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

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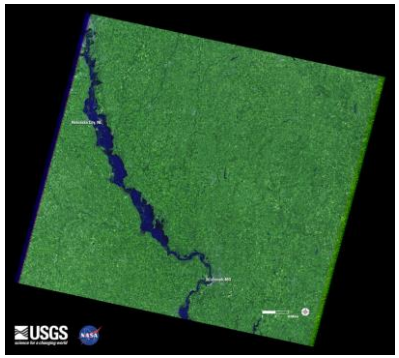
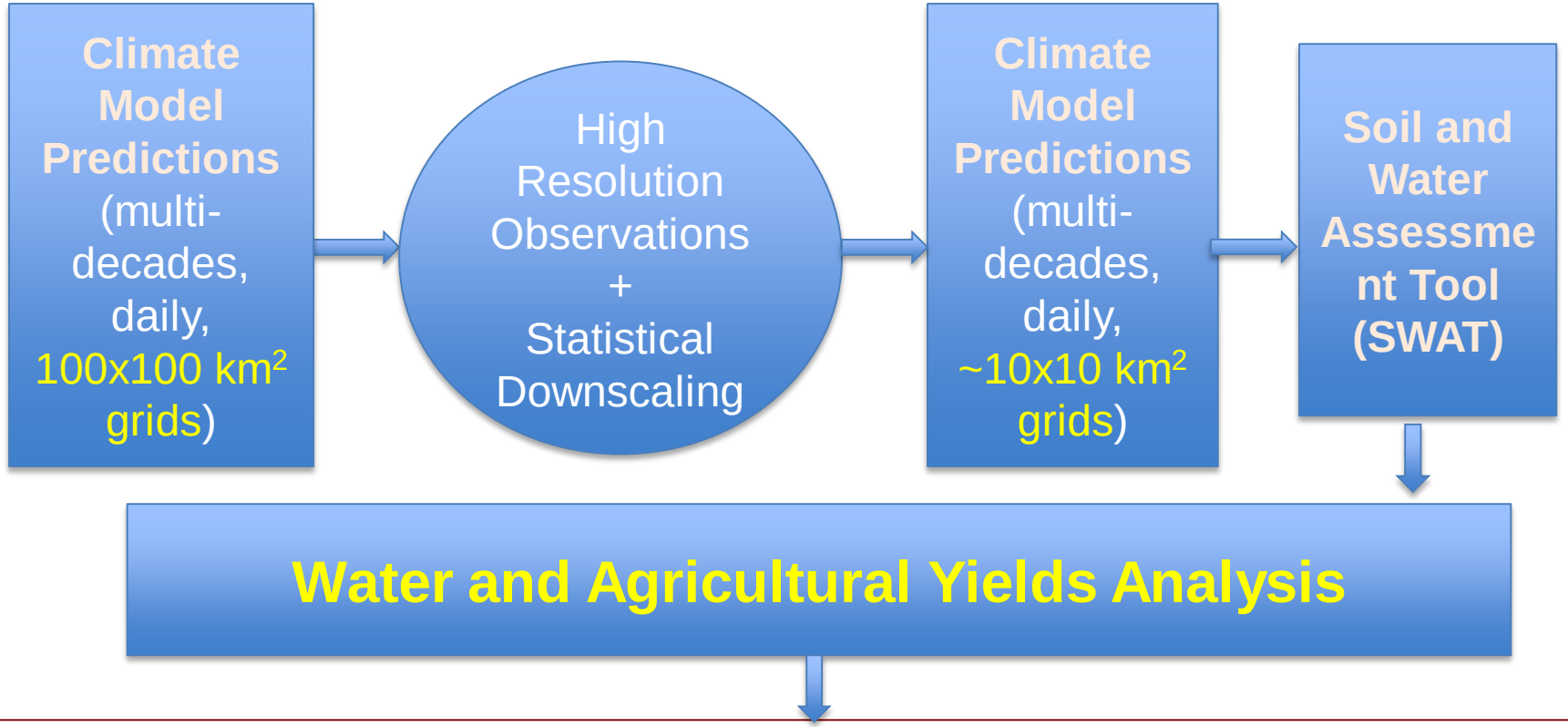


Impacts Assessment of Decadal Climate Variability on Water and Crop Yields in the Missouri River Basin (MRB)

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.

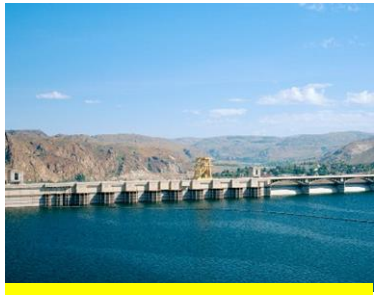
Application Areas: water resources, disasters, health/air quality, wildfires, and land management.

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

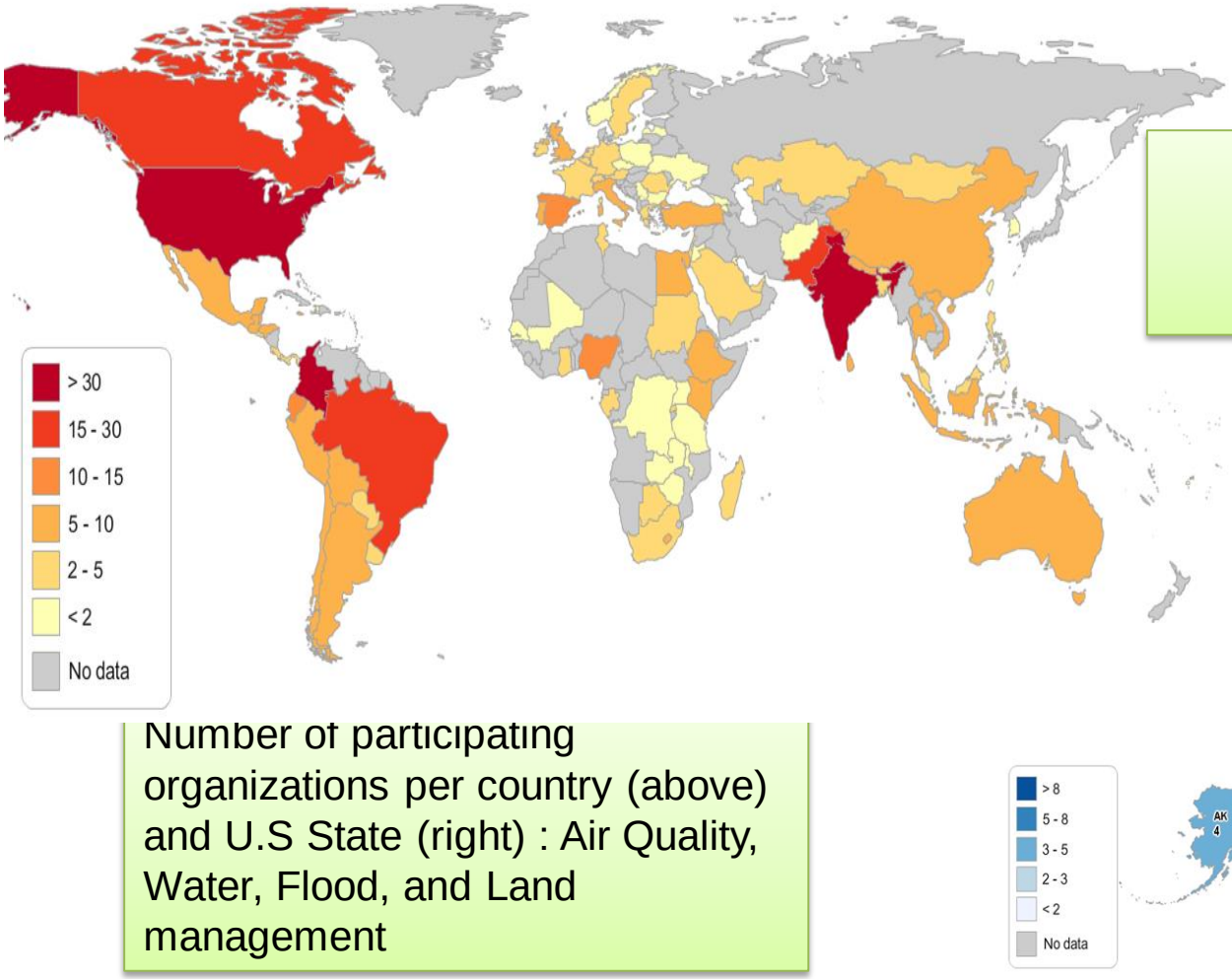
Disasters

Ecological forecasting

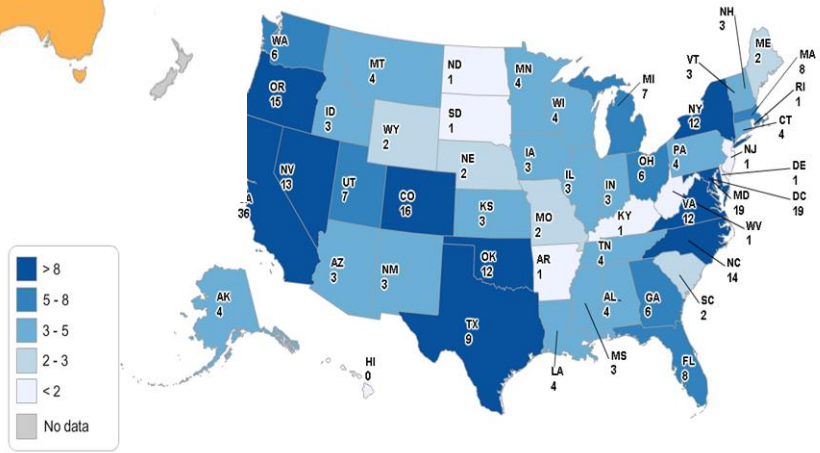
Online and Hands-on Trainings

- **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/

ARSET
Webinars
Workshops
Apply for Training
Personnel
Links
Upcoming Webinar

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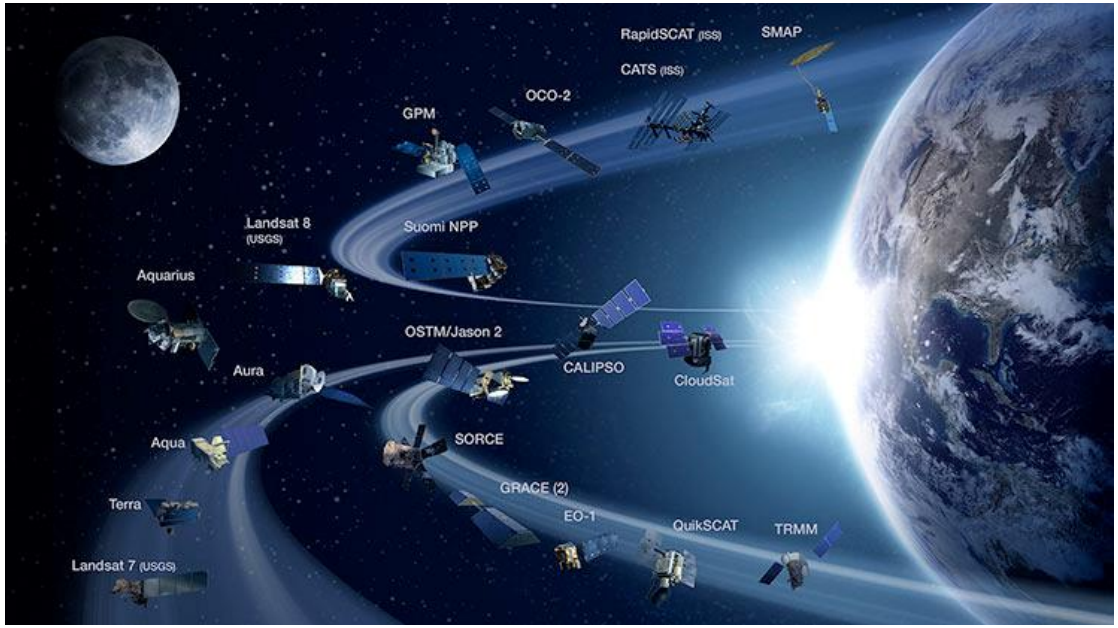
Data Products from NASA Satellites and Atmosphere-Land Models Relevant to SWAT Inputs and Validation

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)

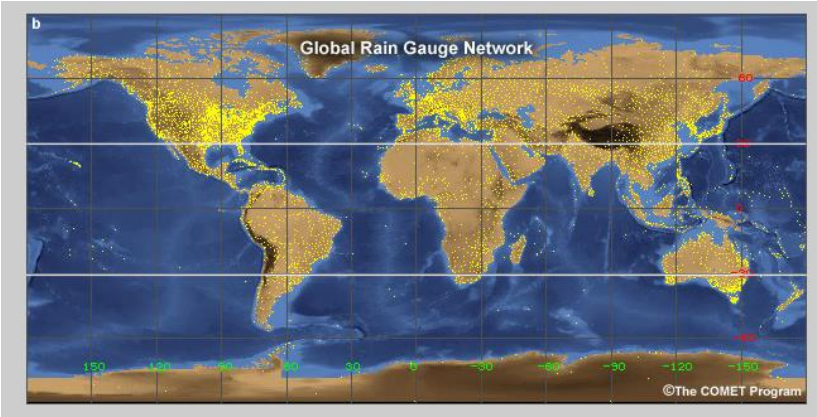
SMAP (1/31/2015-present)

GRACE (3/2002-present)

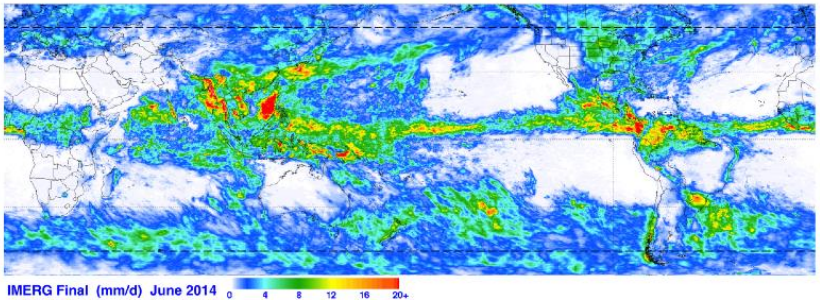
TOPEX/Poseidon, Jason 1-2-3 (1992-present)

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

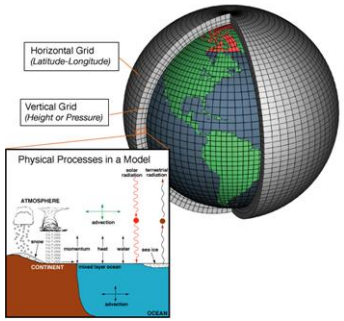


NASA Models Provide Value-added Information For Weather, Climate, and Land Parameters

Remote Sensing + Surface Observations + Numerical Models

Satellite Data

Surface Measurements and In-Situ Data



Numerical Models

NASA Models for Monitoring Weather and Climate

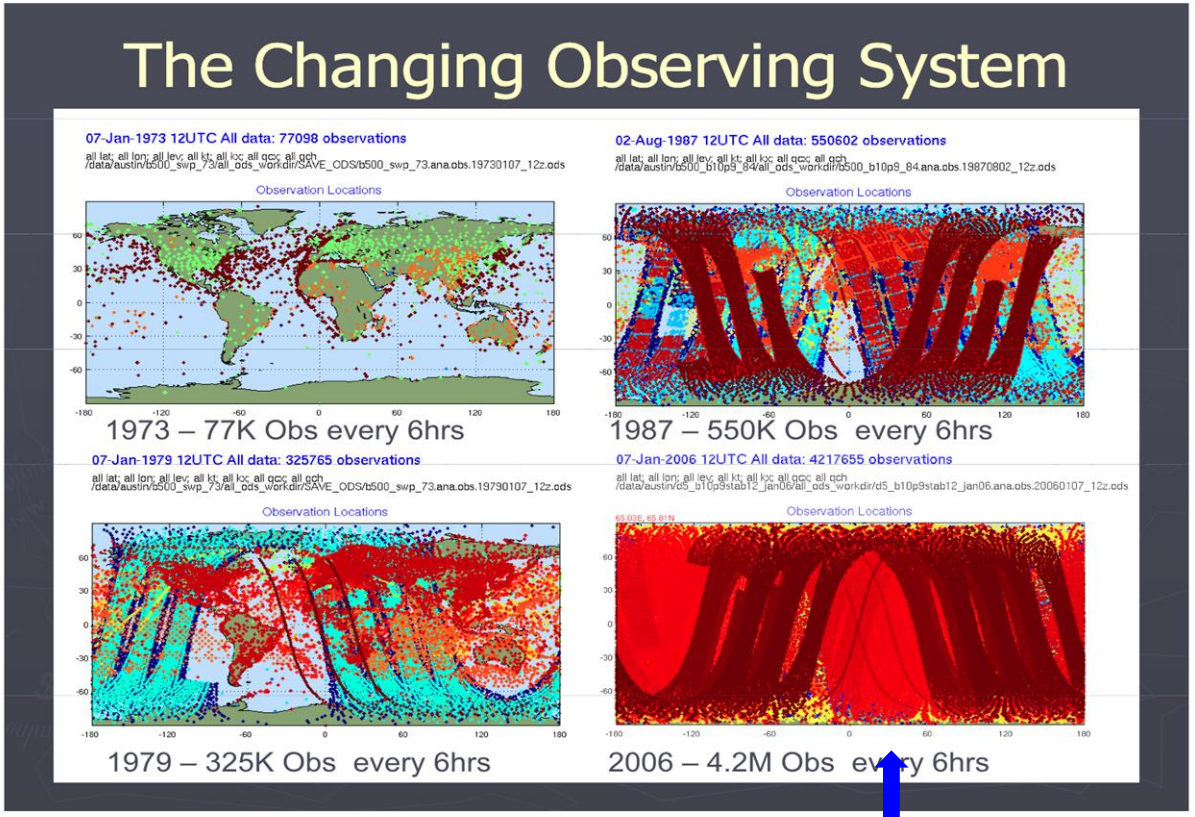
(Atmosphere-Ocean-Land Models)

- 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

MERRA

http://gmao.gsfc.nasa.gov/merra/

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

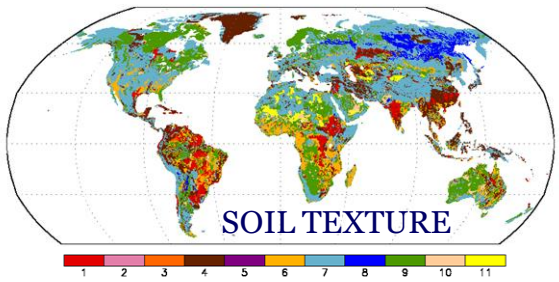


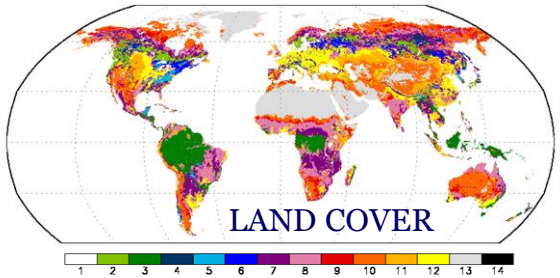
Current satellite coverage assimilated in MERRA

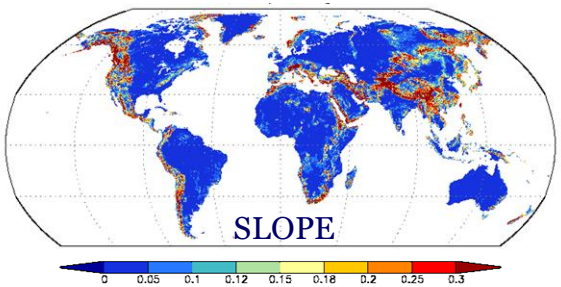
Global Land Data Assimilation System (GLDAS)

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)

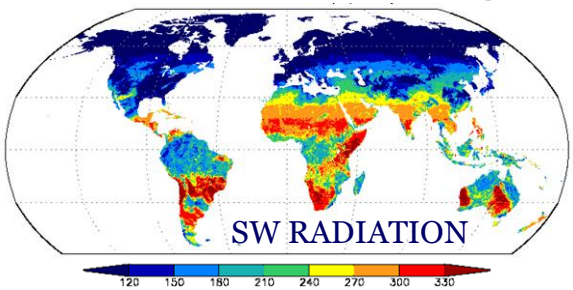
Parameter Inputs

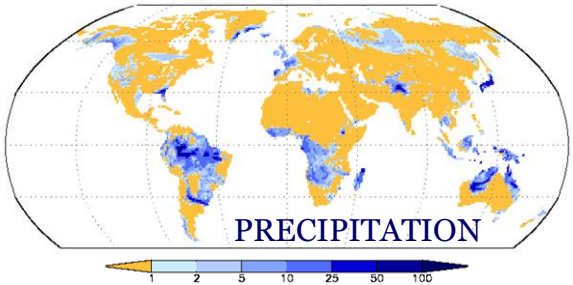






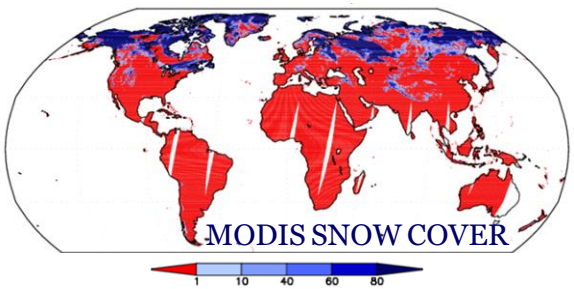
Satellite Based Forcing





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

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
❑ Surface Temperature, Humidity	(Aqua/AIRS, MERRA)
❑ Rain	(TRMM, GPM)
❑ Winds	(MERRA)
❑ Solar Radiation	(Terra, Aqua, NPP – CERES)
❑ Soil Moisture	(GLDAS, SMAP)
❑ Snow Cover	(Terra and Aqua MODIS)
❑ Snow Water Equivalent	(GLDAS)
❑ Terrain	(Shuttle Radar Topography Mission, Terra/ASTER)
❑ Ground Water	(GRACE, GLDAS)
❑ Land Cover	(Landsat, Terra and Aqua/MODIS)
❑ Leaf Area Index	(Terra and Aqua MODIS)
❑ Run Off, ET	(GLDAS)
❑ 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 http://mirador.gsfc.nasa.gov	HDF5, OPenDAP (can be converted to ASCII, Binary, NetCDF)	N/A	Batch Download
Giovanni http://giovanni.gsfc.nasa.gov/giovanni/	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 https://storm.pps.eosdis.nasa.gov/storm	HDF5, PNG	Map Visualization, Interactive Latitude/Longitude Point Data Value Display	FTP

Multiple Data Access Tools are Available

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

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^2 /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!