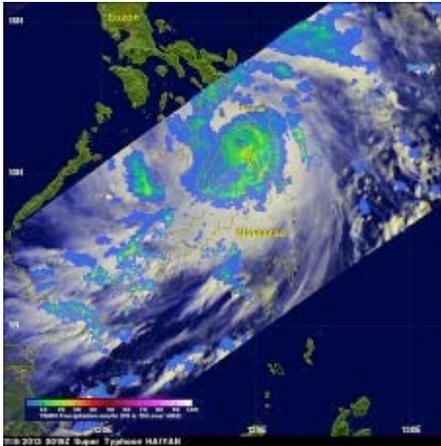


Overview of NASA Applied Remote Sensing Training Program on Water Resources and Disaster Management



ARSET

Applied Remote SEnsing Training
A project of NASA Applied Sciences



Outline

- About ARSET
- ARSET Trainings in Water Resources and Disaster Management : Goals/Structure
- Examples of NASA Data Applications

Applied Remote SEnsing Training (ARSET)

A NASA Applied Sciences Program

NASA Earth Science Applied Sciences Program

Applications to Decision Making: Thematic Areas



**Agricultural
Efficiency**



Air Quality



Climate



**Disaster
Management**



**Ecological
Forecasting**



Public Health



**Water
Resources**



Weather

Applied Remote Sensing Training Program (ARSET) (part of NASA Applied Sciences)

GOAL:

Increase utilization of NASA observational and model data for decision-support

Online and hands-on courses:

- **Who:** policy makers, environmental managers, modelers and other professionals in the public and private sectors.
- **Where:** U.S and internationally
- **When:** throughout the year. Check websites.
- Do NOT require prior remote- sensing background.
- Presentations and hands-on guided computer exercises on how to access, interpret and use NASA satellite images for decision-support.



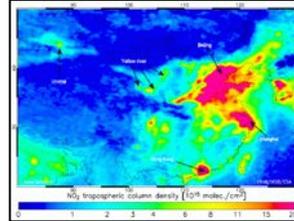
NASA Training for California Air Resources Board, Sacramento

Applied Remote Sensing Training Program (ARSET)

Health (Air Quality)

- 2008 – present
- 26 Trainings
- +700 end-users
- Analysis of dust, fires and urban air pollution.
- Long range transport of pollutants
- Satellite and regional air quality model inter-comparisons.
- Support for air quality forecasting and exceptional event analysis

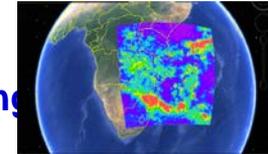
Nitrogen Dioxide over China



Water Resources and Flood Monitoring

- April 2011 – present
- 6 Trainings
- +300 end-users
- Flood/Drought monitoring
- Severe weather and precipitation
- Watershed management
- Climate impacts on water resources
- Snow/ice monitoring
- Evapotranspiration (ET), ground water, soil moisture, and runoff.

Satellite derived precipitation



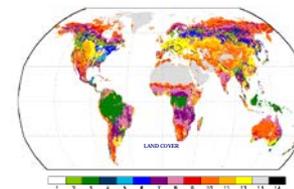
Inundation mapping



Land Use/Change and Ecology

- Beginning in 2014
- Webinars and in-person courses
- Topics to be informed by ongoing end-user needs assessment
- GIS applications
- Land use/change and vegetation indices
- Fire products

Land Cover



Gradual Learning Approach

Basic Courses

Webinars

Hands-on

Assumes no prior knowledge of RS



Advanced Courses

Hands-on

Webinar course generally required

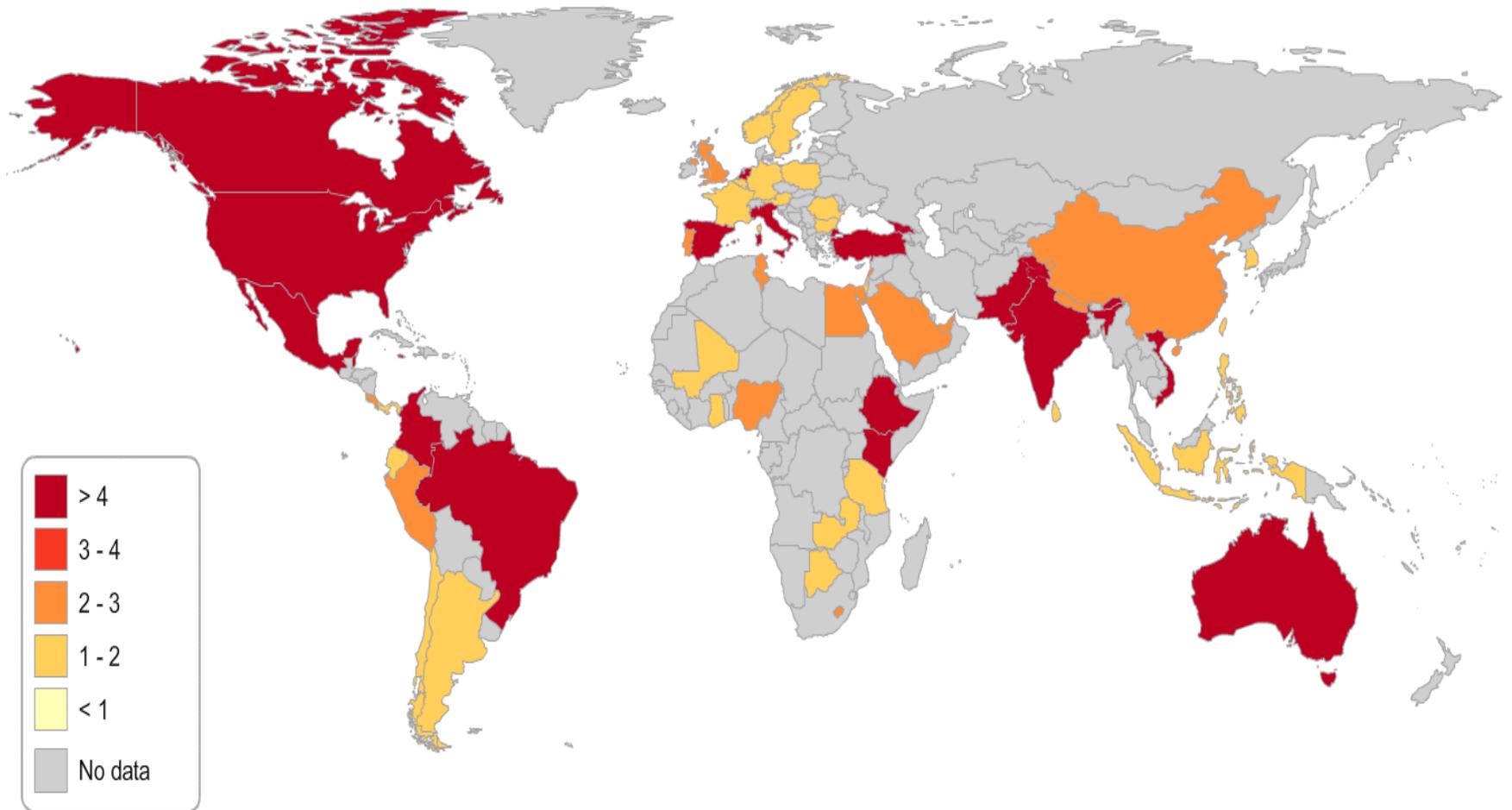
**Focused on a specific application/problem:
for example dust or smoke monitoring in a
specific country or region**



ARSET: 2009 – 2013

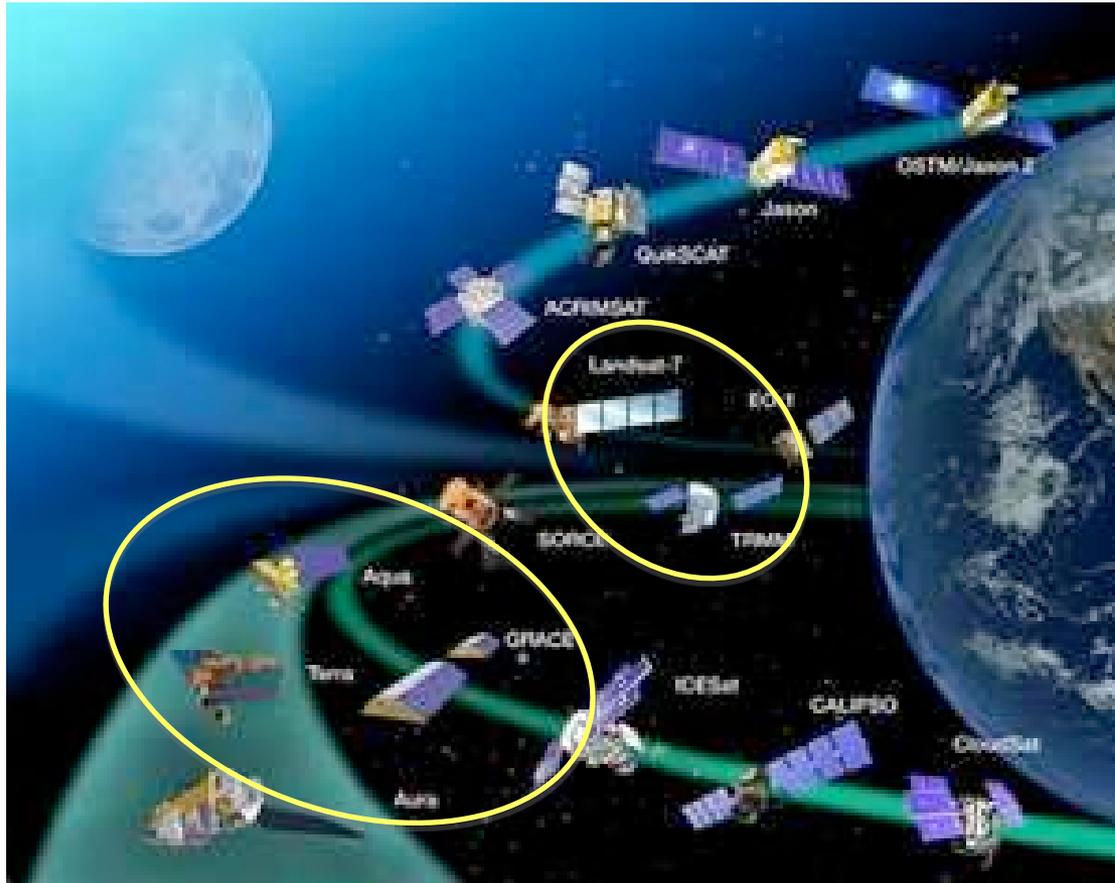
+1000 End-users Reached

Number of participating organizations per country: Air Quality, Water Resources, Flood Monitoring.



**ARSET Trainings in
Water Resources and Disaster Management**

NASA Satellites for Water Quantities



Landsat (07/1972-present)

TRMM (11/1997-present)

GPM (2/2014 - present)

Terra (12/1999-present)

Aqua (5/2002-present)

GRACE (3/2002-present)

TRMM: Tropical Rainfall Measuring Mission

GRACE: Gravity Recovery and Climate Experiment

GPM: Global Precipitation Measurements System (Launched 2/27/2014)

SMAP: Soil Moisture Active Passive (to be launched in late 2014)

NASA Models for Weather, Climate, and Water Resources Quantities

(Atmosphere-Ocean-Land Models)

- **GEOS-5 :** The Goddard Earth Observing System Version 5
- **MERRA:** Modern Era Retrospective-analysis for Research and Application
- **GLDAS :** Global Land Data Assimilation System
- **NLDAS :** North American Land Data Assimilation System

NASA Satellites and Earth Systems models provide global scale water cycle quantities on hourly, daily, seasonal, and multi-year time scales useful for water resources, flood, drought monitoring and management

- Rain
- Temperature
- Humidity
- Winds
- Soil Moisture
- Snow/Ice
- Clouds
- Terrain
- Ground Water
- Vegetation Index
- Evapotranspiration
- Run off

Fresh Water Components over Land

Rain amount

Snow/Ice, Snowmelt amount

Run off, Streamflow

Soil moisture

Evapotranspiration

Ground water

All these quantities are available from satellite observations as well as from models

Quantities in green are derived from satellite observations

Quantities in red are from land and atmosphere-land models in which satellite observations are assimilated

Why Use Satellite and Model Products for Water Resources and Disaster Management?

- Provide information where there are no ground-based measurements available, augment information where there are
- Provide regional and global/large-scale, consistent coverage
- Models Provide quantities that can not directly be observed (for example evapotranspiration, run off)

Why ARSET Trainings?

- There are numerous satellite and model data to choose from according to the application of interest
- There are multiple sources of the same products, with varying spatial/temporal resolutions and accuracies
- Data quality can range from excellent to poor depending assumptions and approximations used to obtain specific data quantity – how to choose a product?

ARSET Introductory Webinars

- Provide overview of fundamentals of remote sensing, NASA remote sensing observations/model-derived Water Cycle Components : **focus on fresh water quantities useful for water resources and disaster management**
- Provide strengths and limitations of remote sensing and modeling data
- **Introduce web-tools for data access, analysis, and imaging**
- **Provide/demonstrate web-based examples of data usage/applications with GIS interface**
- Prerequisite for advanced webinars and in-person ARSET Trainings

ARSET Advanced Trainings

- Designed in response to end-users requirements
- Focus on specific application of NASA products for specific decision support activity (*for example, regionally monitoring precipitation excess or deficit by using multi-satellite data, agricultural drought monitoring using MODIS NDVI*)
- Learn data access tools for user-specific applications
- Hands-on case studies of data interpretation and usage

Recent ARSET Courses: Water Resources/Flooding

Hands-on Courses:

- Cartagena, Colombia, November 2011, Precipitation and Flooding
- University of Oklahoma, National Weather Center, June 2012, Water Resources
- World Bank, DC, March 2013, flooding Applications

Online Courses:

- Fall 2012 : Precip/Flooding/Drought
- Spring 2013: Snow Products
- Fall 2013: Water Resources Management
- Fall 2013: Flood Monitoring

Presentations and Data Application Demonstrations:

- USAID Learning Center, Virginia, April 2014, Water Resources Management



Attendees of the NASA water resources training at the University of Oklahoma on June 19-20, with course instructors Amita Mehta and Ana Prados. Preliminary end-user feedback included a) interest in follow-on advanced/online courses and b) additional topics in land products, e.g. ET and Landsat.

Examples of Data Applications

Monitoring/Early Warning from TRMM (<http://trmm.gsfc.nasa.gov/>)

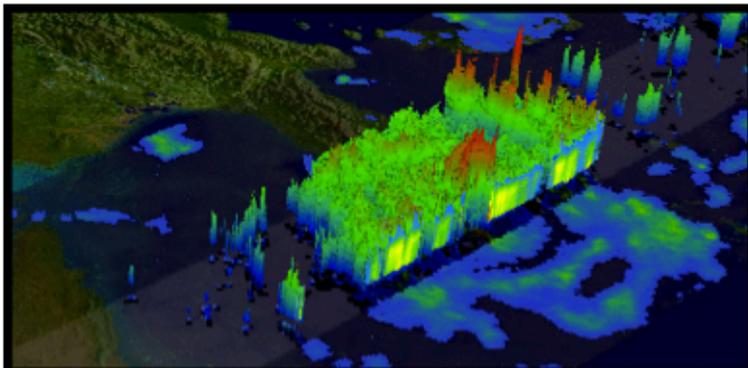
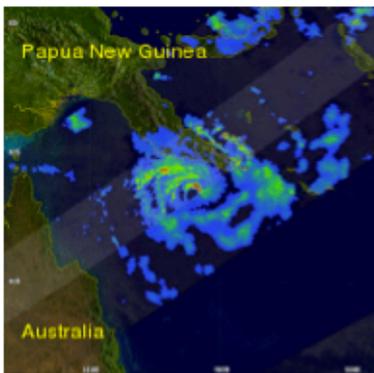
Tropical Cyclone Intensity

Thursday April 10, 2014

Tropical Cyclone ITA Becomes More Powerful

Tropical cyclone ITA, located in the Coral Sea northeast of Australia, continues to intensify while heading toward the northeastern coast of Australia. ITA was seen twice by the TRMM satellite on April 9, 2014. The tropical cyclone's wind speeds had increased from 65kts (about 75 mph) with the first pass at 0536 UTC to 80kts (about 92 mph) when viewed again at 1528 UTC. ITA is predicted to continue becoming more powerful and have sustained winds of 135 kts (about 188 mph) before hitting Australia's Queensland coast tomorrow.

Tropical cyclone ITA's rainfall at 1528 UTC is shown here courtesy of TRMM's Microwave Imager (TMI) and Precipitation Radar (PR) instruments. The area of PR coverage is shown in a slightly lighter shade. TRMM PR data showed that a maximum rainfall rate of almost 163 mm/hr (about 6.4 inches) was located in the eastern side of ITA's eye wall.

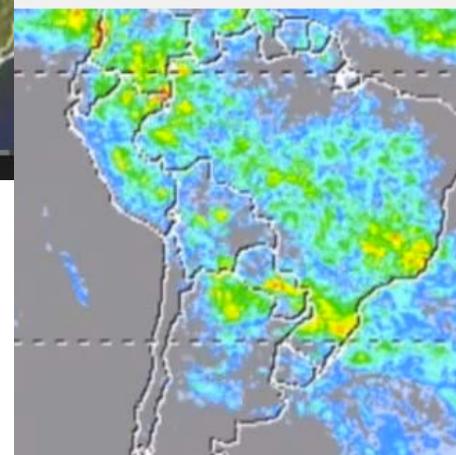


TRMM's Precipitation Radar (PR) instrument sliced through ITA's eye and those data were used in this 3-D "cut-a-way" view. Powerful storms in ITA's eye wall were found to reach heights of over 14km (about 8.7 miles). The tallest thunderstorm towers shown here were reaching heights of over 16 km (about 9.9 miles) in a feeder band well to the northeast of ITA's eye.

Landslide Potential

December 9, 2013

Landslide over Brazil

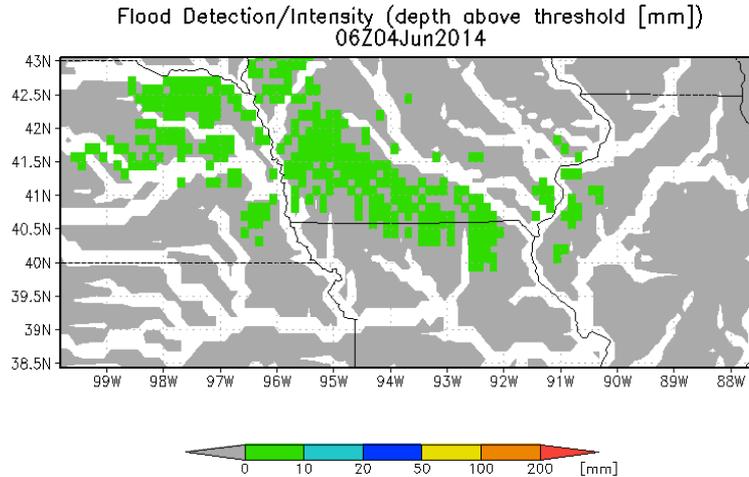


<https://www.youtube.com/watch?v=TfVlz7-x4TE>

Flood Monitoring using TRMM

Global Flood Monitoring System (GFMS)

<http://flood.umd.edu/>



Pan the map

[↑]
Zoom in

[↑↑↑]
Zoom out

Plot time series for an individual point (lat, lon):
(Tips: Zoom in enough to click the point or define it below)

38.47 -100.67

T1: 06Z01Jun2014

T2: 06Z04Jun2014

See time series

Plot different variable:

Flood Detection (Depth) ▾

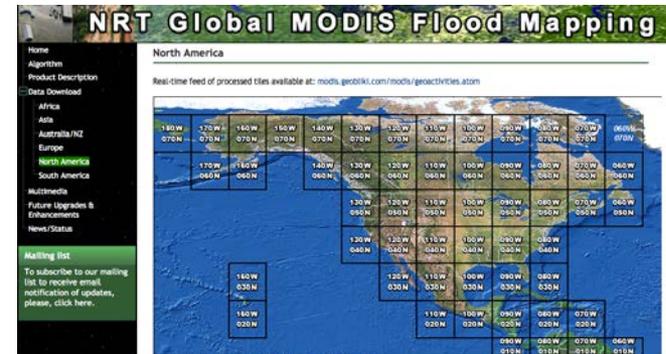
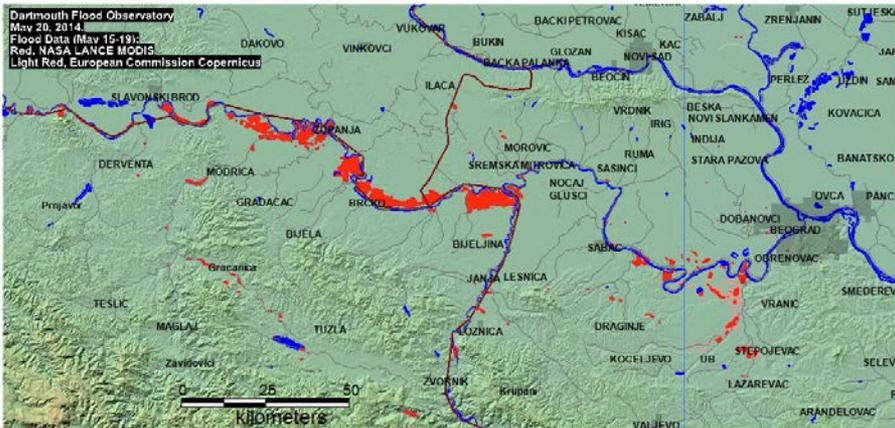
Plot

Inundation Mapping using MODIS

<http://floodobservatory.colorado.edu/>

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

Flood Mapping Underway: Bosnia and Serbia



Water Resources



Integration of Precision NASA Snow Products with the Operations of the Colorado Basin River Forecast Center (CBRFC) to Improve Decision Making Under Drought Conditions

Principle Investigator: Thomas Painter, Jet Propulsion Laboratory

Abstract

The Colorado Basin River Forecast Center (CBRFC) is responsible for the entire Colorado Basin (CRB) and the eastern Great Basin (GB). From a water management perspective, the commitment of water to various users most often occurs in the spring, and is almost entirely based on estimates of the western USA snowpack. Improving seasonal drought predictions requires use of models that provide physically realistic simulations of fundamental hydrologic processes. Among these, for the western USA, representation of snow is perhaps most critical.

As drought frequency increases in the CRB and GB, it is critical that the CBRFC and the dependent water managers have more comprehensive real-time knowledge of the snow cover and its properties for more precise runoff forecasting and stakeholder decision support. The primary objective of this proposal is to integrate real-time high precision MODIS Snow Covered Area and Grain size (MODSCAG) fractional snow covered area (SCA) into CBRFC modeling and analysis systems and into stakeholder oriented data products, drastically reducing SCA uncertainties that have hampered forecasting operations for decades. A secondary objective is to ingest and study MODIS Dust Radiative Forcing in Snow (MODDRFS) radiative forcing imagery, to better understand its value as an input to modeling and forecasting approaches.

This collaboration directly addresses drought prediction, assessment, adaptation, and mitigation in support of energy security/efficiency; natural resource conservation; and household, municipal, industrial, and in-stream demands for water. It will also improve access and availability of actionable water monitoring, hence drought information. The Snow Cover and Dust Forcing products will be generated and distributed in near real-time by the JPL Snow Server for access by CBRFC. CBRFC will offer a direct connection to stakeholders (End Users) and together with other linked NWS operational centers provides an institutional home to maintain the advances of this effort beyond the project's end.

MODSCAG (JPL), Snow Cover and Dust Radiative Forcing Information, along with CBRFC Modeling Analysis is used by Colorado Basin River Forecasts Center for Decision Support

NASA Data Application for Drought Monitoring

<http://drought.unl.edu>



Thursday, May 29, 2014



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Monitoring Tools > NASA GRACE Data Assimilation

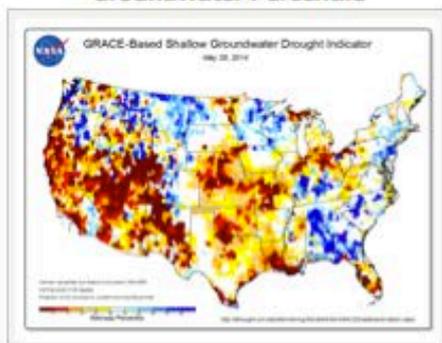
Login

Groundwater and Soil Moisture Conditions from GRACE Data Assimilation

These are experimental products that are still being evaluated and improved. We encourage your specific, constructive feedback as this phase of development proceeds.

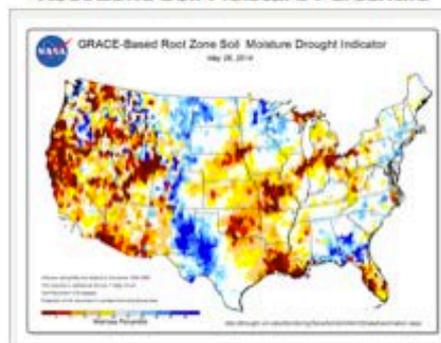
Scientists at NASA's Goddard Space Flight Center generate groundwater and soil moisture drought indicators each week. They are based on terrestrial water storage observations derived from GRACE satellite data and integrated with other observations, using a sophisticated numerical model of land surface water and energy processes. The drought indicators describe current wet or dry conditions, expressed as a percentile showing the probability of occurrence within the period of record from 1948 to the present, with lower values (warm colors) meaning dryer than normal, and higher values (blues) meaning wetter than normal. These are provided as both images and binary data files.

Groundwater Percentile



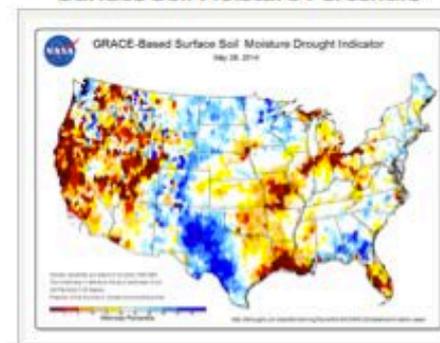
Download image: [PDF](#) | [PNG](#)

Root Zone Soil Moisture Percentile



Download image: [PDF](#) | [PNG](#)

Surface Soil Moisture Percentile



Download image: [PDF](#) | [PNG](#)

NLDAS Soil Moisture – A Major Component of Drought Monitoring

<http://hydrology.princeton.edu/forecast/current.php>

Drought Monitoring and Hydrologic Forecasting with VIC

Nowcast/Forecast | Historical Droughts/Hindcast | Documentation | About the Project

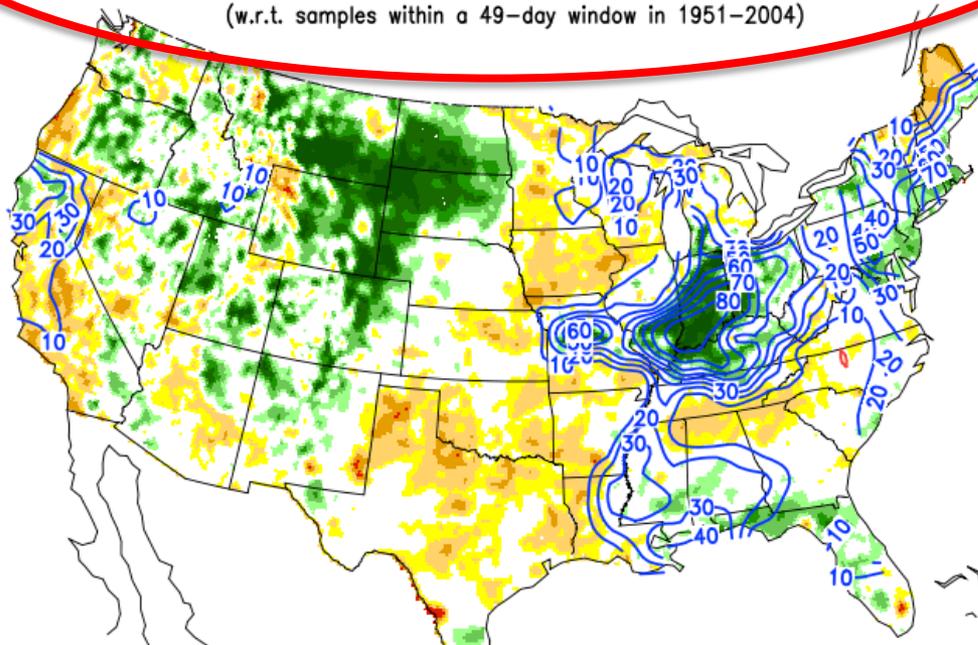
As of 2012/05/01, CFS forecasts are switched to CFSv2. Hover mouse on items to see more info.

Product/Data/Variable (click to change)

Monitoring validated < 2014/04/03 > for Soil Moisture Snow Streamflow Precipitation
Forecast initialized < 2014/01/01 > for Soil Moisture Drought Probability



Total Column Soil Moisture Percentiles for 2014/04/03
based on VIC Simulations forced with NLDAS-2
(w.r.t. samples within a 49-day window in 1951-2004)



Contours show the changes in quantiles in the past 7 days.



Timeline (click & hover to change)

- 2014/02/06
- 2014/02/13
- 2014/02/20
- Preceding 2014/03/27
- Monitoring 2014/03/06
- 2014/03/13
- 2014/03/20
- 2014/03/27

Forecast	CFS	CPC	ESP
2014/04	0.5mo	0.5mo	0.5mo
2014/05	1.5mo	1.5mo	1.5mo
2014/06	2.5mo	2.5mo	2.5mo
2014/07	3.5mo	3.5mo	3.5mo
2014/08	4.5mo	4.5mo	4.5mo
2014/09	5.5mo	5.5mo	5.5mo

Monitoring from other centers:

- US Drought Monitor
- USGS Streamflow/Drought
- CPC Drought Severity
- CPC Soil Moisture
- UW Surface Water Monitor
- NLDAS Drought Monitor

Forecast based on Climate Model

Famine Early Warning System Network (FEWS NET)

<http://www.fews.net/>

FEWS NET
FAMINE EARLY WARNING SYSTEM NETWORK

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SEARCH

WHERE WE WORK

+ CENTRAL AMERICA
AND CARIBBEAN

+ CENTRAL ASIA

+ EAST AFRICA

+ SOUTHERN AFRICA

+ WEST AFRICA

BREAKING NEWS



South Sudan

Over one million people displaced, disruptions to agricultural activities expected to prolong lean season

March 28, 2014 | Food Security Outlook



Chad

Food insecurity expected to rise significantly in Wadi Fira and Barh El-Ghazel

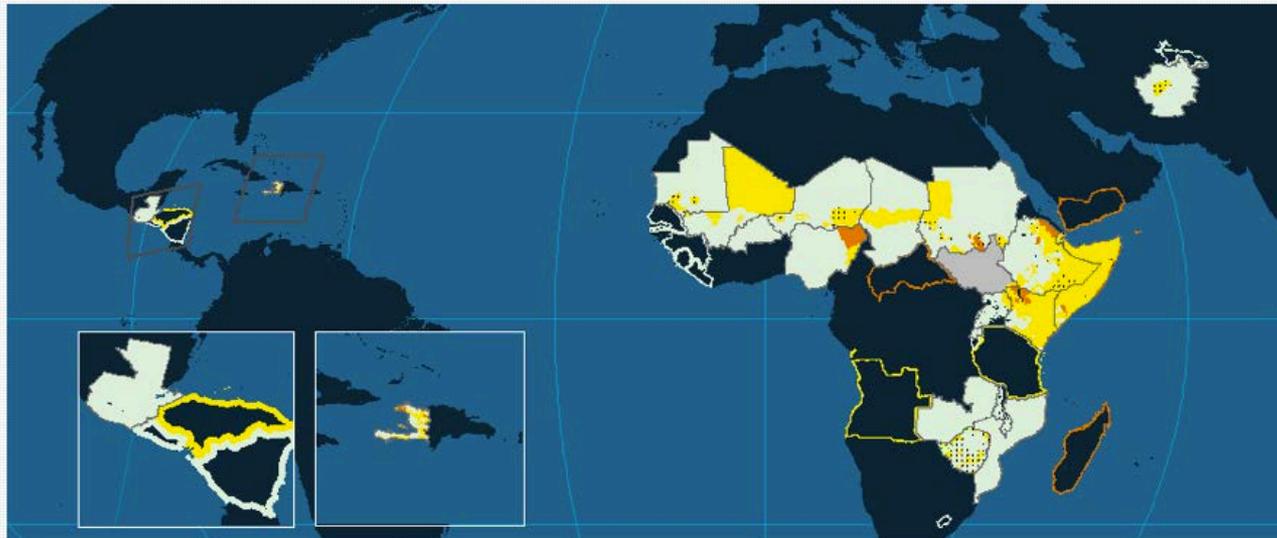
March 27, 2014 | Alert



Somalia

Conflict and displacement increase food insecurity in southern Somalia

March 26, 2014 | Alert



Acute Food Insecurity: Near Term

Presence Countries:

Minimal

Stressed

Crisis

Emergency

Famine

Non-Presence Countries:

Minimal

Stressed

Crisis or Higher

Would likely be worse without current or programmed humanitarian assistance

Operationally
Uses:
Normalized
Difference
Vegetation
Index (NDVI
From
MODIS)

NASA Data Application for Crop Monitoring

<http://www.pecad.fas.usda.gov/>

USDA United States Department of Agriculture
Foreign Agricultural Service

Linking U.S. Agriculture to the World
FAS

Crop Explorer

Global Food Supply Monitoring

Home Help Contact Us

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Explore by Region

Site Index

North America
United States
Canada

Central America
Mexico
Central America and Caribbean

South America
Brazil
Northern South America
Southern South America
Chile

Middle East
Iran, Iraq, Syria and Turkey

South Asia
South Asia
Sri Lanka
Bangladesh

Oceania
Australia

Europe
Europe

Former Soviet Union
Kazakhstan
Russia, Azerbaijan, Armenia and Georgia
Ukraine, Moldova, and Belarus

Africa
North Africa
Southern Africa
East Africa
West Africa

Asia
Eastern China
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Central Asia
Korea

Africa | Asia | Europe | Middle East | North America | South America | World

Explore by Crop

Select a Commodity Submit

Commodity Intelligence Articles and Reports

Top Stories **Production Briefs**

Ukraine: Crop Production Forecasts for 2014/15.
(May 09, 2014)

Specialists from the USDA Foreign Agricultural Service traveled to Kyiv in early April to conduct interviews with agricultural officials and private commodity analysts in order to assess Ukrainian crop-production prospects for 2014. The observations of local specialists were consistent with USDA analysis indicating that winter-crop conditions were better than average as of late April.

Partnerships

NASA InuTeq

View images from the Global Reservoir

Special Projects - NOAA | USAID | GEO | GEOS | UMD

Data from:

JASON-1
TOPEX/POS
EIDON
LANDSAT
MODIS
TRMM

Related Sites

- Agricultural Production
- Archive Explorer
- Articles and Reports
- Explore by Crop
- Future of Land Imaging
- Geographic Search
- Global Climate Change
- Global Crop Production
- Global Reservoirs/Lakes
- Landsat GloVis
- MODIS Image Gallery
- MODIS NDVI Gallery
- MODIS NDVI Time Series
- MPA Rainfall Maps
- Outgoing Longwave Radiation Anomaly
- Photo Gallery
- Tropical Cyclone Archive
- Tropical Cyclone Monitor
- USDA Satellite Imagery Archive
- Vegetation Index Monitor
- WMO Station Explorer
- WMO Station Grapher

NASA and California Department of Water Resources use NASA remote Sensing and Model data to monitor and access California Drought Conditions

<http://www.nasa.gov/jpl/news/california-drought-20140225/#.U0rxGI02olw>



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- Administrator's Speeches
- Budgets & Plans
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Text Size + -       

NASA Responds to California's Evolving Drought February 25, 2014



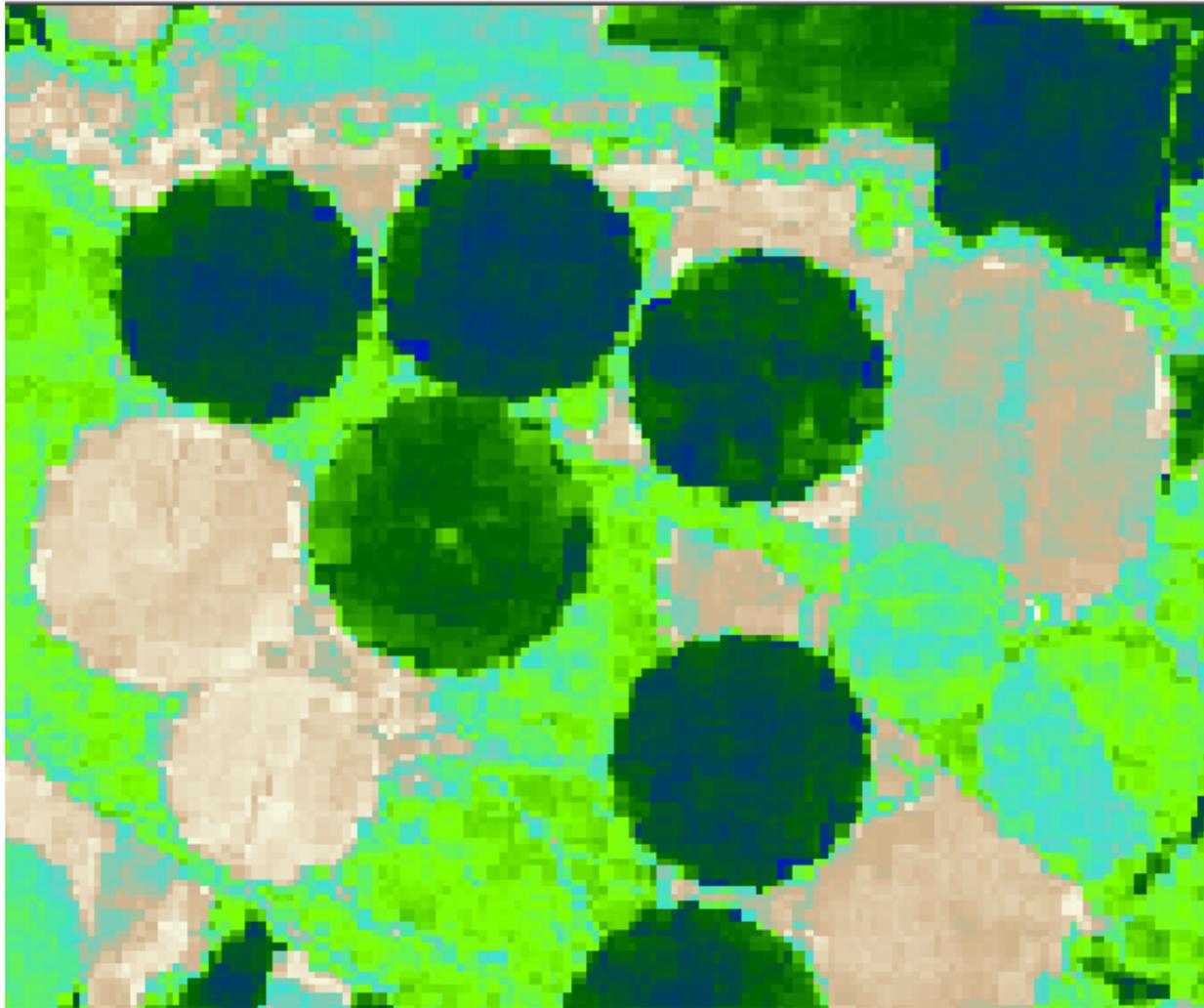
Folsom Lake - July 20, 2011 *Folsom Lake - January 16, 2014*

The severity of California's drought is visible at Folsom Lake, near Sacramento. On July 20, 2011, the lake was at 97 percent of capacity; on Jan. 16, 2014, it was at 17 percent. NASA and California are collaborating to use NASA Earth observation assets to manage and respond to the drought.

Image Credit: California Department of Water Resources

[Full image and caption](#)

Landsat-based Evapotranspiration

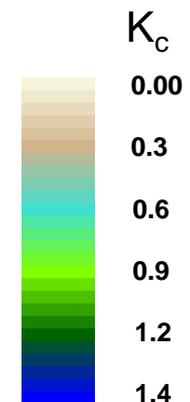


METRIC application in La Mancha, Spain, 2003

ET from
individual Fields
is

Critical for:

- ◆ Water Rights,
- ◆ Water Transfers,
- ◆ Farm Water Management



(K_c based on ET_o)

Beta website: <http://www.ecocast.org/dgw/sims>



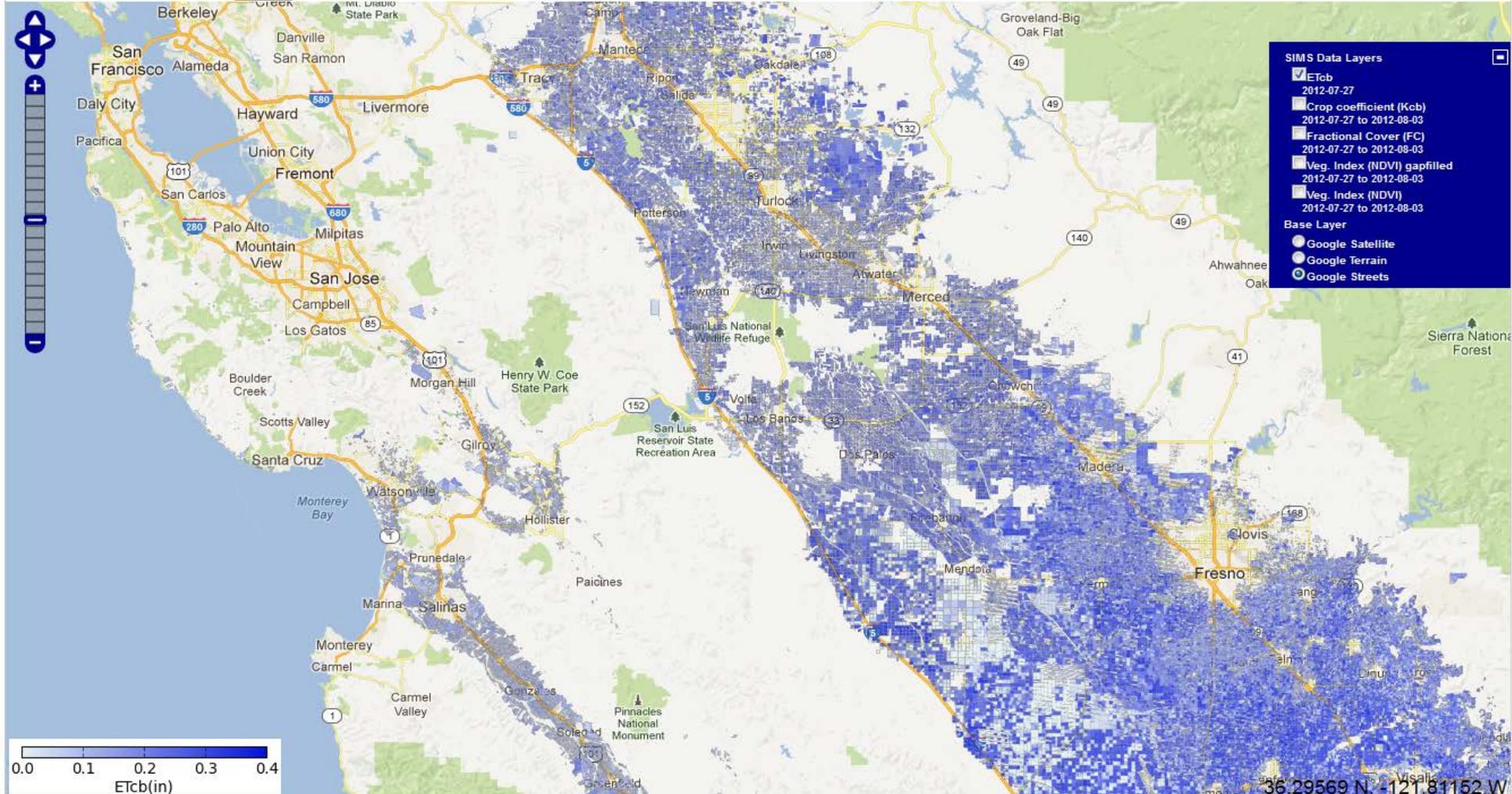
TOPS Satellite Irrigation Management Support

Username: Password: [Login](#)

Go to: [Search](#)

[About](#) [Help](#)

Select Date: 2012-07-27



36.29569 N, -121.81152 W

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



Flood Monitoring using NASA Remote Sensing Data

Tuesday, November 19, 2013 to Tuesday, December 10, 2013

Times: Tuesdays (4 webinars), 8-9 AM Eastern US Time (13 PM UTC)

Objective: To introduce NASA remote sensing data and web-based tools for flood monitoring and inundation mapping.

Registration: [Registration Link](#)

Agenda: [Flood_Webinar_Fall2013_Agenda.pdf](#)

GIS: True

Keywords: [Flooding](#)

Instruments: [MODIS](#), [TRMM](#)

Week 1: Overview of NASA Remote Sensing and Earth Systems Modeling Data and Flood Monitoring Tools

Topics:

- Course Overview
- Fundamentals of Remote Sensing and Model data for Flood monitoring
- Introduction to Flood Monitoring and Inundation Mapping Tools

Documents:

- [Flood Monitoring Webinar, Week 1 - PDF File.](#)
- [Monitoreo de Inundaciones, Semana 1 \(Español\) - PDF File.](#)

English and Spanish

Sign up to the **listserve** for new website information and URL, and for program updates
<https://lists.nasa.gov/mailman/listinfo/nasa-water-training>



Concluding Remarks

- NASA remote sensing and model-based data are **FREE**
- The ARSET Team works with stakeholder organizations to provide ‘hands-on’ trainings to facilitate the use of NASA data for applications and decision support
- The ARSET Team works to liaison NASA scientists and stakeholder communities

Thank You!