

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



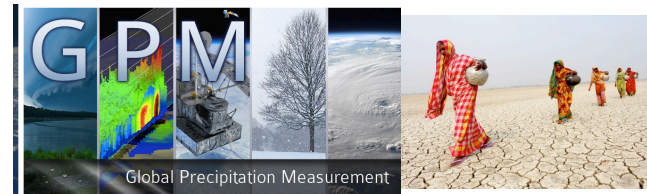
Webinar Outline

Week 1



NASA Remote Sensing Data and Applications for Water Resources Management

Week 2



Precipitation and Soil Moisture Data

Week 3



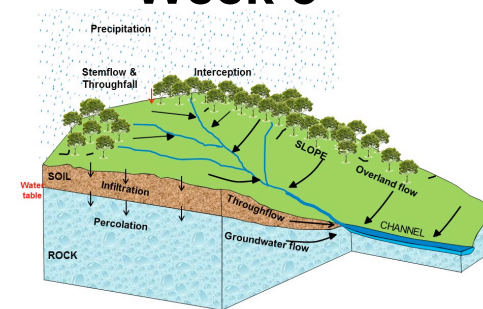
Run off, Streamflow and Reservoir Level Data

Week 4

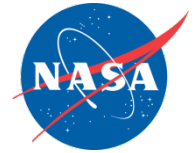


Evapotranspiration and Ground Water Data

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:

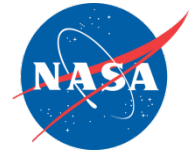
- David Barbato (ARSET): barbato1@umbc.edu

General Inquiries about ARSET:

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

ARSET Website

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



Resources

Search

ARSET

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

Fundamentals of Remote Sensing

NEW On-Demand Training on Fundamentals of Remote Sensing

Presentations and Recordings

Week	Date	Title	Presentation	Recording	Homework
1	10/13/2015	NASA Satellite Missions and Land-Atmosphere Models Relevant to Water Resources Management	English Spanish	Week-1 Recording	Homework-1 due 15 November 2015
2	10/20/2015	Overview of Precipitation and Soil Moisture Data			
3	10/27/2015	Overview of Run off /Streamflow and Reservoir Height Data			
4	11/3/2015	Overview of Evapotranspiration and Ground Water Data			
5	11/10/2015	Land Data Assimilation for Regional Water Budget Estimation and Case Studies with GIS Applications			

Agenda for Week-3



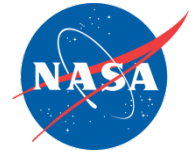
Overview of Run Off/Streamflow and Lake Level Height

- Run Off/Streamflow Data and Access
- Lake Level Height Data and Access



Run Off and Streamflow Data

Surface and Sub-surface Run Off Channel Run Off or Streamflow

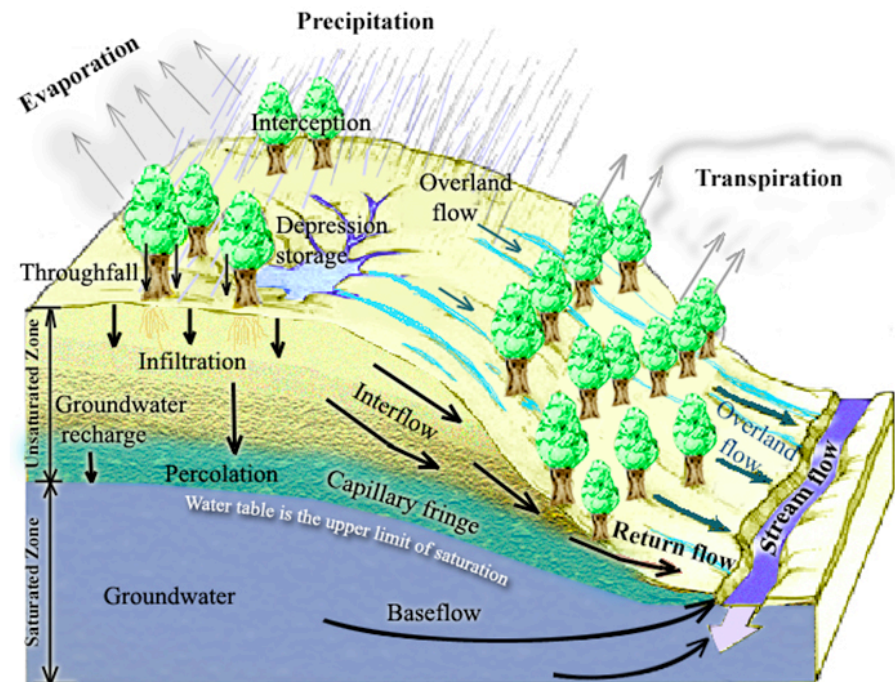


Run Off

- Excess water from rain and/or snowmelt
- Depends on soil saturation and infiltration capacity, rain/snow melt intensity, terrain

Streamflow

- Flow of water in rivers, streams
- Runoff that carries water from land to ocean



Major components of water cycle –
responsible for erosion, flooding,
water quality



NASA Surface Runoff and Streamflow Data

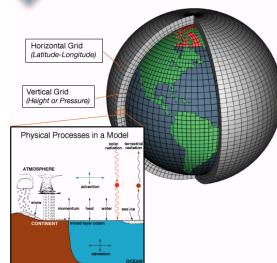
Calculated by using land-atmosphere and Hydrology Models



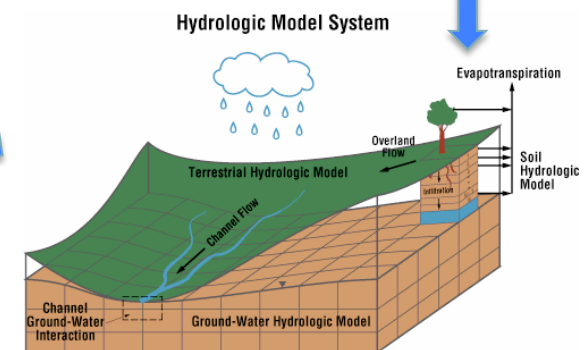
Satellite Data



surface Measurements and In-Situ Data



Atmosphere/
Land Models
For Runoff



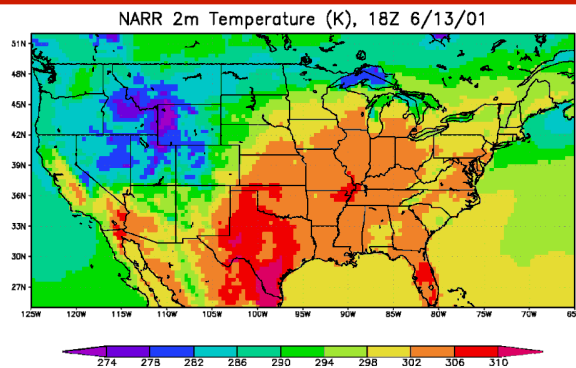
Hydrology Model for
Streamflow

North American Land Data Assimilation System (NLDAS)

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

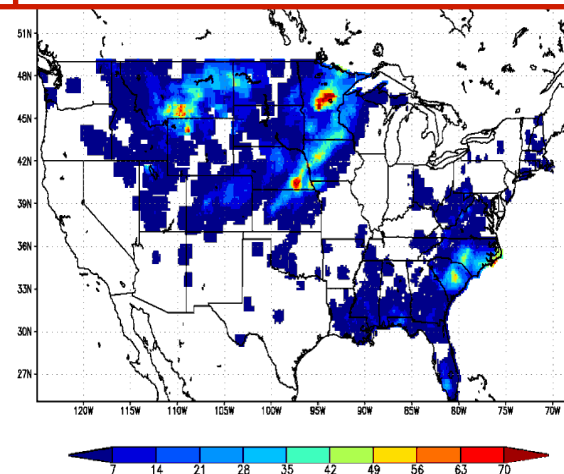
NLDAS combines a high-quality surface forcing dataset and land-surface modeling to produce consistent products

NARR near-surface
meteorology

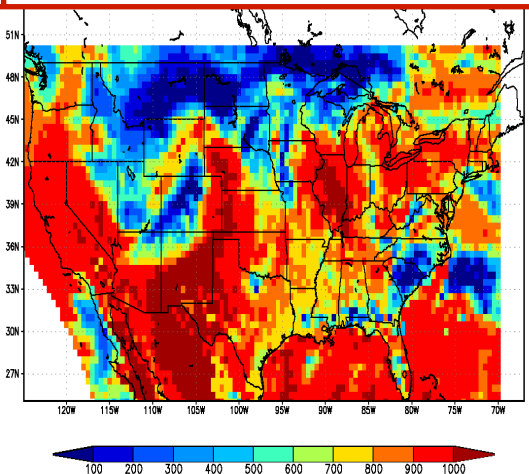


Courtesy: David Mocko NASA-GSFC
david.mocko@nasa.gov

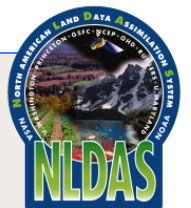
CPC Daily
Precipitation Analysis



Bias-corrected SW
radiation (SRB)

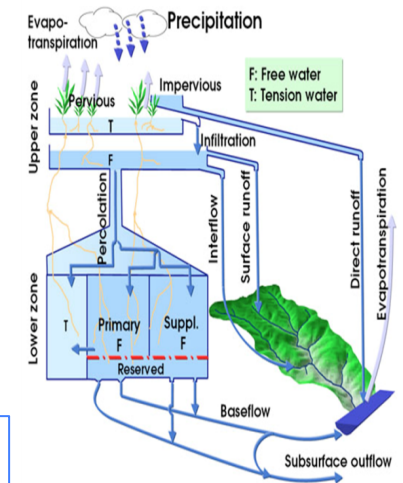
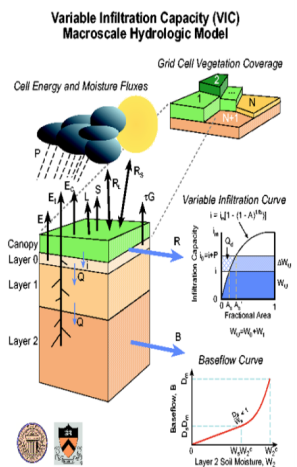
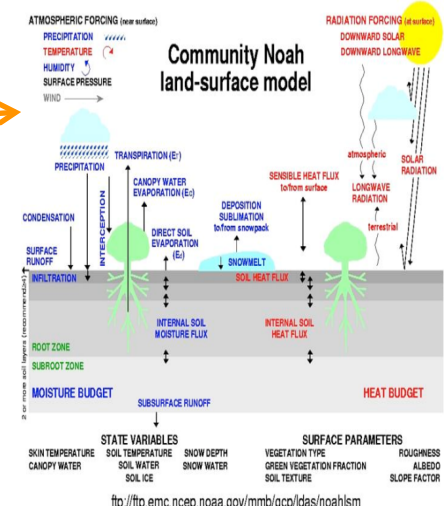
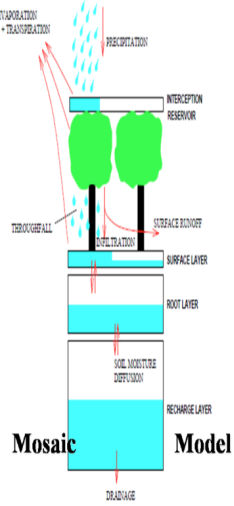
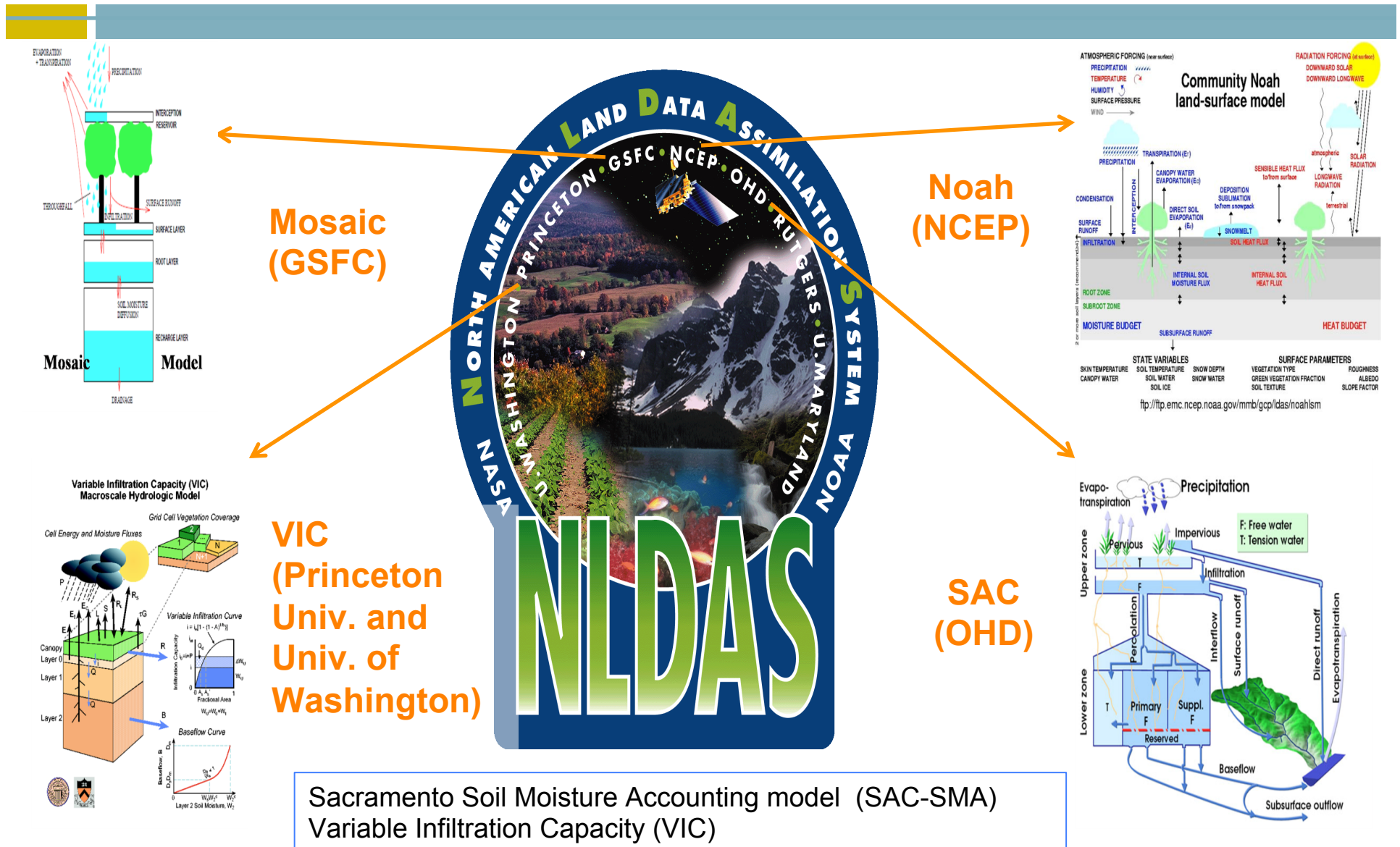


Stage II radar, CMORPH, other precipitation datasets, or NARR used to temporally disaggregate the CPC Daily Analysis into hourly precipitation



Collaboration between NOAA/NCEP/EMC and NASA/GSFC w/ other groups; it runs 4 LSMs (Noah, Mosaic, VIC, & SAC)

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



Sacramento Soil Moisture Accounting model (SAC-SMA) Variable Infiltration Capacity (VIC)

Global Land Data Assimilation System(GLDAS)

<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 uses Different Sources of Inputs (<http://ldas.gsfc.nasa.gov/gldas/GLDASforcing.php>)

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 Multi-satellite Precipitation Analysis, GOES

Rodell, M., et al; The Global Land Data Assimilation System, Bull. Amer. Meteor. Soc., 85(3), 381-394, 2004.

NLDAS & GLDAS Data Availability

<http://disc.gsfc.nasa.gov/hydrology>

- Access via GDS, FTP, or quick-look visualization in Giovanni (below right)
- GRIB and NetCDF formats
- 3-hourly and monthly; 1.0° and 0.25° global grids
- On-the-fly subsetting (below left)
- Full documentation
- NLDAS & GLDAS support a growing number of national and international hydrometeorological investigations and water resources applications

NLDAS

0.125°, 1979-present (operational at NOAA/NCEP, 3.5 day latency), 25 to 53N, -125 to -67W, hourly/monthly: Noah, Mosaic, VIC

GLDAS v1

1.0°, 1979-present (1-2 month latency): Noah, Mosaic, VIC, CLM2
0.25°, 2000-present: Noah w/ MODIS snow cover assimilation

GLDAS v2

1.0° & 0.25°, 1948-2012: Noah

GLDAS v2.1 & v2.2 (coming soon)

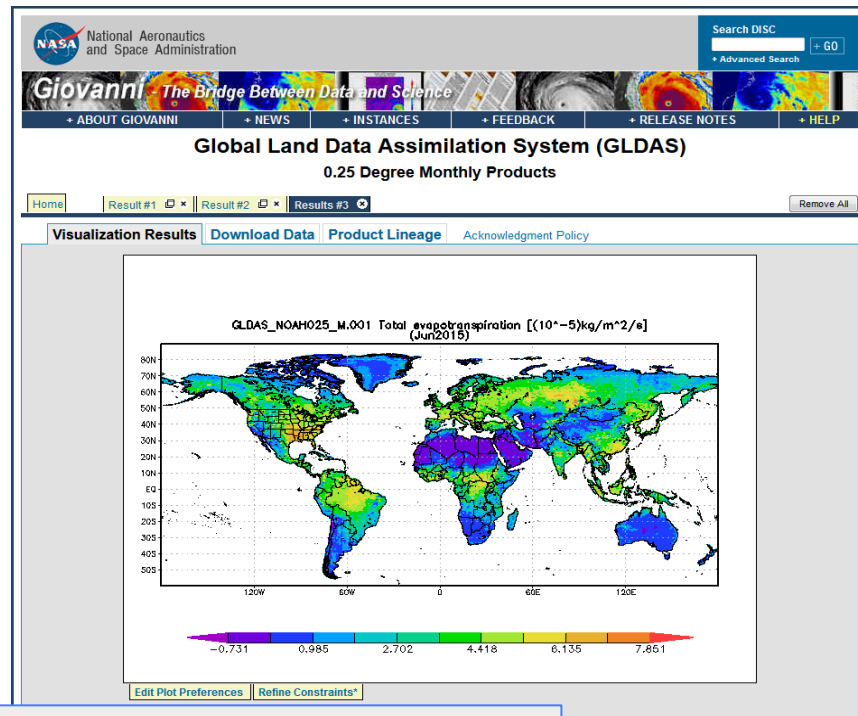
1.0° & 0.25°, 1948-present, with multivariate data assimilation: Noah, Catchment, VIC, CLM4.5

GES DISC Hydrology

Atmospheric Composition, Water and Energy Cycle, and Climate Variability Data

Showing (32) datasets associated with Hydrology...

Image	Dataset	Source	Temporal Resolution	Spatial Resolution	Process Level	Begin Date	End Date
	GLDAS Noah Land Surface Model L4 monthly 0.25 x 0.25 degree Version 2.0 (GLDAS_NOAH025_M.020) - Atmospheric Pressure, Atmospheric Radiation, Atmospheric Temperature	Models/Analyses Noah-LSM	1 month	0.25° x 0.25°	4	1948-01-01	2010-12-31
	GLDAS Noah Land Surface Model L4 monthly 1.0 x 1.0 degree (GLDAS_NOAH10_M.020) - Atmospheric Pressure, Atmospheric Radiation, Atmospheric Temperature	Models/Analyses Noah-LSM	1 month	1° x 1°	4	1948-01-01	2010-12-31
	GLDAS Noah Land Surface Model L4 3 hourly 0.25 x 0.25 degree (GLDAS_NOAH025_3H.020) - Atmospheric Pressure, Atmospheric Radiation, Atmospheric Temperature	Models/Analyses Noah-LSM	3 hours	0.25° x 0.25°	4	1948-01-01	2010-12-31
	GLDAS Noah Land Surface Model L4 3 hourly 1.0 x 1.0 degree (GLDAS_NOAH10_3H.020) - Atmospheric Pressure, Atmospheric Radiation, Atmospheric Temperature	Models/Analyses Noah-LSM	3 hours	1° x 1°	4	1948-01-01	2010-12-31
	NLDAS Secondary Forcing Data L4 Monthly 0.125 x 0.125 degree (NLDAS_FORB0125_M.002) - Altitude, Atmospheric Pressure, Atmospheric Radiation	Models/Analyses Forcing-LSM	1 month	0.125° x 0.125°	4	1979-01-01	present
	NLDAS Secondary Forcing Data L4 Hourly 0.125 x 0.125 degree (NLDAS_FORB0125_H.002) - Altitude, Atmospheric Pressure, Atmospheric Radiation	Models/Analyses Forcing-LSM	1 hour	0.125° x 0.125°	4	1979-01-01	present



Courtesy: Matt Rodell matthew.rodell@nasa.gov

Run Off Data Access

GLAS/NLDAS Run Off data are available from

Mirador (<http://mirador.gsfc.nasa.gov>)

Giovanni (<http://giovanni.gsfc.nasa.gov/giovanni/>)

Model	Spatial Resolution	Temporal Resolution	Temporal Coverage
GLDAS (NOAH V 1)	0.25°x0.25° 1°x1°	3-hourly Monthly	2000-Present
NLDAS VIC	0.125°x0.125°	Hourly Monthly Climatology	1979-Present

GLDAS-VIC (Variable Infiltration Capacity) 1948-2000 Run Off Data

International Research Institute/Princeton University (1°x1° **Monthly Run Off, Climatology**)
(<http://iridl.ldeo.columbia.edu/SOURCES/.Princeton/.VIC/.runoff/>)

Run Off Data Access Using Mirador



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

 [Data Services](#) [Mission Portals](#) [Science Portals](#) [Info](#)


Mirador 1.55
Data Access Made Simple


You are here: [KeywordSearch](#) » [Data sets from NLDAS-VIC search](#) » File Listing » Service Selection » Your Cart » Checkout

[Keyword](#) [Projects](#) [Science Areas](#)


Results 1 - 3 of 3 for **NLDAS-VIC** (1 seconds)

Data Sets

 -More Services (e.g. http download, format conversion, subsets etc) are available for the data set(s). Whenever you add files to the shopping cart, you will be presented with options for selecting a service and service parameters for any data set which has these services.

- NLDAS VIC Land Surface Model L4 Monthly 0.125 x 0.125 degree (NLDAS_VIC0125_M)** 
[View Files](#) | [Info](#) | [Data Calendar](#)
Approx. 440 files found (Avg Size: 5.53 MB)
Parameters: EVAPORATION, EVAPOTRANSPIRATION, RAIN, SNOW, HEAT FLUX, LONGWAVE RADIATION, ALBEDO...
Spatial Resolution: 0.125 degree x 0.125 degree
Temporal Resolution: monthly
- NLDAS VIC Land Surface Model L4 Monthly Climatology 0.125 x 0.125 degree (NLDAS_VIC0125_MC)** 
[View Files](#) | [Info](#) | [Data Calendar](#)
Approx. 1 files found (Avg Size: 5.49 MB)
Parameters: EVAPORATION, EVAPOTRANSPIRATION, HEAT FLUX, LONGWAVE RADIATION, SHORTWAVE RADIATION, CANOPY CHARACTERISTICS, LAND SURFACE TEMPERATURE...
Spatial Resolution: 0.125 degree x 0.125 degree
Temporal Resolution: monthly
- NLDAS VIC Land Surface Model L4 Hourly 0.125 x 0.125 degree (NLDAS_VIC0125_H)** 
[View Files](#) | [Info](#) | [Data Calendar](#)
Approx. 324559 files found (Avg Size: 5.43 MB)
Parameters: EVAPORATION, EVAPOTRANSPIRATION, HEAT FLUX, LONGWAVE RADIATION, SHORTWAVE RADIATION, CANOPY CHARACTERISTICS, LAND SURFACE TEMPERATURE...
Spatial Resolution: 0.125 degree x 0.125 degree
Temporal Resolution: hourly

[Select All](#) [Reset](#) [List Selected Files By Time](#) [See Timeline View](#) [Add Selected Files To Cart](#)

Keyword:
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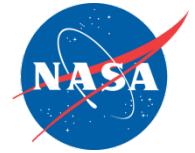
Mirador Live Demo

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



For Bulk Data
Download

Run Off Data Access Using Giovanni



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

EARTHDATA Data Discovery - DAACs - Community - Science Disciplines

GIOVANNI

 The Bridge Between Data and Science v 4.16 [Release Notes](#) [Browser Compatibility](#) [Known Issues](#)

IMERG variables temporarily unavailable... [1 of 3 messages] [Read More](#)

Select Plot

Maps: Time Averaged Map Comparisons: *Select...* Time Series: *Select...* Vertical: *Select...* Miscellaneous: *Select...*

Select Date Range (UTC) **Select Region (Bounding Box or Shapefile)**

YYYY-MM-DD HH:mm Format: West, South, East, North

- to -

Valid Range: 1979-01-01 to 2015-10-10

Spatial and Temporal Selection

Please specify a start date.

Select Variables

Disciplines

- Hydrology (31)
- Water and Energy Cycle (31)

Measurements

- Evaporation (4)
- Evapotranspiration (1)
- Heat Flux (3)
- Incident Radiation (2)
- Precipitation (3)
- Radiation, Net (2)
- Runoff (2)
- Soil Moisture (9)
- Soil Temperature (3)
- Surface Temperature (2)

Platform / Instrument

Spatial Resolutions

Number of matching Variables: 31 of 567 Total Variable(s) included in Plot: 0

Keyword: NLDAS_VIC

<input type="checkbox"/>	Variable Name	Source	Temp. Res.	Spat. Res.	Begin Date	End Date	Units	Vert
<input type="checkbox"/>	Snow water-equivalent (accumulated) (NLDAS_VIC0125_M_v002)	NLDAS Model	Monthly	0.125 °	1979-01-02	2015-08-31	kg/m^2	
<input type="checkbox"/>	Sublimation (evaporation from snow) (NLDAS_VIC0125_M_v002)	NLDAS Model	Monthly	0.125 °	1979-01-02	2015-08-31	W/m^2	
<input type="checkbox"/>	Subsurface runoff (baseflow) (NLDAS_VIC0125_M_v002)	NLDAS Model	Monthly	0.125 °	1979-01-02	2015-08-31	kg/m^2	
<input type="checkbox"/>	Surface radiative temperature (NLDAS_VIC0125_M_v002)	NLDAS Model	Monthly	0.125 °	1979-01-02	2015-08-31	K	
<input type="checkbox"/>	Surface runoff (non-infiltrating) (NLDAS_VIC0125_M_v002)	NLDAS Model	Monthly	0.125 °	1979-01-02	2015-08-31	kg/m^2	
<input type="checkbox"/>	Temperature (average surface							

Giovanni Live Demo



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

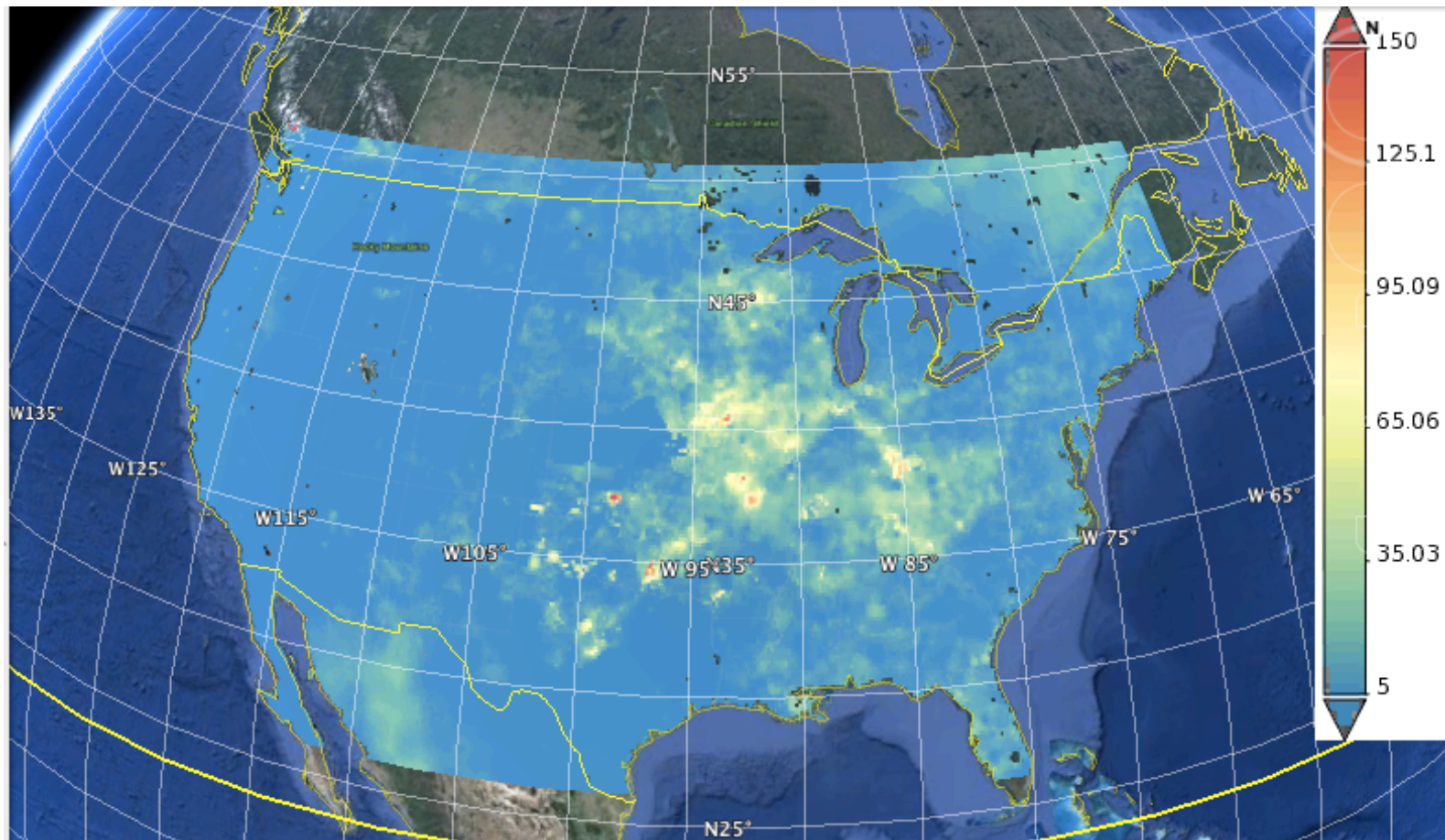
For Analysis, Visualization, and Download

Run Off Data from NLDAS



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

Time Averaged Map of Surface runoff (non-infiltrating) monthly 0.125 deg. [NLDAS Model NLDAS_VIC0125_M v002] kg/m² over 2015-Jul, Region 125W, 26.1328N, 67W, 50.7422N

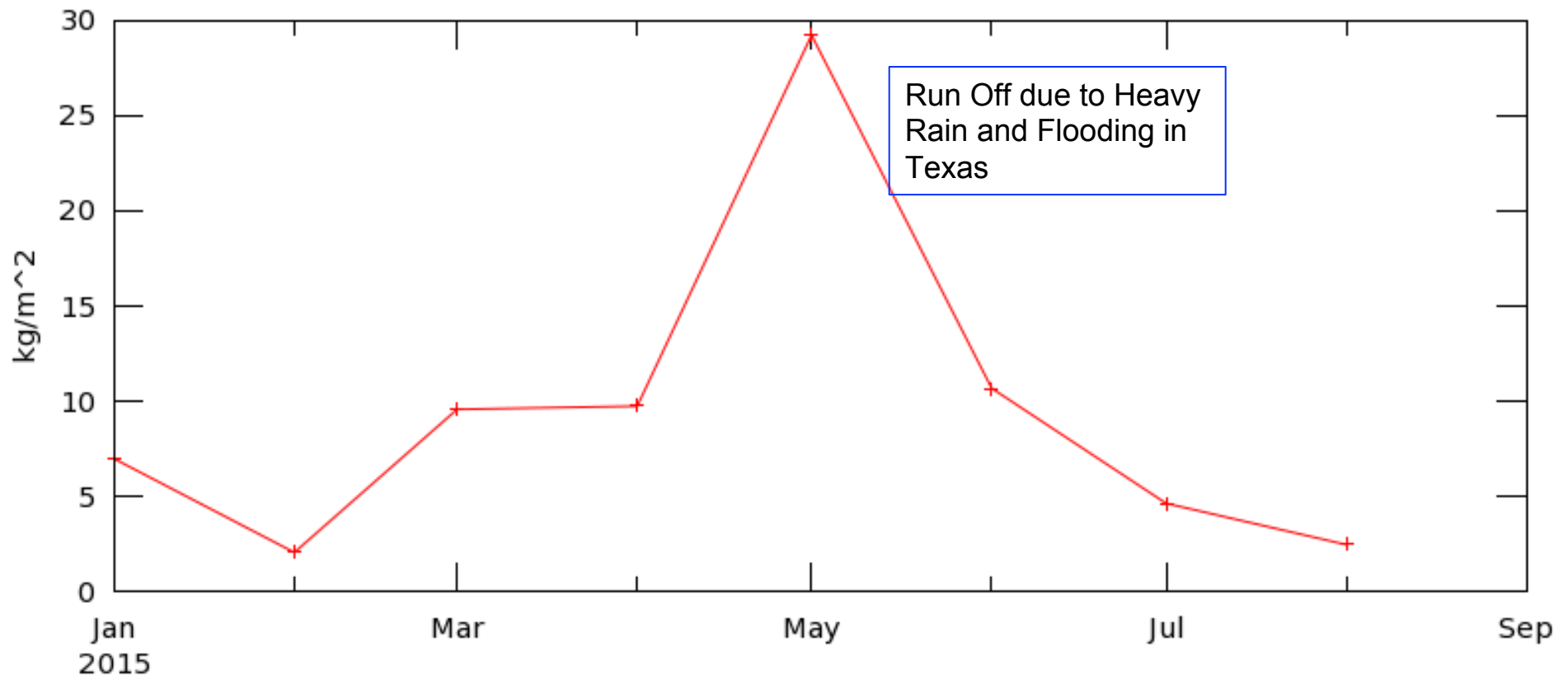


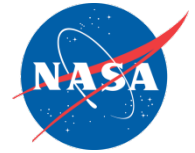
Run Off over Texas from NLDAS



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

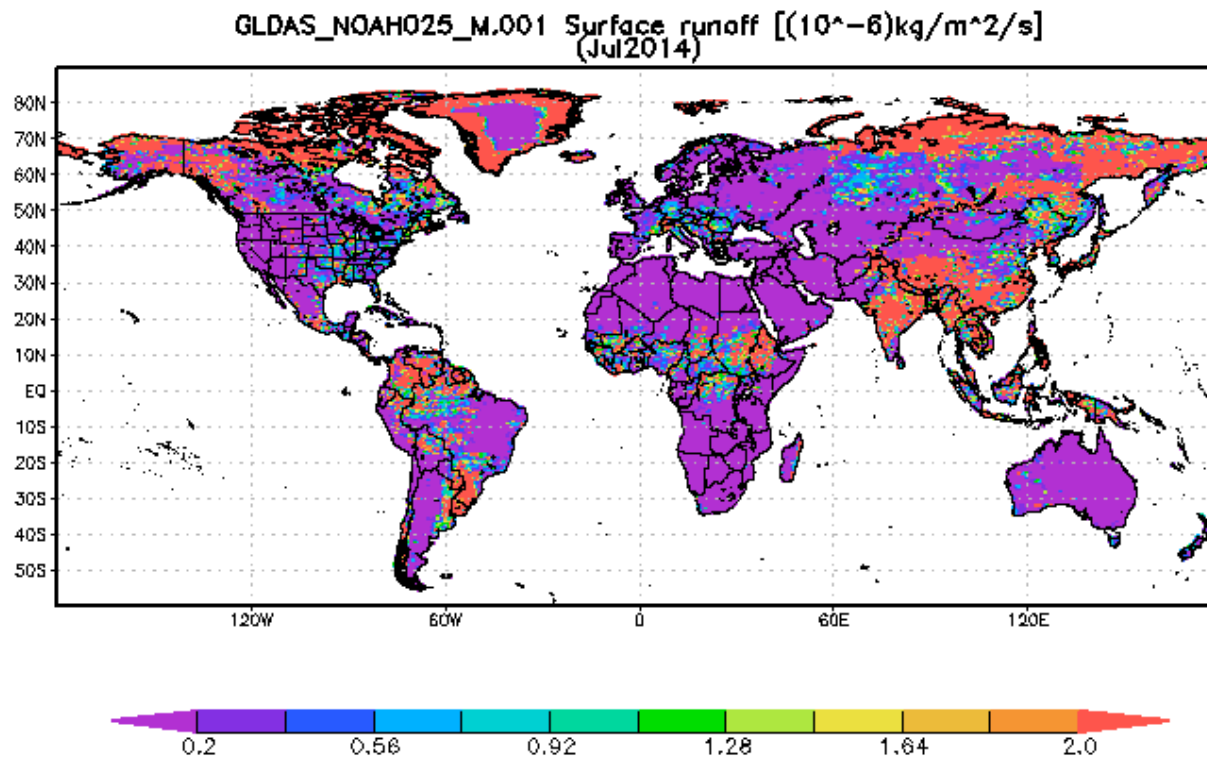
Time Series, Area-Averaged of Surface runoff (non-infiltrating) monthly 0.125 deg. [NLDAS Model NLDAS_VIC0125_M v002] kg/m² over 2015-Jan - 2015-Aug, Shape Texas





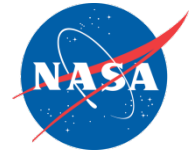
Run Off Data from GLDAS

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



Current GLDAS Data Can be down loaded from <http://disc.gsfc.nasa.gov/hydrology>
But will be available from Giovanni by end of this year/early next year

LDAS Models Validation Papers



Run Off Data are difficult to validate, however, indirect validation by using streamflow data for selected catchment areas suggest *reasonable* values. Validation for the area of interest is highly recommended.

Some useful Papers are:

Zaitchik, B.F., M. Rodell, and F. Olivera, Evaluation of the Global Land Data Assimilation System using global river discharge data and a source to sink routing scheme, *Water Resour. Res.*, 46, W06507, doi:10.1029/2009WR007811, 2010.

Lorenz, C., H. Kunstmann, B. Devaraju, M. J. Tourian, N. Sneeuw, J. Riegger, Large-scale Runoff from Landmasses: A global Assessment of the closure of the hydrology and atmospheric water balances, *J. Hydrometeorology*, 15, 2111-2139, DOI: 10.1175/JHM-D-13-0157.1, 2014.

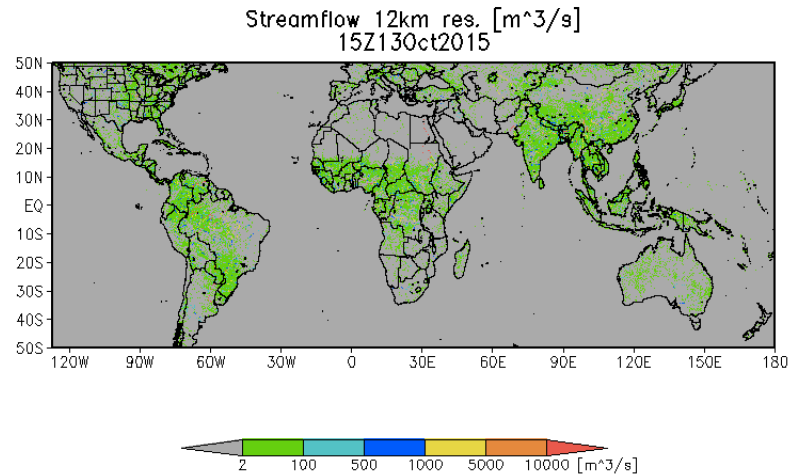
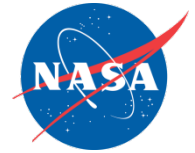
Xia, Y. L., K. Mitchell, M. Ek, B. Cosgrove, J. Sheffield, L. F. Luo, C. Alonge, H. L. Wei, J. Meng, B. Livneh, et al., Continental-scale water and energy flux analysis and validation for North American Land Data Assimilation System project phase 2 (NLDAS-2): 2. Validation of model-simulated streamflow, *J Geophys Res*, 17, D03110, DOI: 10.1029/2011JD016051, 2012.



Streamflow Data from Global Flood Monitoring System (GFMS)

Global Flood Monitoring System (GFMS)

<http://flood.umd.edu>



Provides global maps, time series, and animations (50°S-50°N) of:

- Instantaneous Rain
- Accumulated rain over 24, 72, and 168 hours
- **Streamflow rates at 1/8th degree (~12 km) and also at 1 km**

Global Flood Monitoring System (GFMS)

<http://flood.umd.edu>



Uses a hydrological model together with remote sensing data for flood detection

- **Inputs: TRMM and Multi-satellite Precipitation (TMPA)
Surface temperature and winds from MERRA***
- Runoff generation from U. Washington Land Surface Model (Variable Infiltration Capacity - VIC)
- Runoff routing model from the U. Maryland

***Modern Era Retrospective-analysis for Research and Applications (MERRA): Blends remote sensing and in situ data in to and atmospheric model**

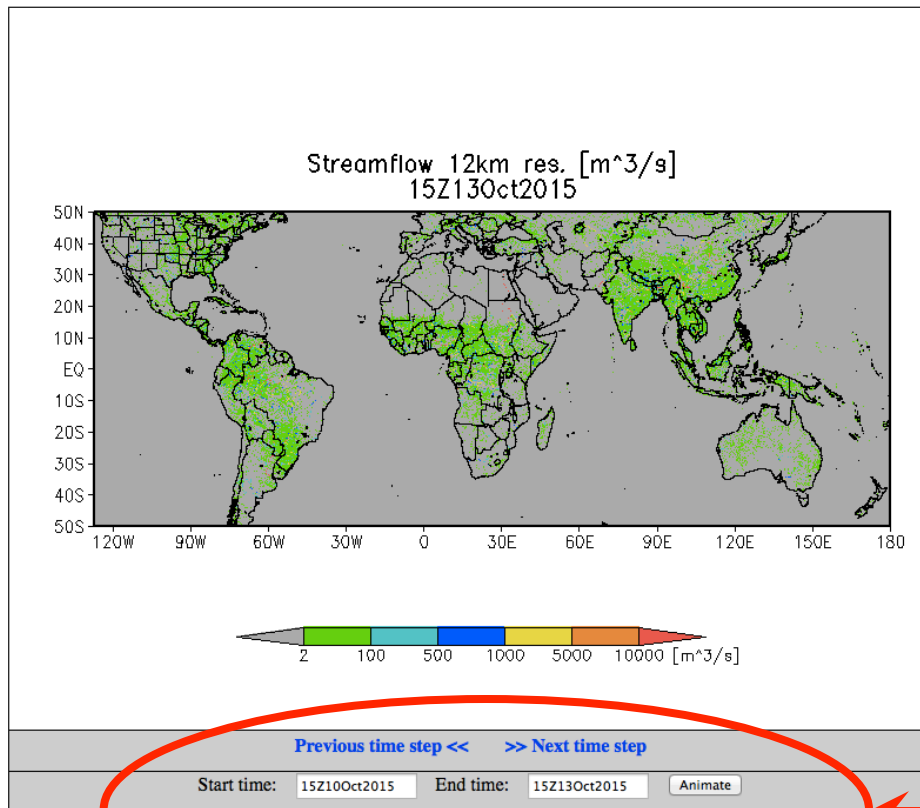
For details see:

Wu, H., R. F. Adler, Y. Tian, G. J. Huffman, H. Li, and J. Wang (2014), Real-time global flood estimation using satellite-based precipitation and a coupled land surface and routing model, *Water Resour. Res.*, 50, 2693.2717, doi:10.1002/2013WR014710.

Wu H., R. F. Adler, Y. Hong, Y. Tian, and F. Policelli (2012), Evaluation of Global Flood Detection Using Satellite-Based Rainfall and a Hydrologic Model. *J. Hydrometeor.*, 13, 1268.1284

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)

71.12 88.36

T1: 15Z10Oct2015
T2: 15Z13Oct2015

See time series

Plot different variable:

Streamflow 12km res. [v]
Plot

Reset

- Map navigation
- Zoom in/out
- Select individual grid point for data for time sequence
- Plot different variables
- 3-hourly output

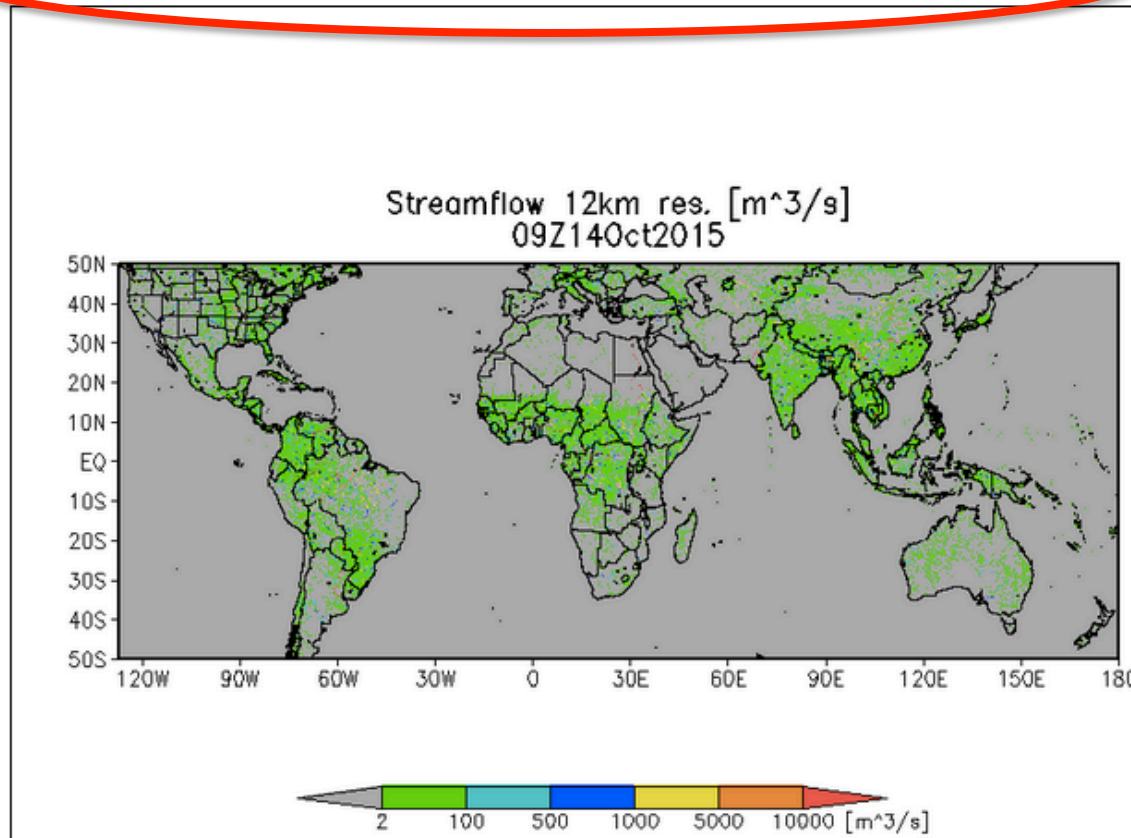
Streamflow Data Download Global Flood Monitoring System (GFMS)

<http://flood.umd.edu>



the changes in topography, land use, and climate conditions (e.g., snowmelt). All the calculations are updated every three hours.

DATA AVAILABILITY: Flood Detection/Intensity at 1/8th degree resolution are available from [here](#)



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)

0 26.375

T1: 09Z11Oct2015

T2: 09Z14Oct2015

See time series

Plot different variable:



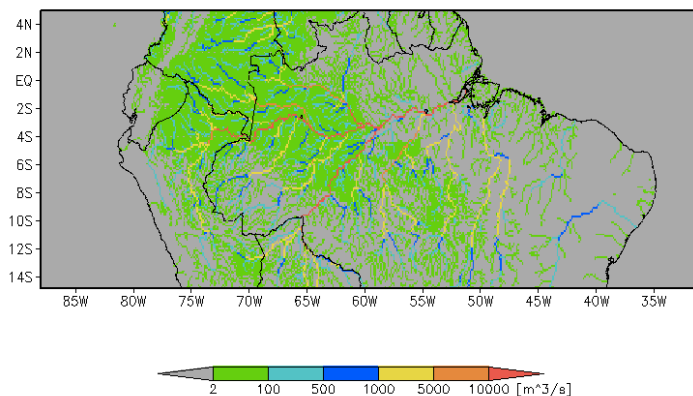
Live Demonstration of GFMS

<http://flood.umd.edu>

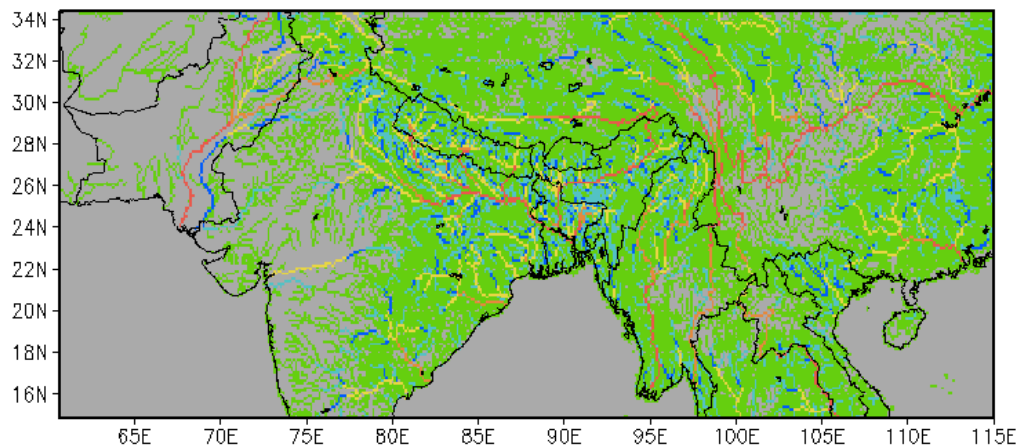
For Map, Animation, Time Series and Download
Streamflow Data

Streamflow in m³/s In Selected River Channels

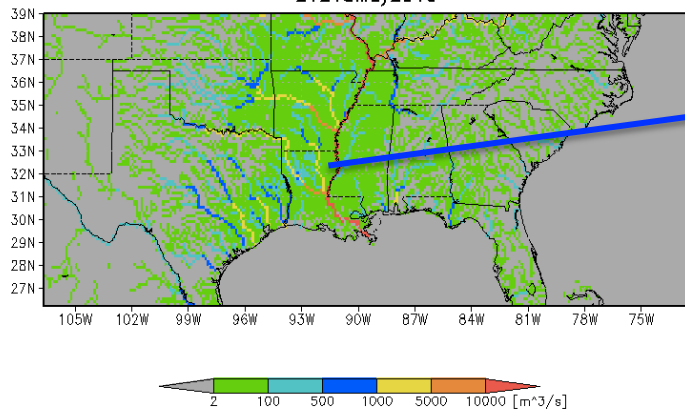
Streamflow 12km res. [m³/s]
15Z13Oct2015



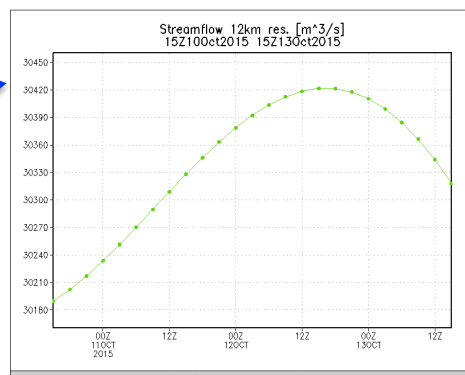
Streamflow 12km res. [m³/s]
12Z16Jul2015



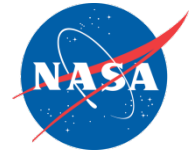
Streamflow 12km res. [m³/s]
21Z18May2015



2 100 500 1000 5000 10000 [m³/s]



Streamflow Data Download Global Flood Monitoring System (GFMS)



<http://flood.umd.edu>

...changes in topography caused by man-made constructions (e.g. dams, levees). All the calculations are updated

DATA AVAILABILITY: Flood Detection/Intensity at 1/8th degree resolution are available from [here](#)

[2013](#)

[2014](#)

[2015](#)

[2016](#)

[2017](#)

[2018](#)

[Data description](#)

	File Name	Var. Name	Unit
1	Flood_byStor_yyyymmddhh.bin	Flood intensity (in depth) above threshold	mm
2	Flood_byQ_yyyymmddhh.bin	Streamflow above flood threshold	m ³ /s
3	Q_yyyymmddhh.bin	Streamflow	m ³ /s
4	Routed_yyyymmddhh.bin	Surface water storage	mm
5	V_yyyymmddhh.bin	Channel water velocity	m/s
6	yyymmddhh.inst.bin	Instant rain	mm/h
7	yyymmddhh.1day.bin	1 day accumulated Rain	mm
8	yyymmddhh.3days.bin	3 day accumulated Rain	mm
9	yyymmddhh.7days.bin	7 day accumulated Rain	mm

Data in Binary Format

**C code available for
reading the data**

Example of reading the data using C

An episode of C code which can be used for reading the data is provided below.



Satellite-based determination of Reservoir and Lake Surface Water Heights

Courtesy: Dr. Charon M. Birkett
Earth System Science Interdisciplinary Center
University of Maryland, College Park
cmb@essic.umd.edu

Satellite-based determination of Reservoir and Lake Surface Water Heights

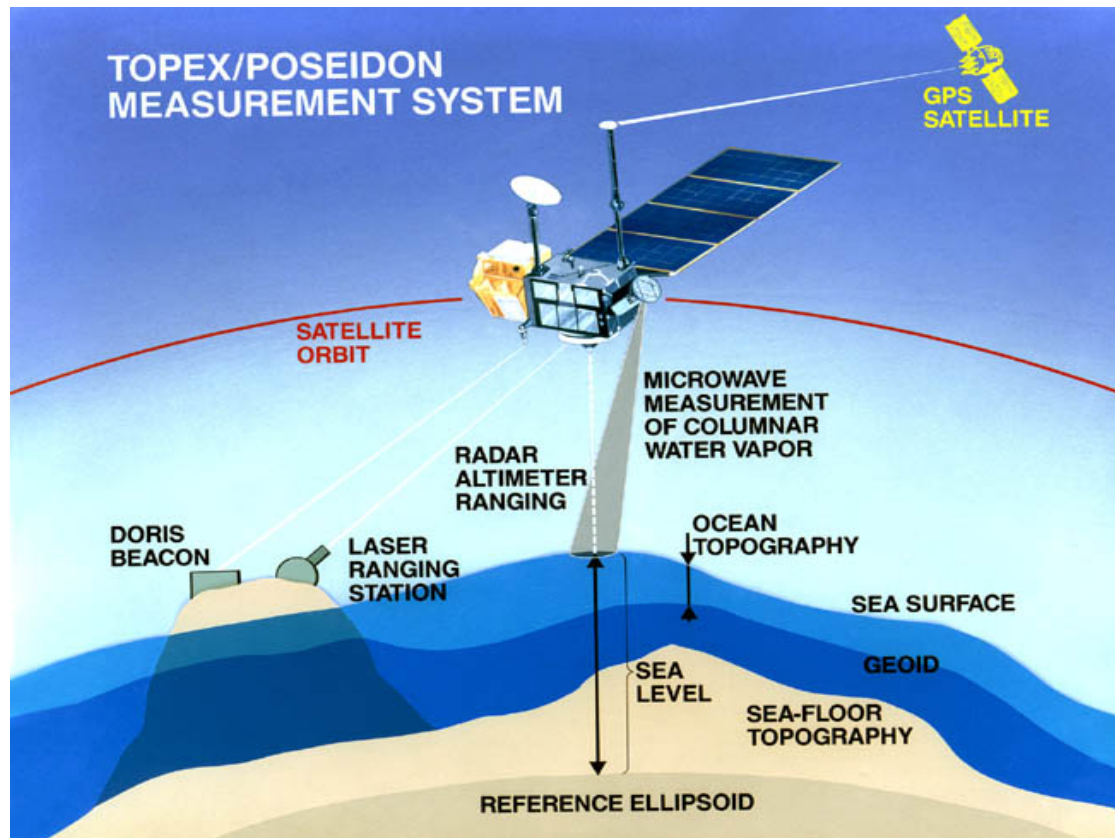


The Principles of Radar Altimetry

Radar Echoes and Surface Elevation

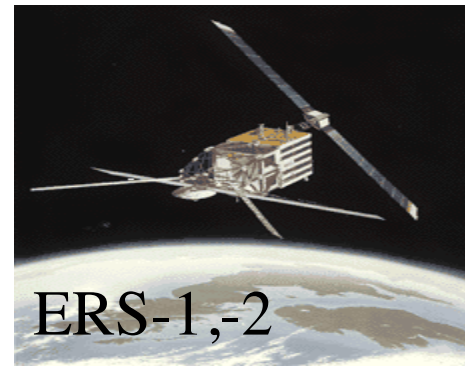
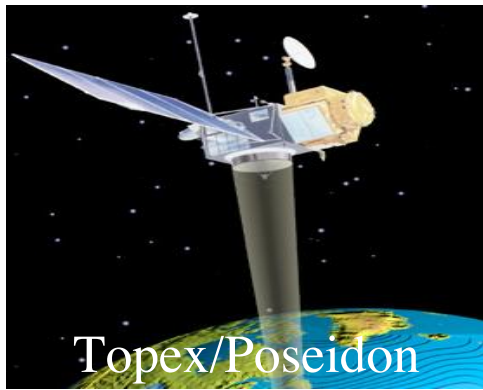
The instruments do not record an image but collect radar echoes along the ground track.

Altimetric “range” is derived and with knowledge of the satellite orbit location, and certain atmospheric and tidal corrections, the range can be converted to a surface elevation – usually given with respect to a reference ellipsoid datum.



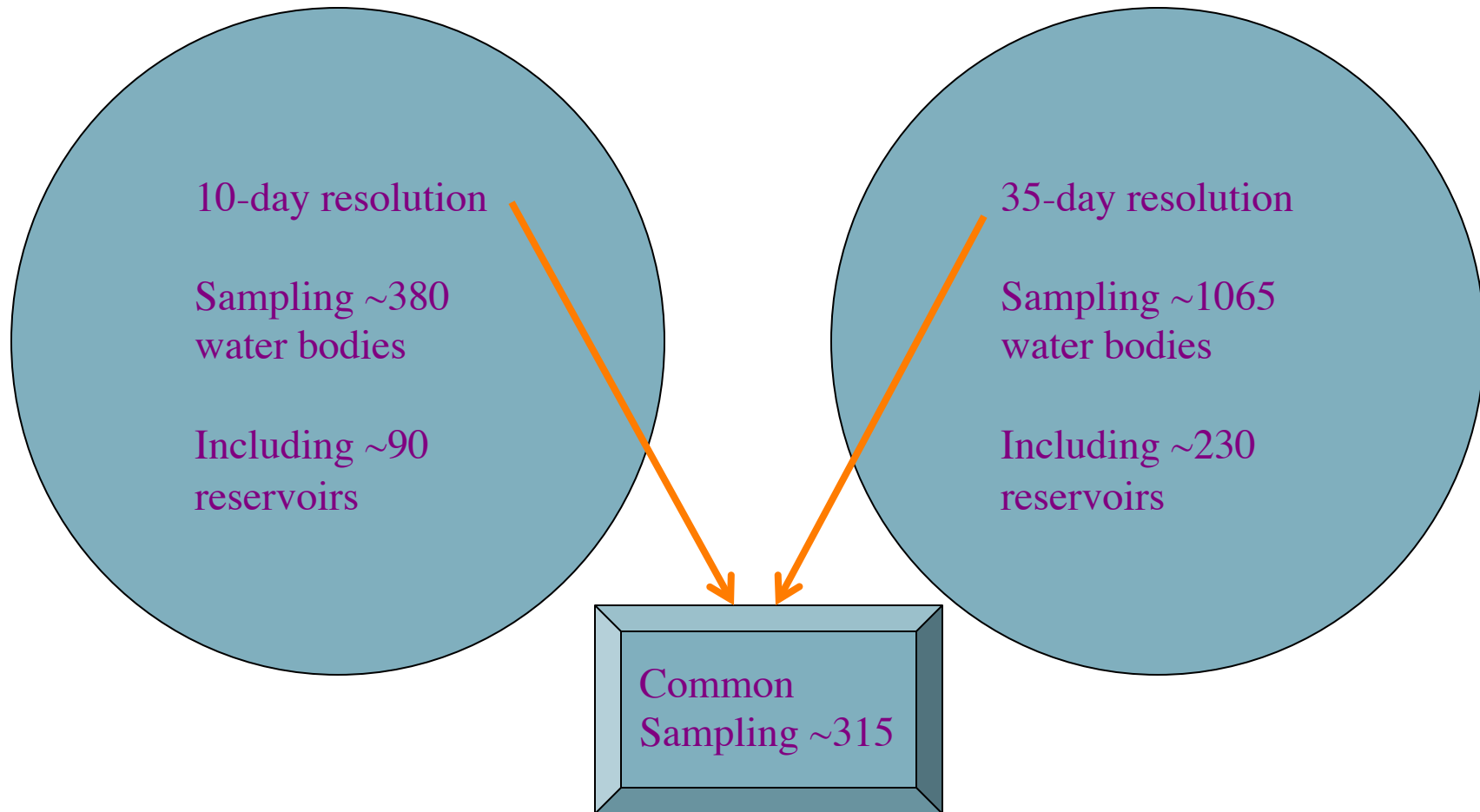
Altimeters were carried on a series of satellites since 1992. Currently Jason-2 is in orbit with an altimeter

Satellite Radar Altimeter Missions

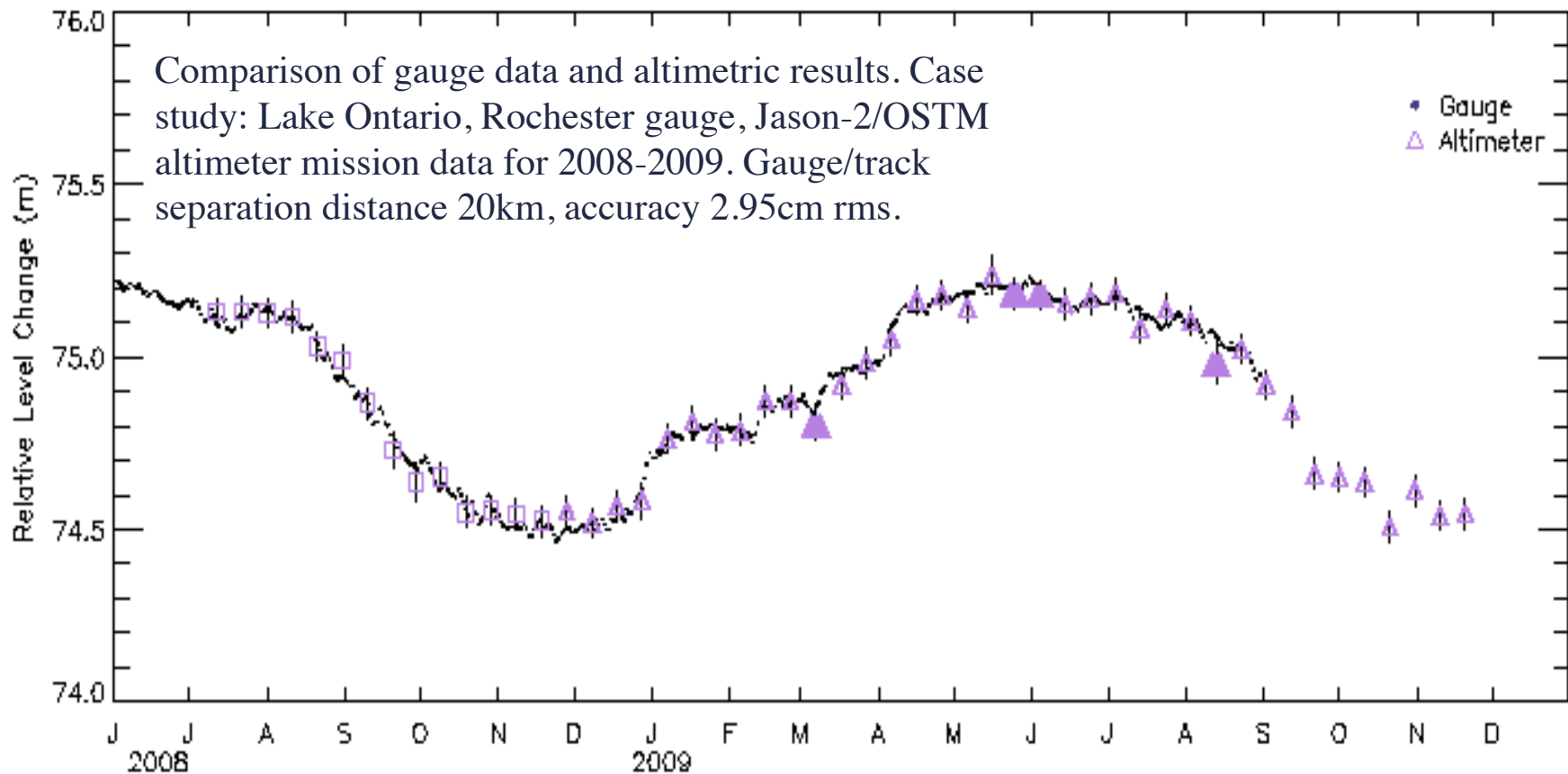


How Many Lakes and Reservoirs?

Current satellite radar altimeters only view a certain proportion of the world's largest water bodies, with a trade-off between temporal and spatial resolution.



Validation of Altimetric Height Variations



Radar Altimetry - Advantages and Limitations

ADVANTAGES

The contribution of new height information where traditional gauge (stage) data is absent.

Day/night and all weather operation.

Generally unhindered by vegetation or canopy cover.

Determined surface heights are with respect to one common reference frame.

Repeat orbits (to $\pm 1\text{km}$) enable systematic monitoring of rivers, lakes, wetlands, inland seas and floodplains.

Surface water heights are potentially obtainable for any target beneath the satellite overpass.

The ability to monitor seasonal to inter-annual variations during the lifetime of the missions.

Validated techniques.

LIMITATIONS

The satellite orbit scenario determines the spatial and temporal coverage.

Data can only be retrieved along a narrow nadir swath.

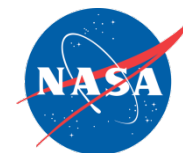
Highly undulating or complex topography may cause data loss.

Height accuracy (4-20 cm rms large open lakes) is dominated by the size and surface roughness of the target.

Major wind events, heavy precipitation, tidal effects, ice formation, will effect data quality and accuracy.

Minimum target size (50-100km²) is also dependent on many factors and the retrieved heights are an "average" not a "spot" height at a specific location.

Reservoir and Lake Surface Water Heights Data Usage by USDA to Monitor Agricultural and Hydrological Droughts



The VOLUME of stored water for irrigation potential considerations.

USDA integrates Lake Surface Height data with a wide variety of data sets.

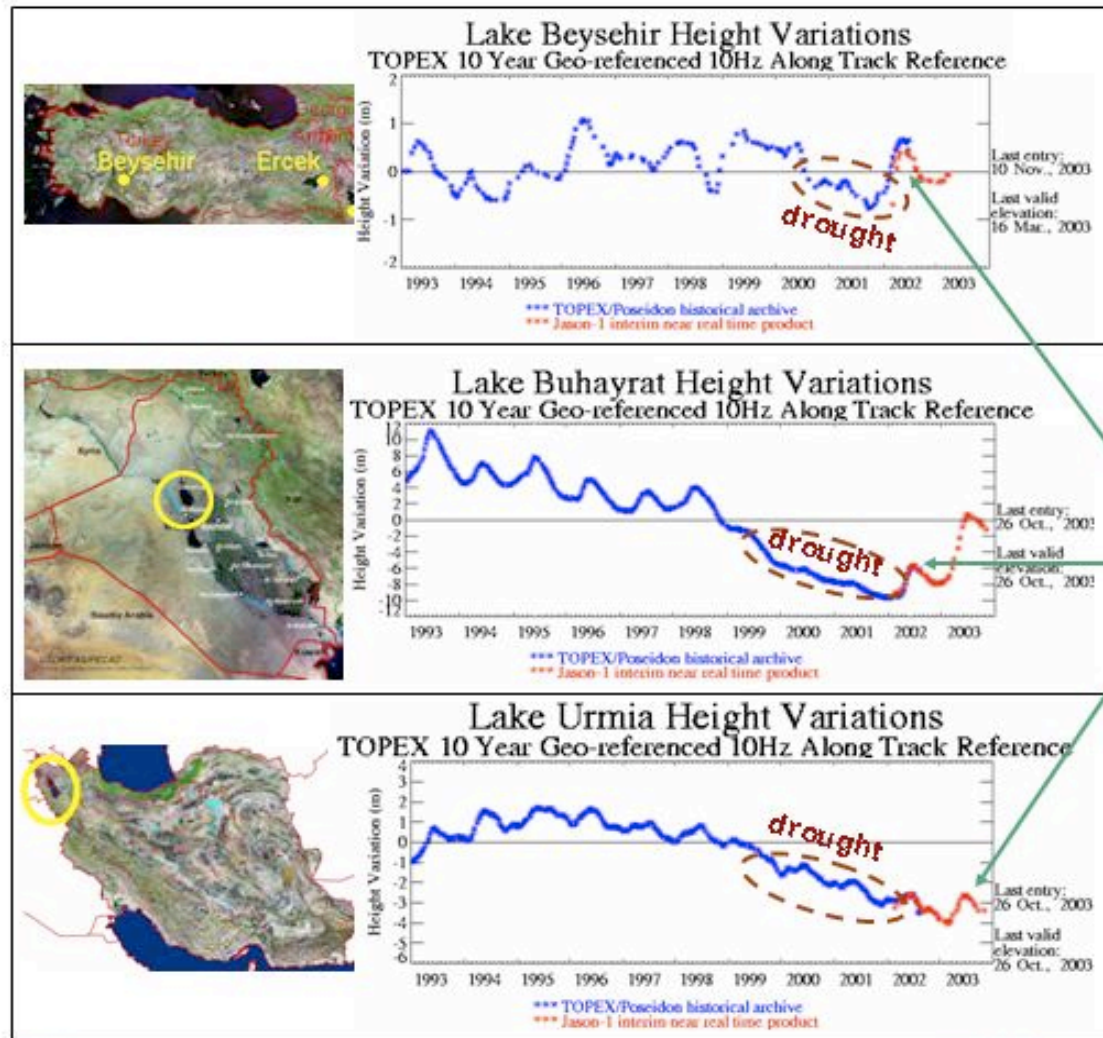
Information is input into a monthly 'lockup' process which sets global Crop Condition Production numbers and provides an 'Early Warning of Events' .

Output information is shared between USDA and US Gov agencies for various Decision Support Protocols.

Estimates drive or influence markets, price discovery, trade and foreign policies, agriculture production, and farm and food programs.



**Middle East and Turkey:
Warmer Than Normal and Plenty of Moisture**



Shown are relative lake height variations for Lake Beysehir in Turkey, Lake Buhayrat in Central Iraq and Lake Urmia in northwest Iran. A period of drought occurred from 1999 to 2001. Rainfall in Turkey, northern Iraq and adjacent regions increased in both 2002 and 2003 and has gradually recharged reservoirs.

Initial recovery in water levels observed in 2002-2003.
Drought began in 1999.



Reservoir and Lake Surface Water Heights Data Access



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

[USDA United States
Department of
Agriculture Foreign
Agricultural Service
Crop Explorer](#)

The screenshot shows the USDA Foreign Agricultural Service Crop Explorer interface. At the top, there is a navigation bar with the USDA logo and the text 'United States Department of Agriculture Foreign Agricultural Service'. Below this is a banner image with the text 'Crop Explorer'. A 'Toolbox' button is visible on the left. The main content area is titled 'Latest Product News' and features a section for 'October 8th 2015 - Upgrades and New Products'. This section contains three bullet points detailing product updates, including the inclusion of correction factors and the availability of lake products from 2008 to the present. A 'NOTE !!!' section follows, providing important user instructions regarding satellite ground tracks and visualization aids. Below the text is a world map titled 'Global Reservoir and Lake Monitor: 10-day resolution', which displays numerous red location pins across various continents. The map includes a 'Map Satellite' toggle, a zoom control, and the Google logo. At the bottom of the map, there is a caption: '10-day Status products with datum based on a 9 year (1993-2001) mean'.

USDA United States Department of Agriculture Foreign Agricultural Service

Crop Explorer

Toolbox

Latest Product News

October 8th 2015 - Upgrades and New Products

- The surface water level variation products have recently been upgraded (from TPJO.1.1 to TPJO.1.3 and TPJO.2 to TPJO.2.3). They have been re-calculated based on updated altimetric parameters and a revised reference datum. End users are advised not to mix the old/new product versions.
- The upgraded products now include correction factors in the ascii text file header which will enable end users to translate the satellite-based time series into various orthometric frames (approximating mean sea level). At the lake product level there is also the option (left-hand panel) to view the reference and geoid height profiles which were used to determine these correction factors. Details can be found in the Q&A link.
- Additional lake products displaying variations from 2008 to the present day at 10-day resolution are also now available..

NOTE !!!

- End users must consider the location of the satellite ground track AND the section of track used to create the products. This is particularly important for complex and drought-prone lakes and reservoirs, where height variability may be location dependent. See the product headers.
- End users must also note that the graphs/products associated with the filtered time series are provided as a visualization aid only.

10-day Near Real Time products with datum based on a single satellite overpass (1 day)

Global Reservoir and Lake Monitor: 10-day resolution

Map Satellite

Google

10-day Status products with datum based on a 9 year (1993-2001) mean

Live Demonstration of USDA-FAS-Crop Explorer



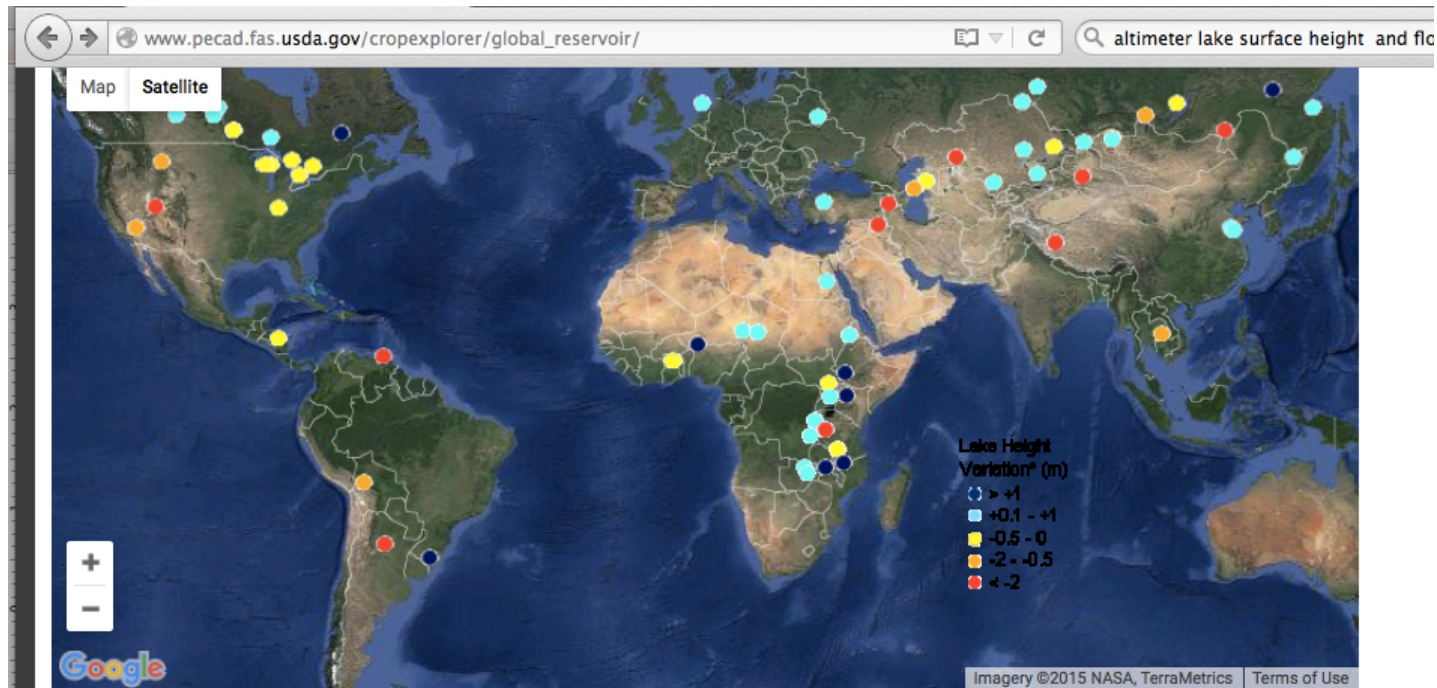
http://www.pecad.fas.usda.gov/cropexplorer/global_reservoir/

For Map, Time Series, and Download Data



Data Access from USDA-FAS-Crop Explorer

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



[Click here to add your Comments/Feedback](#)

One-click Options

- [Click here to download the Lake Status Graph files](#)
- [Click here to download the Lake Status Text files](#)
- [Click here to download Lake Smooth Text files](#)
- [Click here to view the ENVISAT map](#)
- [Click here to download the ENVISAT Lake Graph files](#)
- [Click here to download the ENVISAT Lake Text files](#)
- [Click here to download the ENVISAT Lake Smooth Text files](#)
- [Click here to download a summary list of ENVISAT product lakes](#)
- [Click here to download a summary list of Jason-2/OSTM product lakes](#)
- [Click here to download a summary list of lakes used to create the Lake Status map](#)



Data Files in Text Format



Data Access from USDA-FAS-Crop Explorer

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

Data Files in Text Format

```

TPJ0.1.1           : Data Processing Version ID
0012 Winnipeg     : Lake database id number and name
52.00 262.00      : Latitude and longitude (degrees East) of lake mid-point
52.75 261.11      : Start latitude and longitude (degrees East) of pass traversing
lake
53.61 262.34      : End latitude and longitude (degrees East) of pass traversing
lake
52.83 53.53       : Latitude range of pass traversing lake at which data is
accepted
195 98            : Satellite pass and revolution number designation
0.31              : Jason-1 Bias adjustment (m)
0.72              : Jason-2 Bias adjustment (m)

```

```

Column 1: satellite mission name
Column 2: satellite repeat cycle
Column 3: year,month,day of along track observations traversing lake
Column 4: hour of day at mid point of along track pass traversing lake
Column 5: minutes of hour at mid point of along track pass traversing lake
Column 6: lake height variation with respect to TOPEX/POSEIDON 9 year mean level
Column 7: estimated error of lake height variation with respect to TOPEX/POSEIDON
mean level (meters)
Column 8: mean along track K-band backscatter coefficient (decibels)
Column 9: wet tropospheric correction applied to range observation (TMR=radiometer
FMO=ECMWF model)

```

```

OSTM 239 20150104 14 2 0.00 0.045 22.17 MIX
OSTM 240 20150114 12 0 0.06 0.045 22.06 AMR
OSTM 241 20150124 9 59 0.07 0.046 20.14 AMR
OSTM 242 20150203 7 57 -0.04 0.046 19.06 AMR
OSTM 243 20150213 5 56 -0.12 0.047 17.04 AMR
OSTM 244 20150223 3 54 -0.19 0.047 16.67 AMR
OSTM 245 20150305 1 53 -0.14 0.048 16.28 AMR
OSTM 246 99999999 99 99 999.99 99.999 999.99 N/A
OSTM 247 20150324 21 50 0.18 0.046 18.68 AMR
OSTM 248 20150403 19 48 0.18 0.045 16.17 MIX
OSTM 249 20150413 17 47 0.36 0.044 35.11 AMR
OSTM 250 20150423 15 45 0.26 0.044 17.55 MIX
OSTM 251 20150503 13 44 0.20 0.044 21.49 MIX
OSTM 252 20150513 11 42 0.19 0.046 33.32 AMR
OSTM 253 20150523 9 41 0.05 0.047 25.41 AMR
OSTM 254 20150602 7 39 0.14 0.044 14.34 AMR
OSTM 255 20150612 5 38 0.09 0.045 18.08 AMR
OSTM 256 20150622 3 37 0.14 0.044 14.16 AMR
OSTM 257 20150702 1 35 0.10 0.046 26.71 AMR
OSTM 258 20150711 23 34 0.15 0.046 21.52 AMR
OSTM 259 20150721 21 32 0.07 0.048 20.69 AMR
OSTM 260 20150731 19 31 0.16 0.044 13.45 AMR
OSTM 261 20150810 17 29 0.16 0.062 31.25 AMR
OSTM 262 20150820 15 28 0.24 0.044 14.44 AMR
OSTM 263 20150830 13 26 0.22 0.045 13.90 AMR

```



Next Week:

Evapotranspiration Data and Applications

Ground Water Data and Applications



Thank You!

Amita Mehta

email: amita.v.mehta@nasa.gov