



# Building Capacity in Utilizing NASA Remote Sensing Observations in SWAT for Water Resources and Agricultural Management Applications

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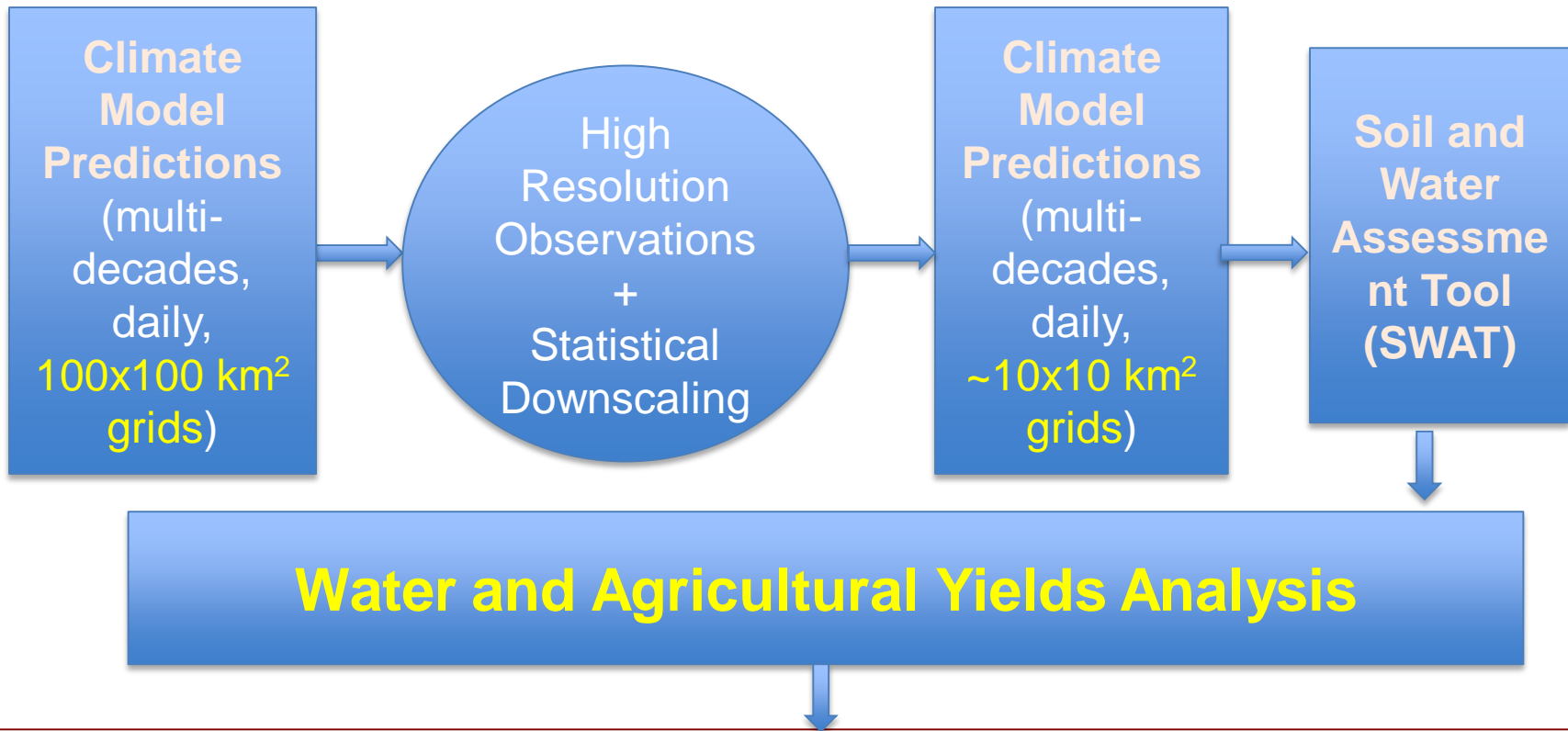




# Impacts Assessment of Decadal Climate Variability on Water and Crop Yields in the Missouri River Basin (MRB)



A multi-institution project (CRCES, Texas A&M, UMBC-JCET, NDMC)



Economic Impact assessment over MRB  
Development of management strategy over MRB



# Objectives

- Provide an overview of weather, climate, and land parameters based on NASA remote sensing observations relevant for SWAT inputs and useful for verification for SWAT simulations
- Engage the SWAT users community in discussing possibilities of developing joint capacity building trainings in using NASA remote sensing data in SWAT for regional decision support activities



# Outline

## Overview of:

- Applied Remote Sensing Training (ARSET) Program
- Data products from NASA satellites and atmosphere-land models
- How to request on-line and/or on-site trainings for data information and access

# NASA Applied Remote Sensing Training Program

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

**GOAL:** Increase utilization of NASA observational and model data for decision-support through training activities for environmental professionals.

**Application Areas:** water resources, disasters, health/air quality, wildfires, and land management.

**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. Major focus on data access

**Train the Trainers:** Courses and training manuals for those interested in conducting their own remote sensing training.



Health and Air Quality



Water Resources



Disasters



Ecological forecasting

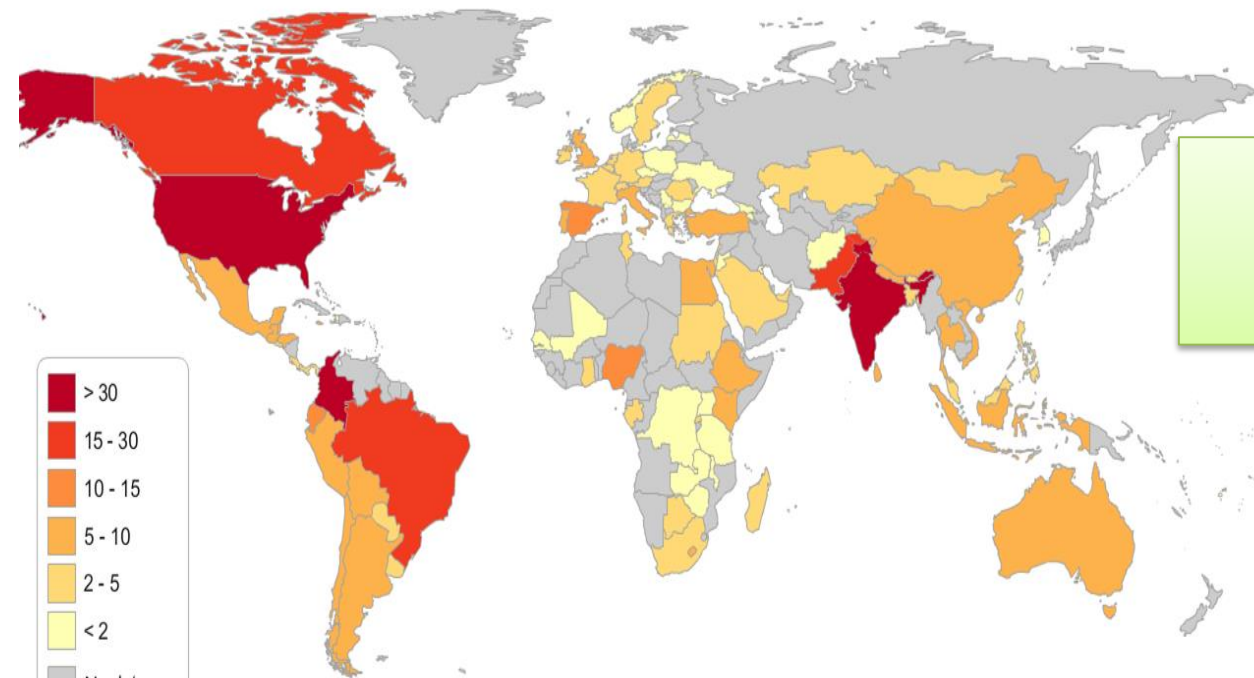
# Online and Hands-on Trainings

- **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 data for various applications



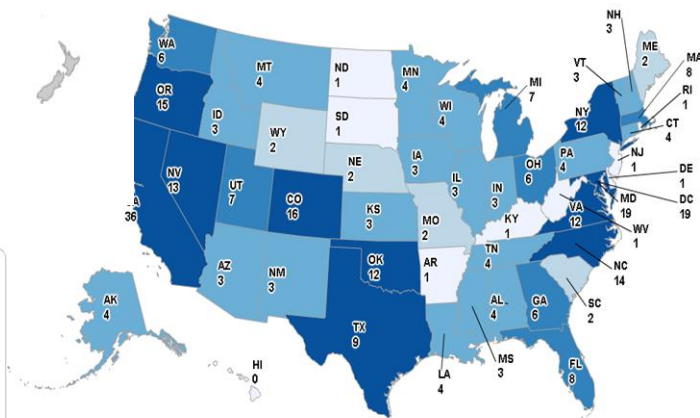


# ARSET: 2009 – 2015



**52 Trainings**  
**3000+ End-users**  
**800+ Organizations**

Number of participating organizations per country (above) and U.S State (right) : Air Quality, Water, Flood, and Land management





# 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 Applied Remote Sensing Training" header with a search bar. A main navigation bar includes "DISASTERS", "ECO FORECASTING", "HEALTH & AIR QUALITY", and "WATER RESOURCES". A red box highlights a secondary menu with the following items: "ARSET", "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 side of the slide that lists these same items in a larger font. 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 contains contact information and dates.

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: Suannish Pearce  
Curator: Ane Pradee

- Science and Exploration  
- Atmospheric Laboratory  
- Hydropheric & Biospheric Laboratory

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## ARSET

[Webinars](#)

[Workshops](#)

[Apply for Training](#)

[Personnel](#)

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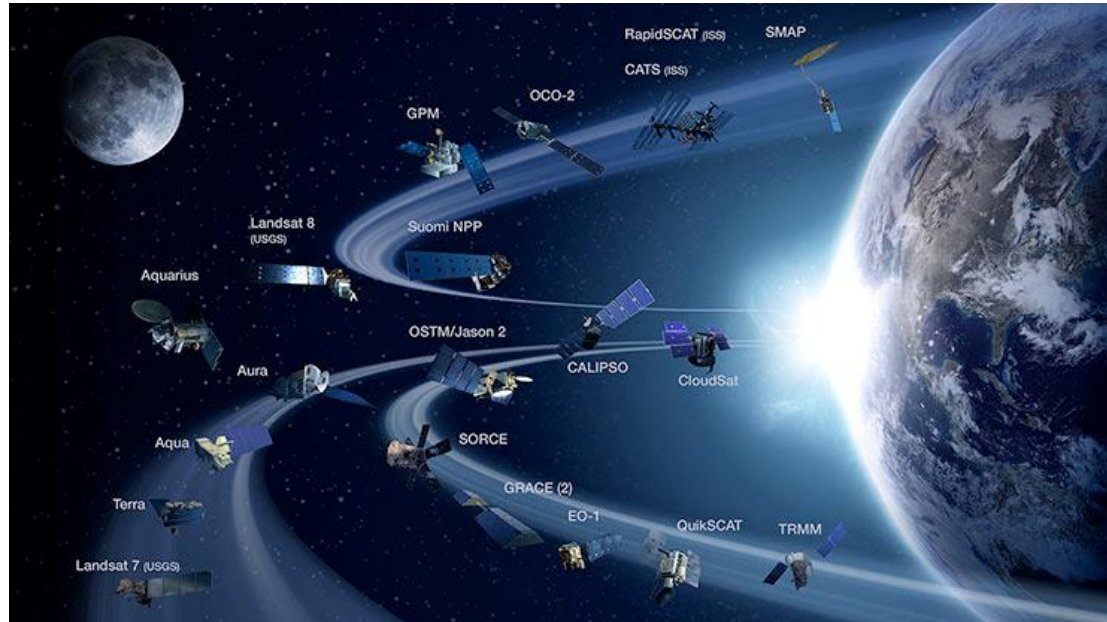
[Upcoming Webinar](#)





# Data Products from NASA Satellites and Atmosphere-Land Models Relevant to SWAT Inputs and Validation

# NASA Earth Observing Satellites for Weather, Climate, and Land Surface Parameters



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

**Landsat** (07/1972-present)

**TRMM** (11/1997-4/2015)

**GPM** (2/27/2014-present)

**Terra** (12/1999-present)

**Aqua** (5/2002-present)

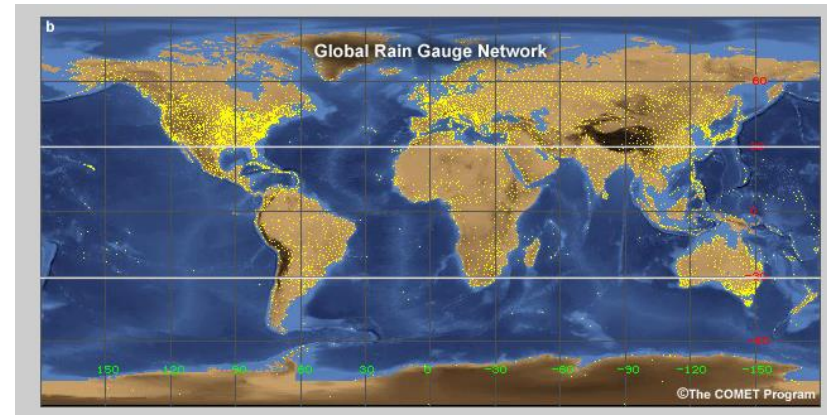
**SMAP** (1/31/2015-present)

**GRACE** (3/2002-present)

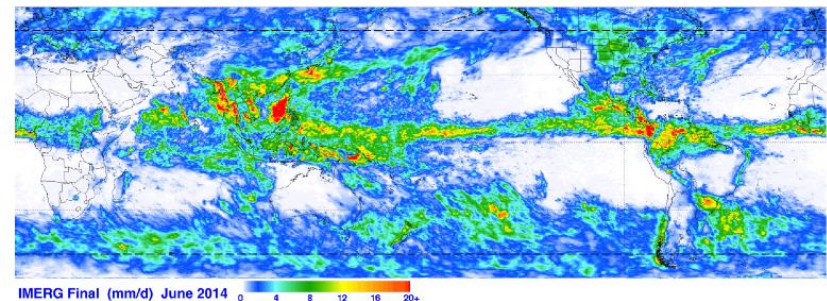
**TOPEX/Poseidon, Jason 1-2-3**  
(1992-present)

# Advantages of Remote Sensing Observations

- Provide information where surface-based measurements are not available and augment existing measurements
- Provide global/near-global coverage with consistent, continuous, large-scale coverage compared to point measurements
- Enhance and improve model performance when assimilated in weather and climate models



Continuous Coverage  
From TRMM Multi-satellite Precipitation



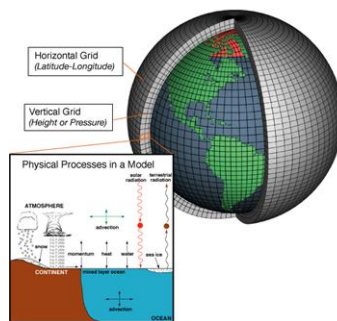
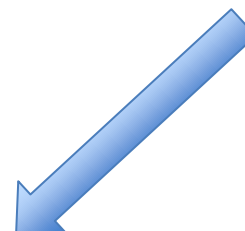
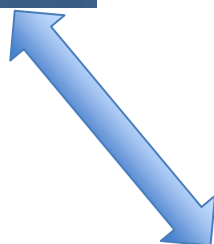
## Remote Sensing + Surface Observations + Numerical Models



Satellite Data



Surface Measurements and In-Situ Data



Numerical Models



# NASA Models for Monitoring Weather and Climate



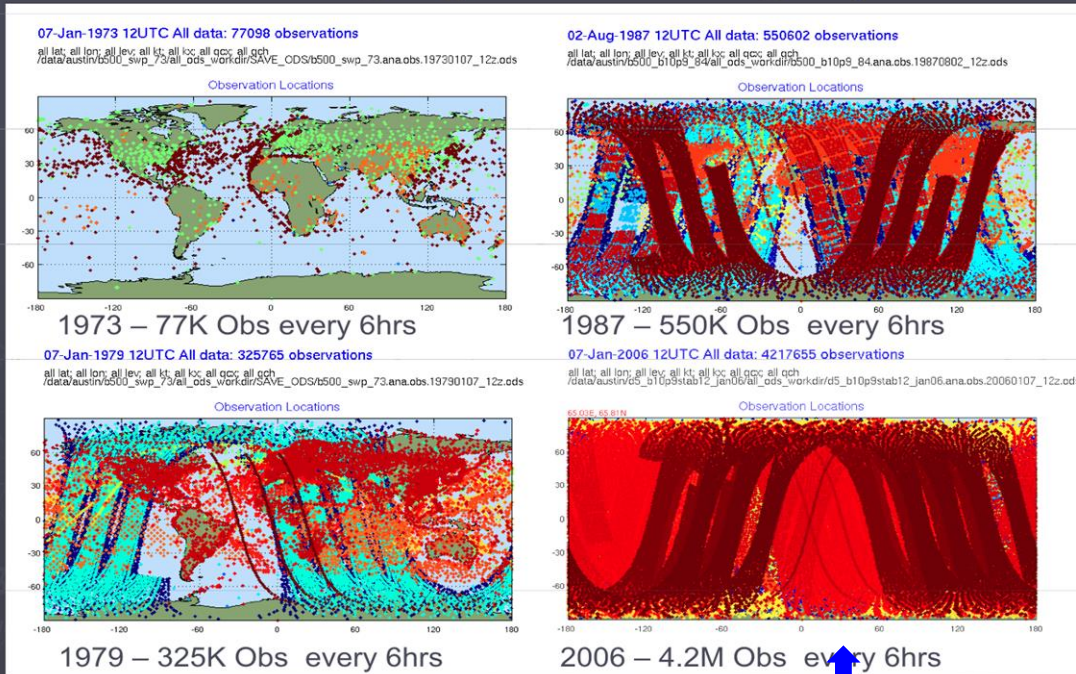
## (Atmosphere-Ocean-Land Models)

- **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



Blends the vast quantities of observational data with output data of the Goddard Earth Observing System (GEOS) model [1979-present]

## The Changing Observing System



Current satellite coverage assimilated in MERRA

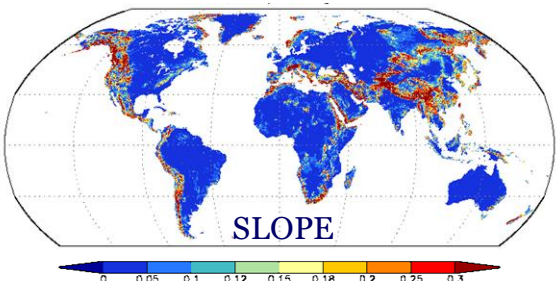
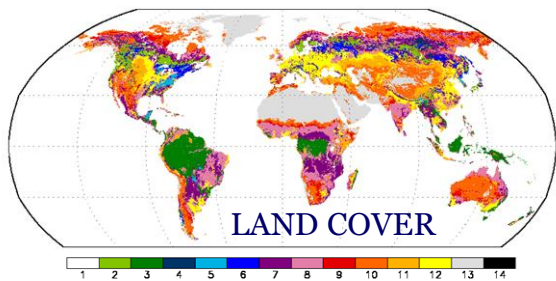
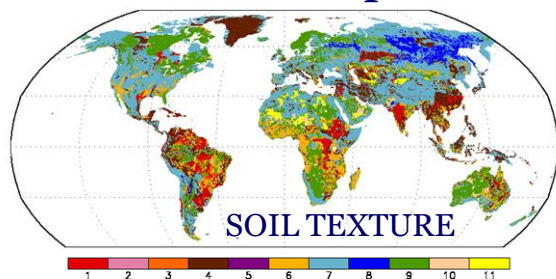


# Global Land Data Assimilation System (GLDAS)

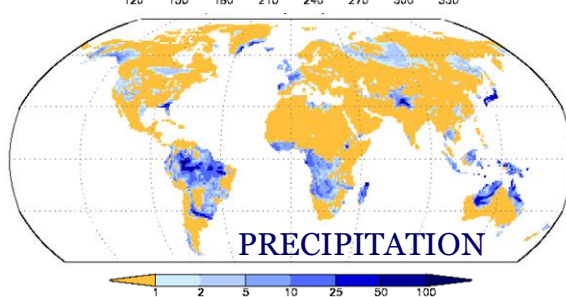
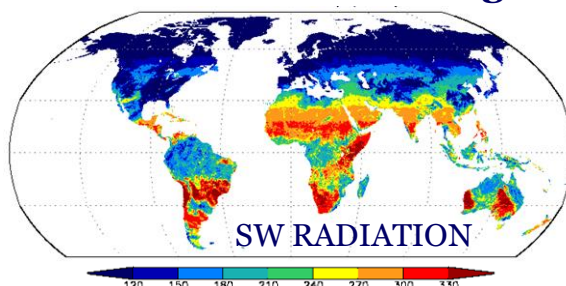


**GOAL:** Integrate ground and satellite observations within sophisticated numerical models to produce physically consistent, high resolution fields of land surface states (e.g., snow) and fluxes (e.g., evaporation)

## Parameter Inputs

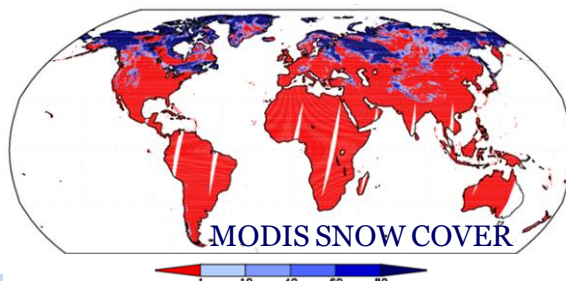


## Satellite Based Forcing



**AVAILABILITY:** Output from 1979-present simulations of Noah (1/4°; 1°), CLM (1°), and Mosaic (1°), and VIC (1°), are available at <http://disc.gsfc.nasa.gov/hydrology/index.shtml>

## Assimilated Observations



**USES:** Weather and climate forecast initialization studies, water resources applications, hydrometeorological investigations

## Integrated Output

**Soil Moisture**  
**Evapotranspiration**  
**Runoff**  
**Snow Water Equivalent**

Courtesy Matt Rodell,  
NASA-GSFC

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



# Primary SWAT Input Parameters

[http://swat.tamu.edu/media/69302/ch01\\_overview.pdf](http://swat.tamu.edu/media/69302/ch01_overview.pdf)

## Watershed Level Input Data (Daily):

Precipitation

*(Rainfall, Snow Fraction and Snow Water Equivalent)*

Maximum and Minimum Temperatures

Solar Radiation

Winds

Relative Humidity

Climate Data



# Additional SWAT Data Parameters

Land Cover

Leaf Area Index

Terrain

Soil Moisture

Ground Water

Lake Level Height



# NASA Data Parameters and Sources Useful for SWAT



Parameter	Source
<input type="checkbox"/> Surface Temperature, Humidity	(Aqua/AIRS, MERRA)
<input type="checkbox"/> Rain	(TRMM, GPM)
<input type="checkbox"/> Winds	(MERRA)
<input type="checkbox"/> Solar Radiation	(Terra, Aqua, NPP – CERES)
<input type="checkbox"/> Soil Moisture	(GLDAS, SMAP)
<input type="checkbox"/> Snow Cover	(Terra and Aqua MODIS)
<input type="checkbox"/> Snow Water Equivalent	(GLDAS)
<input type="checkbox"/> Terrain	(Shuttle Radar Topography Mission, Terra/ASTER)
<input type="checkbox"/> Ground Water	(GRACE, GLDAS)
<input type="checkbox"/> Land Cover	(Landsat, Terra and Aqua/MODIS)
<input type="checkbox"/> Leaf Area Index	(Terra and Aqua MODIS)
<input type="checkbox"/> Run Off, ET	(GLDAS)
<input type="checkbox"/> Lake Levels	(TOPEX/Poseidon, Jason-Altimeters)





# Temperature and Rainfall Data Required for SWAT Input



Parameter	Source	Spatial Resolution and Coverage	Temporal Resolution and Coverage
Rainfall (uniformly gridded by space/time averages of multiple satellites and sensors)	TRMM	0.25°x0.25°, Global 50°S-50°N	3-hourly, Daily, 11/1997-4/2015
	GPM	0.1°x0.1°, Global 65°S-65°N	Half-hourly, Daily, 2/2015-Present
Temperature	MERRA	1.25°x1.25°, Global	Hourly, 1979-Present
	Aqua/AIRS	1.0°x1.0°, Global	Twice-daily, 5/2002-Present

Note: Most Data Products can be Imported into ArcMap



# Multiple Data Access Tools are Available

Tools	Data Formats	Analysis and/or Visualization	Data Download
Mirador <a href="http://mirador.gsfc.nasa.gov">http://mirador.gsfc.nasa.gov</a>	HDF5, OPenDAP (can be converted to ASCII, Binary, NetCDF)	N/A	Batch Download
Giovanni <a href="http://giovanni.gsfc.nasa.gov/giovanni/">http://giovanni.gsfc.nasa.gov/giovanni/</a>	NetCDF, GeoTIFF, PNG	Visualization: Map, Time Series, Scatter Plot Histogram Analysis: Time-averaged Maps, Time Series, Scatter Plot, Map Correlations, Vertical Profiles, Time-averaged Differences	Download by Select and Click on Data Files
PPS/STORM <a href="https://storm.pps.eosdis.nasa.gov/storm">https://storm.pps.eosdis.nasa.gov/storm</a>	HDF5, PNG	Map Visualization, Interactive Latitude/Longitude Point Data Value Display	FTP



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NSIDC <a href="http://nsidc.org/">http://nsidc.org/</a>	HDF5, GeoTIFF,, Binary (Data Product Dependent)	Data Search And Images	FTP  Download Via Reverb
Reverb-ECHO <a href="http://reverb.echo.nasa.gov/reverb">http://reverb.echo.nasa.gov/reverb</a>	HDF, Image	Map Visualization	Batch Download Possible
LP DAAC/USGS Earth Explorer, GloVIS, <a href="https://lpdaac.usgs.gov/">https://lpdaac.usgs.gov/</a> <a href="http://glovis.usgs.gov/">http://glovis.usgs.gov/</a> <a href="https://lpdaac.usgs.gov/data_access/usgs_earthexplorer">https://lpdaac.usgs.gov/data_access/usgs_earthexplorer</a>	Image, GeoTIFF,	Visualization Image and Data Download	Batch Download Possible



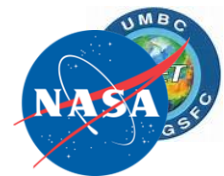
# How to Request On-line and/or On-site Trainings for Data Information and Access

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

ARSET can design trainings according to your interests/needs, application areas, and geographic regions

The screenshot shows the ARSET website interface. At the top, there are navigation tabs for 'DISASTERS', 'ECO FORECASTING', 'HEALTH & AIR QUALITY', and 'WATER RESOURCES'. Below these is a sidebar menu with the following items: 'ARSET', 'Webinars', 'Workshops', 'Apply for Training', 'Personnel', 'Links', and 'Upcoming Webinar'. A red box highlights the 'Apply for Training' option, with a red arrow pointing down to a larger, detailed view of the same menu. The main content area of the website is titled 'Applied Remote Sensing Training' and contains text about the project's goals and activities, including sections for 'Webinars (Free)', 'In-Person Courses', and 'Skills Taught'.

This block shows a detailed view of the ARSET navigation menu. The items listed are: 'ARSET', 'Webinars', 'Workshops', 'Apply for Training', 'Personnel', 'Links', and 'Upcoming Webinar'. A red box highlights the 'Apply for Training' option.



# ARSET ListServ

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

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





# Summary

**Many of the input parameters used by SWAT are **freely** available from NASA remote sensing and modeling activities**

There are multiple sources of data with different spatial/temporal resolutions and coverage (*Landsat:30 m/16days, GPM:5 to 10 km/half-hourly, GLDAS and MERRA: 12 km to 125 km/hourly to daily, GRACE -150000 km<sup>2</sup>/monthly*)

*Multiple data access tools are available*

Data pre-processing may be required for using them in SWAT

ARSET can provide introductory and advanced trainings to SWAT user-groups to build capacity in using NASA earth science data for SWAT simulations and validation

**ARSET seeks opportunities for conducting workshops and trainings for SWAT end-users**



# Thank You!