# NASA Science Mission Directorate
# Earth Science Division
# Applied Sciences Program
# WATER RESOURCES APPLICATION AREA

***JACIE MEETING***

***16 April 2013***

# NASA Water Resources Program

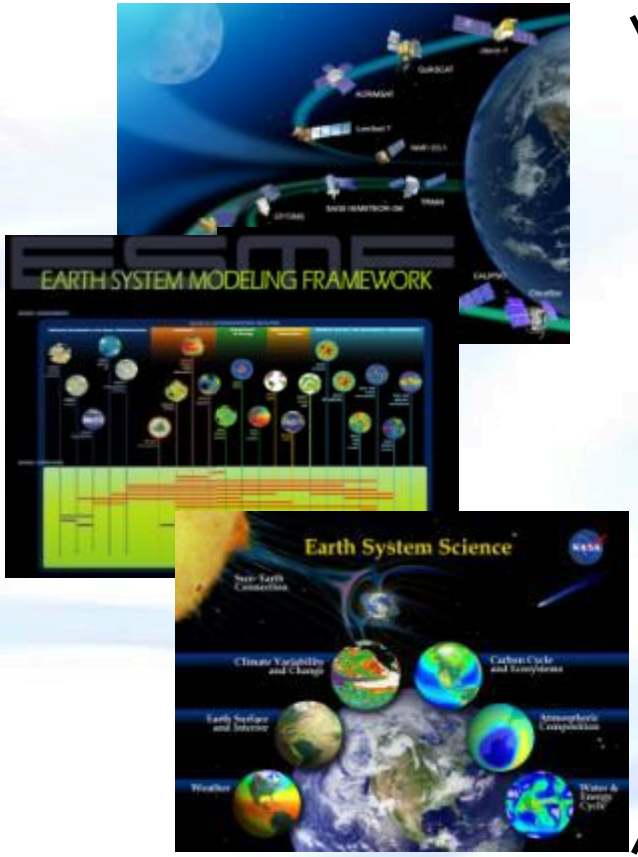
*The Water Resources program focuses NASA observations and science results applied to water resource management concerns and decision processes related to water supply, demand, and availability. The Water Resources program establishes partnerships with Federal agencies, academia, private firms, and international organizations to meet its mission goals.*

# NASA Applied Sciences Program

## *A Pathway Between Earth Science & Society*

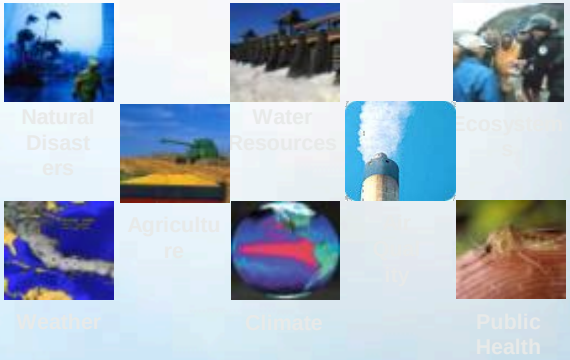
**Results of NASA Earth Science Research**

**Uses by Partners and Stakeholder Communities**

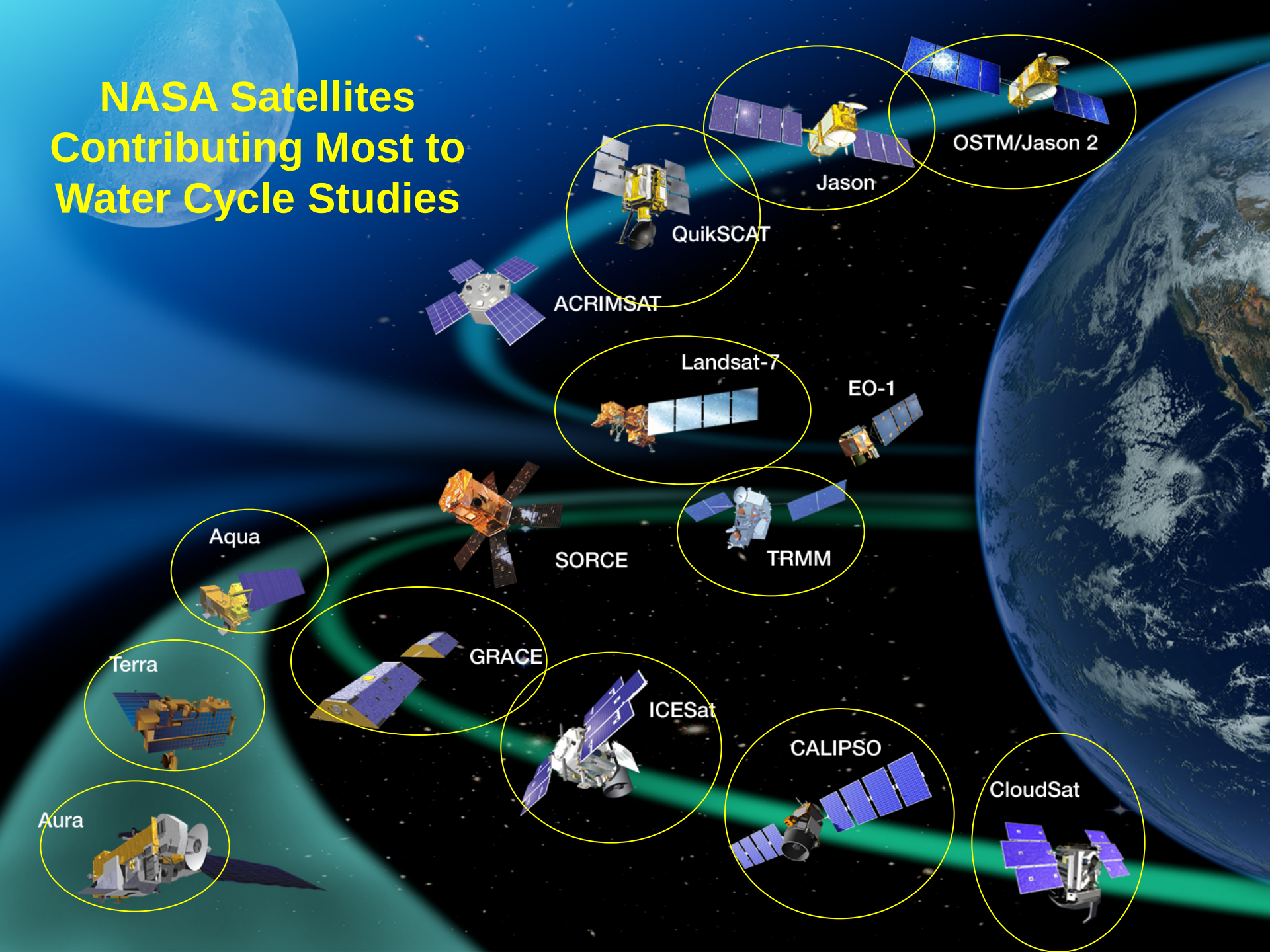



**NASA Applied Sciences Program**

**GEOSS Societal Benefit Areas**

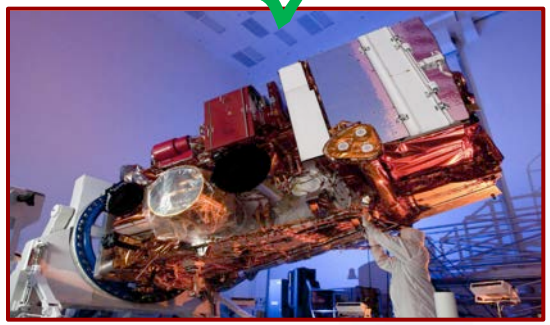


# NASA Satellites Contributing Most to Water Cycle Studies

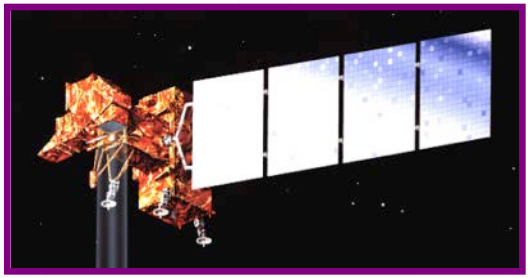


# Missions in Formulation and Implementation

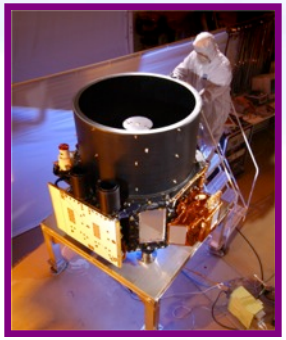
AQUARIUS
**6/10/2011**
w/CONAE; SSS



NPP
**10/25/2011**
w/NOAA
EOS cont., Op Met.



LDCM
02/11/2013
w/USGS; TIRS



ICESat-2
**April 2016**
Ice Dynamics

**SMAP***
**Late CY2014**
w/CSA
Soil Moist., Frz/Thaw

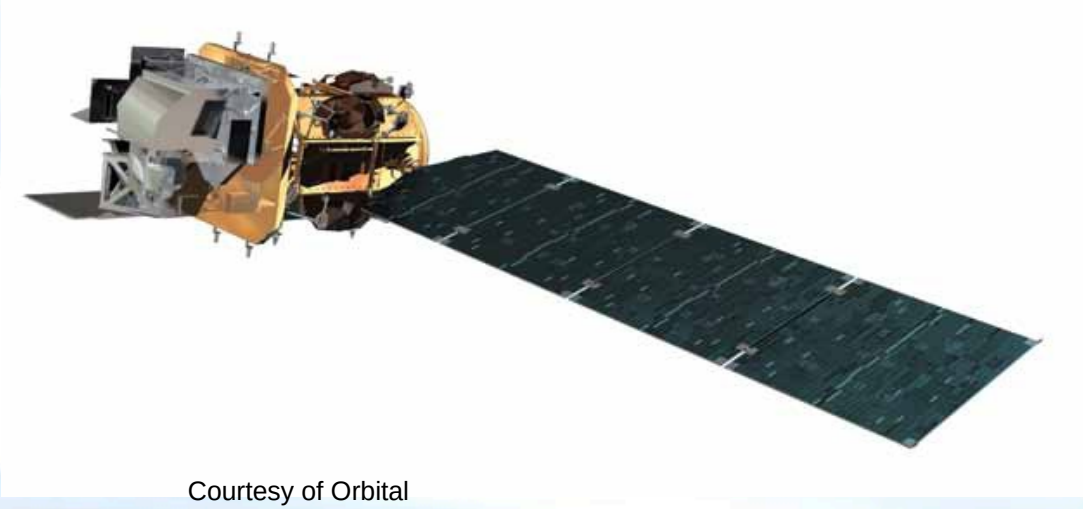
GPM
**7/2013 (TBR)**
w/ JAXA; Precip

OCO-2
**2013***
Global $CO_2$

*** LRDs in flux because of launch vehicle failures**

# Landsat Data Continuity Mission (LDCM)
## (on transfer to operations to be called Landsat 8)

- The Landsat Data Continuity Mission (LDCM) is being prepared for a February, 2013 launch
  - Developed as a NASA / USGS partnership



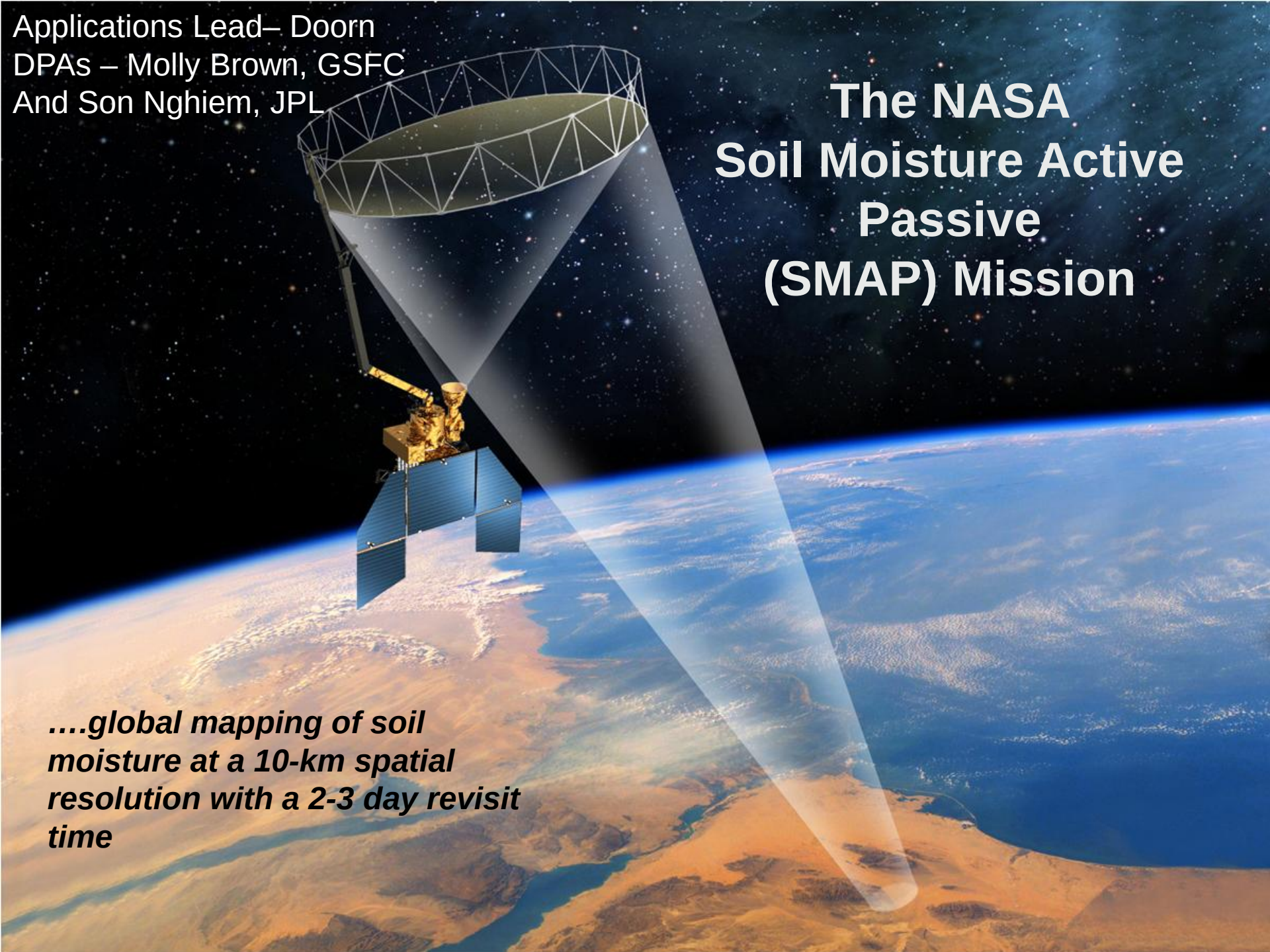
Courtesy of Orbital

Launch from Vandenberg Air Force Base on an Atlas V

*Successful launch on Feb 11, 2013!*

Applications Lead– Doorn
DPAs – Molly Brown, GSFC
And Son Nghiem, JPL

# The NASA Soil Moisture Active Passive (SMAP) Mission



***….global mapping of soil moisture at a 10-km spatial resolution with a 2-3 day revisit time***

TOPS Satellite Irrigation Manag...

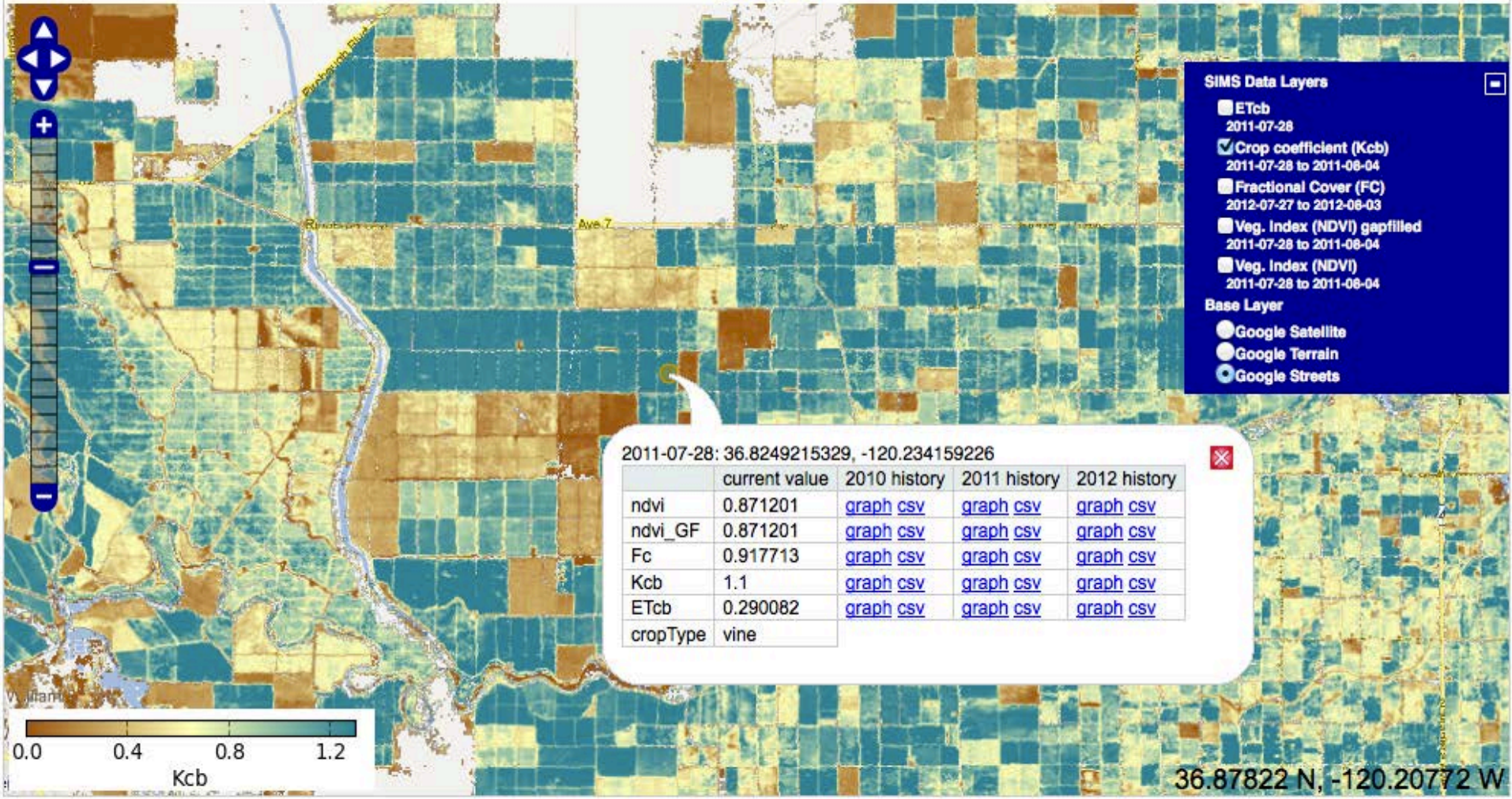
ecocast.org/dgw/sims

Google

Username: Password: Login

# TOPS Satellite Irrigation Management Support

Go to: Search About Help Select Date: 2011-07-28




2011-07-28: 36.8249215329, -120.234159226

| | current value | 2010 history | 2011 history | 2012 history |
|---|---|---|---|---|
| ndvi | 0.871201 | graph csv | graph csv | graph csv |
| ndvi_GF | 0.871201 | graph csv | graph csv | graph csv |
| Fc | 0.917713 | graph csv | graph csv | graph csv |
| Kcb | 1.1 | graph csv | graph csv | graph csv |
| ETcb | 0.290082 | graph csv | graph csv | graph csv |
| cropType | vine | | | |

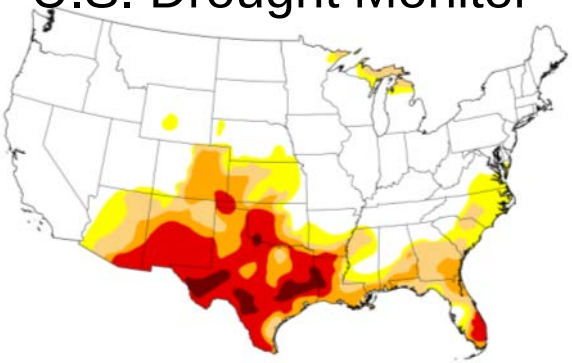
**Disclaimer: This data is for research and evaluation purposes only.**

NASA Official: Ramakrishna R.Nemani Curator: Forrest Melton Privacy Statement

# Delivery of GRACE-Based Drought Indicators

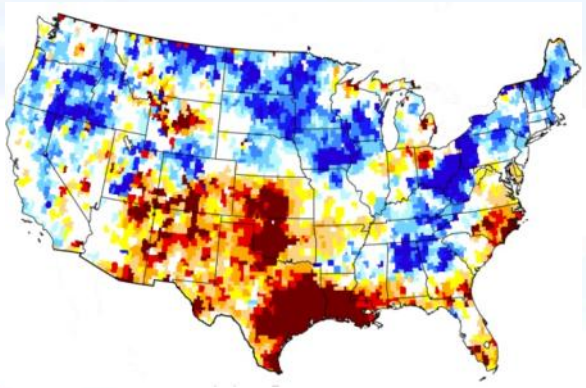
Funded by the Applied Sciences program, scientists at NASA/GSFC have teamed with the principals of the U.S. and North American Drought Monitors at NOAA and U. Nebraska, to improve the DMs by incorporating drought indicators for soil moisture and groundwater based on data from GRACE and other observations which have been integrated within a numerical model, thereby addressing a need for objective information on these deep water storage conditions. The first drought indicator products were delivered in April 2011. (M. Rodell, NASA/GSFC)

U.S. Drought Monitor

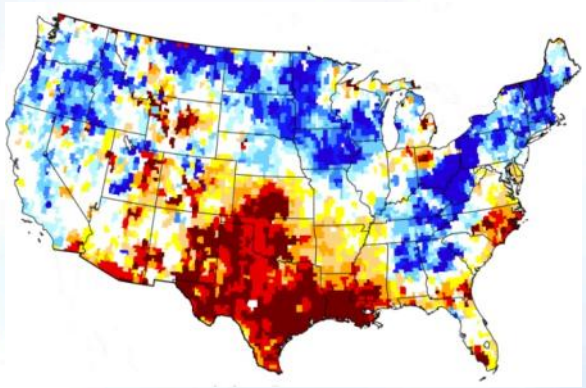


Above: U.S. Drought Monitor product for April 26, 2011.

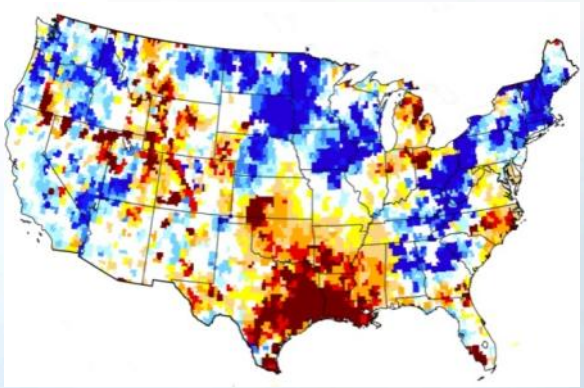
Surface Soil Moisture

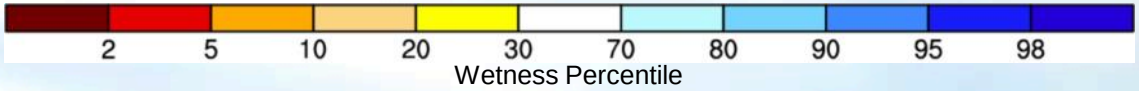


Root Zone



Groundwater






GRACE-based drought indicators for April 21, 2011: rank percentiles of surface soil moisture, root zone soil moisture, and groundwater.

# The Quick Drought Response Index (QuickDRI)

*Brian Wardlow and Mark Svoboda, National Drought Mitigation Center/University of Nebraska-Lincoln*

## Highlight:

- Scientists at the National Drought Mitigation Center, USGS EROS, NASA/GSFC, USDA ARS, and NOAA are teaming up to develop a new rapid-response agricultural drought indicator based on an integration of satellite-derived data inputs from NASA's MODIS and GRACE instruments and NLDAS-modeled soil moisture with climate data and general biophysical variables.

- QuickDRI is intended to provide "drought-specific" information about early-stage and rapid-onset vegetation drought stress patterns across the continental United States, which is difficult to detect and monitor using current climate and remote sensing-based approaches.

## Relevance:

- QuickDRI is primarily targeted to enhance the agricultural drought monitoring capabilities of the U.S. Drought Monitor (USDM), which is used by a wide range of federal and state decision making activities across the U.S. including the USDA Farm Service Agency (FSA) Range and Forage Program disaster assistance program.

- Numerous other decision making activities are expected to use QuickDRI information such as the National Weather Service, National Integrated Drought Information System (NIDIS) and state drought task forces.

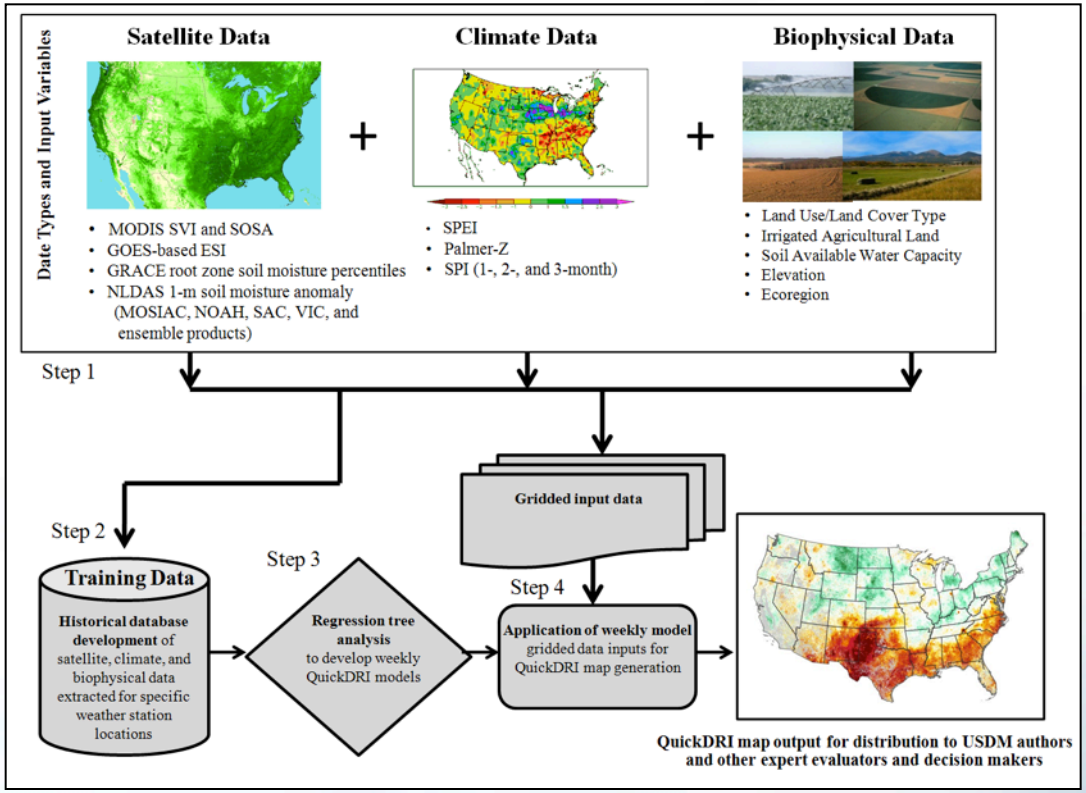



**Figure 1:** QuickDRI model methodology and processing flow including the specific data inputs, the modeling algorithm, and map development.

# NASA's Project Nile maps Agroecosystems of the Blue Nile

*Belay Simane (Addis Ababa University), Ben Zaitchik (Johns Hopkins University), Mutlu Ozdogan (University of Wisconsin)*

Highlight: In the diverse terrain of the Blue Nile Highlands it can be difficult to perform a complete survey of agricultural potential. In this project, NASA Project Nile researchers partnered with an Ethiopian agronomist to generate an objective, satellite-informed map of agroecosystems of Choke Mountain, at the heart of the Blue Nile Highlands. The map replicates and extends on the results of time consuming traditional agroecological survey.

Relevance:

- The Blue Nile Highlands are currently facing combined pressures of population growth, low agricultural productivity, and climate change. Development interventions intended to enhance climate resilience and reduce soil erosion are difficult to design and to scale up because climate, hydrology, and soils are so diverse across the region. Objective mapping techniques like those applied in this study can be used to target development strategies in a manner that improves their likelihood of success and allows lessons learned in one location to be applied to similar locations across the landscape.
- In the Blue Nile, effectively targeted land management is important both for local development and for enhancing downstream water value in the Nile River system.

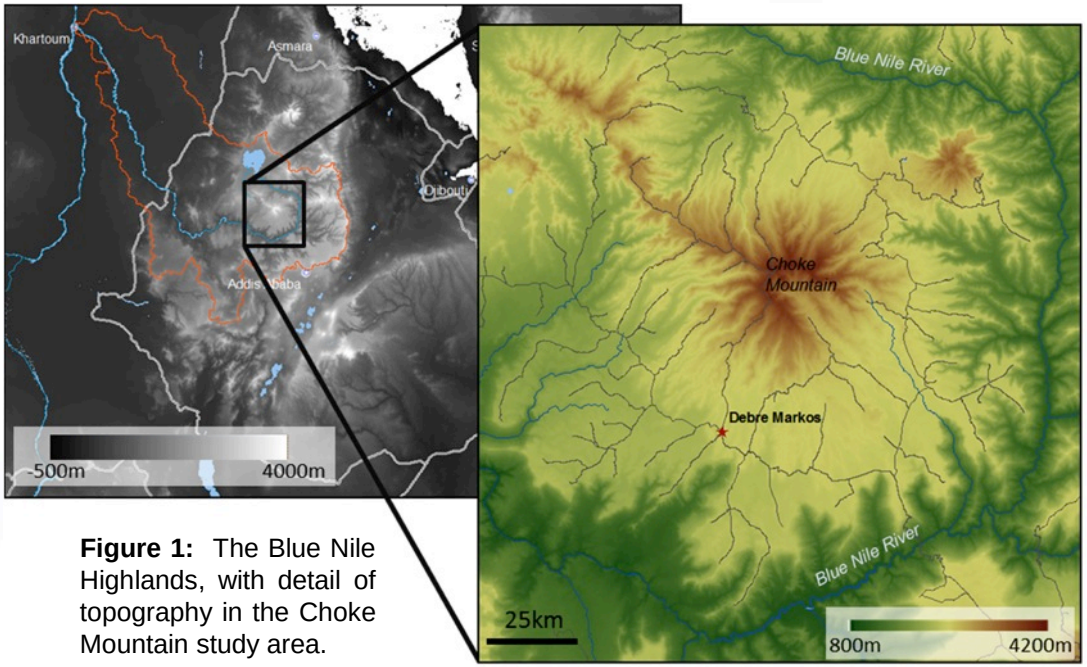



**Figure 1:** The Blue Nile Highlands, with detail of topography in the Choke Mountain study area.

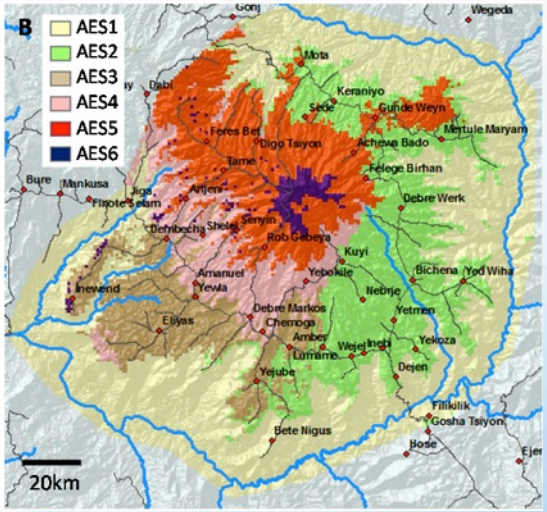
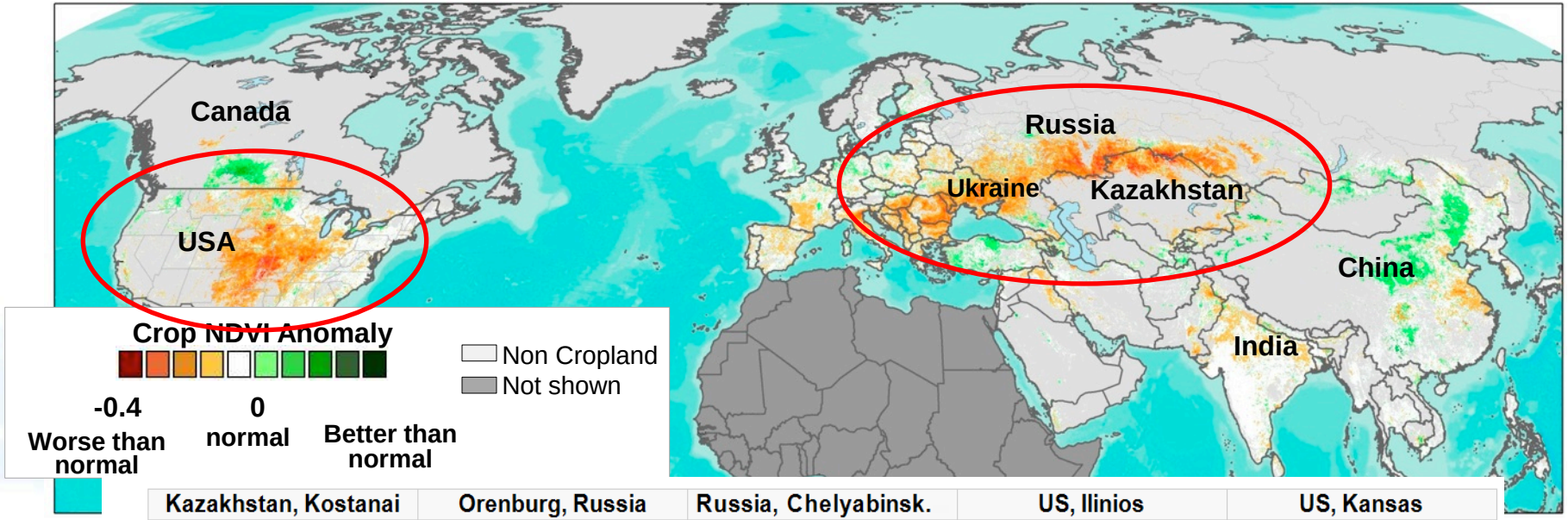
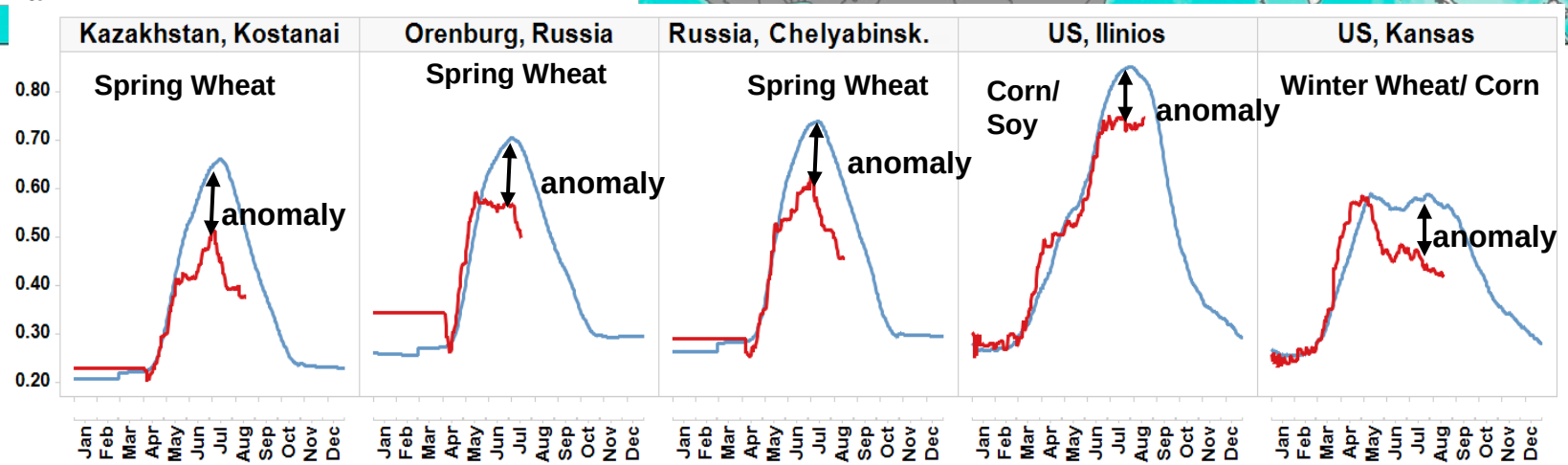



**Figure 2:** The six agroecosystems defined for Choke Mountain, ranging from the hot, dry sorghum-growing region in the Blue Nile gorge (AES1) to the afroalpine natural zone at the mountain summit (AES6). Between are the intensive tef-growing region represented by AES2, the productive maize and wheat zone (AES3), the less productive wheat and barley zone (AES4), and the low productivity barley zone (AES5).

**ESD Applied Sciences – (Insert focus area here)**

# Northern Hemisphere Crop NDVI Anomalies
# August 13th, 2012




Current season crop development (2012)
Average season development (2000-2011)

# Global Reservoir and Lake Monitor
# Example of Lake level Product

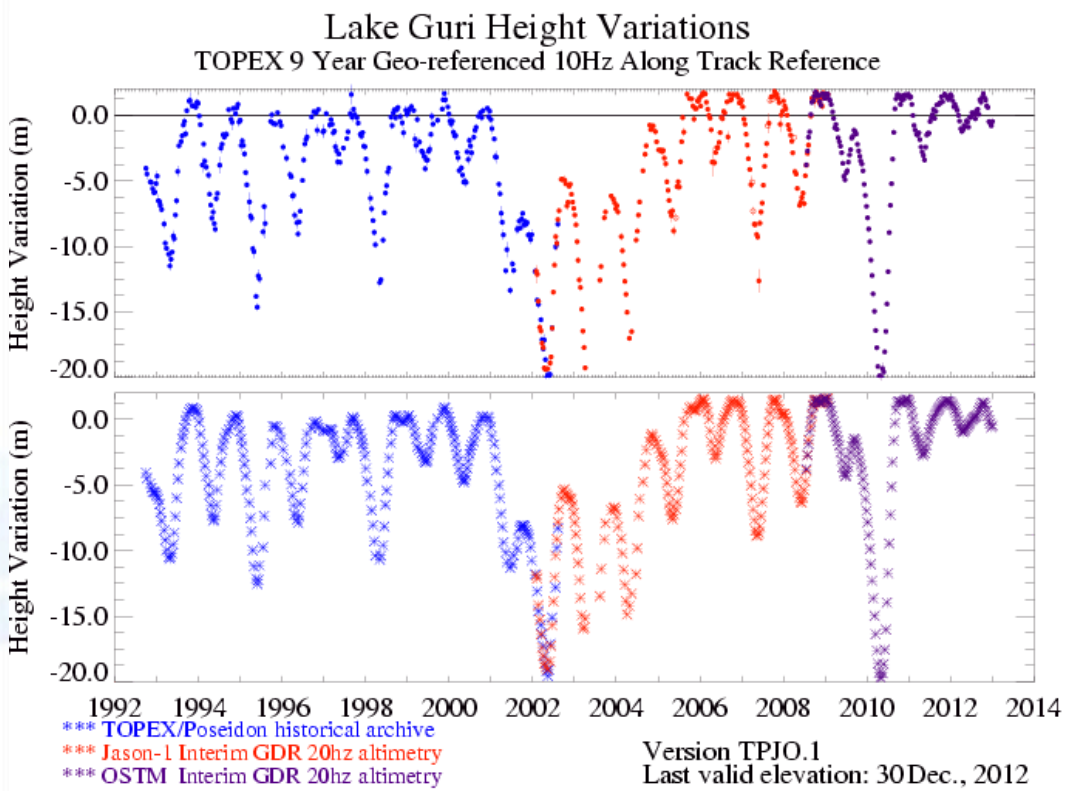



Figure 1 Lake level variations as monitored by the NASA/CNES radar altimeter missions for Lake Guri, Venezuela. Top plot, raw results, bottom plot, filtered results. Regional drought in 2010 led to a severe decline in water level behind the dam raising concerns for water resources, the production of hydrolectric power, and global oil markets. End users of the GRLM products requested checks on product quality, and additional information on satellite reference datum, as they attempted to predict whether the reservoir would reach its "dead-level" beyond which power production would cease in the region.

## Venezuela to Ration Water Because of Low El Nino Rainfall

October 22, 2009

*Venezuelan President Hugo Chavez urged citizens to cutback on showering time as the country's electric and water supply problems mount.*

Venezuela will enact new water conservation methods, including reducing supply by 25 percent until May, because of low El Nino rainfall, President Hugo Chavez announced on TV late last night.

The drier cycle has caused "critically low" levels for the country's hydroelectric stations and drinking water reserves, including the El Guri reservoir, one of the world's largest dams, Chavez said. The El Guri is located on the Caroni River, which provides 70 percent of Venezuela's electricity. Usually the Caroni River, located in the Orinoco Basin, has a high discharge rate, but it has had difficulty replenishing itself lately.

This drought has aggravated the country's already fragile situation. Growing demand for and under-investment in water lead to several major blackouts in Venezuela earlier this year.

## Power cut of 2,000 MW required if Guri dam level reaches 240 meters

The largest power reduction must be made in central states and Venezuelan Guayana's Corporation (CVG)

**ENERGY**

Government authorities believe that the water level of the Guri reservoir will reach the critical level of 240 meters above sea level by June, and at point additional power rationing will be required.

The level of the Guri reservoir is declining over 10 centimeters per day due to the lower flow of the Caroni River (Photo: Gustavo Bandres)

The Executive branch of government has already outlined two scenarios for operating the Guri hydroelectric plant if the reservoir drops to such level. According to a report prepared by the National Electric Corporation (Corpoelec) there are two options: operating the electricity grid with the support of new power plants or without the addition of the new generation units.

# Development of Numeric Water Quality Criteria from the Satellite Record

*Blake Schaeffer[1], James Hagy[1], Robyn Conmy[1], John Lehrter[1], and Richard Stumpf[2]*

*[1]US EPA, Gulf Breeze, FL; [2]NOAA, Silver Spring, MD*

Highlight: EPA adopts water quality criteria derived using satellite data products

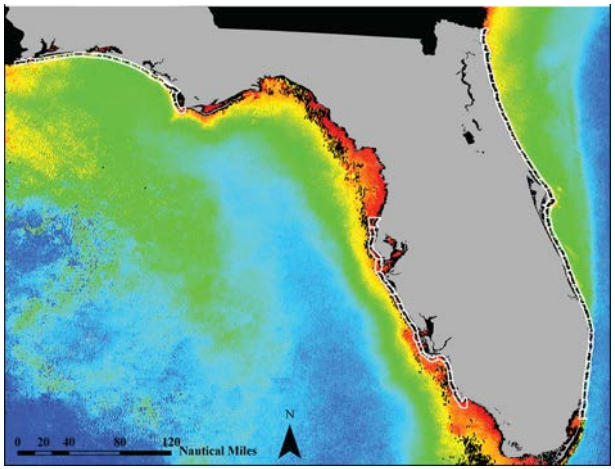
- The remote sensing methodology and results presented in this paper were adopted by EPA in the recent rule for numeric criteria in Florida waters (http://water.epa.gov/lawsregs/rulesregs/florida_coastal.cfm)

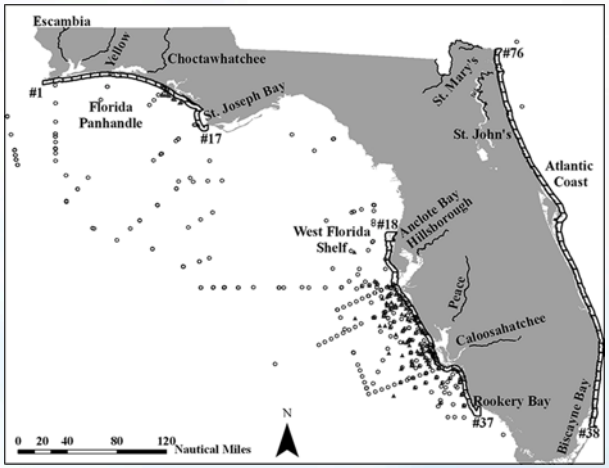
- Water quality criteria were developed for all of Florida's coastal waters using the satellite date records

- The methods for developing criteria from the 13-year satellite time-series were vetted by the EPA Science Advisory Board and could be used by other coastal states and states with large inland waters where remote sensing can be used reliably.

Schaeffer BA, Hagy JD, Conmy RN, Lehrter JC, Stumpf RP. 2012. An approach to develop numeric water quality criteria for coastal waters using the SeaWiFS satellite record. *Environmental Science and Technology* 46:916-922.

Schaeffer, Hagy, & Stumpf. An approach to developing numeric water quality criteria for coastal waters: transitioning from SeaWiFS to MODIS and MERIS. *Water Research*. (*In Review*).



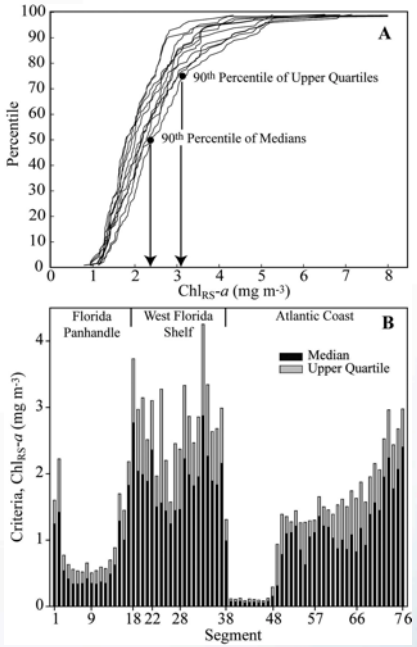




***Figure 1: Numeric water quality criteria for the coastal water bodies of Florida were proposed by EPA in November 2013 based on this work.***

# Radiative forcing by light absorbing impurities in snow from MODIS surface reflectance data

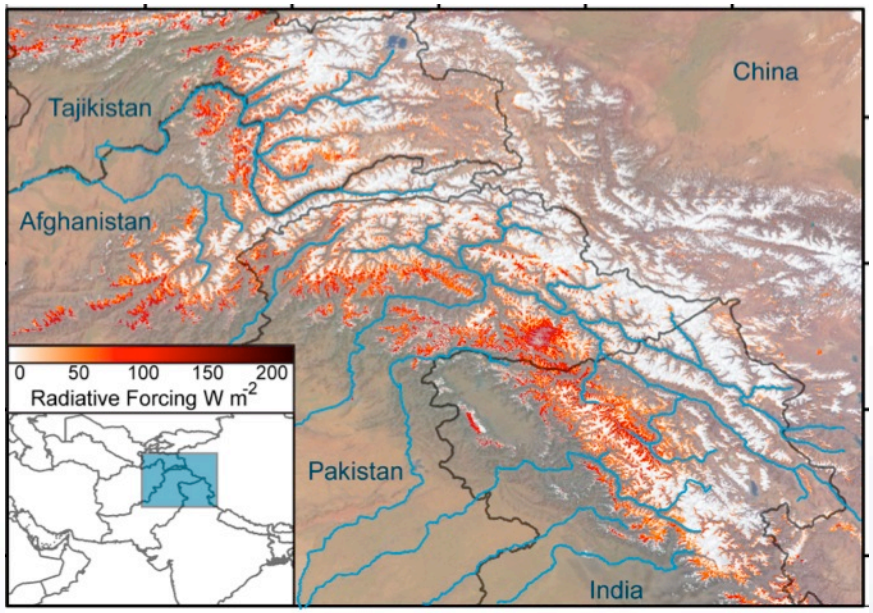
Painter, Bryant, and Skiles (2012), *Geophysical Research Letters,* doi: 10.1029/ 2012GL052457

Highlight: Snow team at JPL has developed and published the first retrieval of dust and black carbon radiative forcing in snow.

•Recent in situ measurements and modeling suggest that dust and carbonaceous particles are accelerating snow and glacier melt in the world's mountains.

•MODDRFS retrievals offer unique knowledge of the spatial and temporal distribution of aerosol radiative forcing in mountain snow.

•The retrievals will facilitate hypothesis building on the aerosol-cryosphere processes and constrain snow/glacier modeling.



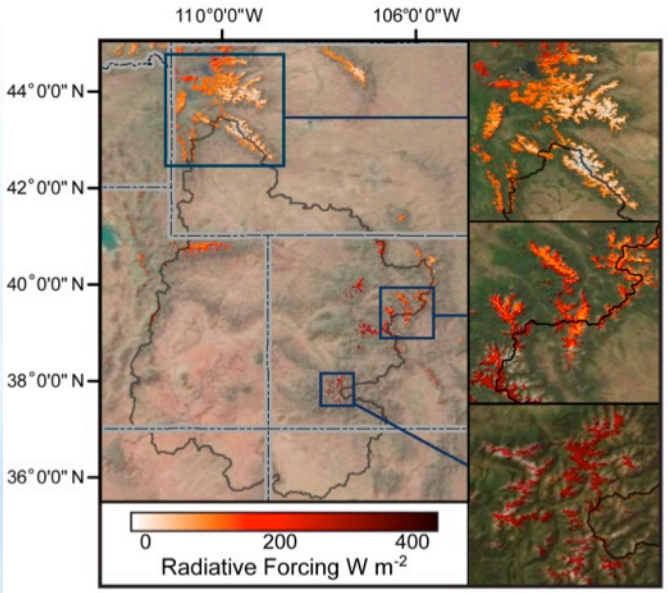

Relevance:

•The MODDRFS retrievals provide timely, spatially-complete knowledge of the acceleration of snowmelt to water managers and forecasters in regions such as the Colorado River Basin and Hindu Kush/Himalaya.

•Near real-time global availability of the products from MODIS facilitates operational ingest and use of the products.

.The JPL team is working with the NWS Colorado Basin River Forecast Center and SERVIR-Himalaya on the MODDRFS products, directly supporting NASA ESD Applied Sciences' mission.

**Figure 1:** a) Dust radiative forcing in snow for Hindu Kush-Himalaya on June 21, 2010 at time of MODIS overpass, ~05:40 UTC. (b) Dust radiative forcing in snow for eastern half of the Upper Colorado River Basin on May 18, 2009 at time of MODIS overpass, ~17:55 UTC.

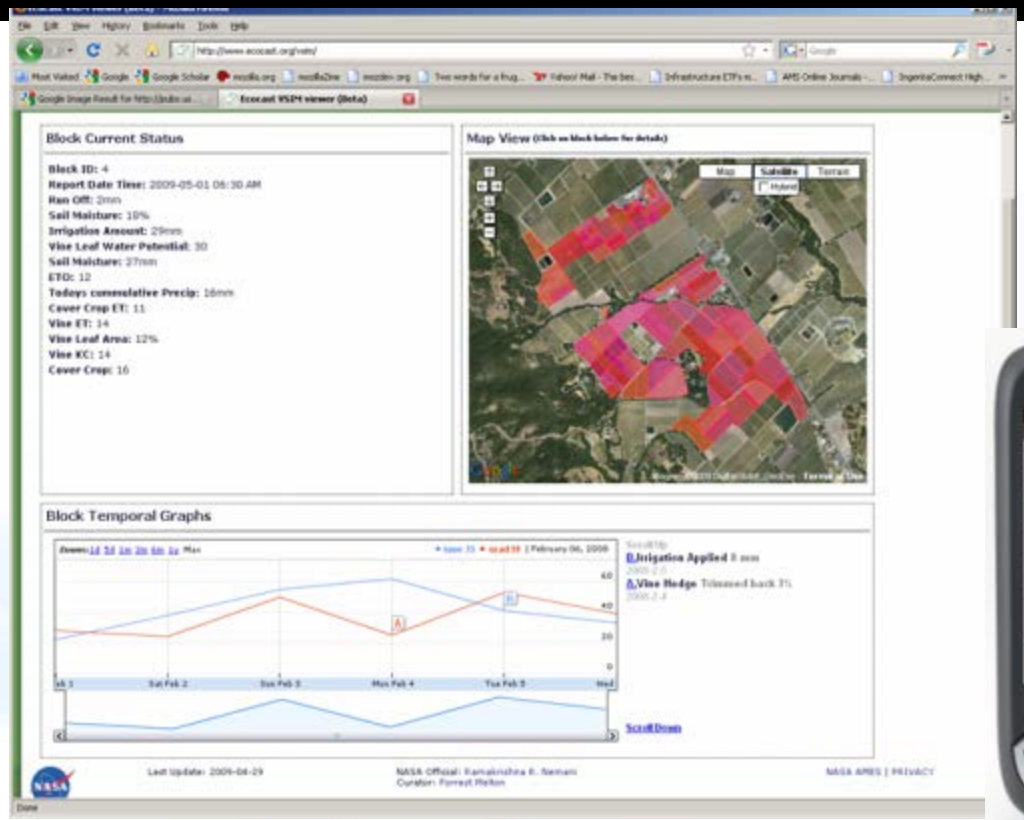


# Water Supply and Management in California, Scalable to Regional and National Applications

Image credit: NRDC, 2006

- Joint project between three NASA Centers (ARC, JPL, MSFC)
- Collaboration with CA Dept. Water Resources (DWR), CA Cooperative Snow Survey, CO River Board, local water districts, USDA, agricultural producers
- Project components:
  - Optimization of agricultural water use through irrigation forecasting (ARC, MSFC)
  - Snow Water Equivalent mapping (JPL, MSFC)
  - Regional Climate Model Diagnostic Toolkit (JPL)
  - Flood/surface water monitoring (JPL, DFO)
  - Groundwater monitoring (JPL)

# Irrigation Optimization(DWR, USDA, Ag Industry) Modeling, ET



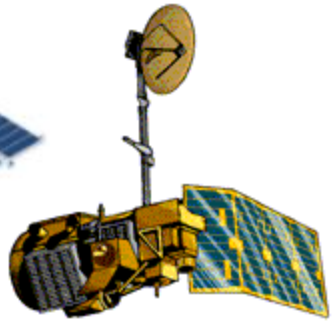
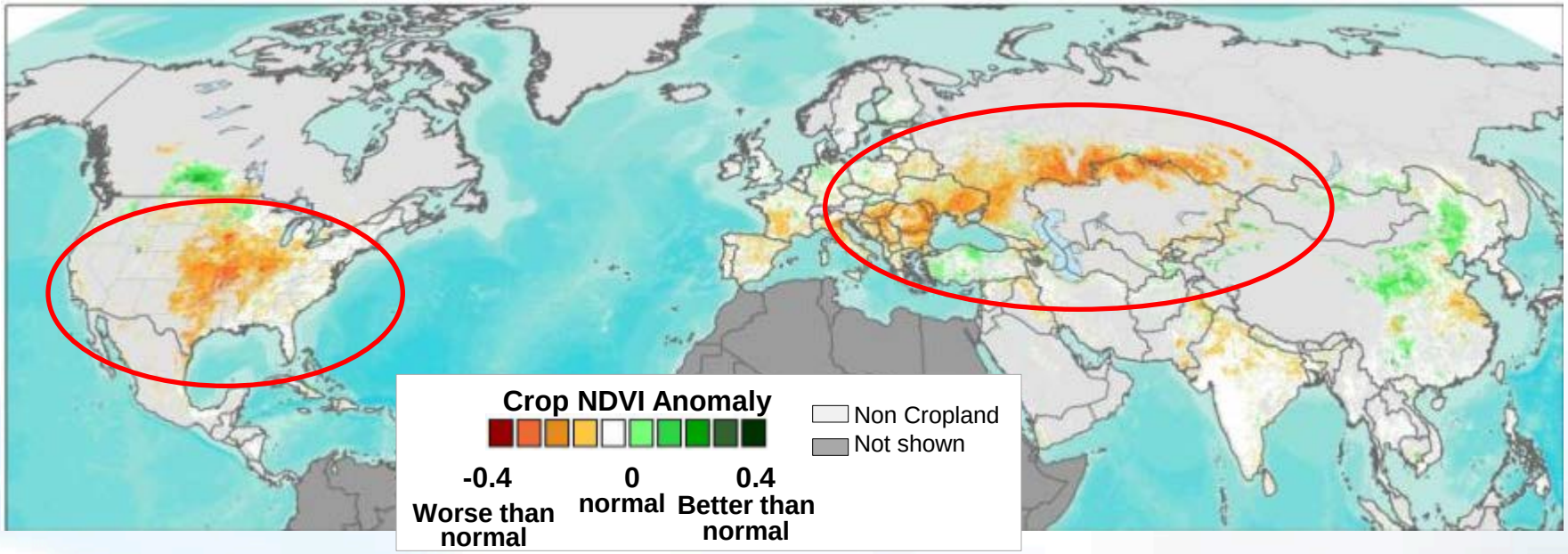


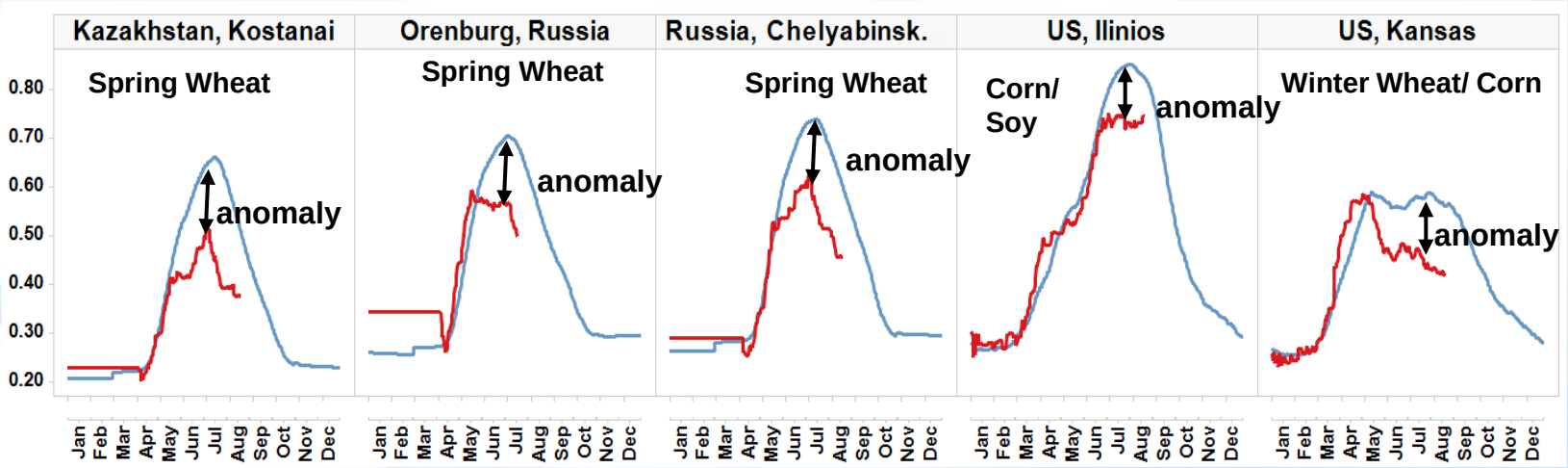
Image provided by USGS

- **Application of the NASA Terrestrial Observation and Prediction System (TOPS) to integrate satellite and weather data to estimate ET, water balance, and irrigation demand**
- **Builds on CIMIS, as well as previous success in vineyards**
- **Data exchange with users via applications for web and mobile devices**
- **Use of wireless soil moisture sensor networks for calibration**
- **Partnerships with CA Dept. Water Resources, USDA-ARS, Agricultural producers, Universities, and Irrigation consultants**

# Crop Condition: Global Outlooks

*Northern Hemisphere Crop NDVI Anomalies, Aug 13th, 2012*




Current season crop development (2012);
Average season development (2000-2011)

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***Thank You***