

WELCOME TO NASA APPLIED REMOTE SENSING TRAINING (ARSET) WEBINAR SERIES



Water Resources Management Using NASA Earth Science Data

COURSE DATES: EVERY Tuesday, October 13, 20, 27; November 3, 10
TIME: 10 TO 11 AM AND 2 TO 3 PM Eastern US Time
(UTC-4 Hours for October and UTC-5 Hours for November)



Applied Remote Sensing Training



Objective

To provide information about availability and access to global freshwater data from NASA remote sensing observations and land-atmosphere models to facilitate applications and decision support activities in planning **water allocation, flood and drought management, agricultural management, and reservoir/dam management**



Webinar Outline

Week 1



NASA Remote Sensing Data and Applications for Water Resources Management

Week 2



Precipitation and Soil Moisture Data Access and Applications

Week 3



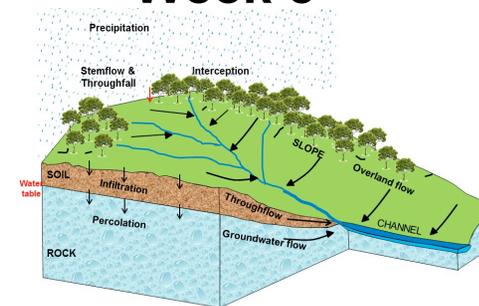
Run off, Streamflow and Reservoir Level Data Access and Applications

Week 4



Evapotranspiration and Ground Water Data Access and Applications

Week 5



Land Data Assimilation for Water Budget Estimation and Case Studies with GIS Applications



Training Team

Instructors:

- Amita Mehta (ARSET): amita.v.mehta@nasa.gov
- Cynthia Schmidt (ARSET): cynthia.l.schmidt@nasa.gov (Week-4)
- Brock Blevins (ARSET): bblevins37@gmail.com

Guest Speakers:

- Eni Njoku(NASA-JPL): eni.g.njoku@jpl.nasa.gov (Week-2)
- Brian Thomas (NASA-JPL): Brian.F.Thomas@jpl.nasa.gov (Week-4)
- Sujay Kumar (NASA-GSFC): sujay.v.kumar@nasa.gov (Week-5)

Spanish Translation:

- David Barbato (ARSET): barbato1@umbc.edu

General Inquiries about ARSET:

- Brock Blevins (ARSET) bblevins37@gmail.com
- Ana Prados (ARSET) aprados@umbc.edu



Important Information

Certificate of Completion (upon request):

You must attend all 5 live sessions

You must submit the homework assignments

(homework assignment links will be provided after Week-1 and Week-5)

Contact : Marines Martins

Email: marines.martins@ssaihq.com

Agenda for Week-1

NASA Satellite Missions and Land-Atmosphere Models Relevant to Water Resources Management



- About Applied Remote Sensing Training (ARSET) Program
- Water Resources Management
- Satellites and Earth Science Models Useful for Water Resources Management
- Water Resources Data Search, Access, Analysis, and Visualization Tools
- Water Resources Data Applications



About ARSET

ARSET is a Capacity Building Program of NASA Applied Sciences



Disasters



Ecological forecasting



Health and Air Quality



Water Resources



Agriculture



Climate



Energy



Oceans



Meteorology

NASA Applied Sciences Themes



ARSET Capacity Building Training Areas



Disasters



Ecological forecasting



Health and Air Quality



Water Resources



Agriculture



Climate



Energy



Oceans



Meteorology

Applied Remote SEnsing Training (ARSET)



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

- ❑ **GOAL:** To increase utilization of NASA observational and model data for decision-support through training activities for environmental professionals.
- ❑ **Online Trainings:** Live and recorded, 4-6 weeks in length. Include demos on data access
- ❑ **In person Trainings:** In a computer lab, 2- 4 days. Large focus on data access
- ❑ **Train the Trainers:** Courses and training manuals for those interested in conducting their own remote sensing training.
- ❑ **Application Areas:** water resources, disasters, health/air quality, and land management



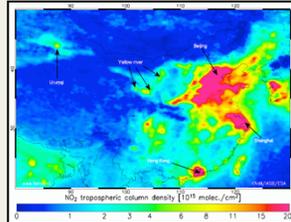
Accomplishments (2008 – 2015)

- 53 trainings completed
- 4000+ participants worldwide
- 1400+ organizations
- 130+ countries

Applied Remote Sensing Training (ARSET)

Health (Air Quality)

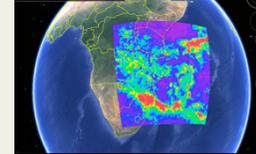
- 2008 – present
- 33 Trainings
- 1000+ end-users
- Analysis of dust, fires and urban air pollution.
- Long range transport of pollutants
- Satellite and regional air quality model inter-comparisons.
- Support for air quality forecasting and exceptional event analysis



Water Resources and Flood Monitoring

- April 2011 – present
- 11 Trainings
- 1200+ 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



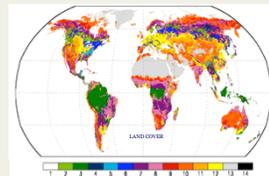
Inundation mapping



Land Management

- Launched in 2014
- 2 Trainings, +300 end-users
- GIS Applications
- Vegetation indices
- Fire products (beginning in 2015)

Land Cover



Train the Trainers (Starting in 2015)

- Courses and guidance on how to design and develop, *YOUR OWN* online and/or computer based remote sensing training
- How to develop effective presentations and exercises.

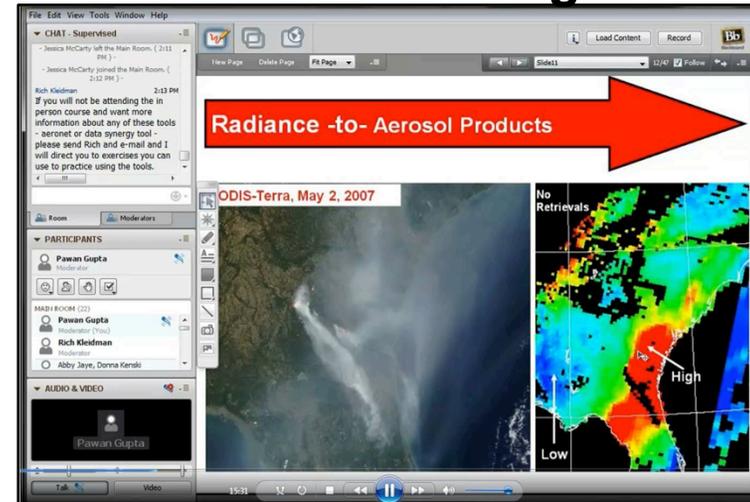
Gradual Learning Approach

Online Training

Basic Training
Webinars
Hands-on
Assumes no prior knowledge of RS



Advanced Training
Hands-on
Webinar course generally required
Focused on a specific application/
problem/Data: for example **flood**
monitoring in a specific country or
region



In-Person Training



ARSET Website

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



The screenshot shows the ARSET website interface. At the top, there are navigation links for "Earth Science Division", "Applied Sciences", and "ASP Water Resources". Below this is the ARSET logo and a search bar. A horizontal menu contains "DISASTERS", "ECO FORECASTING", "HEALTH & AIR QUALITY", and "WATER RESOURCES". A red box highlights the "ARSET" dropdown menu, which lists "Webinars", "Workshops", "Apply for Training", "Personnel", "Links", and "Upcoming Webinar". A red arrow points from this menu to a larger, light blue box on the left that lists the same items. The main content area on the right is titled "Applied Remote Sensing Training" and contains introductory text, sections for "Webinars (Free)" and "In-Person Courses", a "Skills Taught" list, and a sponsor acknowledgment. The footer includes contact information and a list of related programs.

Earth Science Division Applied Sciences ASP Water Resources

NASA ARSET
Applied Remote Sensing Training

DISASTERS ECO FORECASTING HEALTH & AIR QUALITY WATER RESOURCES

ARSET

- Webinars
- Workshops
- Apply for Training
- Personnel
- Links
- Upcoming Webinar

Applied Remote Sensing Training

The goal of the NASA Applied Remote SENSing Training (ARSET) is to increase the utility of NASA earth science and model data for policy makers, regulatory agencies, and other applied science professionals in the areas of Health and Air Quality, Water Resources, Eco Forecasting, and Disaster Management.

The two primary activities of this project are webinars and in-person courses.

Webinars (Free)

Webinars are offered throughout the year in all four application areas, generally 4-5 weeks in duration, 1 hour per week. They are intended for those new to remote sensing. For more information and to register please go to the webinars section of the website.

In-Person Courses

ARSET in-person courses are a combination of lectures and computer hands-on activities that teach professionals how to access, interpret, and apply NASA data at regional and global scales with an emphasis on case studies. ARSET works with organizations who will host the training for groups within their geographical region, tailoring the curriculum to the needs of the projected participants. NASA does not charge an attendance fee, but attendees must make their own arrangements to travel to the course meeting location.

Skills Taught:

- Search, access, and download of NASA data products and imagery
- Appropriate use and interpretation of satellite imagery.
- Visualization and analysis of NASA imagery using NASA, EPA, and NOAA webtools and other resources such as GIS, Google Earth, Panoply, RSIG, and HDFLook

ARSET is sponsored by the Applied Sciences Program within NASA's Earth Sciences Division. We would like to thank Nancy Searby, Applied Sciences' Capacity Building Program Manager for her support of this project.

Last updated: August 18, 2014
NASA Official: Kenneth Pickering
Webmaster: Susannah Pearce
Curator: Ana Prada

- Sciences and Exploration
- Atmospheric Laboratory
- Hydrospheric & Biospheric Laboratory
- Contact Us
- Site Map
- Privacy Policy and Important Notices

Access to ARSET Trainings

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

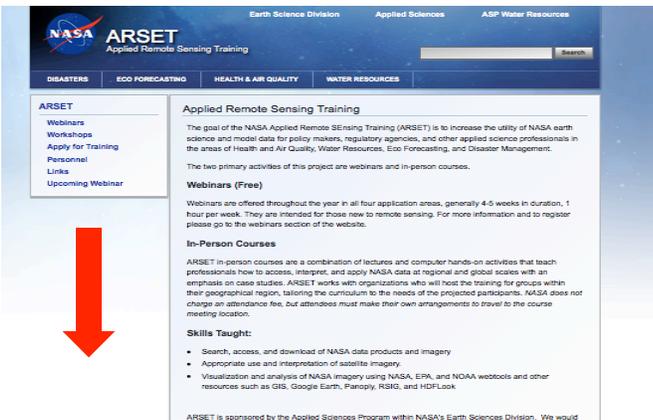


The screenshot displays the ARSET website interface. At the top, there is a navigation bar with four main categories: **DISASTERS**, **ECO FORECASTING**, **HEALTH & AIR QUALITY**, and **WATER RESOURCES**. Below this, a secondary navigation bar lists sub-categories: **DISASTERS**, **ECO FORECASTING**, **HEALTH & AIR QUALITY**, and **WATER RESOURCES**. A red circle highlights the **WATER RESOURCES** link in the secondary navigation bar. A red arrow points from this link down to the **Webinars** link in the left-hand sidebar. The sidebar also contains links for **Webinars**, **Workshops**, **Apply for Training**, **Personnel**, **Links**, and **Upcoming Webinar**. The main content area features a section titled **Webinars** with two featured training events:

- Water Resources Management Using NASA Earth Science Data**
Tuesday, October 13, 2015 to Tuesday, November 10, 2015
10 to 11 AM and 2 to 3 PM Eastern US time (UTC-5)
Application Area: **Water Resources**
Keywords: **Flooding, Satellite Imagery, Tools**
Instruments/Missions: **Aqua, GPM, SMAP, Terra, TRMM**
[Read more](#)
- Satellite Remote Sensing of Particulate Matter Air Quality: Data, Tools, Methods and Applications (Aka AOD-PM)**
Thursday, October 1, 2015 to Thursday, October 29, 2015
11:30 AM (EDT)
Application Area: **Airquality**
Keywords: **Aerosols, Air Pollution, PM10, PM2.5**
Instruments/Missions: **MISR, MODIS, VIIRS**
[Read more](#)

Request a Training

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



Apply for Training

The NASA Applied Remote Sensing Training Program provides webinars and in-person courses. The goal of these training activities is to build the capability and skills to utilize NASA earth science observations and model data for environmental management and decision-support. Courses are primarily intended for applied science professionals and decision makers from local, state, federal agencies, NGOS, and the private sector. ARSET also offers a Train the Trainers program, which is recommended for establishing or growing your organizations' capacity in applied remote sensing.

ARSET trainings are NOT designed for research but for operational and application driven organizations.

To apply for a training email Ana Prados at Ana.I.Prados@nasa.gov

The program offers four types of courses. For in-person courses, applicants must provide a computer laboratory or similar facility.

1. Overview webinar course: held over a period of 4-5 weeks, 1 hour per week
2. Basic hands-on: In person applied remote sensing course for those new to remote sensing. Generally 2-3 days in length held. It is highly recommended that attendees first take the webinar course.
3. Advanced hands-on: In person applied remote sensing course that builds the skills to use NASA data for a specific environmental management problem. Intended for those who have already taken the basic course or have previous experience using NASA data and resources. Generally 1-2 days in length.
4. Train the Trainers: In person applied remote sensing course intended for existing remote sensing/geospatial trainers within the organization/institution/agency.

ARSET

Webinars

Workshops

Apply for Training

Personnel

Links

Upcoming Webinar



ARSET ListServ

For information on upcoming courses and program updates, sign up to the listserv

<https://lists.nasa.gov/mailman/listinfo/arset>



Water Resources Management

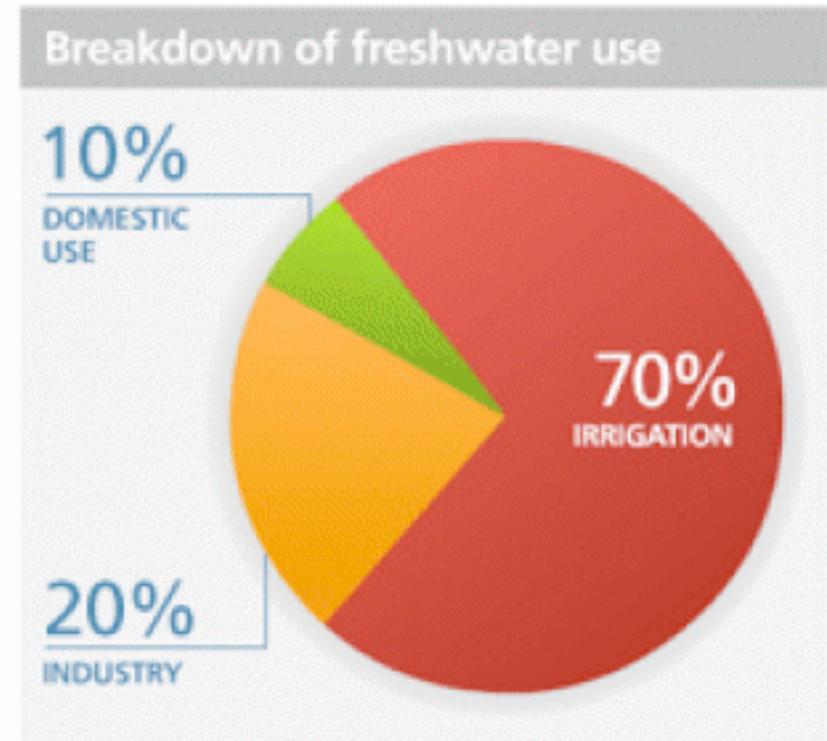


Water Resources Management

- ❑ Requires balancing availability and consumption of freshwater
- ❑ Planning for water allocation among various sectors
- ❑ Planning for disasters (droughts, floods)

Major Challenges:

- Regional and temporal imbalances in freshwater availability and usage
- Increasing demands -- population increase, agricultural and industrial demands
- Cross-boundary water sharing issues
- Climate variability and change



www.unwater.org

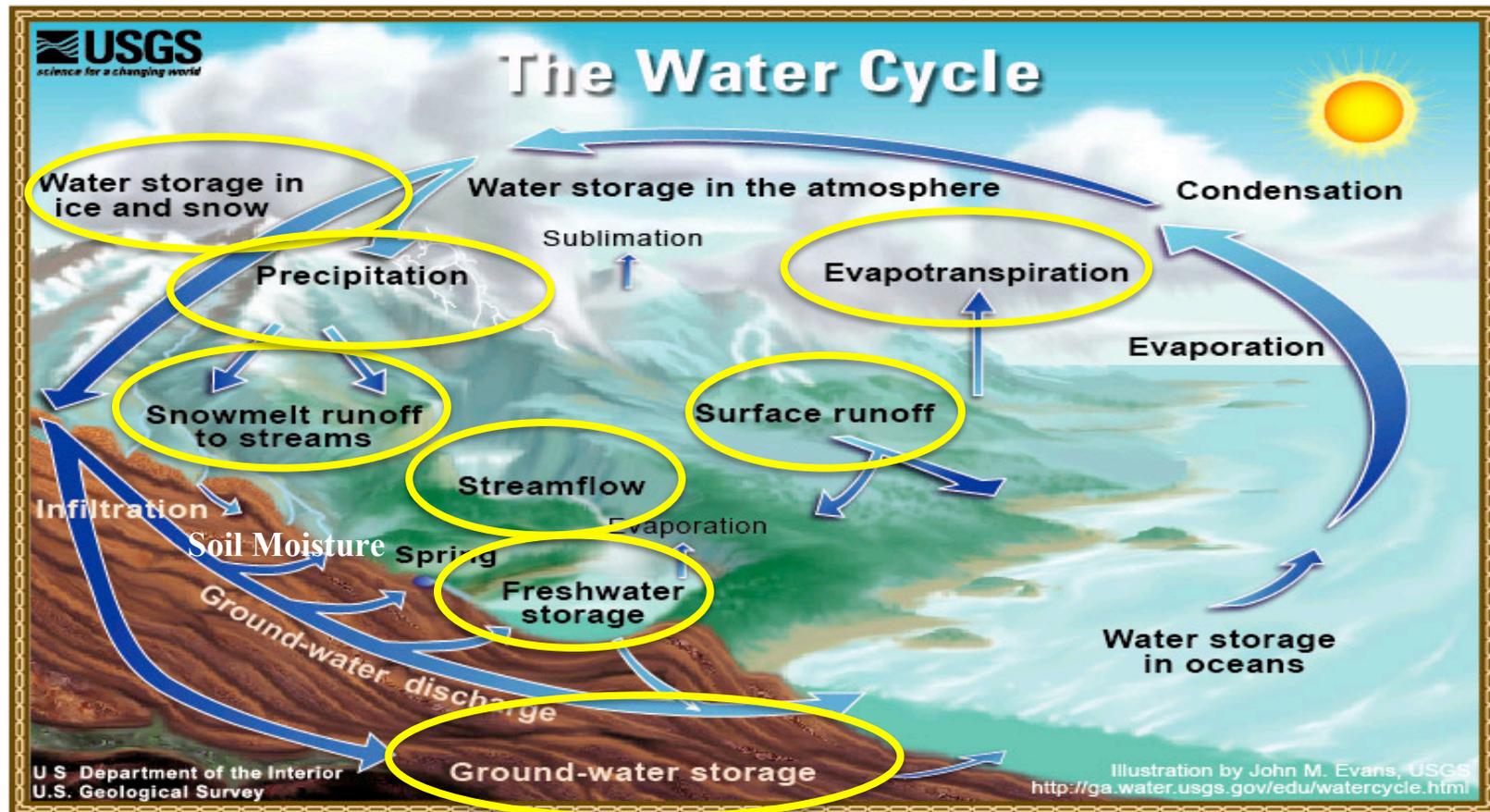
The definition of freshwater is water containing less than 1,000 milligrams per liter of dissolved solids, most often salts

<http://water.usgs.gov/edu/watercyclefreshstorage.html>

Water Resources Management



For sustainable water management, it is critical to have accurate estimates of water cycle components





Water Resources Management

Freshwater Components

Over a watershed, river basin, or region:

- ❑ **Precipitation (rain, snow)** is the main source of Fresh Water; regionally, **runoff/streamflow, lakes, soil moisture, and ground water** also contribute to available Fresh Water
- ❑ **Evaporation and Evapotranspiration** through the loss of water to the atmosphere and **runoff** outflow contribute to the depletion of available Fresh Water
- ❑ Surface Fresh water availability W is largely controlled as follows:

$$W = (\text{Precipitation} + \text{Runoff in the region}) \text{ minus} \\ (\text{Evaporation/Evapotranspiration} + \text{Runoff Outflow} + \text{Infiltration})$$



Freshwater Information

- Not all water cycle components can easily be measured directly (e.g. evapotranspiration, runoff, water vapor transport)
- NASA Satellites and Earth Systems Models measure/calculate **all** water cycle components



Overview of Satellites and Earth Science Model Data for Water Resources Management

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 management



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

Water Resources Management:

Rain Amount, Snowmelt Amount
Runoff
Soil Moisture
Evapotranspiration
Ground Water

Hydrology Modeling Inputs:

Rain Amount, Snowmelt Amount
Surface Temperature, Wind, Humidity
Terrain, Land Cover
Solar and Terrestrial Radiation at the Surface

All other quantities are available from satellite observations as well as from models
Quantities in green are derived from satellite observations
Quantities in red are from atmosphere-land models in which satellite observations are assimilated

NASA Satellites for Water Resources Monitoring



Landsat (07/1972-present)

TRMM (11/1997-04/2015)

GPM (2/27/2014-present)

Terra (12/1999-present)

Aqua (5/2002-present)

SMAP (1/31/2015-present)

GRACE (3/2002-present)

Jason-1&2 (12/2001-present)

TRMM: Tropical Rainfall Measuring Mission
GRACE: Gravity Recovery and Climate Experiment
GPM: Global Precipitation Measurements
SMAP: Soil Moisture Active Passive



Fundamentals of Satellite Remote Sensing

To use satellite observations, it is important to understand principles of remote sensing and attributes of satellite data:

- What is Remote Sensing? What is Measured?
- Types of Satellite Orbits
- Types of Satellite Sensors/Instruments, Spectral Bands
- Conversion from Sensor Measurements to Geophysical Quantities (i.e. Temperature, Rain, Soil Moisture, Carbon Dioxide etc.)
- Spatial and Temporal Resolutions and Coverage
- Spectral and Radiometric Resolutions
- Levels of Satellite Data Products
- Strengths and Limitations of Remote Sensing Data

The following link provides concepts and definitions about the above topics that will be used through out this webinar series:
<https://arset.adobeconnect.com/fundrsession1/event/registration.html>



NASA Satellites for Water Resources Monitoring

- ❑ Each satellite carries one or more sensors/instruments with specific spectral channels to observe specific geophysical quantities
- ❑ Sensors most useful for the water resources data will be described in this training

Landsat (07/1972-present)

TRMM (11/1997-04/2015)

GPM (2/27/2014-present)

Terra (12/1999-present)

Aqua (5/2002-present)

SMAP (1/31/2015-present)

GRACE (3/2002-present)

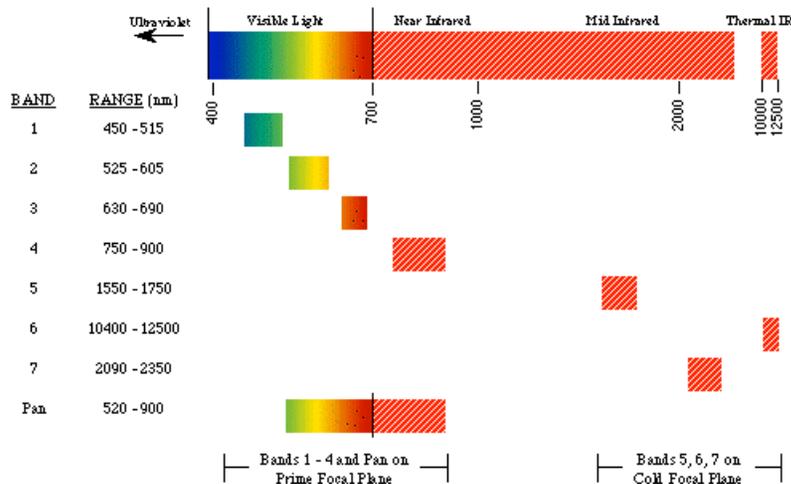
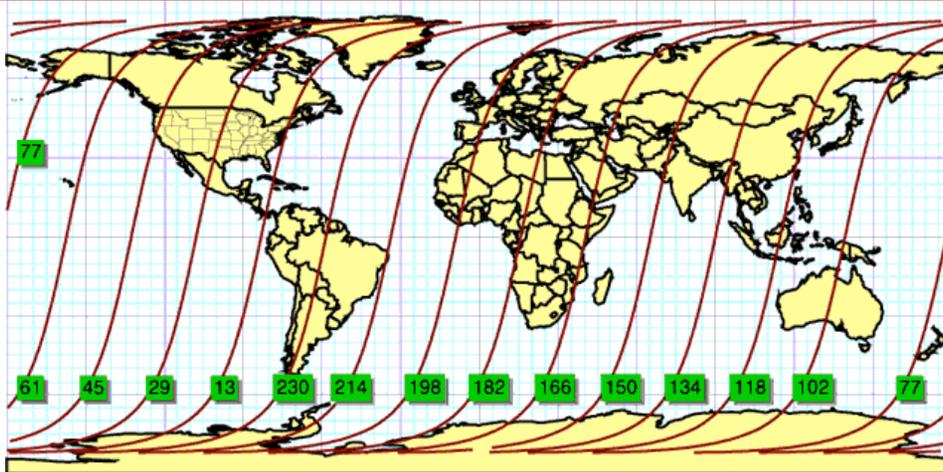
Jason-1&2 (12/2001-present)

Landsat (07/1972 – Present)



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

Continuous mission with multiple satellites, Landsat-1 launched in July 23, 1972



- Near-polar orbit, 10 am equator-crossing time
- Global coverage
- July 1972- Present, 16-day revisit time
- Sensors:
MSS, TM, ETM+, OLI, TIRS

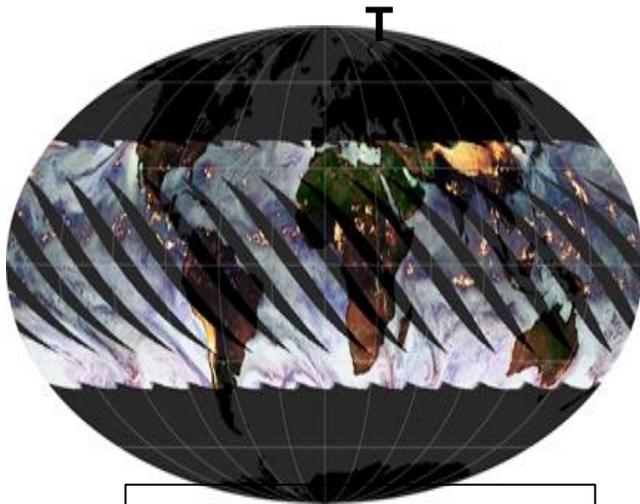
Quantities:
Land Cover

TRMM (11/1997 – 4/2015)

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



**TRMM stopped
collecting data in April 2015**



Quantities:
Surface Rainfall
Rainfall Profiles
Latent Heating

- **A non-polar, low inclination orbit**
Revisit time ~11-12 hours, but time of the observation changes daily
- There are 16 TRMM orbits a day **covering global tropics between 35° S to 35°N latitudes**
- Sensors

*Precipitation Radar (PR)**
TRMM Microwave Imager (TMI)
Visible and Infrared Scanner (VIRS)

Important Note:

The TRMM mission was terminated in April 2015 but near-real time TRMM-calibrated rainfall from other satellites are available until GPM data become available in near-real time

TRMM data from 1997-2014 are widely used for weather, climate, and hydrology applications and will be used in this

GPM (2/2014 – Present)

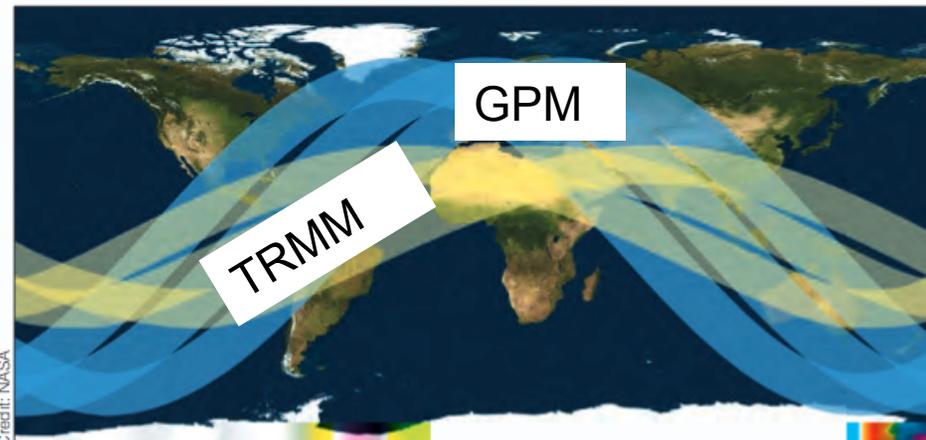


<http://pmm.nasa.gov/GPM>

- ❑ Non-polar, low inclination orbit with 16 orbits per day
- ❑ **GPM observes global region between 65°S to 65°N latitudes**
- ❑ Sensors:

Dual frequency Precipitation Radar (DPR)

GPM Microwave Imager (GMI)



the area covered by three TRMM orbits [yellow] versus orbits of the GPM Core Observatory [blue]

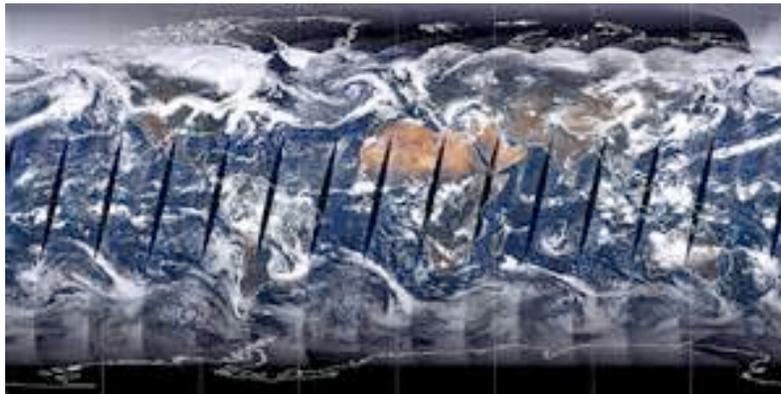
Quantities:

**Surface Precipitation (Rain and Snow)
Precipitation Profiles**

Terra (12/1999 – Present)



<http://terra.nasa.gov>



Quantities:
Land Cover
Snow Cover
Clouds
Water Vapor
Radiative Fluxes
Aerosol Information
Digital Elevation

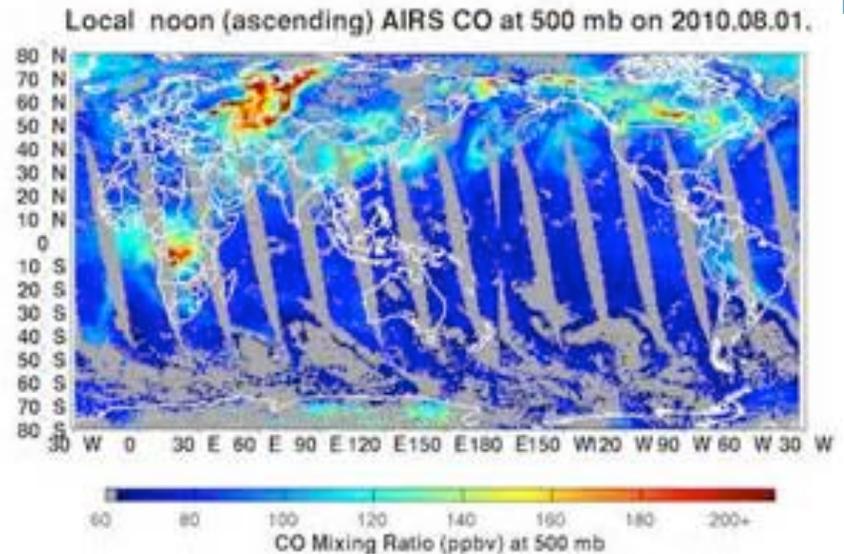
- ❑ Polar, Sun-Synchronous Orbit, Global Coverage
- ❑ Twice-daily Observations **10:30 AM/PM** Descending Orbits
- ❑ Sensors:
 - Moderate Resolution Imaging Spectroradiometer (MODIS)
 - Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER)
 - Clouds and Earth's Radiant Energy System (CERES)
 - Multi-angle Imaging Spectroradiometer (MISR)
 - Measurements of Pollution in the Troposphere (MOPITT)

Aqua (5/2002 – Present)

<http://aqua.nasa.gov>



- ❑ Polar, Sun-Synchronous Orbit, Global Coverage
- ❑ Twice-daily Observations **1:30 AM/ PM** Descending Orbits
- ❑ Sensors:
 - [Moderate Resolution Imaging Spectroradiometer \(MODIS\)](#)
 - [Atmospheric Infrared Sounder \(AIRS\)](#)
 - [Advanced Microwave Sounding Unit \(AMSU-A\)](#)
 - [Advanced Microwave Scanning Radiometer for EOS \(AMSR-E\)](#)
 - [Clouds and the Earth's Radiant Energy System \(CERES\)](#)



Quantities:

Land Cover

Snow Cover

Clouds

Temperature, Humidity

CO₂, CO, CH₄, O₃

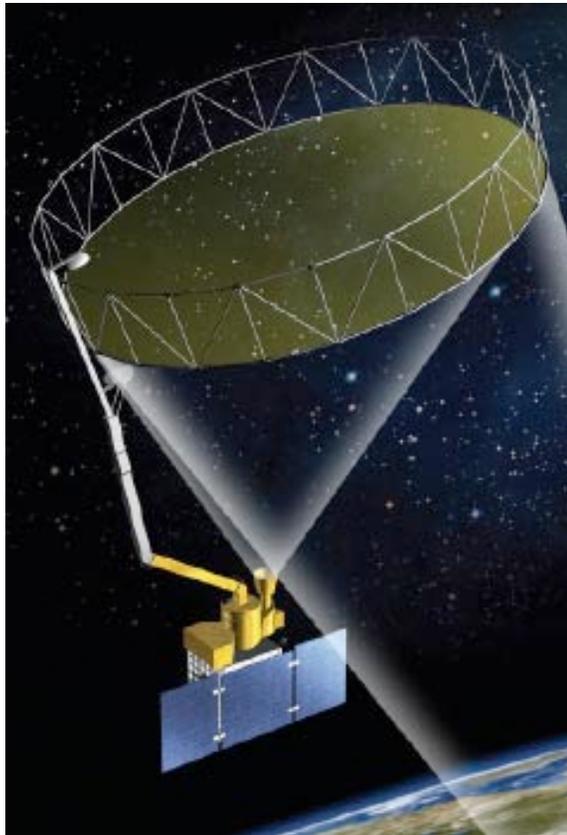
Radiative Fluxes

Aerosol Information

SMAP (1/2015 – Present)



<http://smap.jpl.nasa.gov>



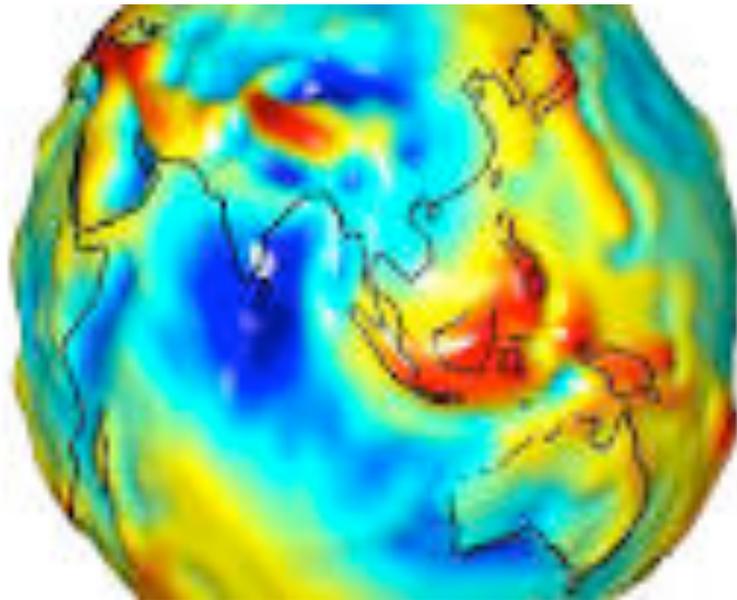
- ❑ Polar, Sun-Synchronous Orbit, Global Coverage
- ❑ Twice-daily Observations **6:00 AM/PM** Equator Crossing
- ❑ Sensors:
 - Microwave Radiometer*
 - Microwave Radar*

Quantities:
Soil Moisture
Freeze-Thaw State

GRACE (3/2002 – Present)



<http://www.jpl.nasa.gov/missions/details.php?id=5882>



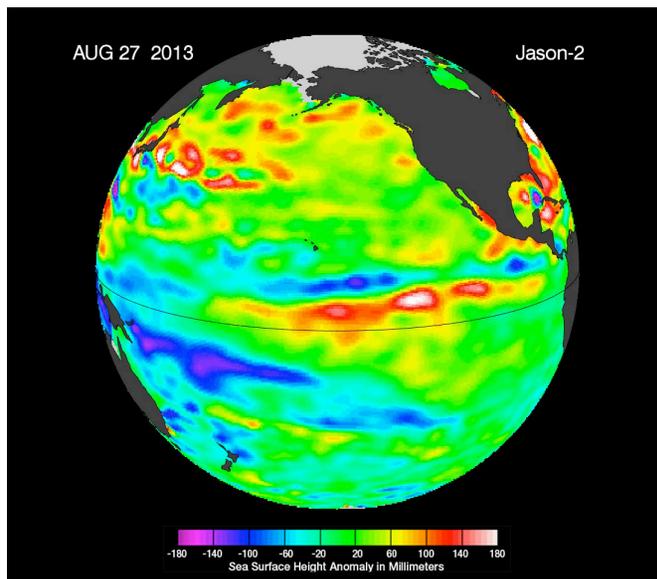
Quantity:
Terrestrial Water

- Polar, Sun-Synchronous Orbit, Global Coverage
- 250 gravity profiles per day
- Sensors:
 - Microwave K-band ranging instrument*
 - Accelerometers*
 - Global Positioning System Receivers*

Jason-1 (12/2001 – 7/2013) & Jason-2 (6/2008-Present)



<http://sealevel.jpl.nasa.gov/missions>



Quantity:
Sea Level Height

- ❑ Polar, Sun-Synchronous Orbit, Global Coverage
- ❑ 10-day Repeat Time
- ❑ Focus on Ice-free Oceans
- ❑ Sensors:
 - Poseidon Altimeter (C- and Ku-band)*
 - Jason Microwave Radiometer (JMR) (Jason-1)*
 - Advance Microwave Radiometer (AMR) (Jason-2)*
 - DORIS Doppler tracking antenna*
 - Global Positioning System*
 - Laser Retroreflector array*

Altimeter Data used to observe Lake Levels

Earth System Models Provide Value-added Information



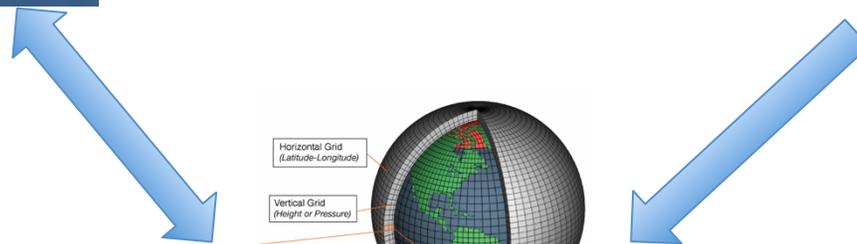
Remote Sensing + Surface Observations + Numerical Models



Satellite Data



Surface Measurements and In-Situ Data



Numerical Models

NASA Models Useful for Water Resources Management

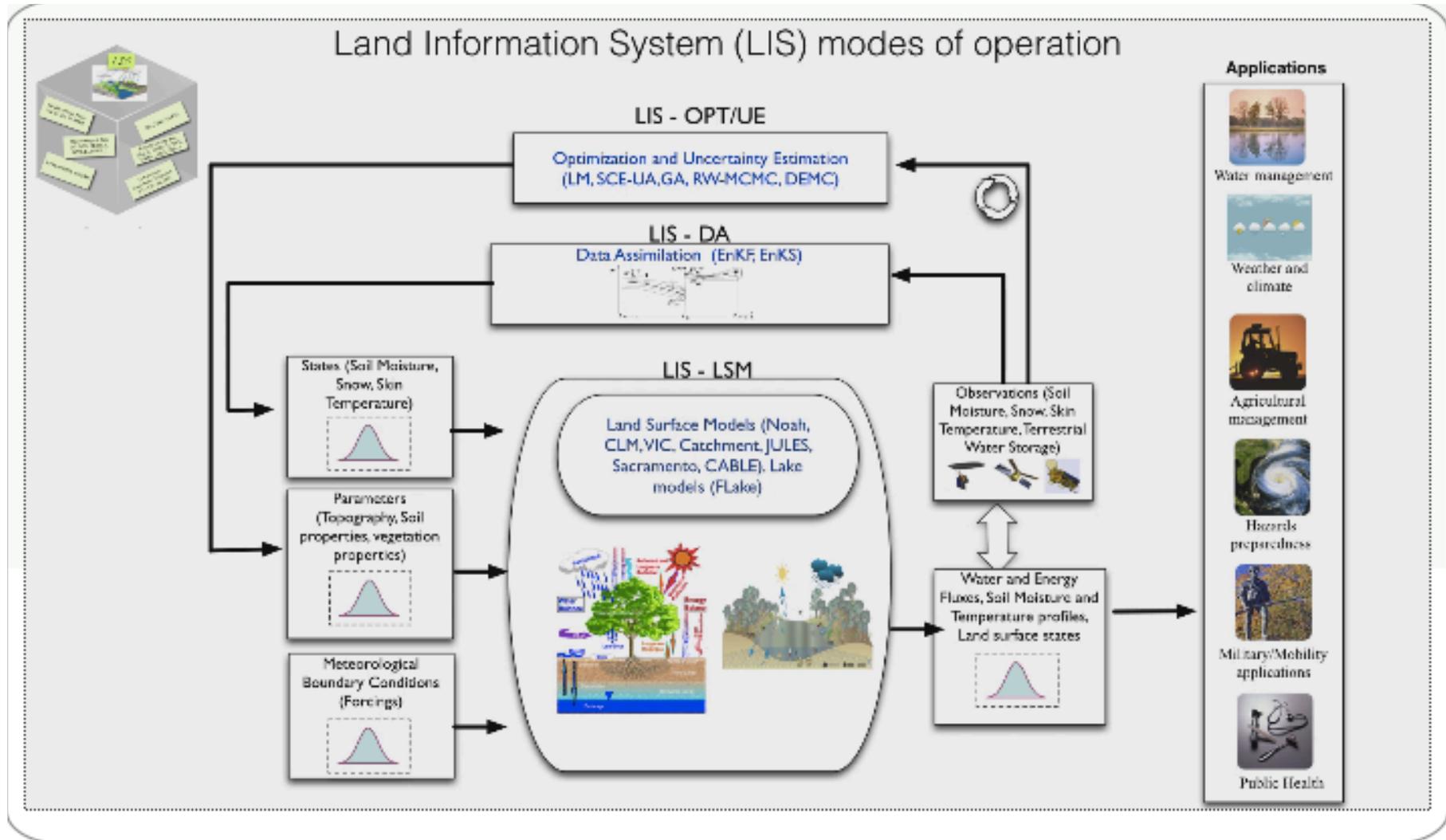


(Atmosphere-Ocean-Land Models)

- **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

Land Information System (LIS)

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



Global Land Data Assimilation System(GLDAS) North American Land Data Assimilation System (NLDAS)

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

Integrate ground and satellite observations within sophisticated numerical models to produce physically consistent, high resolution fields of land surface states and fluxes

GLDAS and a Version of NLDAS use LIS with Different Sources of Inputs

Meteorological Analysis
Surface Solar Radiation
Precipitation
Soil Texture
Vegetation Classification and Leaf Area Index
Topography

Integrate Output for Water Resources

Soil Moisture
Evapotranspiration
Surface/Sub-surface Runoff
Snow Water Equivalent

Satellite Data used in LDAS: MODIS, TRMM ,GOES

This Training will Focus on the Following Satellites and Models for Monitoring Freshwater Components



- ❑ Rain Amount (TRMM, GPM)
- ❑ Snow Cover (Terra and Aqua MODIS)
- ❑ Soil Moisture (SMAP, NLDAS/GLDAS)
- ❑ Evapotranspiration (Terra and Aqua MODIS, Landsat, NLDAS/GLDAS)
- ❑ Runoff/Streamflow (TRMM,GPM, NLDAS/GLDAS)
- ❑ Lake Level Height (Jason-2)

This Training will Focus on the Following Satellites and Models for Monitoring Freshwater Components



- ❑ Rain Amount (TRMM, GPM)
- ❑ Snow Cover (Terra and Aqua MODIS)
- ❑ Soil Moisture (SMAP, NLDAS/GLDAS)
- ❑ Runoff/Streamflow (TRMM,GPM, NLDAS/GLDAS)
- ❑ Lake Level Height (Jason-1 and -2)
- ❑ Evapotranspiration (Terra and Aqua MODIS, Landsat, NLDAS/GLDAS)
- ❑ Terrestrial Water (GRACE)
- ❑ Regional Water Budget (NLDAS/GLDAS)

Week-2

Week-3

Week-4

Week-5

This Training will Focus on the Following Satellites and Models for Monitoring Freshwater Components



- ❑ Rain Amount (TRMM, GPM)
- ❑ Snow Cover (Terra and Aqua MODIS)
- ❑ Soil Moisture (SMAP, NLDAS/GLDAS)
- ❑ Run Off/Streamflow (TRMM,GPM, NLDAS/GLDAS)
- ❑ Lake Level Height (Jason-1 and -2)
- ❑ Evapotranspiration (Terra and Aqua MODIS, Landsat, NLDAS/GLDAS)
- ❑ Terrestrial Water (GRACE)
- ❑ Regional Water Budget (NLDAS/GLDAS)

Week-2

Week-3

Week-4

Week-5



Data Search, Access, Analysis, and Visualization Tools

There are Multiple Web-based Tools for Water Resources Data Search, Analysis, and Download



Mirador

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

Precipitation, LDAS -Run Off, Soil Moisture, ET

Reverb-ECHO

<http://reverb.echo.nasa.gov/reverb>

Selected Water Resources Data

Giovanni-4

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

Geospatial Interactive Online Visualization And aNalysis Infrastructure -- Selected Data Access [Precipitation, LDAS – Run Off, Soil Moisture, ET]

PPS-STORM

<https://storm.pps.eosdis.nasa.gov/storm>

Precipitation Processing Systems - Science Team
On-Line Request Module [Precipitation]

NSIDC, JPL Snow Server

<http://nsidc.org>

<http://snow.jpl.nasa.gov/portal/data/map/>

Snow Cover

GFMS

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

Global Flood Monitoring System [Run Off/Streamflow]

USDA

Crop Explorer

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

[/cropexplorer/global_reservoir](http://www.pecad.fas.usda.gov/cropexplorer/global_reservoir)

Reservoir Height



Water Resources Data Applications



Water Resources Data Applications

Freshwater components crucial for the following Activities

Water Allocation

Water Budget
including all
the freshwater
components

Agricultural and Irrigation Management

Precipitation
Soil Moisture
Evapotranspiration

Flood/Drought Management

Precipitation
Runoff/
Streamflow
Soil Moisture
Evapotranspiration
Ground Water

Reservoir/Dam Management

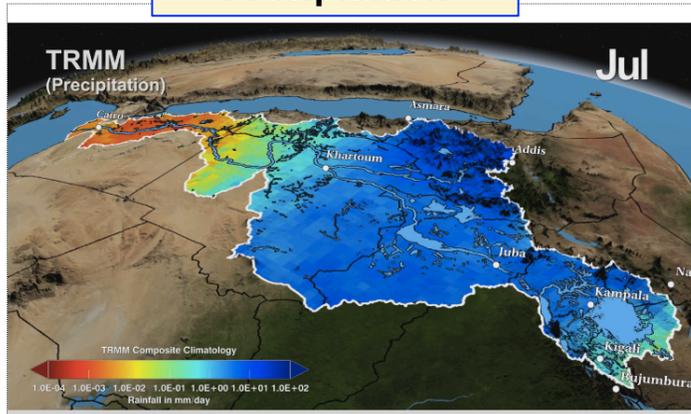
Reservoir Height
Precipitation
Runoff/
Streamflow

NASA Observations and Modeling Systems Offer Capabilities to Monitor Water Balance in the Nile Basin

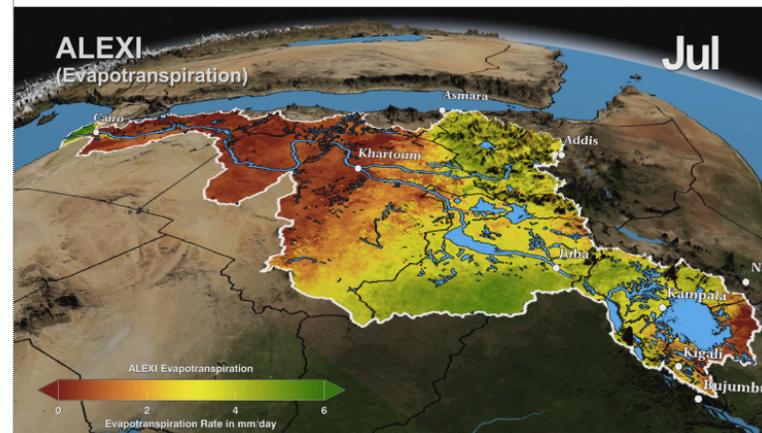


<http://svs.gsfc.nasa.gov/cgi-bin/details.cgi?aid=4044>

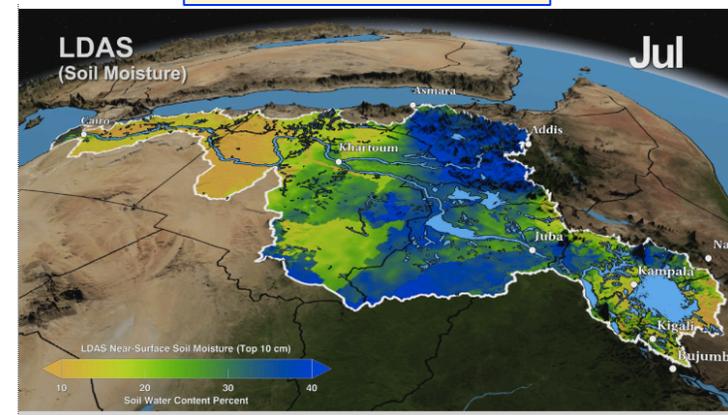
Precipitation



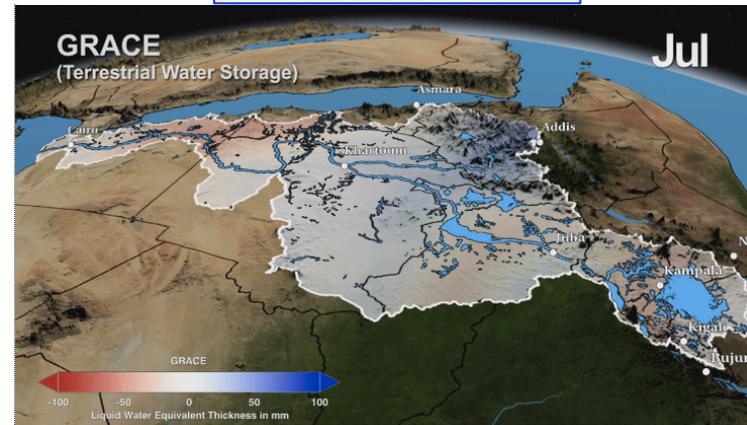
Evapotranspiration



Soil Moisture



Terrestrial Water

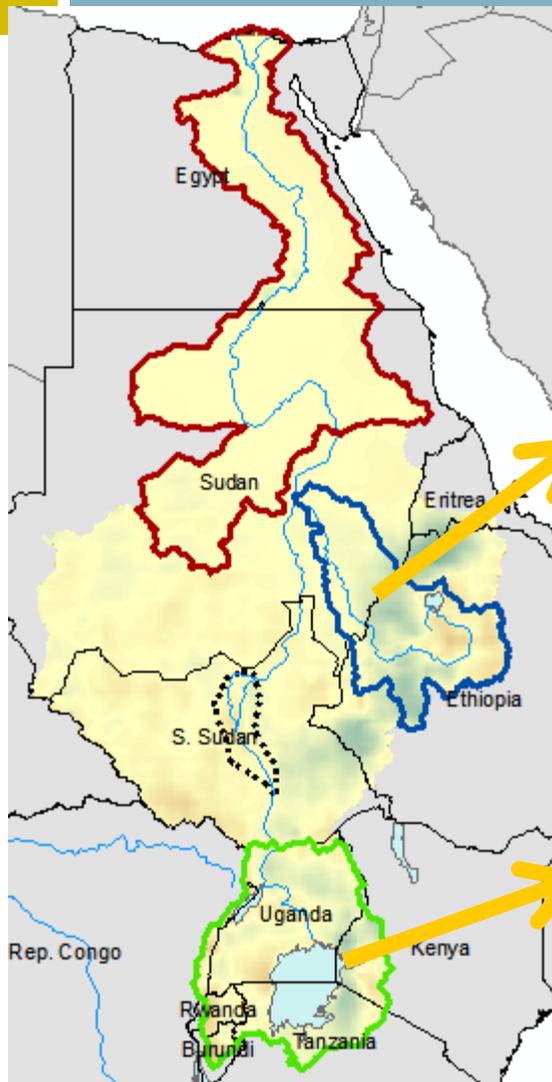


Applied Sciences Project Scientist: Ben Zaitchik (Johns Hopkins University)

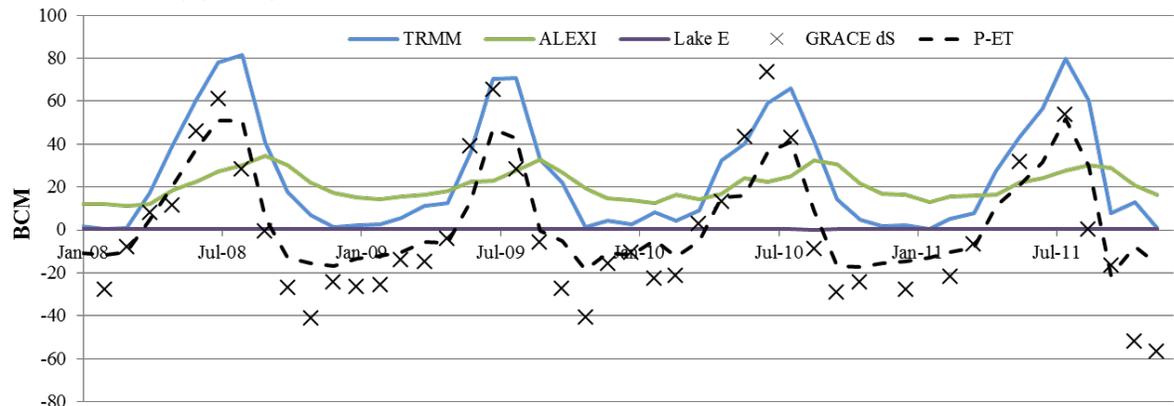


Nile - Basin Scale Water Balance

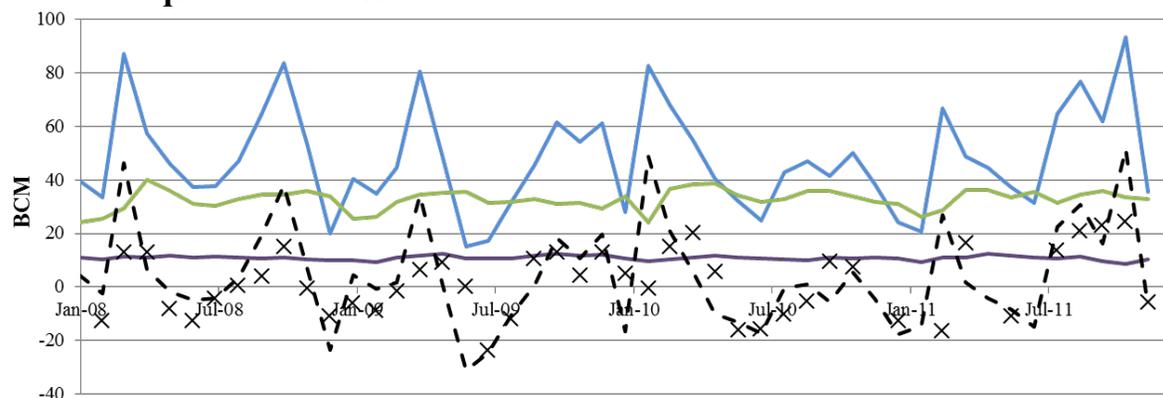
Collaborators and Stakeholders: Egyptian Ministry of Water Resources and Irrigation, Cairo, Egypt; Water Resource Planning and Management Project, The Nile Basin Initiative, Addis Ababa, Ethiopia; Arab Water Council, Cairo, Egypt; The World Bank



A: Blue Nile



B: Equatorial Lakes



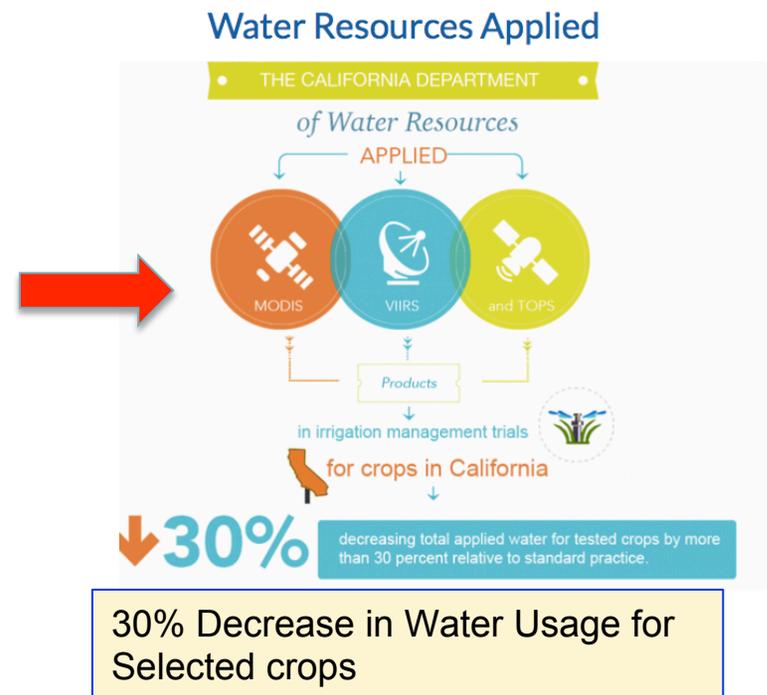
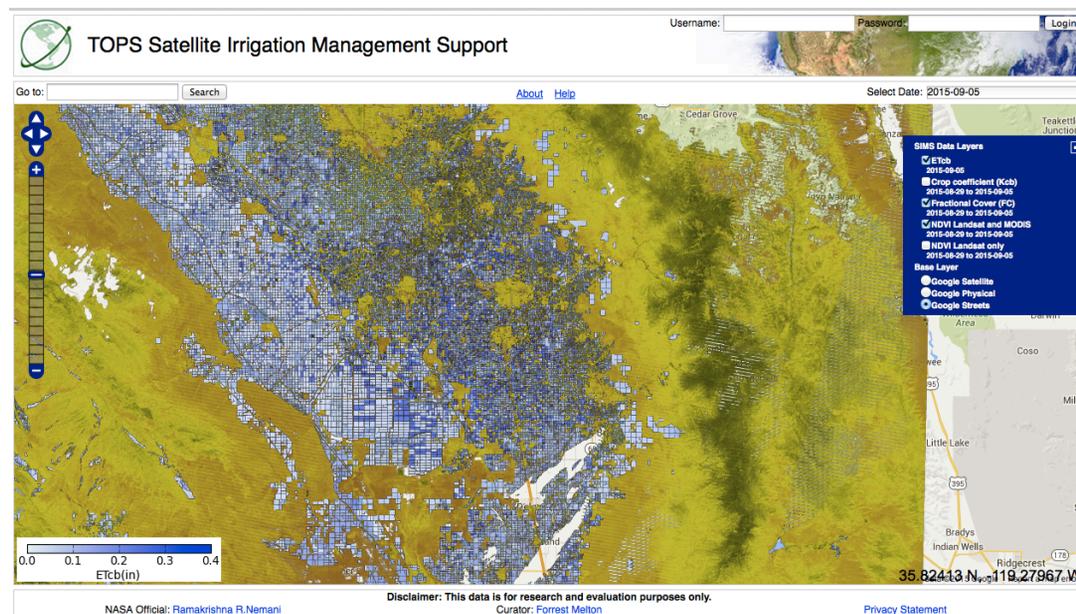
Courtesy: Ben Zaitchik (Johns Hopkins University)



Irrigation Management Using Satellite-based ET

<http://ecocast.arc.nasa.gov/dgw/sims/>

Collaborators and Stakeholders: California Department of Water Resources, Western Growers Association, University of California Cooperative Extension, USDA Agricultural Research Service, NOAA National Weather Service, Tanimura & Antle, Farming D Ranch, Pereira Bros. & Sons, Booth Ranches, Fresh Express, Ryan Palms Farms, Del Monte, Inc., Constellation Wines, E. & J. Gallo, Meyer Farms



<http://appliedsciences.nasa.gov/programs/water-resources-program>

Project Scientist : Forrest Melton, NASA ARC-CREST / California State University

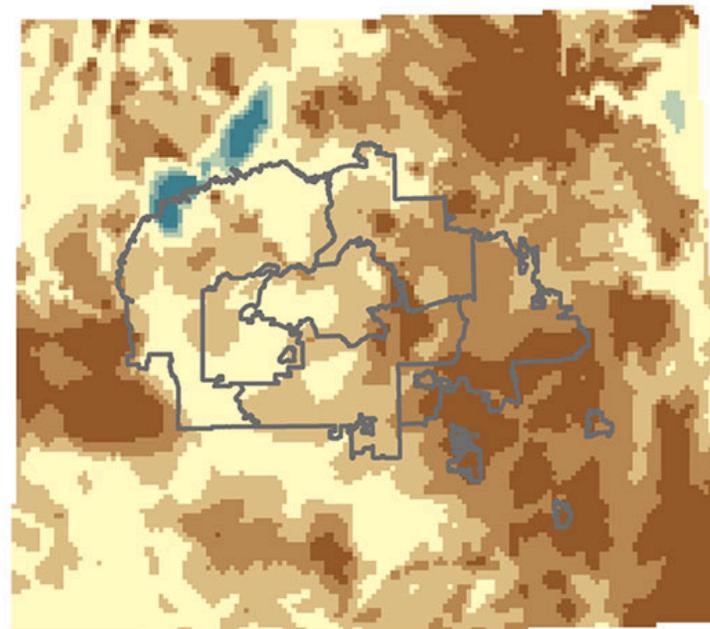
A Drought Monitoring Decision Support Tool for the Navajo Nation



http://develop.larc.nasa.gov/2015/summer_term/NavajoNationClimateII.html

Stakeholders: Navajo Nation

Based on Precipitation Index from TRMM and GPM



April 2014

- Extremely Dry
- Severely Dry
- Moderately Dry
- Near Normal
- Moderately Wet
- Severely Wet
- Extremely Wet

A Drought Monitoring Decision Support Tool for Customized Calculation of a Standardized Precipitation Index Value in the Navajo Nation

LOCATION
NASA Ames Research Center

National Drought Monitoring with GRACE Terrestrial Water Data



<http://drought.unl.edu/MonitoringTools/NASAGRACEDataAssimilation.aspx>



Monitoring Tools > NASA GRACE Data Assimilation

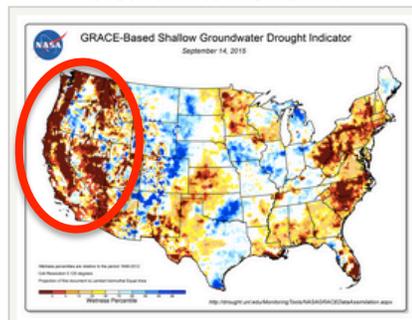
Login

Groundwater and Soil Moisture Conditions from GRACE Data Assimilation

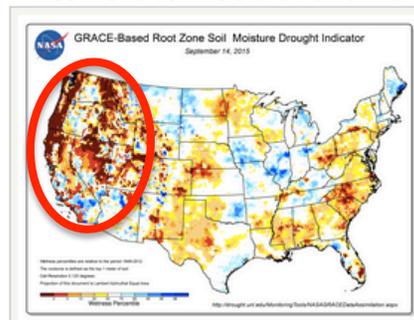
These are experimental products that are still being evaluated and improved. We encourage your specific, constructive feedback as this phase of development proceeds.

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.

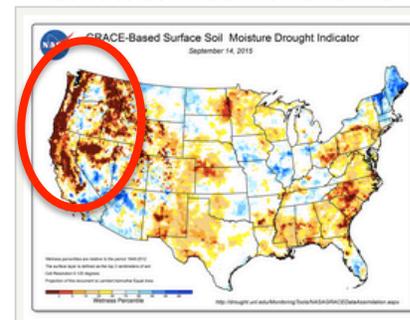
Groundwater Percentile



Root Zone Soil Moisture Percentile



Surface Soil Moisture Percentile



Products are currently being evaluated

NASA Satellites Allow USDA to See World's Lakes Rise and Fall

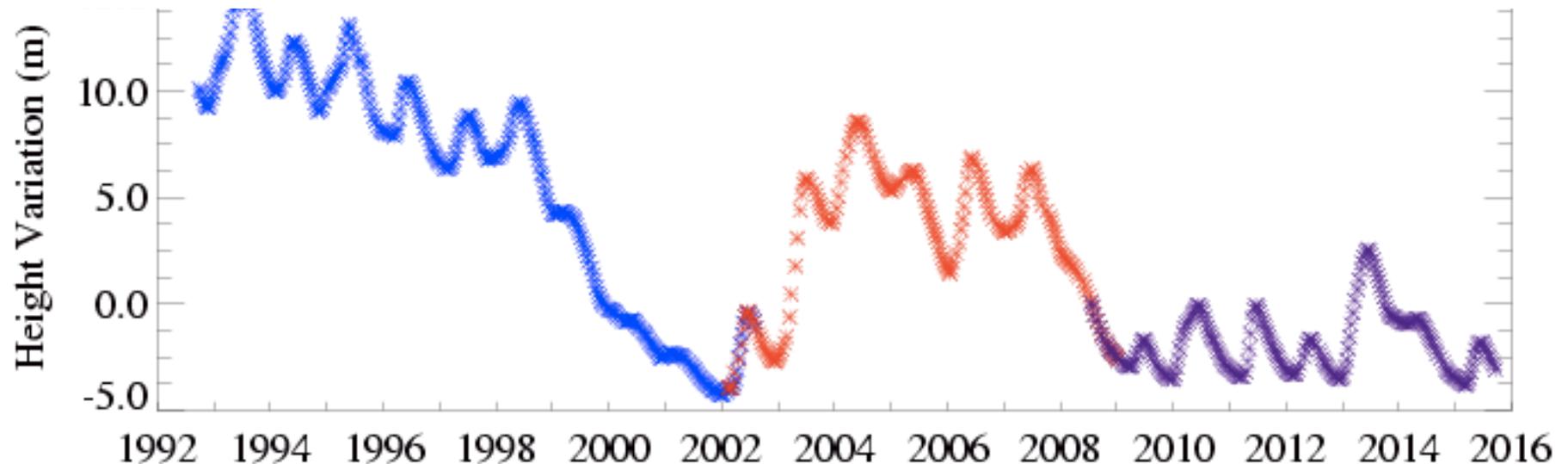


http://www.pecad.fas.usda.gov/cropexplorer/global_reservoir/



Lake Tharthar Height Variations

Jason-2 Geo-referenced 20Hz Along Track Reference Pass 133 Cycle 70



*** TOPEX/Poseidon historical archive

*** Jason-1 Interim GDR 20hz altimetry

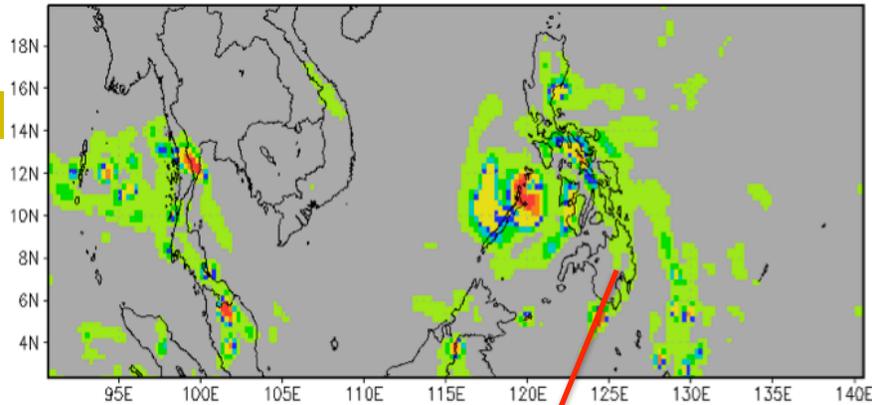
*** OSTM Interim GDR 20hz altimetry(ice mode)

Version TPJO.2

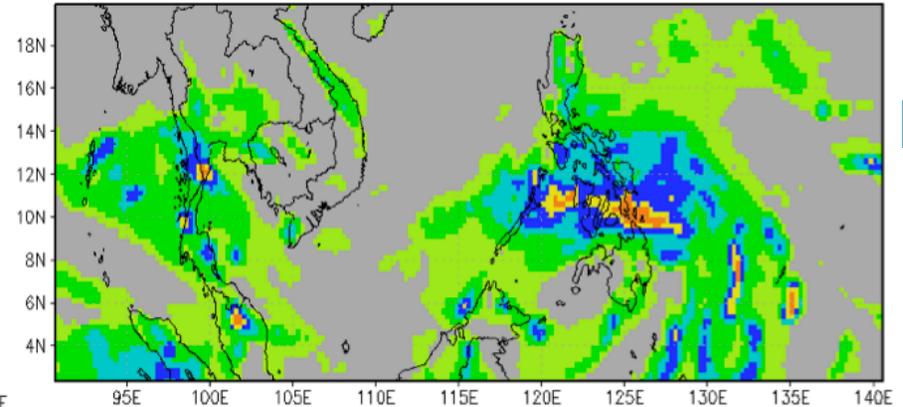
Last valid elevation: 16 Sep., 2015

Streamflow Estimates, Flood Detection, Landslide Estimation

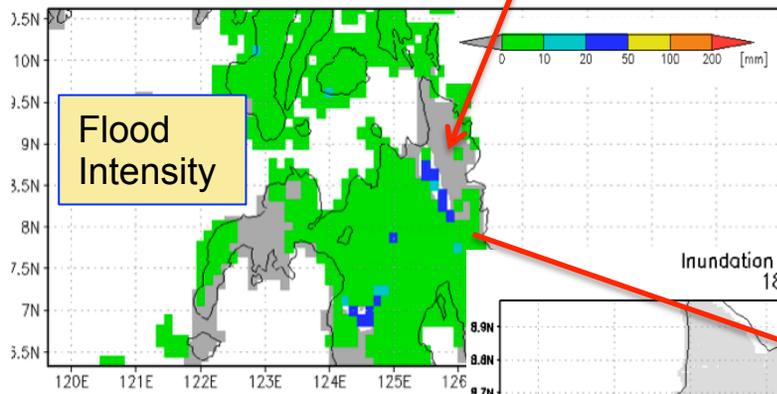
Rainfall (Instantaneous) [mm/h] 12Z08Nov2013



Rainfall (1-day accum.) [mm] 12Z08Nov2013

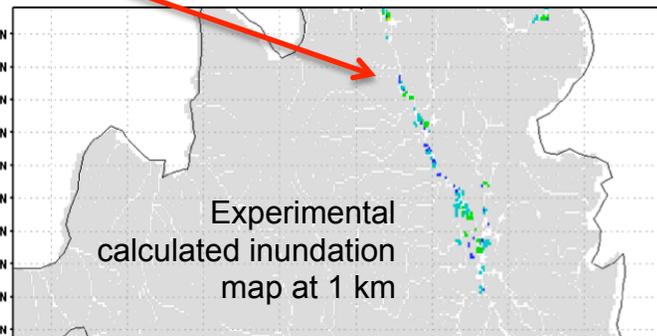


Flood Detection/Intensity (depth above threshold [mm]) 18Z07Nov2013



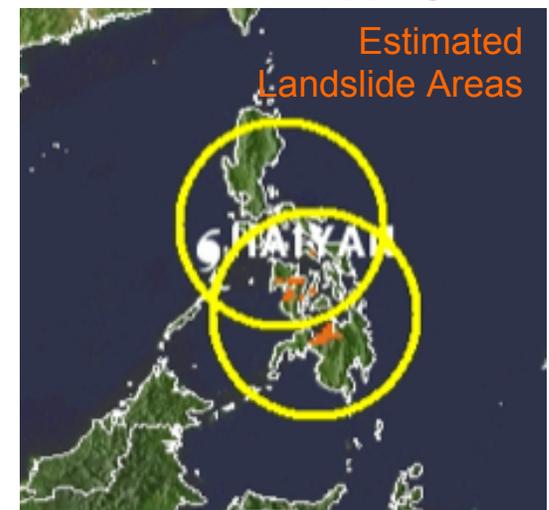
Using TRMM Precipitation in a Hydrological Model Typhoon Haiyan produced rainfall up to about 300 mm. Flooding estimated from Haiyan and previous rainfall along with landslides. **GPM will enable high resolution (compared to TRMM) flood detection and mapping.**

Inundation map 1km res. [mm] 18Z07Nov2013



flood.umd.edu

Adler/Wu
U. of Maryland



Courtesy: Dalia Kirschbaum, *GPM Applications Science Lead*



Home Work

Please review the presentation on “**Fundamentals of Remote Sensing**” before the next session:

<https://arset.adobeconnect.com/fundrsession1/event/registration.html>

Complete the following on-line Assignment by **November 15, 2015:**

https://docs.google.com/forms/d/1xDzBArgzUMsh3-JoIBacWBw1l_QWZG6IrtKpkV-KDp0/viewform



Coming Up Next Week

- ❑ Overview of NASA Precipitation and Soil Moisture Data
- ❑ Live Demonstration of Precipitation and Soil Moisture Data Access



Thank You!

Amita Mehta

email: amita.v.mehta@nasa.gov