy assessment***

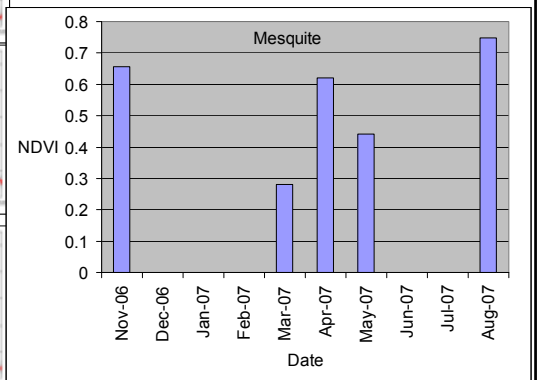
Results:

- ***Accurate woody cover maps***
- ***CART is fast***
- ***Phenology and Co-registration important***

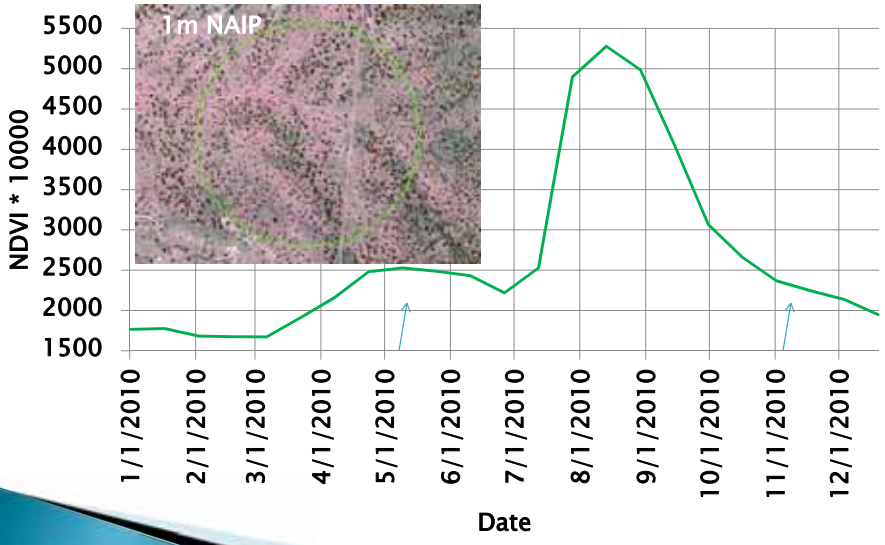
The Nature Conservancy
Protecting nature. Preserving life.™

Mesquite Pheno-phase Pheno-spectra

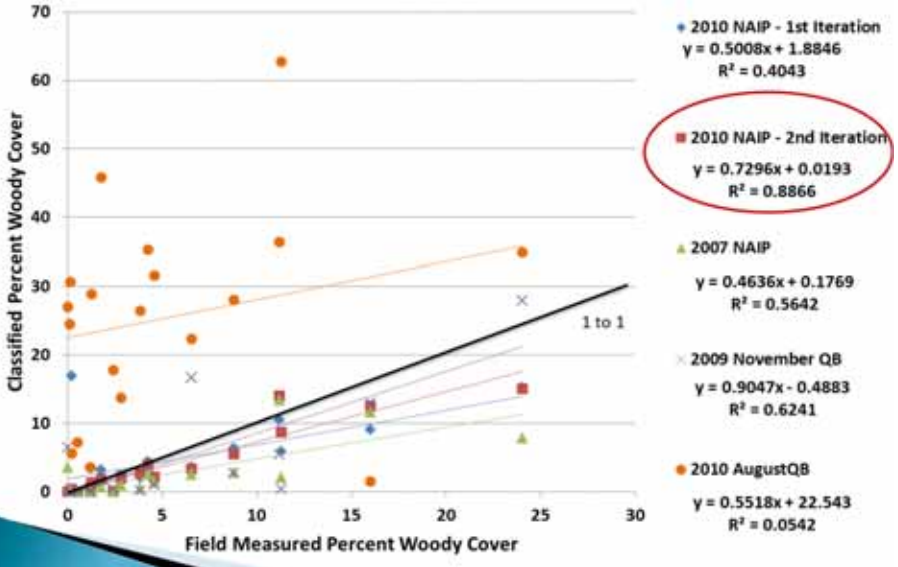




Las Cienegas National Conservation Area – Sparse Shrub Cover (MODIS time series)



SEE5 Classifications to Estimate Percent Woody Cover



Q. How does habitat affect distribution patterns of pronghorns and Ferruginous Pygmy-Owls?

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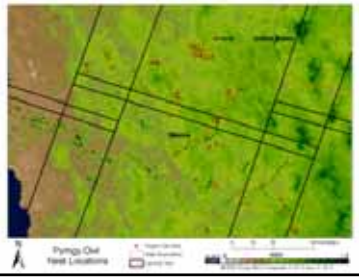
USDA



Science Issue:

- **Climate, land use and land cover variability and changes impact the owl and pronghorn populations.**
- **How can we use satellite data to characterize habitat?**

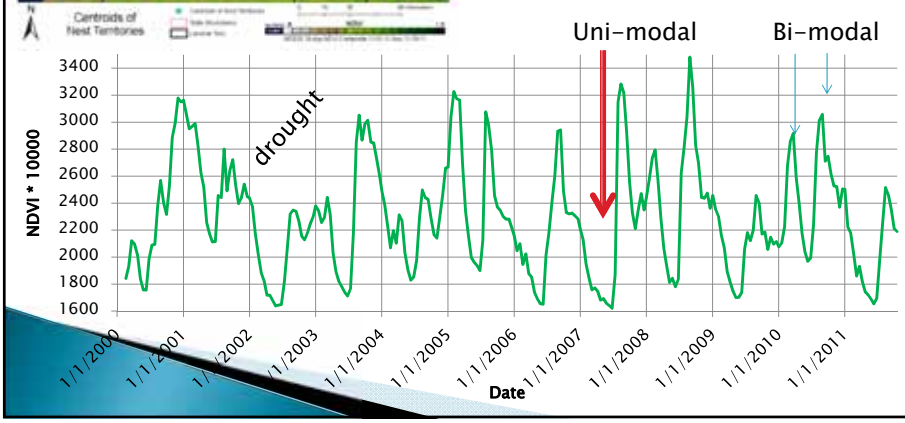
Tools:

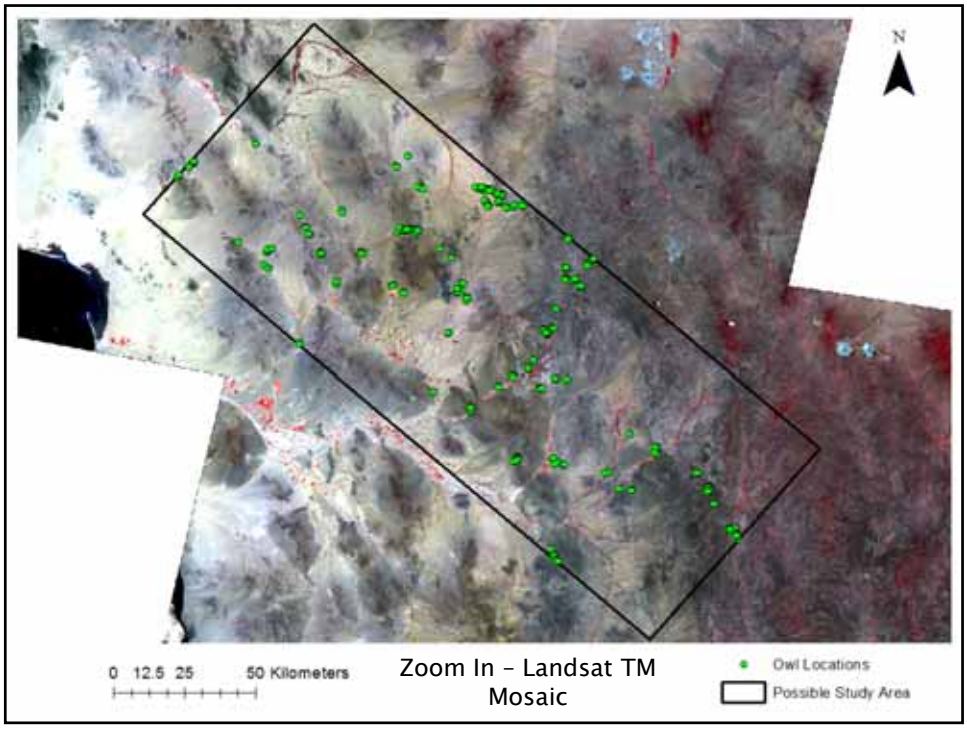
- **Multi-resolution time series of reflectance and NDVI data from MODIS, Landsat, and NAIP.**
- **GIS data integration**

Approach:

- **Land cover classification mixture modeling, and habitat fragmentation.**
- **Quantifying seasonal and interannual variability in vegetation growth patterns (phenology, land use, land cover, fragmentation, connectivity) for owl and pronghorn locations.**

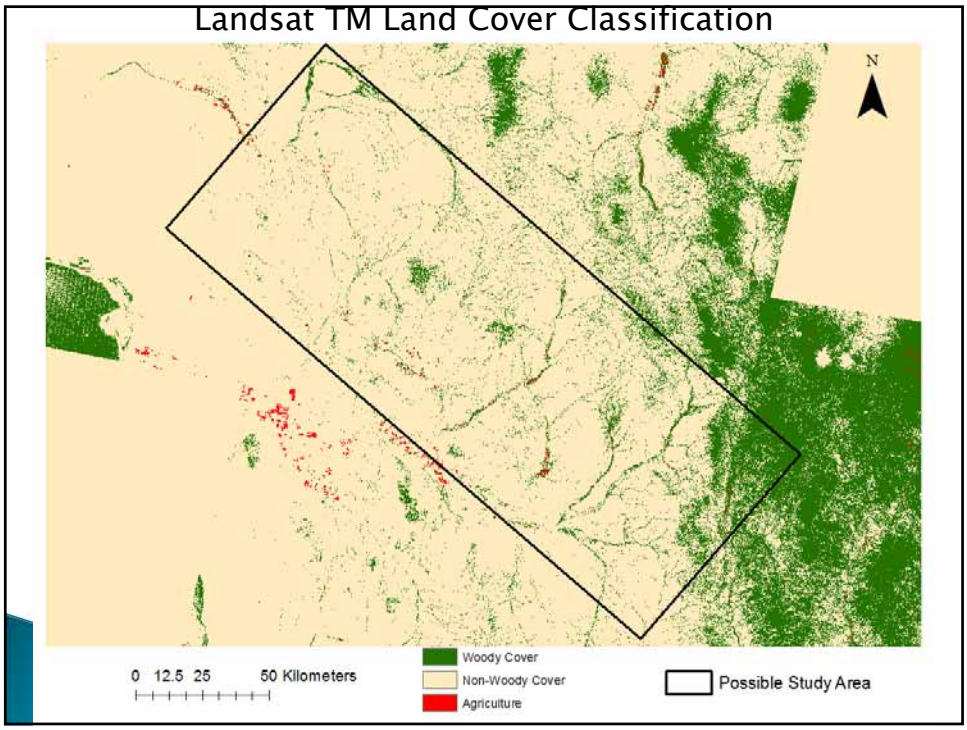
MODIS NDVI time series



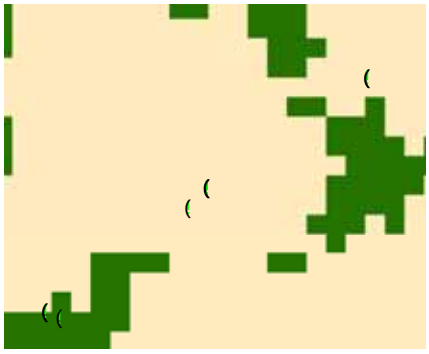


Zoom In – Landsat TM Mosaic

Landsat TM Land Cover Classification

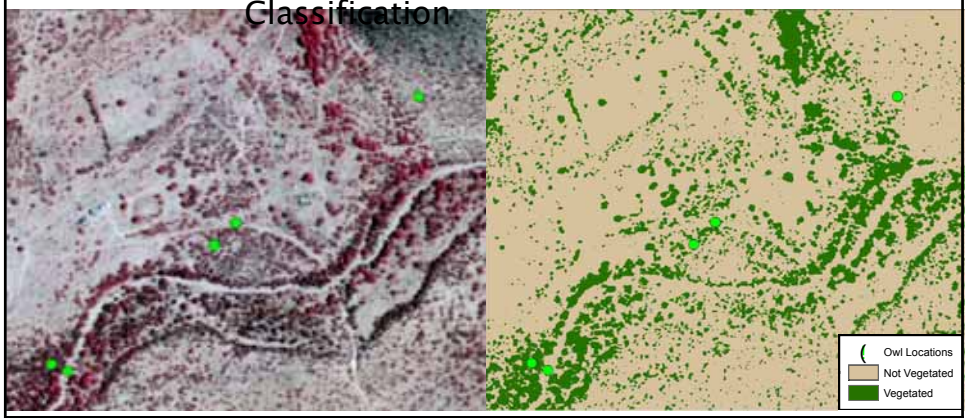


Landsat TM Land Cover Classification Accuracy Assessment and Subset



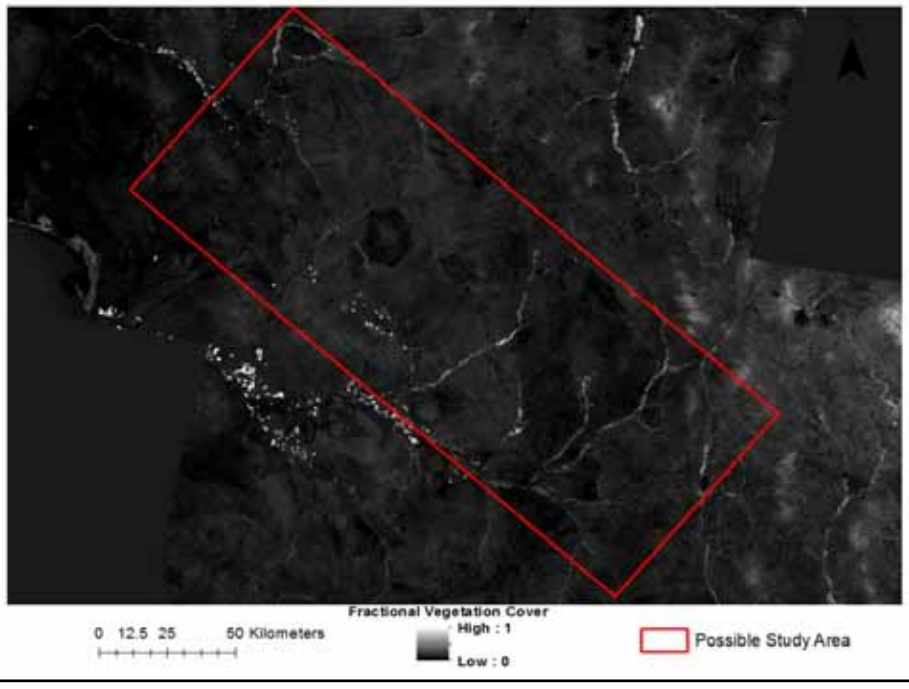
		1	2	3	Total	User	Commission	Kappa
Woody Cover	1	49	0	1	50	98.00%	2.00%	0.9700
Non-Woody Cover	2	0	50	0	50	100.00%	0.00%	1.0000
Agriculture	3	1	0	49	50	98.00%	2.00%	0.9700
	Total	50	50	50	150			
	Produce r	98.00%	100.00 %	98.00%		148		
	Omissio							

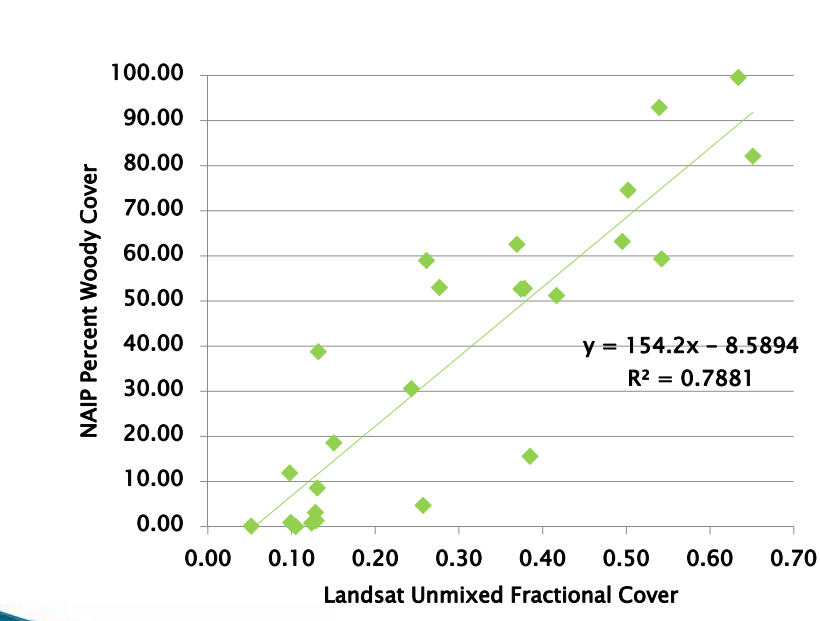
Subset of NAIP Data and Land Cover Classification



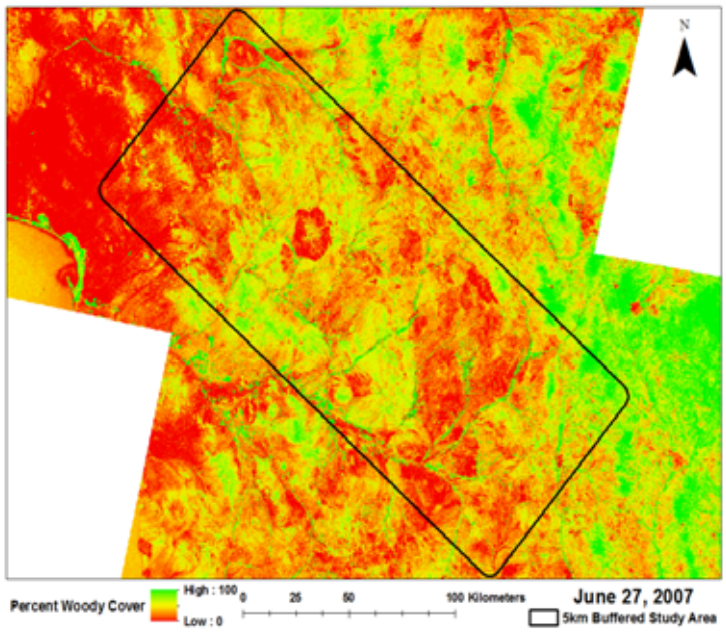
		1	2	Total	User	Commission	Kappa
Vegetated	1	48	1	49	97.96%	2.04%	0.9592
Not Vegetated	2	2	49	51	96.08%	3.92%	0.9216
	Total	50	50	100			
	Produce r	96.00%	98.00%		97		
	Omissio n	4.00%	2.00%			97.00%	
	Kappa	0.9216	0.9592				0.9400

Spectral Unmixing of Landsat Mosaic for June 27, 2007





Percent woody cover



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Q. How can we create the longest seamless greenness satellite time series data and what are the implications for Earth System Science?

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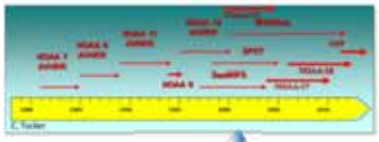
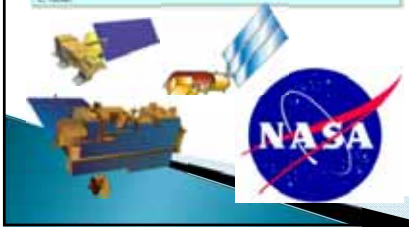




PI: Dr. Kamel Didan

Science Issue:

- **Land surface phenological response to climate change and variability impacts and represents ecosystem processes at multiple temporal, spatial and organizational scales.**

Tools:

- **Multi sensor time series of global vegetation index data; GigaFLOPS; Web interface to examine data.**

Approach:

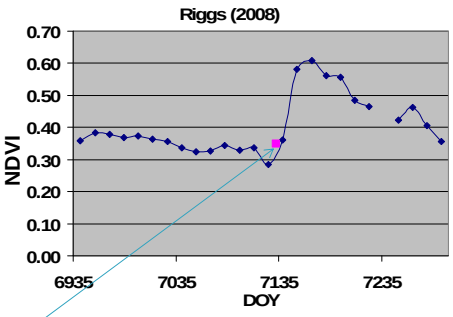
- **Data quality control algorithms to minimize atmospheric noise and data gaps.**
- **Atmospheric and canopy radiative transfer modeling to calibrate and translate cross sensor vegetation index data.**
- **Phenology algorithms.**

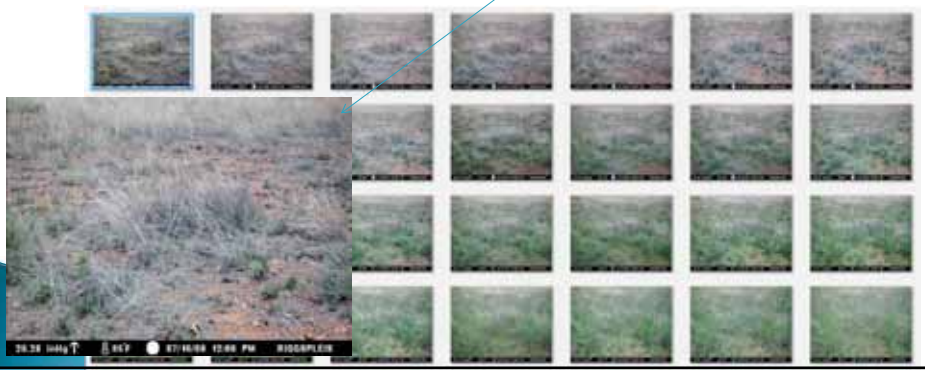
Results: http://measures.arizona.edu/

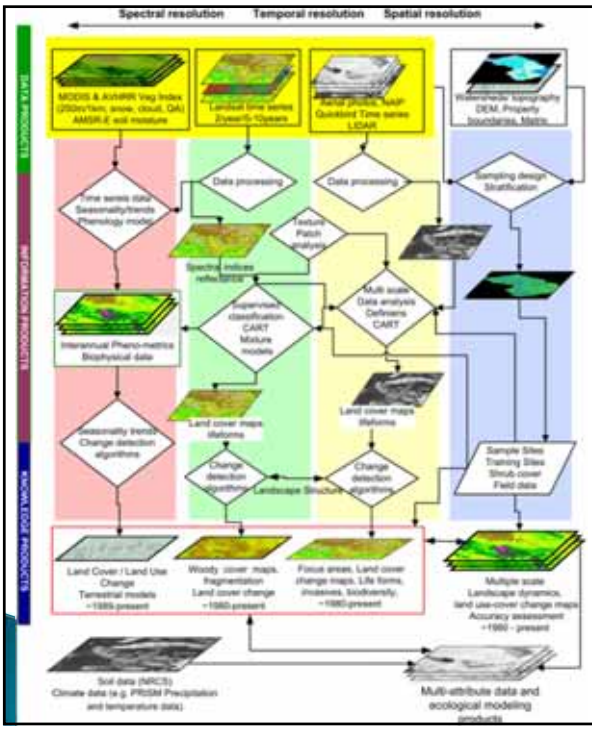
- **Version 2 daily global 5km resolution seamless vegetation index data (1982-2011).**
- **Land surface phenology climate data record.**

Validation of Phenology (SOS)

Repeat Photography





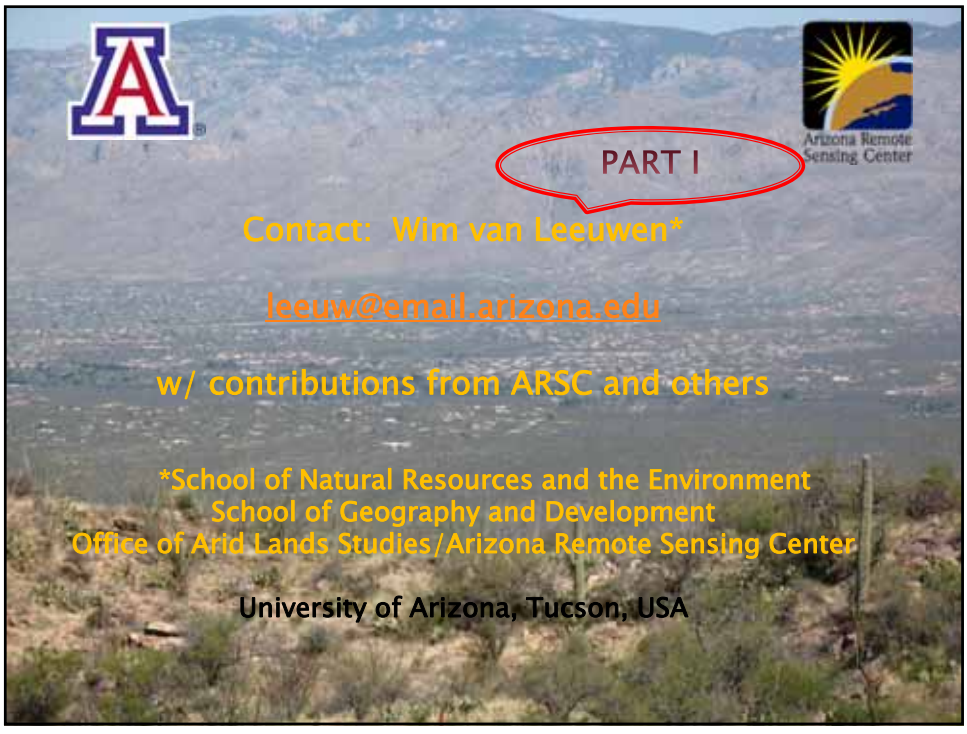


Hierarchical Landscape Inventory, Monitoring, Assessment and Modeling Framework Using Remotely Sensed Data and Products.

These data and product can be used or integrated with climate and soil information to model biogeochemical and ecological processes and possibly verify their results.

Ecosystem – land cover RS framework

- **Multi sensor solutions (passive, active)**
  - Multispectral, LiDAR, Fusion
- **Nested temporal, spatial and spectral resolutions**
  - MODIS-Landsat-Quickbird/NAIP-Field
  - Continuous (woody cover) and discrete data (land cover class)
  - Data resolution < phenomena resolution
  - Fine resolution co-registration!
- **Timing of phenomena (uni-, multi-modal)**
  - Phenology of life forms
- **Timing of data acquisition**
  - Sun angle (shadows)
- **Bridge interplay between organizational scales**
  - Local, landscape, continental upscaling←→ downscaling
  - Biophysical and socio-economic drivers, management



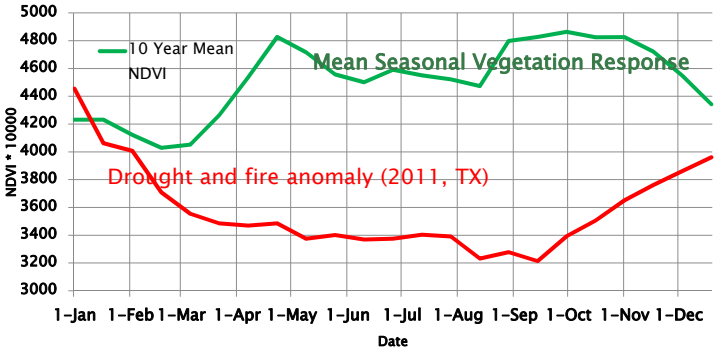
RS and GIS demonstrations (PART II)

- Data download tools (MODIS & Landsat data)
  - Spatial, point and temporal data
  - Data links
- Data viewing verification tools (Google Earth, Landsatlook)
- Free GIS and RS tools
- Commercial tools (ESRI, ENVI, ERDAS, Matlab, JMP, etc.)
- Open source tools (Quantum GIS, GRASS, R, GPicSync, GPSbabel, Google Earth, Picasa, OpenOffice, GIMP, etc)

Remote Sensing Resources

1. NASA http://earthdata.nasa.gov/
   1. http://earthdata.nasa.gov/data/data-tools/search-and-order-tools
2. Application Earth Science
   1. http://appliedsciences.nasa.gov/
3. NASA EARTH Observatory
   1. http://earthobservatory.nasa.gov/
4. Get data and service
   1. http://reverb.echo.nasa.gov/reverb/
   2. http://gdex.cr.usgs.gov/gdex/
   3. http://daac.ornl.gov/
5. MODIS overview
   1. https://lpdaac.usgs.gov/products/modis_overview
6. Landsat tools
   1. http://landsat.gsfc.nasa.gov/data/where.html
   2. http://landsatlook.usgs.gov/
7. Hydrologic and Atmospheric data
   1. http://disc.sci.gsfc.nasa.gov/giovanni/overview/index.html

Comparison of 10 Year Mean NDVI and 2011 Mean NDVI – Edwards Plateau (TX)

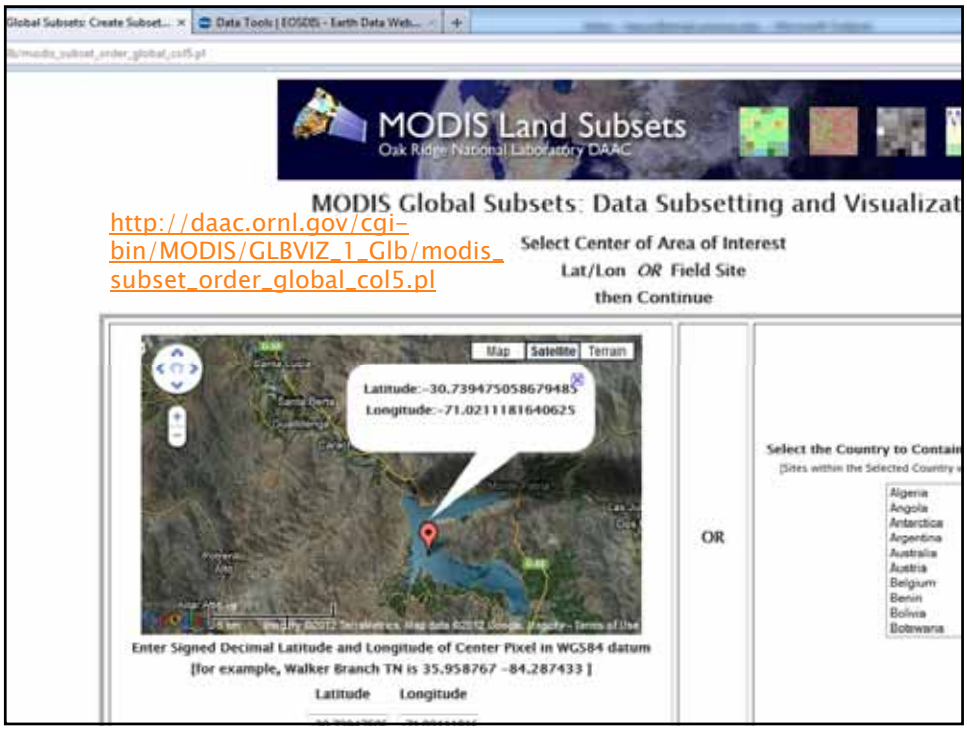


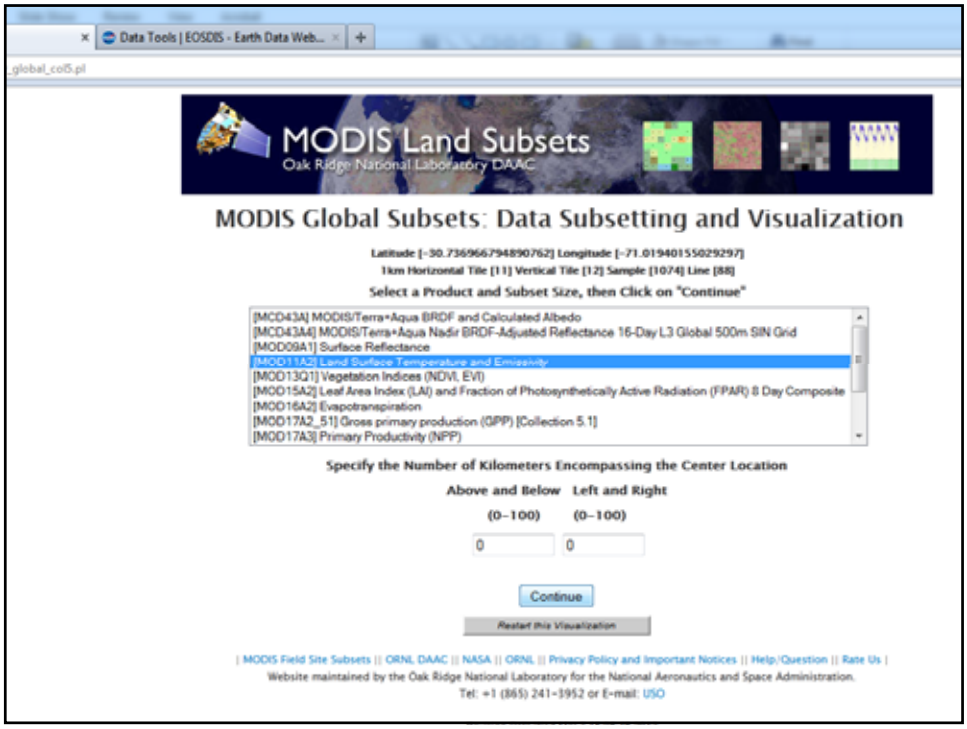
Where to download MODIS time series data using a web-interface

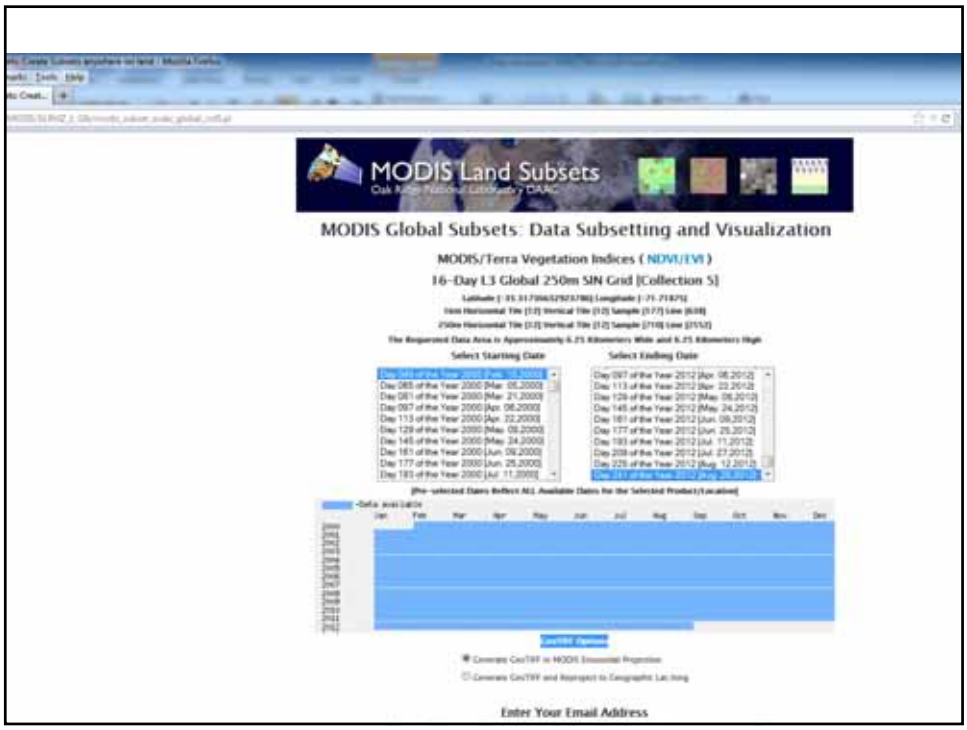
- Order, download, display, interpret and discuss NDVI time series for Chile for a latitudinal gradient with different land cover types.
- Use http://daac.ornl.gov/cgi-bin/MODIS/GLBVIZ_1_Glb/modis_subset_order_global_col5.pl
- Extract, download, create and plot data by creating a spreadsheet, graph the data, create a ppt with 3-5 data points at different latitudes.

Short list of instructions

1. Open http://daac.ornl.gov/cgi-bin/MODIS/GLBVIZ_1_Glb/modis_subset_order_global_col5.pl
2. Choose your site of interest using latitude and longitude coordinates or the graphical user interface, then "Continue" (see slide 3 below)
3. Select a Product and Subset Size. Specify the Number of Kilometers Encompassing the Center Location, Above and Below (0-100), - Left and Right (0-100) ."0"means you're choosing 1 pixel. You can choose an area around the center for up to 200 km and download these as ASCII or GEOTIFF data later. Click on "Continue" (see slide 4 below)
4. Select Starting Date; Select Ending Date ; select your GeoTiff projection: Enter your email Click on "Continue" (see slide 5 below)
5. Order Verification - MODIS Global Subsets: Data Subsetting and Visualization - If the Selected Parameters Above are Correct, Select "Create Subset" to Begin Processing, or use the Browser's "Back" Button to Access Previous Choices, or Select "Restart this Visualization" to Restart the Selection Process (see slide 6 below)
6. You will get an email with the link to the data you ordered. (see slide 7) When you open the link in the email, the data is visualized for you (slide 8 and 9). If you scroll down, you can download the data you want using the links (see slide 10). E.g. " Statistical Data of the subset" Use the "Help" button for explanations.
7. To order more or other data sets for the same area go to the end of the link that was sent to you (Slide 11). Click "Create subsets for this location". This will bring you to the ordering tool again to order more data for the same area.




Data Tools | EOSDIS - Earth Data Web...
MODIS Land Subsets
Oak Ridge National Laboratory DAAC
MODIS Global Subsets: Data Subsetting and Visualization
Latitude [-30.736966794890762] Longitude [-71.01940155029297]
1km Horizontal Tile [11] Vertical Tile [12] Sample [1074] Line [88]
Select a Product and Subset Size, then Click on "Continue"
[MCD43A] MODIS/Terra+Aqua BRDF and Calculated Albedo
[MCD43A4] MODIS/Terra+Aqua Nadir BRDF-Adjusted Reflectance 16-Day L3 Global 500m SIN Grid
[MOD09A1] Surface Reflectance
[MOD11A2] Land Surface Temperature and Emissivity
[MOD13Q1] Vegetation Indices (NDVI, EVI)
[MOD15A2] Leaf Area Index (LAI) and Fraction of Photosynthetically Active Radiation (FPAR) 8 Day Composite
[MOD16A2] Evapotranspiration
[MOD17A2_51] Gross primary production (GPP) [Collection 5.1]
[MOD17A3] Primary Productivity (NPP)
Specify the Number of Kilometers Encompassing the Center Location
Above and Below
(0-100)
Left and Right
(0-100)
0
0
Continue
Restart this Visualization
| MODIS Field Site Subsets || ORNL DAAC || NASA || ORNL || Privacy Policy and Important Notices || Help/Question || Rate Us |
Website maintained by the Oak Ridge National Laboratory for the National Aeronautics and Space Administration.
Tel: +1 (865) 241-1952 or E-mail: USO


MODIS Land Subsets
MODIS Global Subsets: Data Subsetting and Visualization
MODIS/Terra Vegetation Indices (NDVI/EVI)
16-Day L3 Global 250m SIN Grid [Collection 5]
Select Starting Date
Select Ending Date
Enter Your Email Address

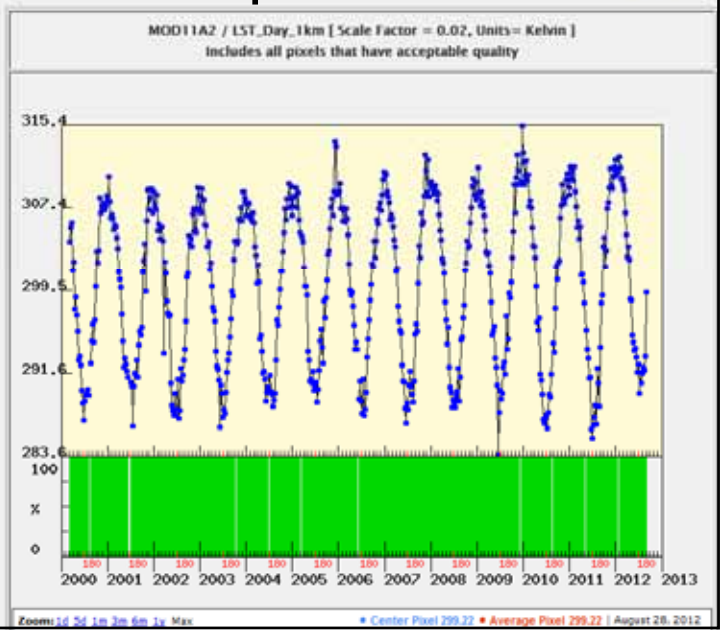
Water temp. – Lake

http://daac.ornl.gov/glb_viz_2/11Sep2012_13:12:46_238727498L-30.7369667948907621_-71.01940155029297S111_MOD11A2/index.html
Order Summary
Product:MOD11A2
Location Centered on: Latitude [-30.736966794890762] Longitude [-71.01940155029297]
Size: Approximately 1 Km wide and 1 Km high Time Period: March. 05, 2000 to August. 28, 2012

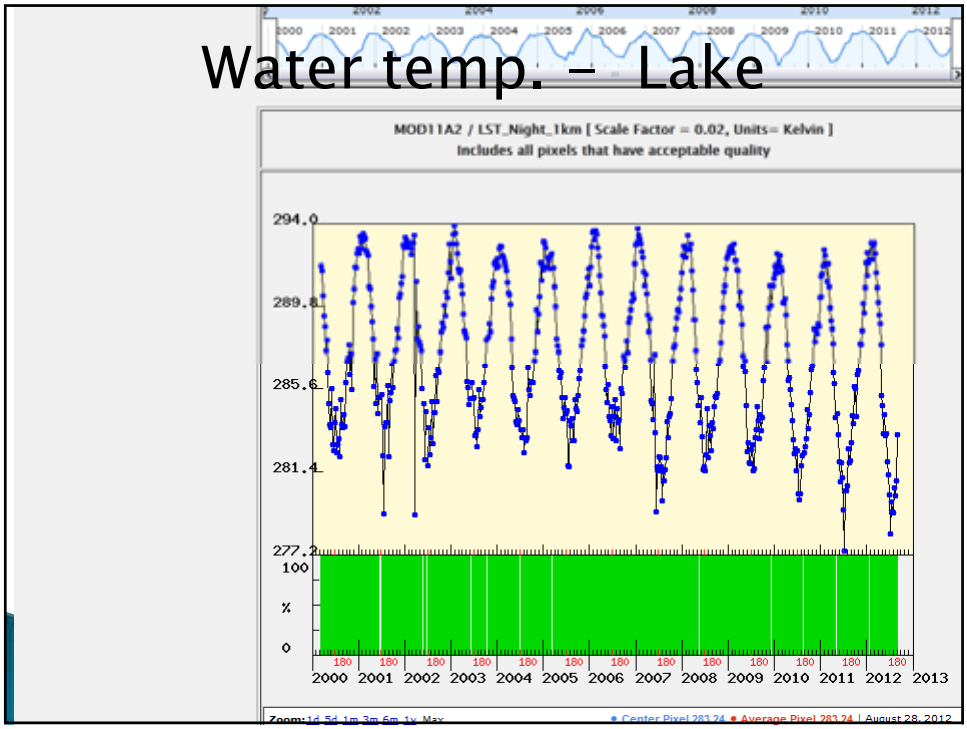
These subset orders will be deleted 30 days from the date of the order.

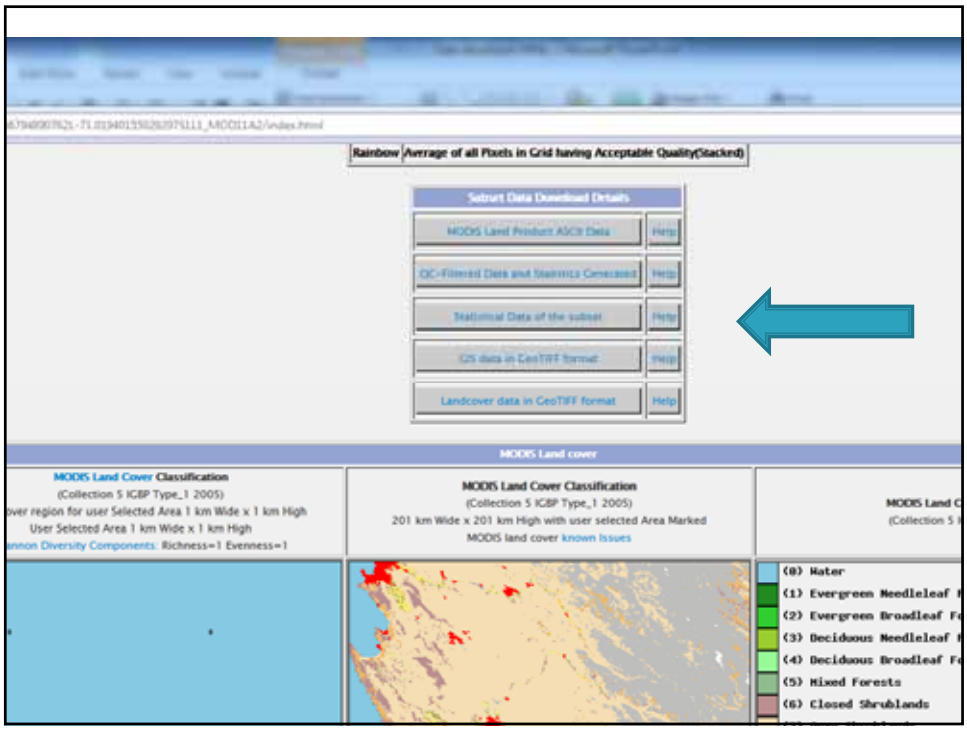
Data Citation:
Oak Ridge National Laboratory Distributed Active Archive Center (ORNL DAAC). 2012. MODIS subsetted land products, Collection 5. Available on-line [http://daac.ornl.gov/MODIS/modis.html] from ORNL DAAC, Oak Ridge, Tennessee, U.S.A. Accessed Month dd, yyyy.

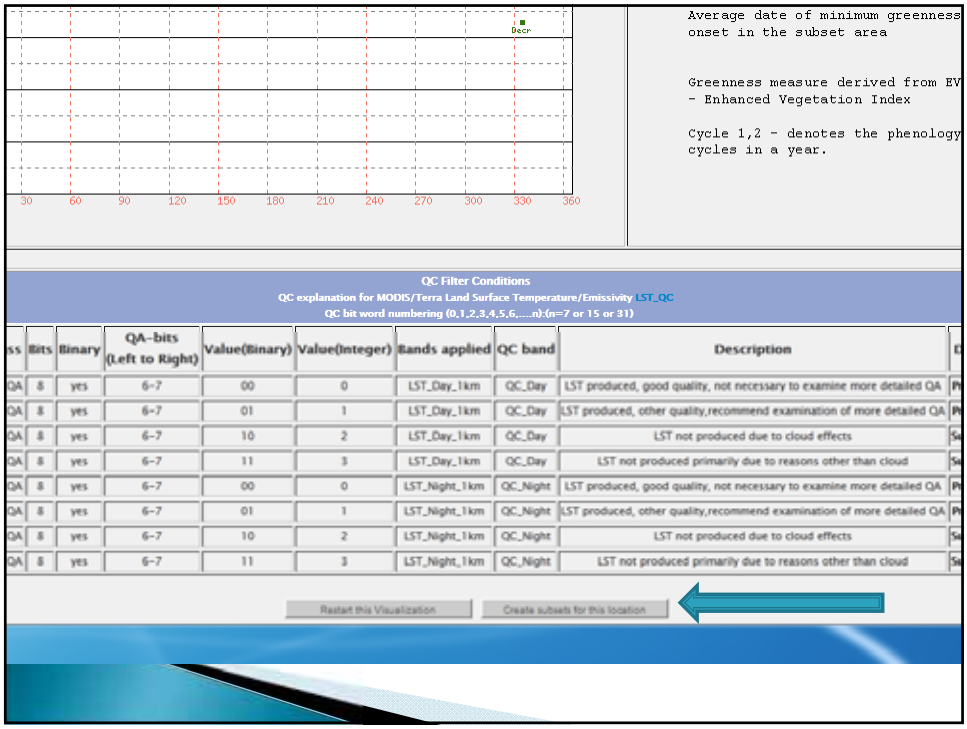
Water temp. – Lake



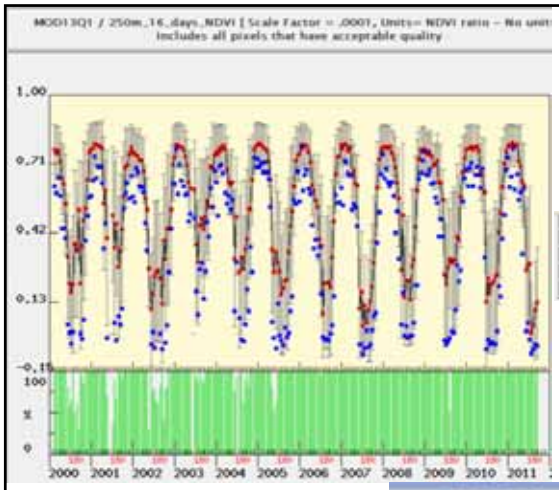
Water temp. – Lake





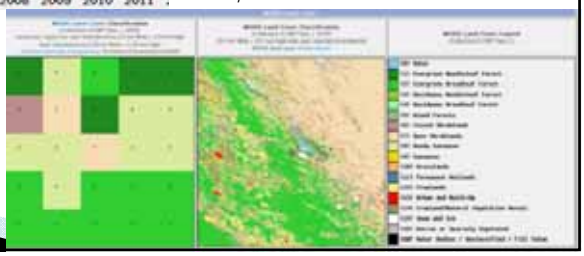

Average date of minimum greenness onset in the subset area
Greenness measure derived from EV - Enhanced Vegetation Index
Cycle 1,2 - denotes the phenology cycles in a year.
30 60 90 120 150 180 210 240 270 300 330 360
QC Filter Conditions
QC explanation for MODIS/Terra Land Surface Temperature/Emissivity LST_QC
QC bit word numbering (0,1,2,3,4,5,6,....n):(n=7 or 15 or 31)
ss | Bits | Binary | QA-bits (Left to Right) | Value(Binary) | Value(Integer) | Bands applied | QC band | Description
QA | 8 | yes | 6-7 | 00 | 0 | LST_Day_1km | QC_Day | LST produced, good quality, not necessary to examine more detailed QA
QA | 8 | yes | 6-7 | 01 | 1 | LST_Day_1km | QC_Day | LST produced, other quality,recommend examination of more detailed QA
QA | 8 | yes | 6-7 | 10 | 2 | LST_Day_1km | QC_Day | LST not produced due to cloud effects
QA | 8 | yes | 6-7 | 11 | 3 | LST_Day_1km | QC_Day | LST not produced primarily due to reasons other than cloud
QA | 8 | yes | 6-7 | 00 | 0 | LST_Night_1km | QC_Night | LST produced, good quality, not necessary to examine more detailed QA
QA | 8 | yes | 6-7 | 01 | 1 | LST_Night_1km | QC_Night | LST produced, other quality,recommend examination of more detailed QA
QA | 8 | yes | 6-7 | 10 | 2 | LST_Night_1km | QC_Night | LST not produced due to cloud effects
QA | 8 | yes | 6-7 | 11 | 3 | LST_Night_1km | QC_Night | LST not produced primarily due to reasons other than cloud
Restart this Visualization
Create subsets for this location


MODIS Global Subsets: Data Subsetting and Visualizatio
http://daac.ornl.gov/glb_viz_2/09Oct2012_09:18:12_296516235L-30.76632414342836L-71.0427474975586S1L1_MOD13Q1/index.html
Order Verification
MODIS/Terra Vegetation Indices (NDVI/EVI)
16-Day L3 Global 250m SIN Grid [Collection 5]
The Requested Data Area is Approximately 6.25 Kilometers Wide and 6.25 Kilometers High
The Time Period Considered Will Include February. 18, 2000 to August. 28, 2012
Red Box Marks the Approximate Location of the Subset Area
... Presented For Visual Interest Only ...
Image courtesy of Google
Map Satellite Earth Terrain
If the Selected Parameters Above are Correct, Select "Create Subset" to Begin Processing,
or use the Browser's "Back" Button to Access Previous Choices,
or Select "Restart this Visualization" to Restart the Selection Process
Create Subset

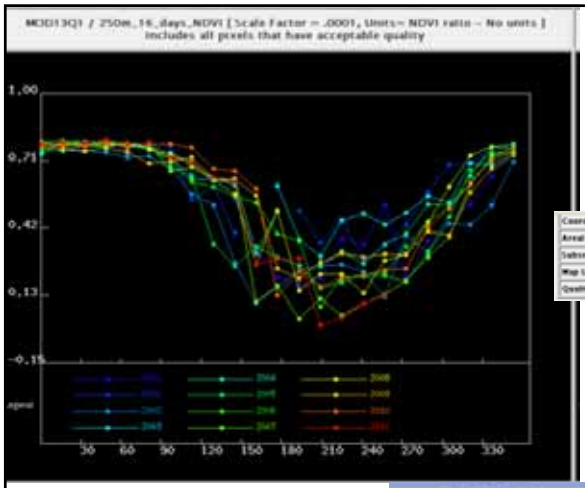


NDVI interannual time series -Forest

http://daac.ornl.gov/glb_viz_2/16Oct2011_18:51:41_357041069L-37.448497L-71.521944S9L9_MOD13Q1/index.html

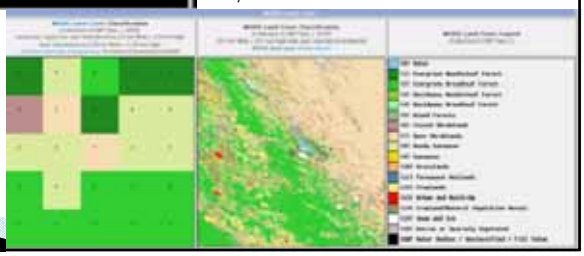


Oak Ridge National Laboratory Distributed Active Archive Center (ORNL DAAC). 2010. MODIS subsetted land products, Collection 5. Available on-line [http://daac.ornl.gov/MODIS/modis.html] from ORNL DAAC, Oak Ridge, Tennessee, U.S.A. Accessed 10-16-2011.

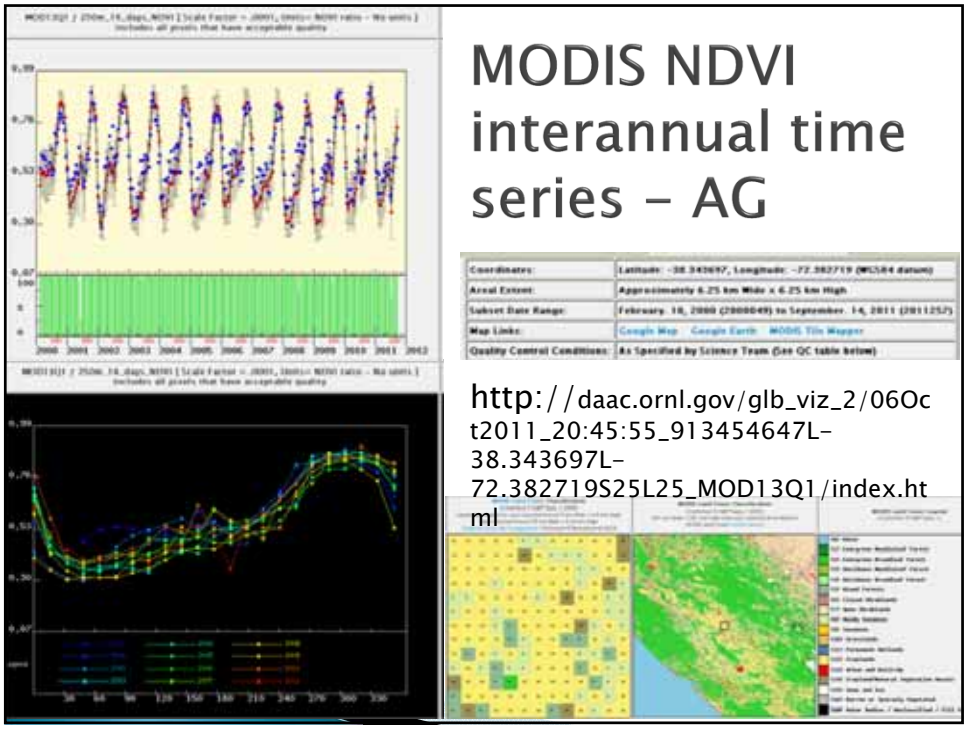


NDVI interannual time series - Forest

http://daac.ornl.gov/glb_viz_2/16Oct2011_18:51:41_357041069L-37.448497L-71.521944S9L9_MOD13Q1/index.html

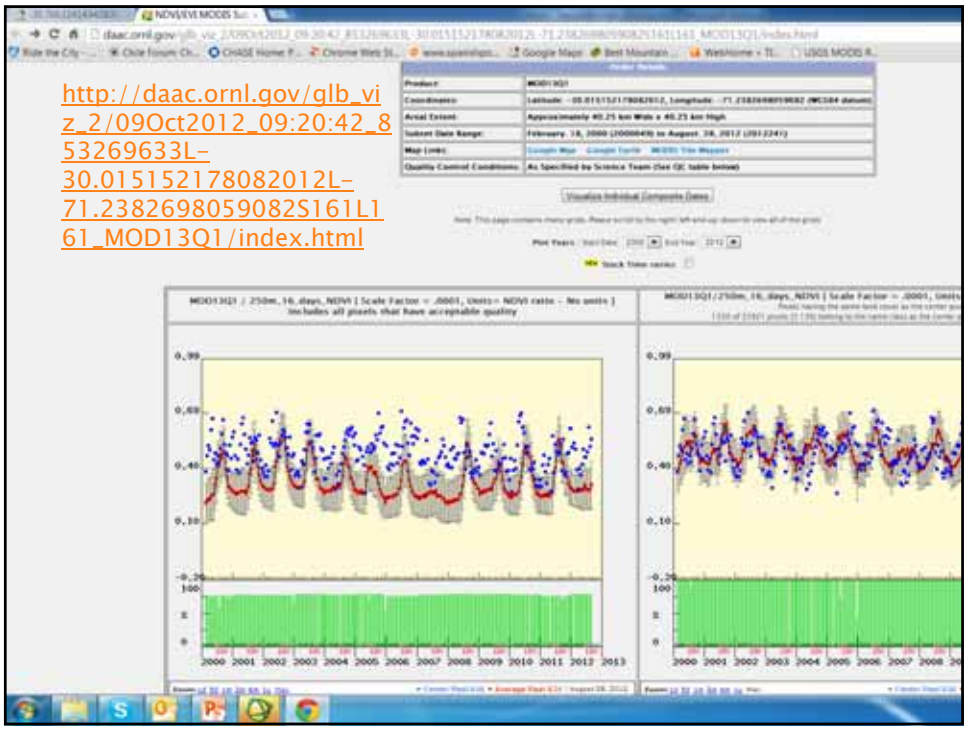


Oak Ridge National Laboratory Distributed Active Archive Center (ORNL DAAC). 2010. MODIS subsetted land products, Collection 5. Available on-line [http://daac.ornl.gov/MODIS/modis.html] from ORNL DAAC, Oak Ridge, Tennessee, U.S.A. Accessed 10-16-2011.



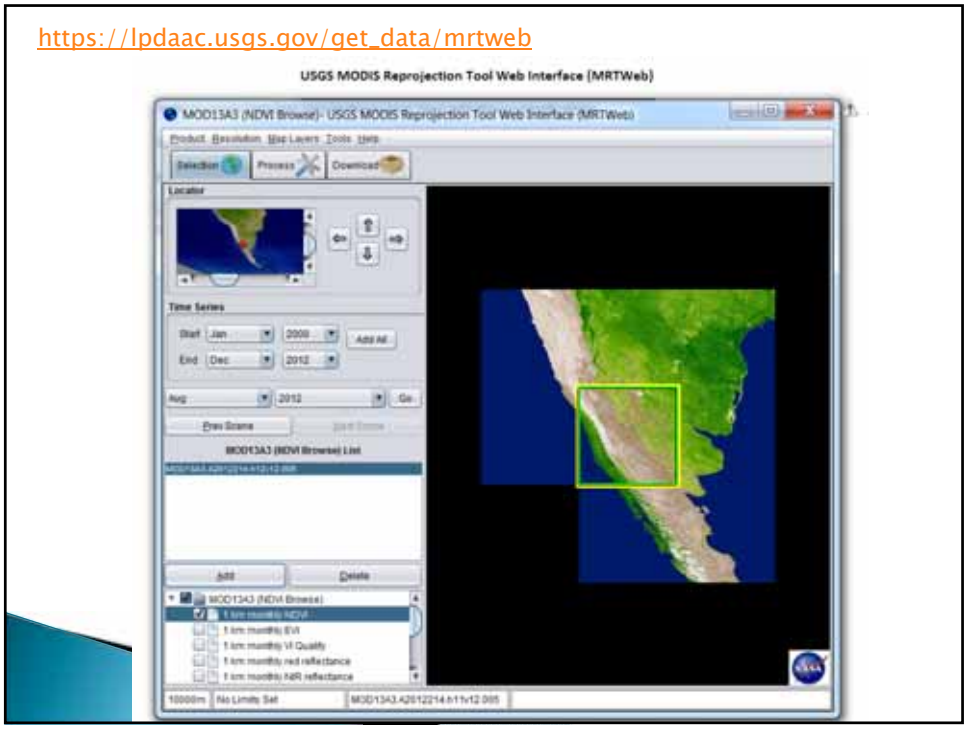
MODIS NDVI interannual time series – AG

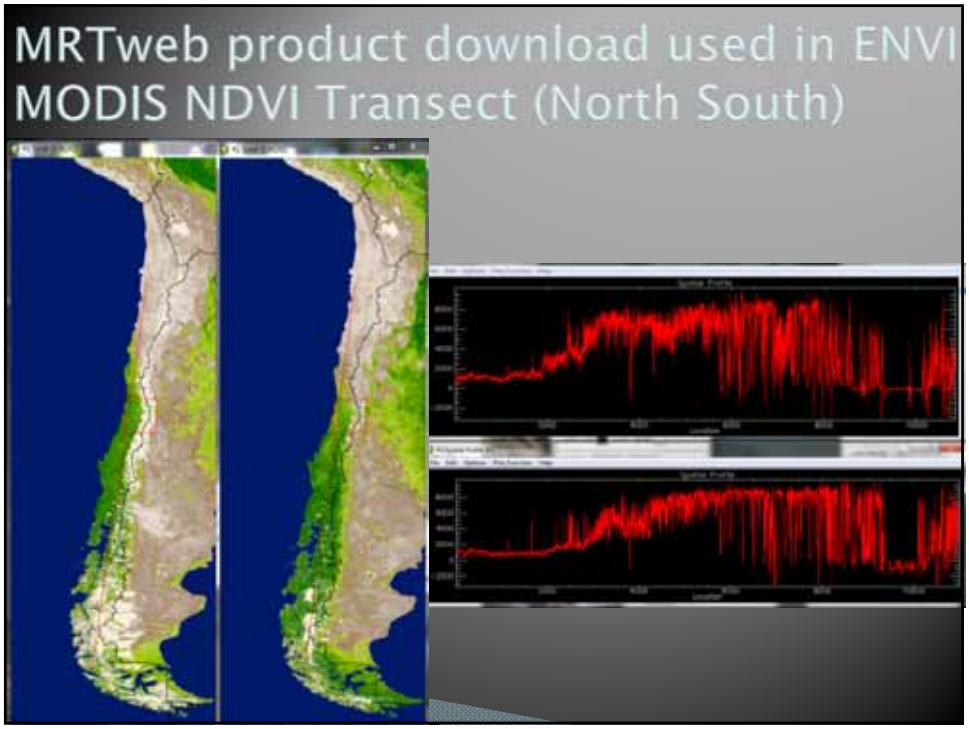
http://daac.ornl.gov/glb_viz_2/06Oct2011_20:45:55_913454647L-38.343697L-72.382719S25L25_MOD13Q1/index.html



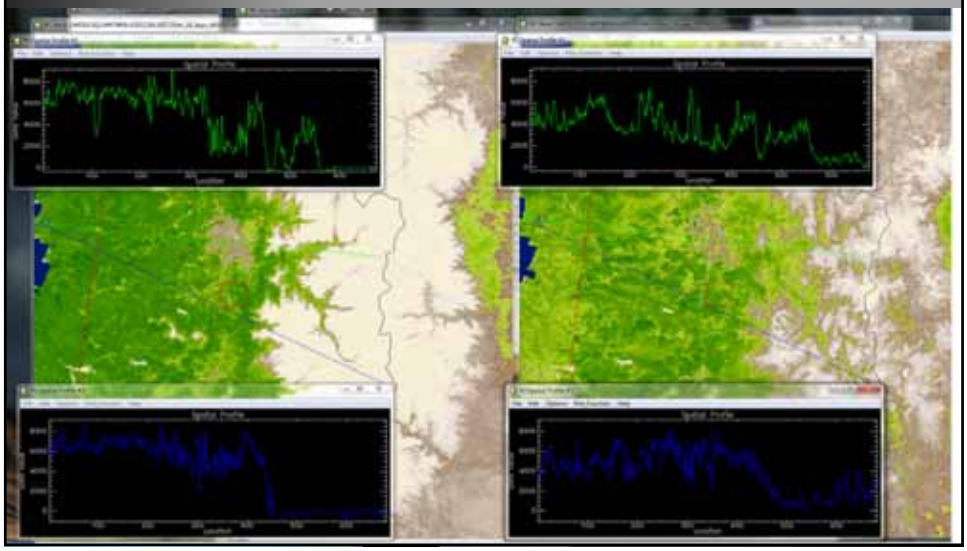
http://daac.ornl.gov/glb_viz_2/09Oct2012_09:20:42_853269633L-30.015152178082012L-71.2382698059082S161L161_MOD13Q1/index.html

https://lpdaac.usgs.gov/get_data/mrtweb



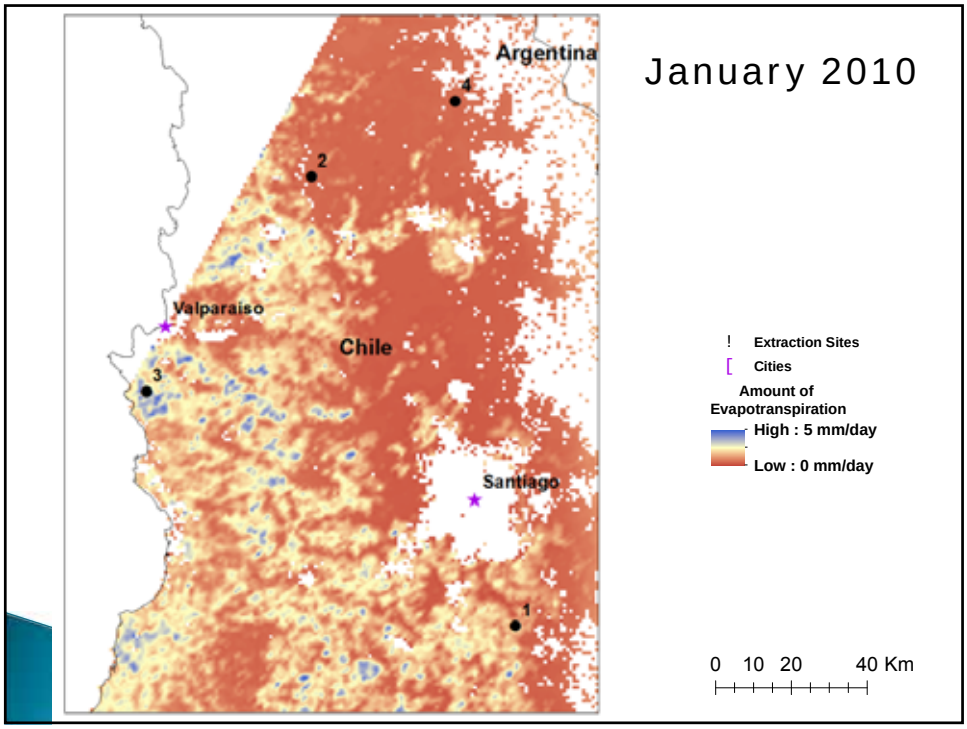


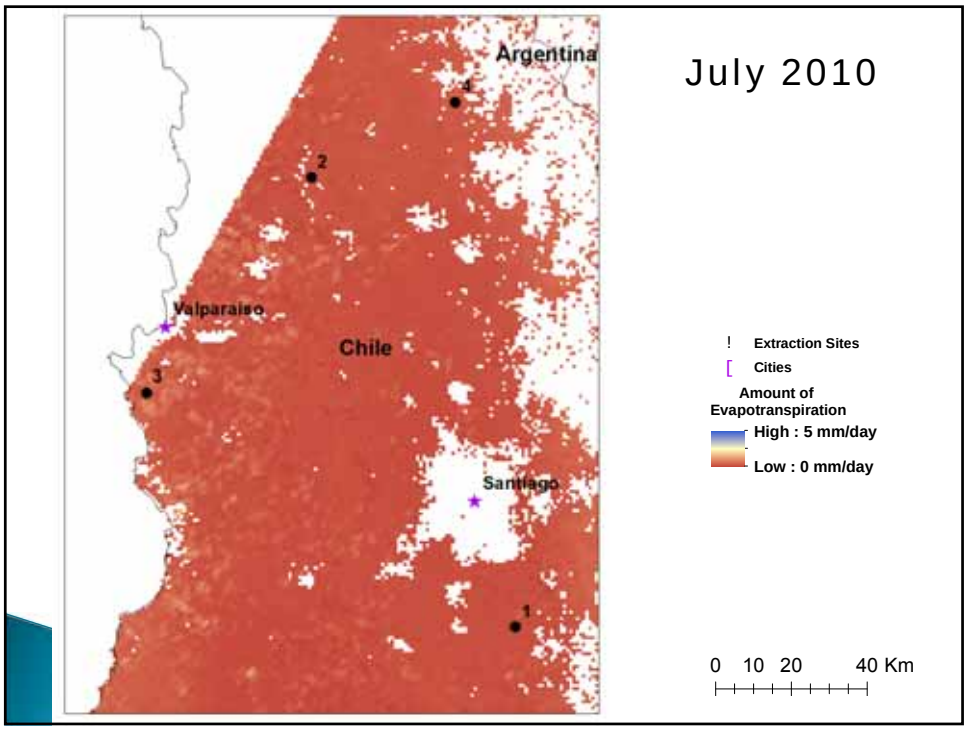
MODIS NDVI TRANSECTS (WEST-EAST)

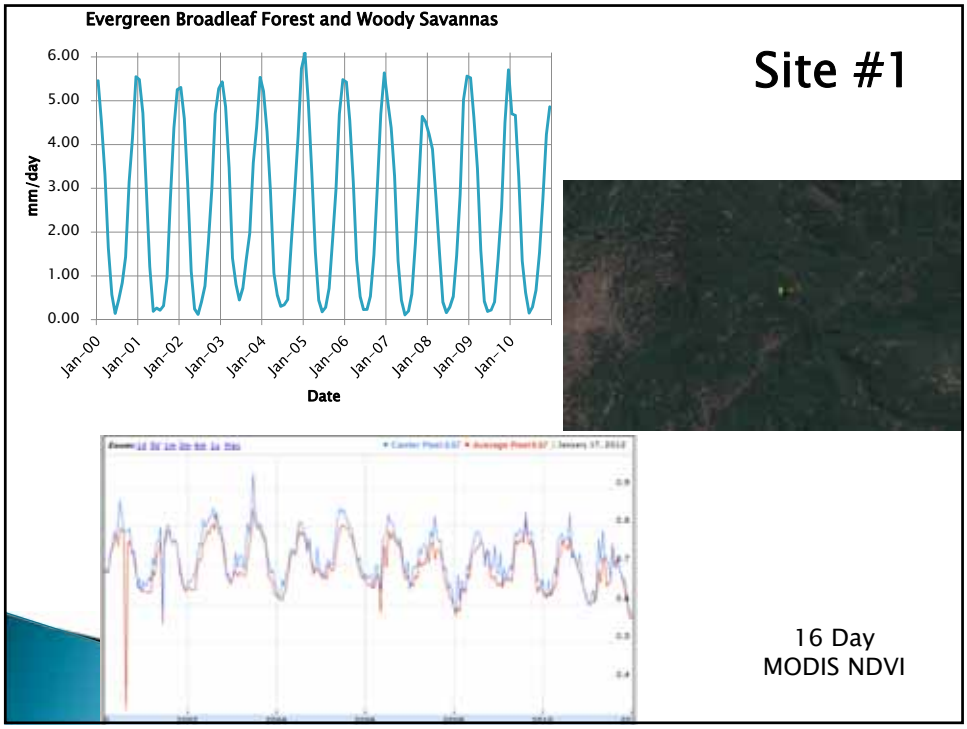


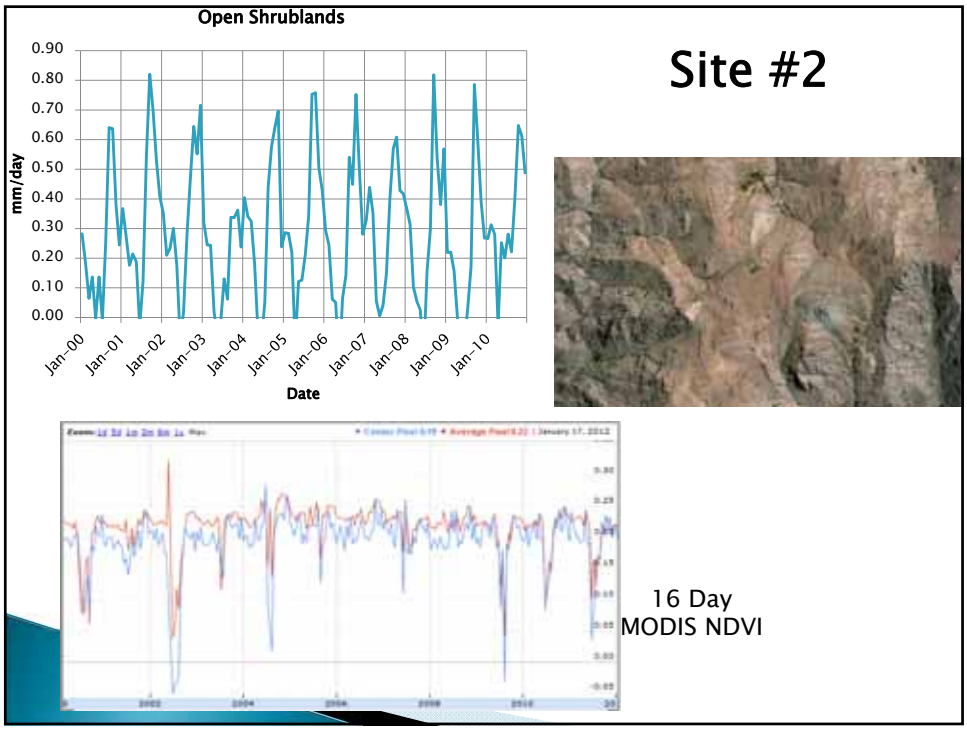
How do download the ET and NDVI data in ARCMAP using the Toolbox?

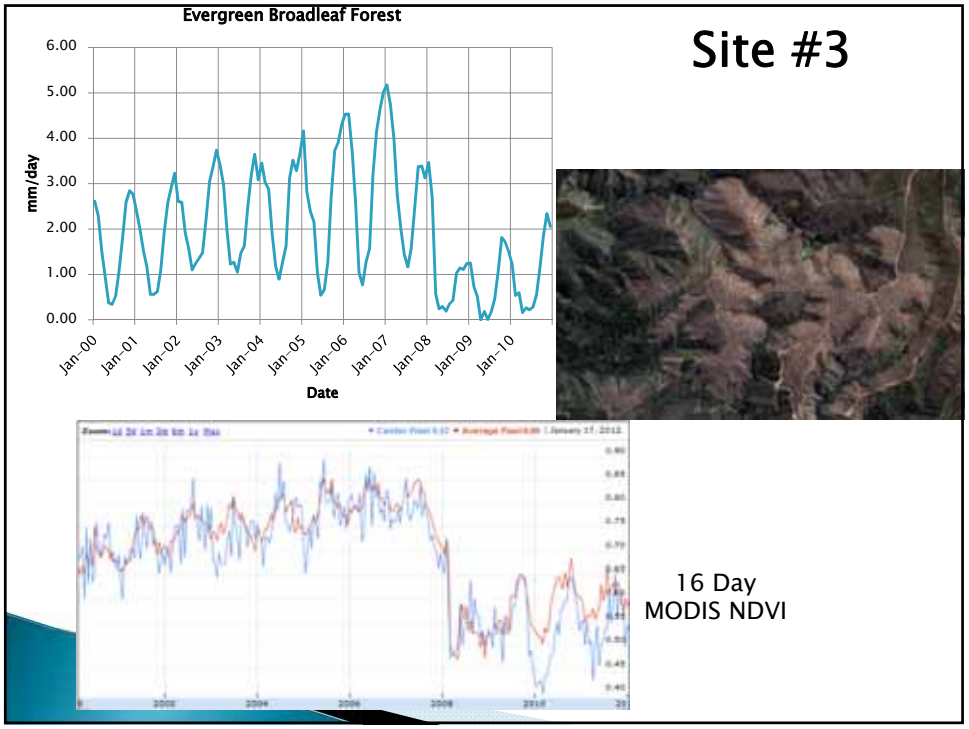
- http://blogs.esri.com/esri/arcgis/2011/03/21/global-evapotranspiration-data-accessible-in-arcmap-thanks-to-modis-toolbox/
- http://resources.arcgis.com/gallery/file/geoprocessing/details?entryID=9CC382D2-1422-2418-34F8-DC9F97B24052

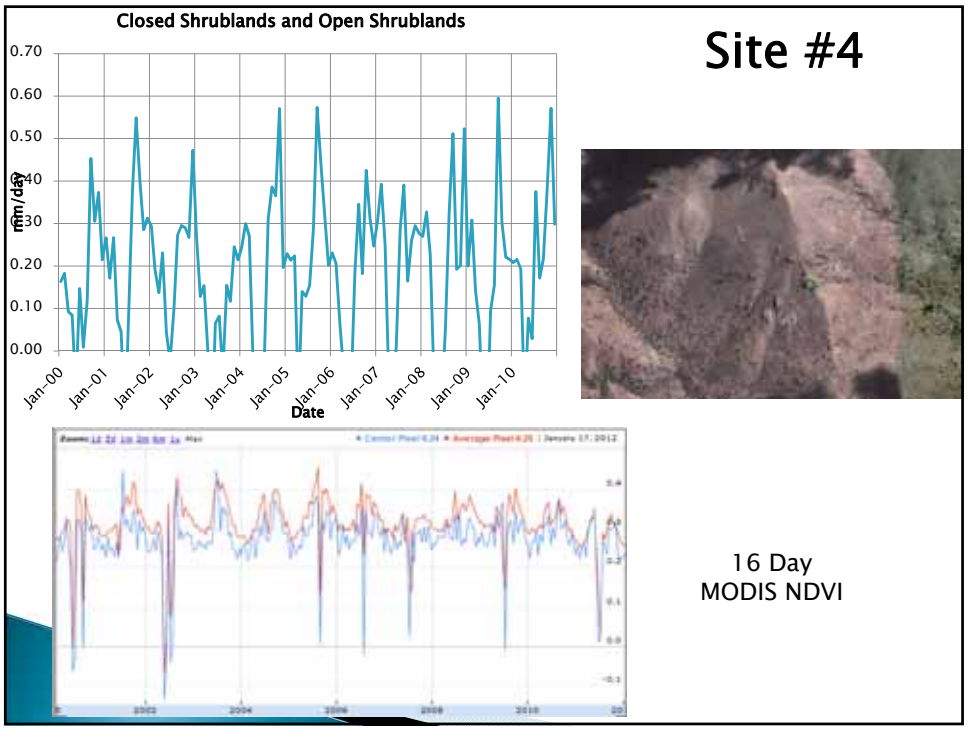

January 2010
Argentina
Chile
Valparaiso
Santiago
1
2
3
4
! Extraction Sites
[Cities
Amount of Evapotranspiration
High : 5 mm/day
Low : 0 mm/day
0 10 20 40 Km


July 2010
Argentina
Chile
Valparaiso
Santiago
1
2
3
4
! Extraction Sites
[Cities
Amount of Evapotranspiration
High : 5 mm/day
Low : 0 mm/day
0 10 20 40 Km


Evergreen Broadleaf Forest and Woody Savannas
mm/day
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Date
Site #1
16 Day
MODIS NDVI

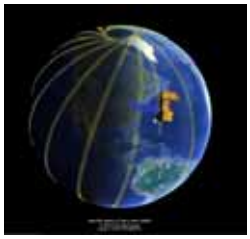

Open Shrublands
mm/day
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Date
Site #2
16 Day
MODIS NDVI


Evergreen Broadleaf Forest
6.00
5.00
4.00
3.00
2.00
1.00
0.00
mm/day
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Date
Site #3
16 Day
MODIS NDVI

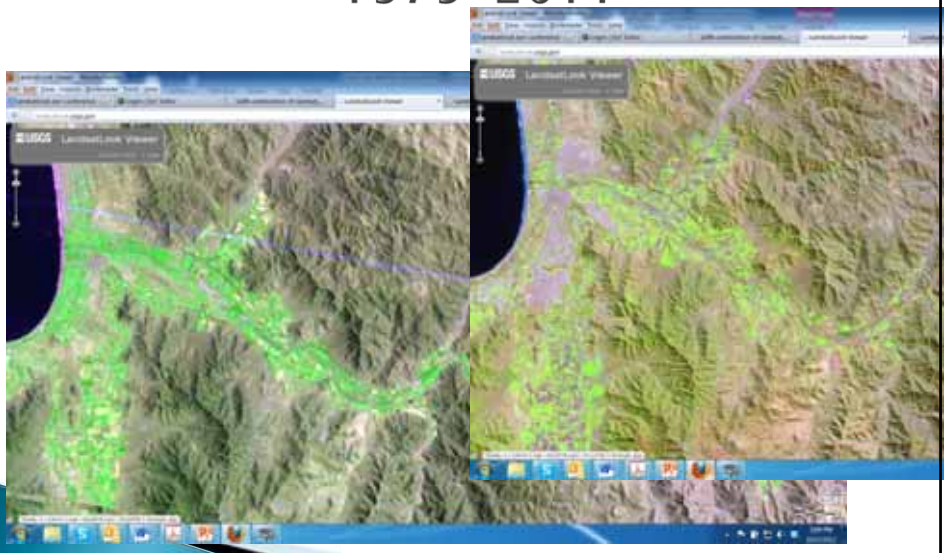

Closed Shrublands and Open Shrublands
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
mm/day
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Date
Site #4
16 Day
MODIS NDVI

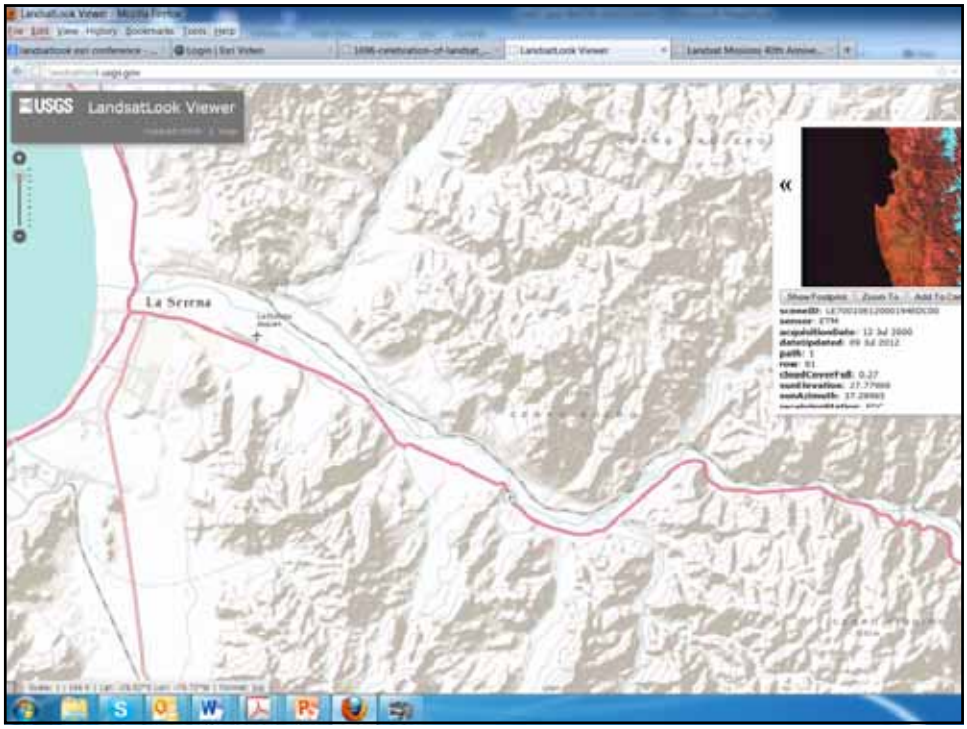
How to view & download Landsat scenes using web services.

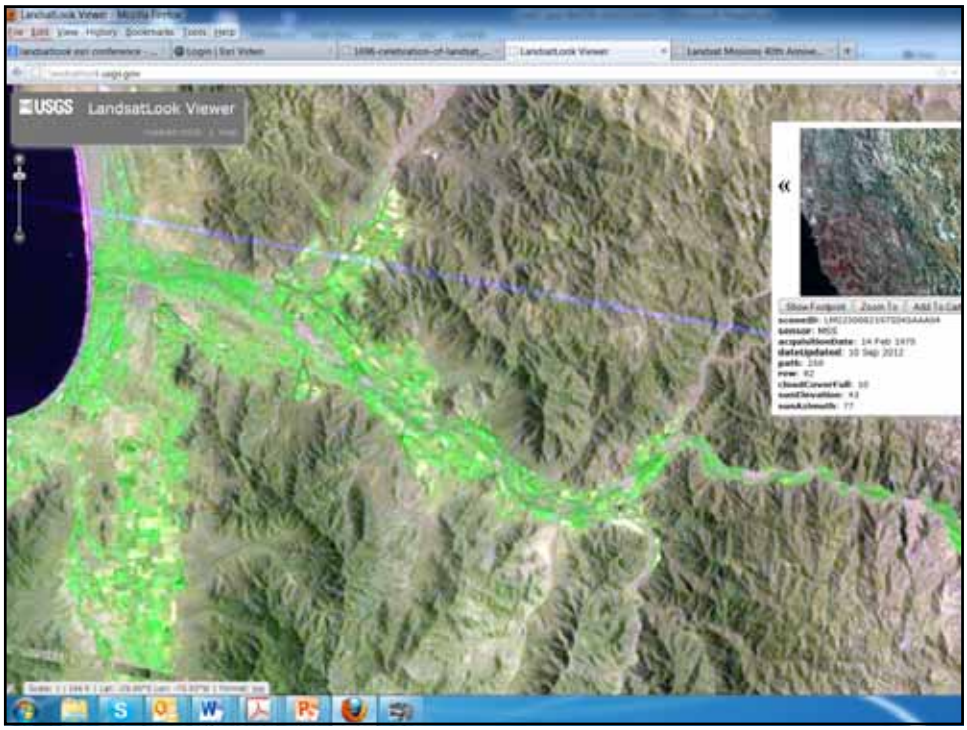
- http://www.esri.com/news/arcnews/spring11articles/esri-introduces-landsat-data-for-the-world.html
- http://www.esri.com/landsat-imagery/viewer.html
- http://landsat.usgs.gov/LandsatLook_Viewer.php
- http://www.youtube.com/watch?v=Ezn1ne2Fj6Y
- http://landsat.gsfc.nasa.gov/data/where.html
- http://landsatlook.usgs.gov/
- http://video.esri.com/watch/1696/celebration-of-landsat

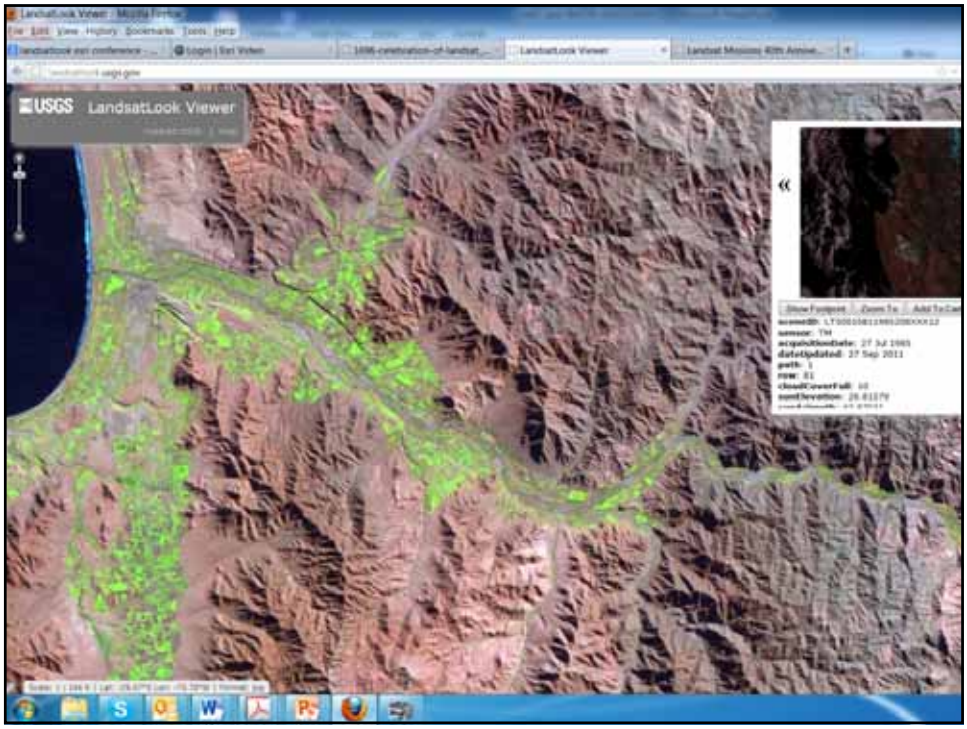


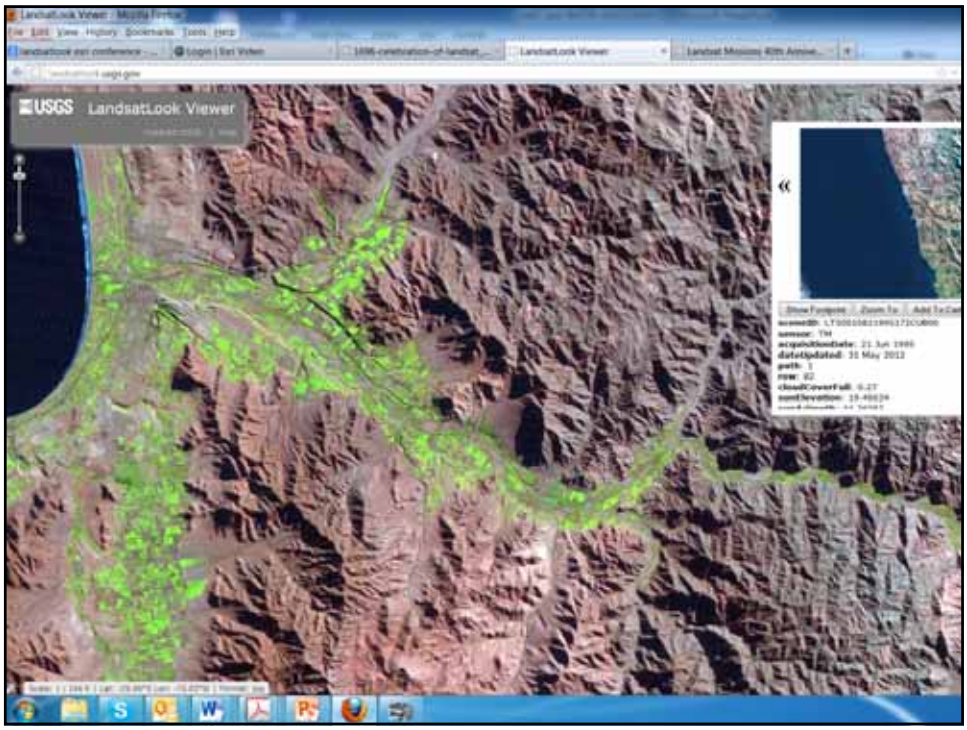
LANDSAT – La Serena – Elqui Valley 1975-2011

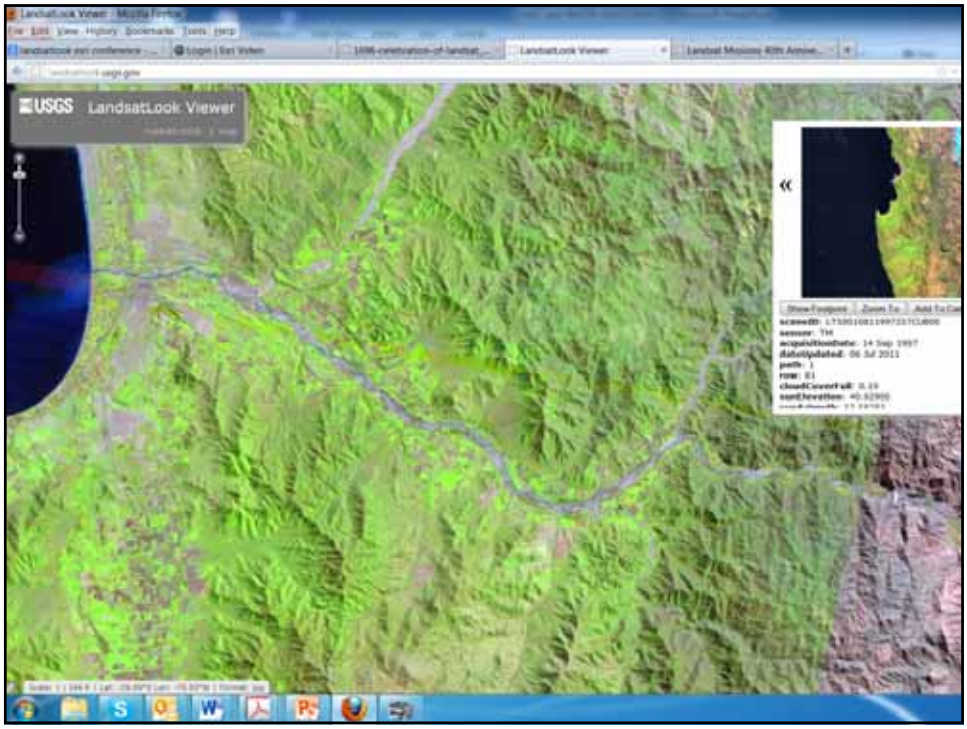


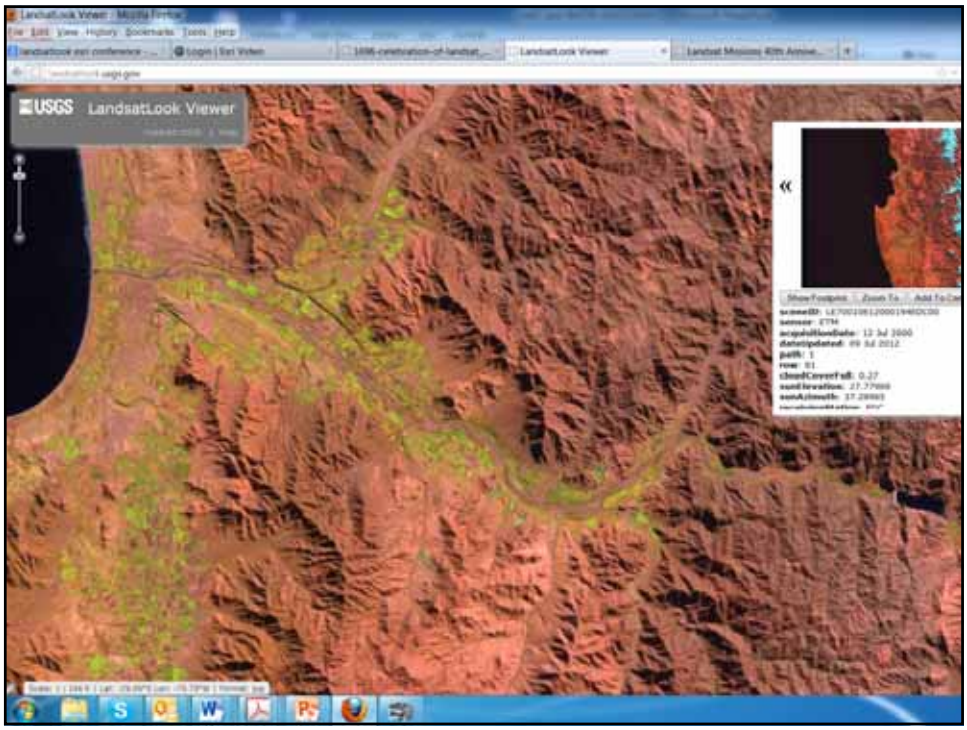

USGS LandsatLook Viewer
La Serena

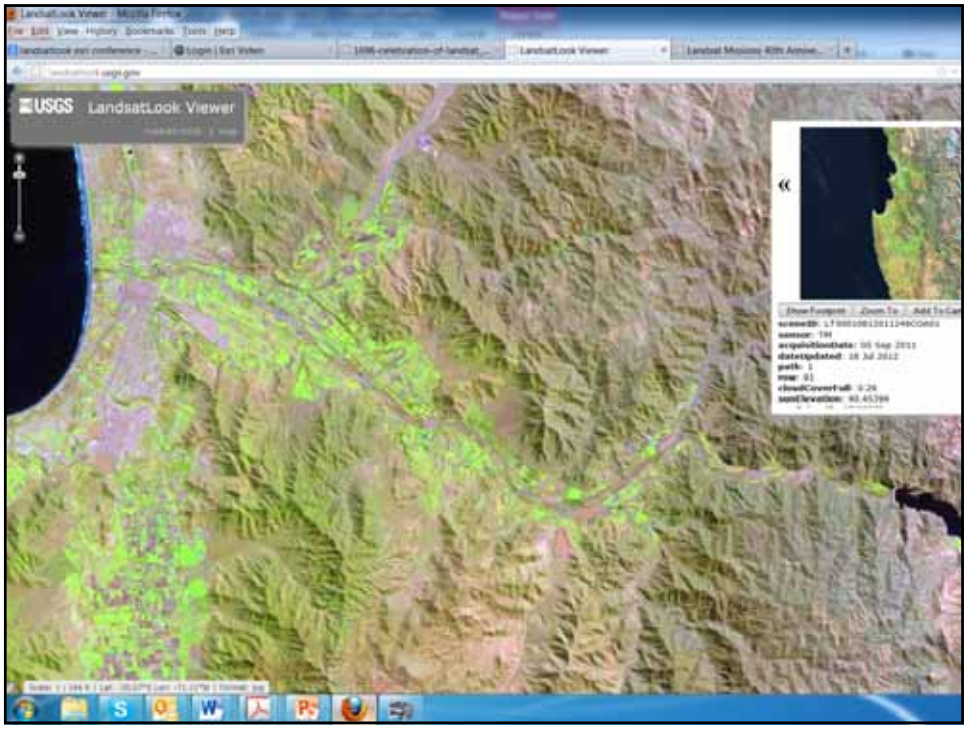

USGS LandsatLook Viewer


USGS LandsatLook Viewer


USGS LandsatLook Viewer


USGS LandsatLook Viewer


USGS LandsatLook Viewer


USGS LandsatLook Viewer


Fieldobservation.kmz
Google earth


GIOVANNI — GES DI
disc.sci.gsfc.nasa.gov/giovanni/overview/what-is-giovanni
GES DISC
Goddard Earth Sciences Data and Information Services Center
Search
GES DISC Home
Data Services
Science Portals
Mission Portals
Giovanni - The Bridge Between Data and Science
OVERVIEW
GIOVANNI
What Is Giovanni?
Additional Features
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Newsletters
Feedback
FAQ


http://disc.sci.gsfc.nasa.gov/giovanni/overview/index.html
GES DISC
Goddard Earth Sciences Data and Information Services Center
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Mission Portals
Giovanni - The Bridge Between Data and Science
OVERVIEW
Giovanni

http://gdata1.sci.gsfc.nasa.gov/daac-bin/G3/gui.cgi?instance_id=TRMM_3B42_Daily

http://earthdata.nasa.gov/

RS and GIS demonstrations (PART II)

- Data download tools (MODIS & Landsat data)
  - Spatial, point and temporal data
  - Data links
- Data viewing verification tools (Google Earth, Landsatlook)
- Free GIS and RS tools
- Commercial tools (ESRI, ENVI, ERDAS, Matlab, JMP, etc.)
- Open source tools (Quantum GIS, GRASS, R, GPicSync, GPSbabel, Google Earth, Picasa, OpenOffice, GIMP, etc.)

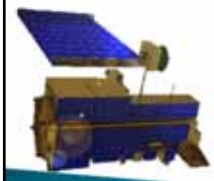
Synthesis (PART III)

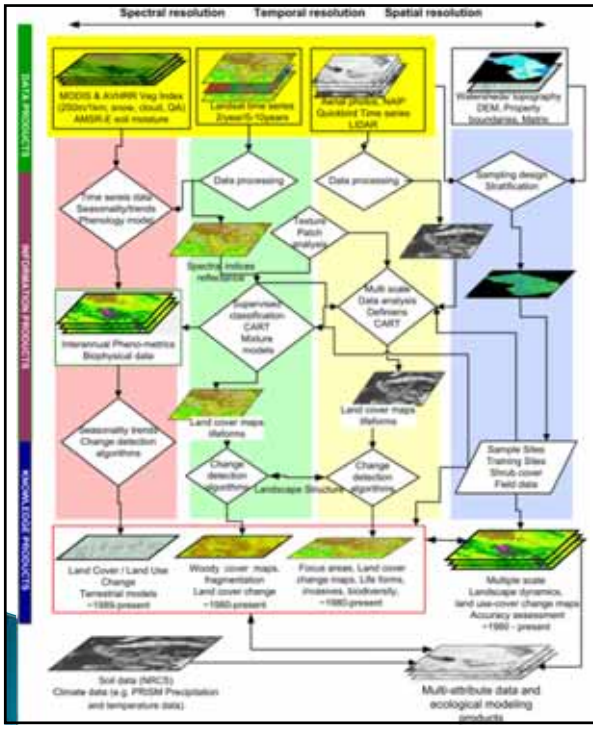
Ecosystem – land cover RS framework

- **Multi sensor solutions (passive, active)**
  - Multispectral, LiDAR, Fusion
- **Nested temporal, spatial and spectral resolutions**
  - MODIS-Landsat-Quickbird/NAIP-Field
  - Continuous (woody cover) and discrete data (land cover class)
  - Data resolution < phenomena resolution
  - Fine resolution co-registration!
- **Timing of phenomena (uni-, multi-modal)**
  - Phenology of life forms
- **Timing of data acquisition**
  - Sun angle (shadows)
- **Bridge interplay between organizational scales**
  - Local, landscape, continental upscaling←→ downscaling
  - Biophysical and socio-economic drivers, management

LAND and WATER ASSESSMENTS: GIS and REMOTE SENSING TOOLS→ DECSION SUPPORT SYSTEMS

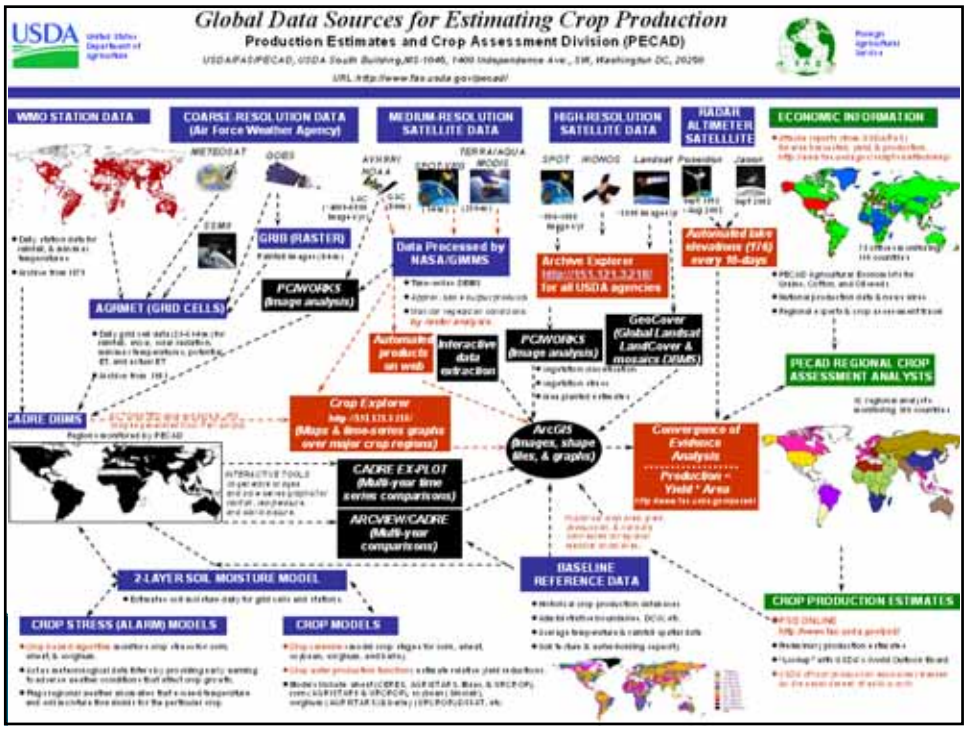
Willem van Leeuwen

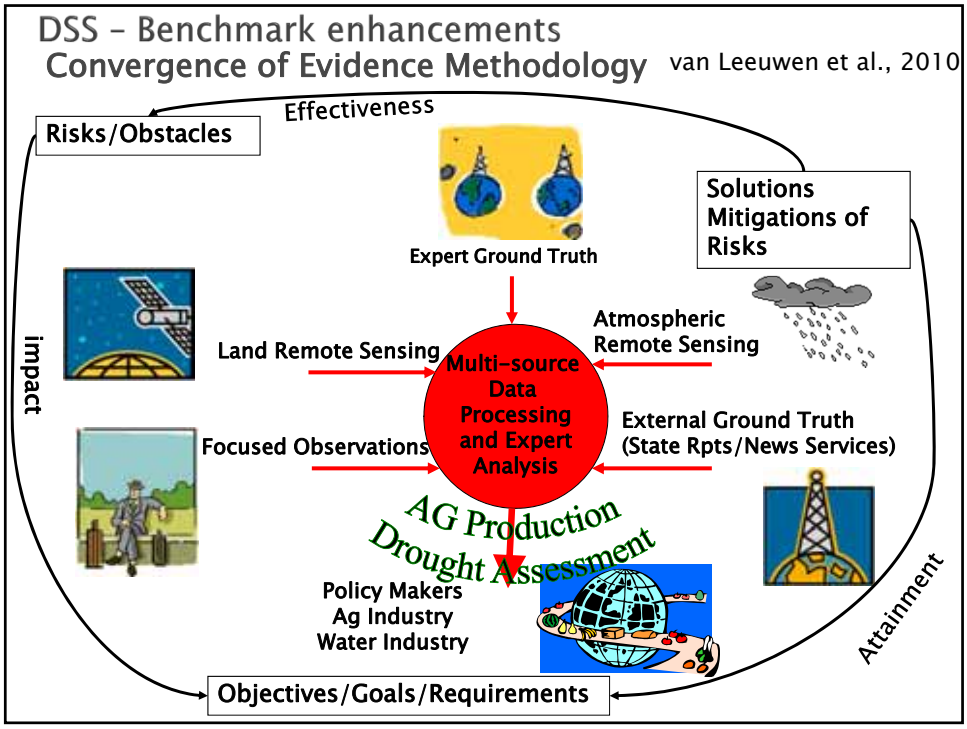




Hierarchical Landscape Inventory, Monitoring, Assessment and Modeling Framework Using Remotely Sensed Data and Products.

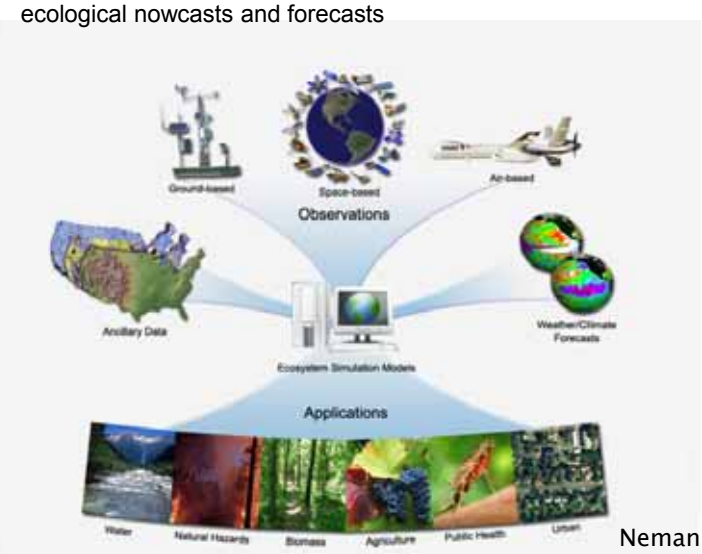
These data and product can be used or integrated with climate and soil information to model biogeochemical and ecological processes and possibly verify their results.





Ecological Forecasting – predicting the effects of changes in physical, chemical, and biological environment on ecosystem state and function

Terrestrial Observation and Prediction System (TOPS) - A data - modeling system for integrating satellite, surface data with simulation models to produce ecological nowcasts and forecasts

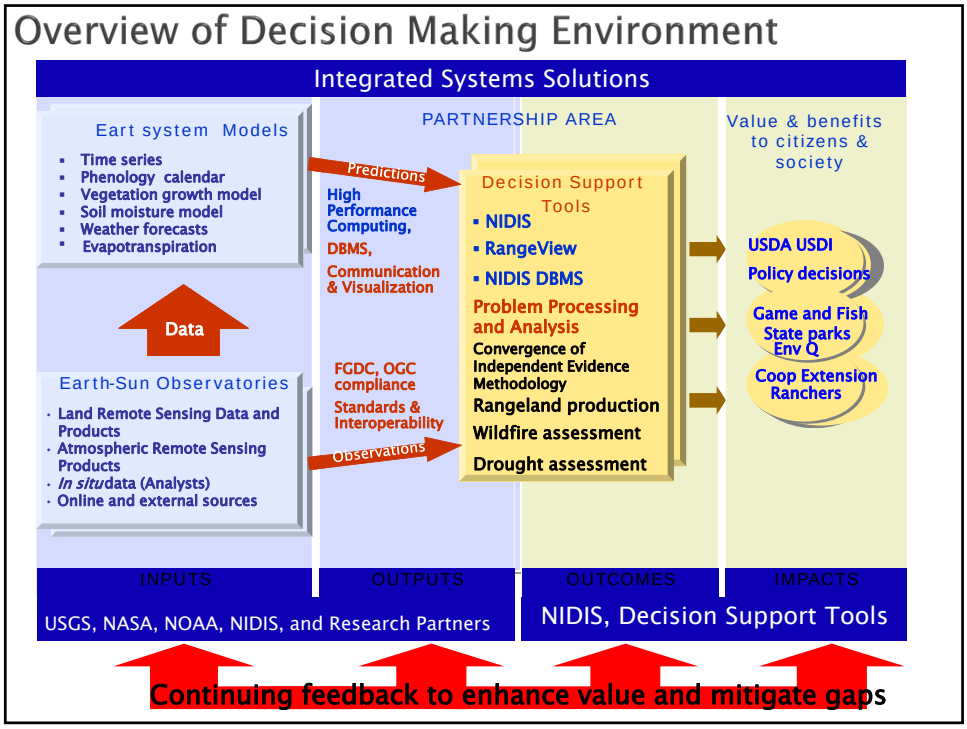


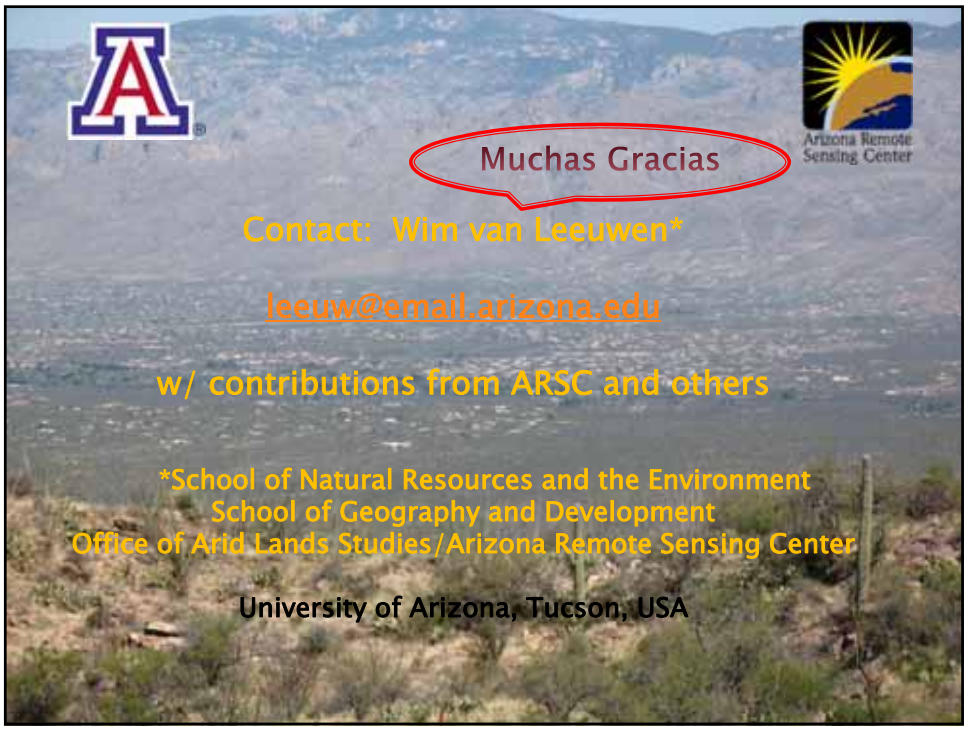
Key elements:

- Monitoring
- Modeling
- Forecasting
- Local to Global

Focus on biogeo-chemical cycles

Nemani et al., 2009, RSE


Overview of Decision Making Environment
Integrated Systems Solutions
Eart system Models
Time series
Phenology calendar
Vegetation growth model
Soil moisture model
Weather forecasts
Evapotranspiration
Data
Earth-Sun Observatories
Land Remote Sensing Data and Products
Atmospheric Remote Sensing Products
In situ data (Analysts)
Online and external sources
PARTNERSHIP AREA
Predictions
High Performance Computing,
DBMS,
Communication & Visualization
FGDC, OGC compliance
Standards & Interoperability
Observations
Decision Support Tools
NIDIS
RangeView
NIDIS DBMS
Problem Processing and Analysis
Convergence of Independent Evidence Methodology
Rangeland production
Wildfire assessment
Drought assessment
Value & benefits to citizens & society
USDA USDI
Policy decisions
Game and Fish
State parks
Env Q
Coop Extension
Ranchers
INPUTS
OUTPUTS
OUTCOMES
IMPACTS
USGS, NASA, NOAA, NIDIS, and Research Partners
NIDIS, Decision Support Tools
Continuing feedback to enhance value and mitigate gaps


Muchas Gracias
Arizona Remote Sensing Center
Contact: Wim van Leeuwen*
leeuw@email.arizona.edu
w/ contributions from ARSC and others
*School of Natural Resources and the Environment
School of Geography and Development
Office of Arid Lands Studies/Arizona Remote Sensing Center
University of Arizona, Tucson, USA