NASA/Ames
Sep 5-6th, 2012

The Global Reservoir and Lake Monitor (GRLM): Expansion and Enhancement of Water Height Products

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Initialization+Hardware+Operations+Product Upgrades: USDA/FAS/OGA

Expansion+Enhancement with V+V Research: NASA Earth Science Applications (NNX08AM72G, NNS06AA15G, NNX12AJ85G), and NASA Ocean Surface Topography Team (NNX08AT88G)

USDA/FAS/OGA Objectives
Crop Production Estimate Chain

USDA integrates a wide variety of data sets.

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

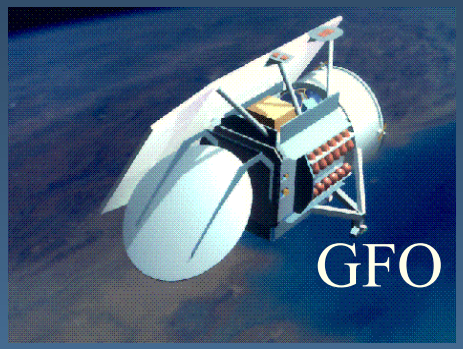
Output information is shared between USDA and US Gov agencies for various Decision Support Protocols.

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

Missing Input - The VOLUME of stored water for irrigation potential considerations.
Use of Lake Levels as a proxy - via satellite-based Radar Altimetry.
Allows agricultural drought (weeks-months, crop season) and hydrological drought (months-years, water supplies) to be observed

Satellite Radar Altimeter Missions

Pulse limited Ku altimetry, nadir profiling, repeat track data sets spanning several decades, ocean/ice missions so limited to lakes >100km^2, accuracies variable 3-5cm to tens of cm rms, ATS=10-20Hz, variable tracking options.



17-day, GDR

Naval Research Lab

10-day, IGDR/GDR

35-day, GDR

USDA United States Department of Agriculture
Foreign Agricultural Service

Linking U.S. Agriculture FAS to the World

Crop Explorer

Global Food Supply Monitoring

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Explore by Crop

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Commodity Intelligence Articles and Reports

Pakistan: Rice and Cotton Production Regions Damaged by Floods.
(Sep 13, 2010)

From late July through August, Pakistan received abundant to excessive monsoon rainfall across the country including many of the major rice and cotton growing areas. The excessive precipitation triggered severe overland and river flooding. The impact of the floodwater is most severe in Khyber Pakhtunkhwa (N.W.F.P), Baluchistan, Punjab, and the northern districts of Sindh. These provinces have experienced significant loss of cropland and damage to agricultural infrastructure. The major kharif season (June-November) crops are rice and cotton, but a substantial amount of corn, millet, and sorghum is grown during the kharif season as well. The floodwaters are receding in the mid- and upper-reaches of the Indus Valley but continue to expand in the southern district of Sindh. The final extent of the floodwaters and the resulting damage to crops is still uncertain. The USDA's preliminary assessment, based primarily on satellite imagery, indicates significant crop damage in major rice and cotton areas along the Indus River in Punjab and Sindh provinces. The USDA forecasts 2010/11 Pakistan rice production at 5.3 million tons, down

News & Events

- Tropical Cyclone Monitor
- Google Gadgets
- Iraq Operational Agricultural Monitoring Project
- RSS News Feeds
- Speaker Presentations on Global Food Security Challenges

Related Sites

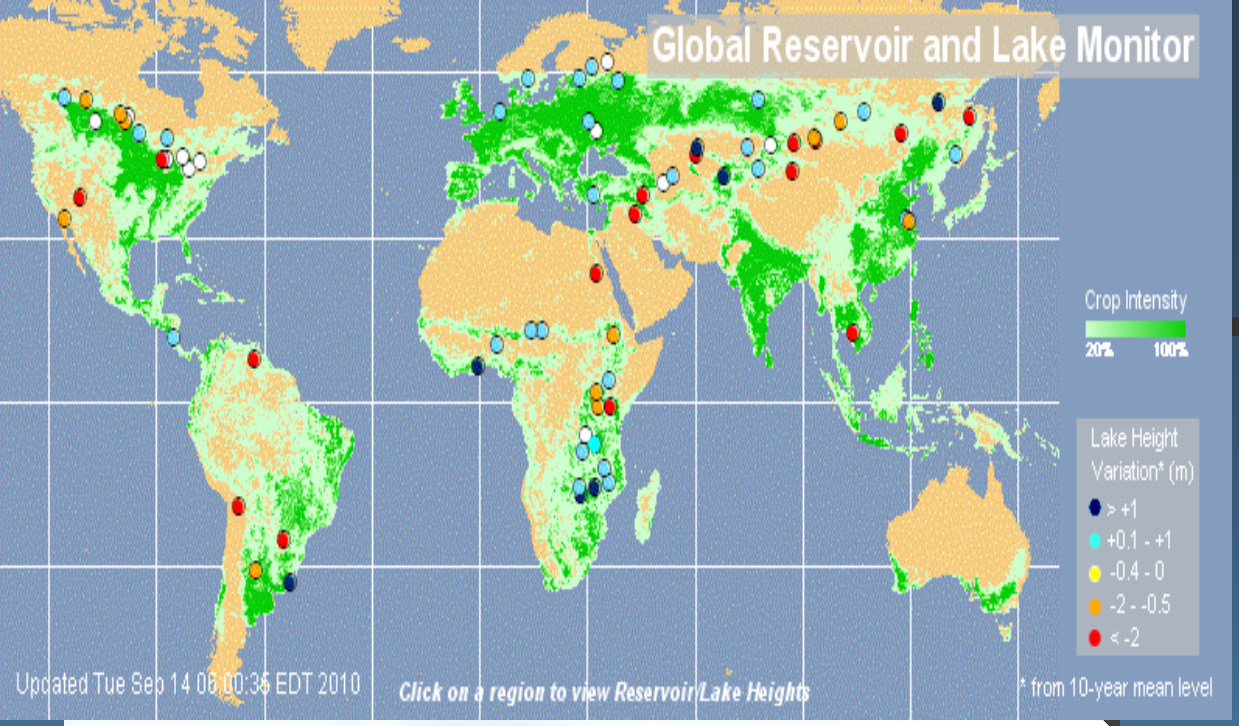
- Agricultural Production
- Articles and Reports
- Explore by Crop
- Future of Land Imaging
- Geographic Search
- Global Climate Change
- Global Crop Production
- Global Reservoirs/Lakes
- Landsat GloVis
- MODIS Image Gallery
- MODIS Image Archive
- MODIS NDVI Gallery
- MODIS NDVI Time Series
- MPA Rainfall Maps
- Photo Gallery
- USDA Satellite Imagery Archive

Metadata

- Live Data and Maps
- GeoSpatial One-Stop

USDA/FAS Crop Explorer

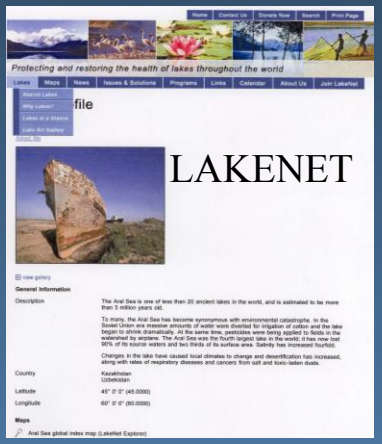
Portal for data sets



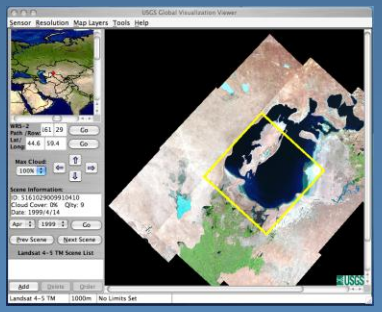
The Global Reservoir and Lake Monitor

Operational since 2003

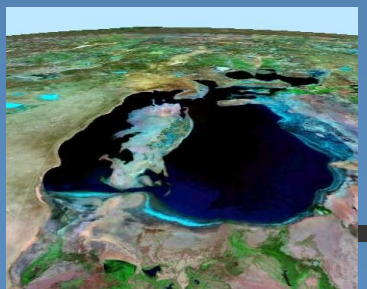
Based on NASA Pathfinder System, ARL=9 (current data)



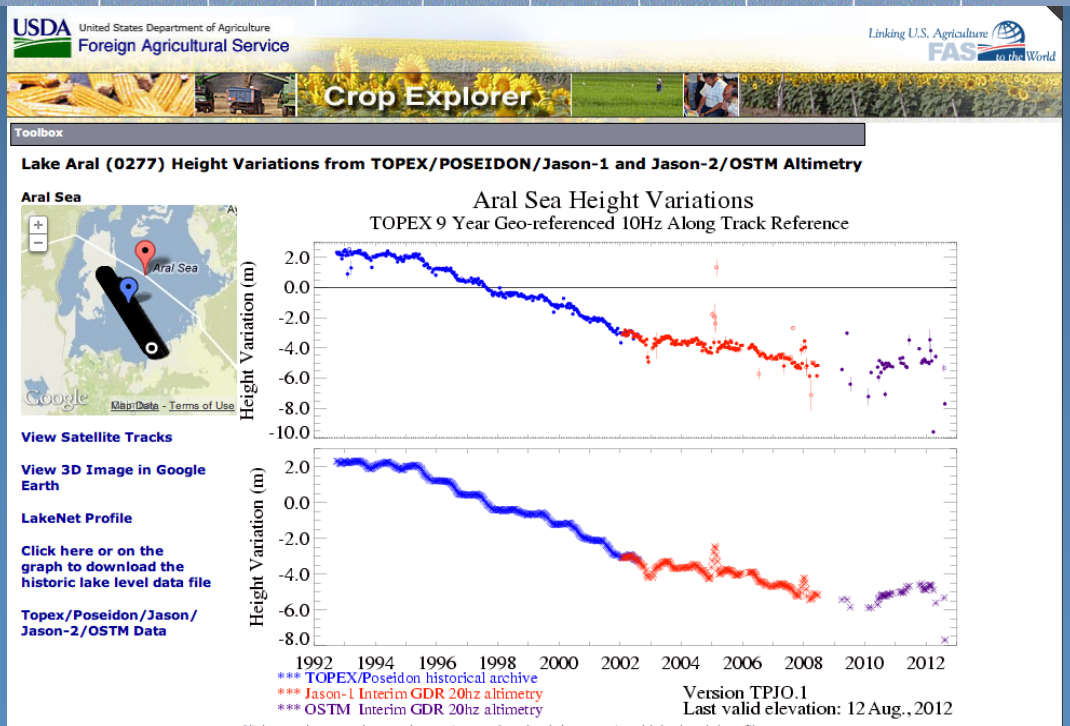
databases, Web links, etc

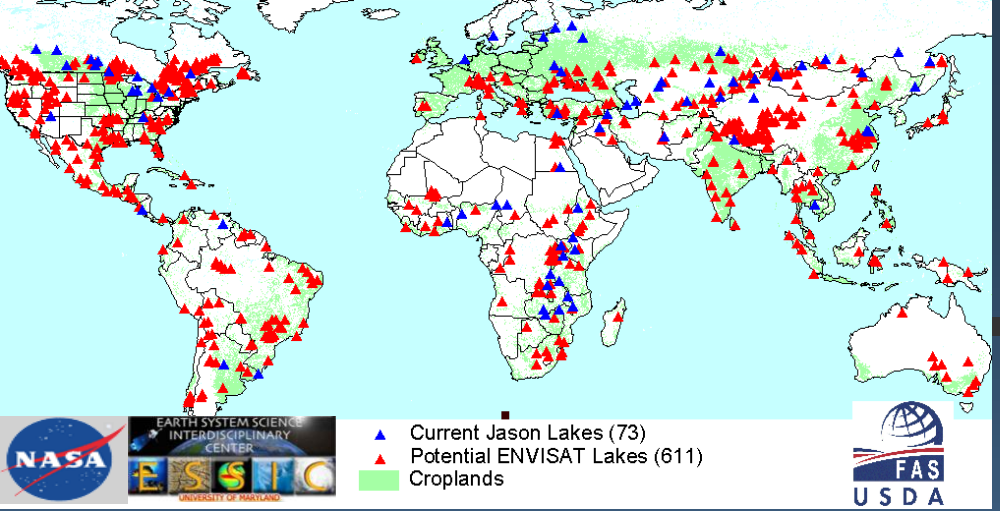


USGS Global Visualization Viewer



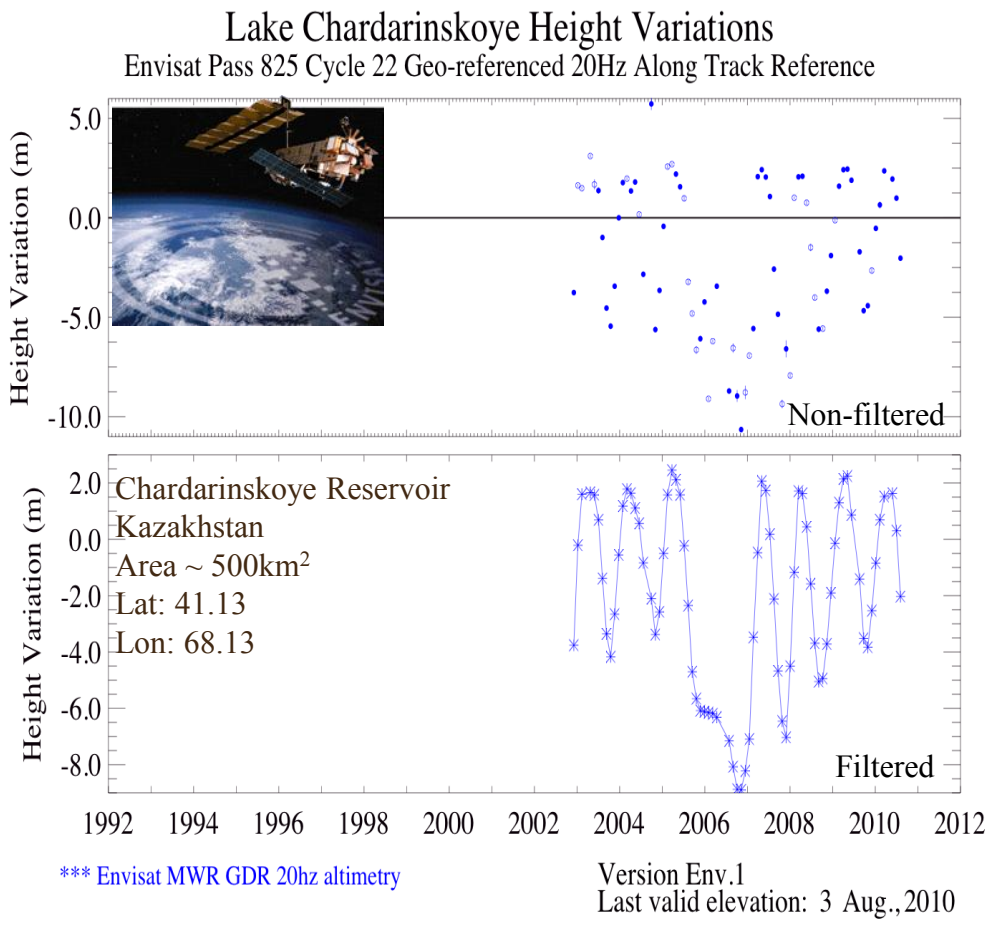
3-D Imagery

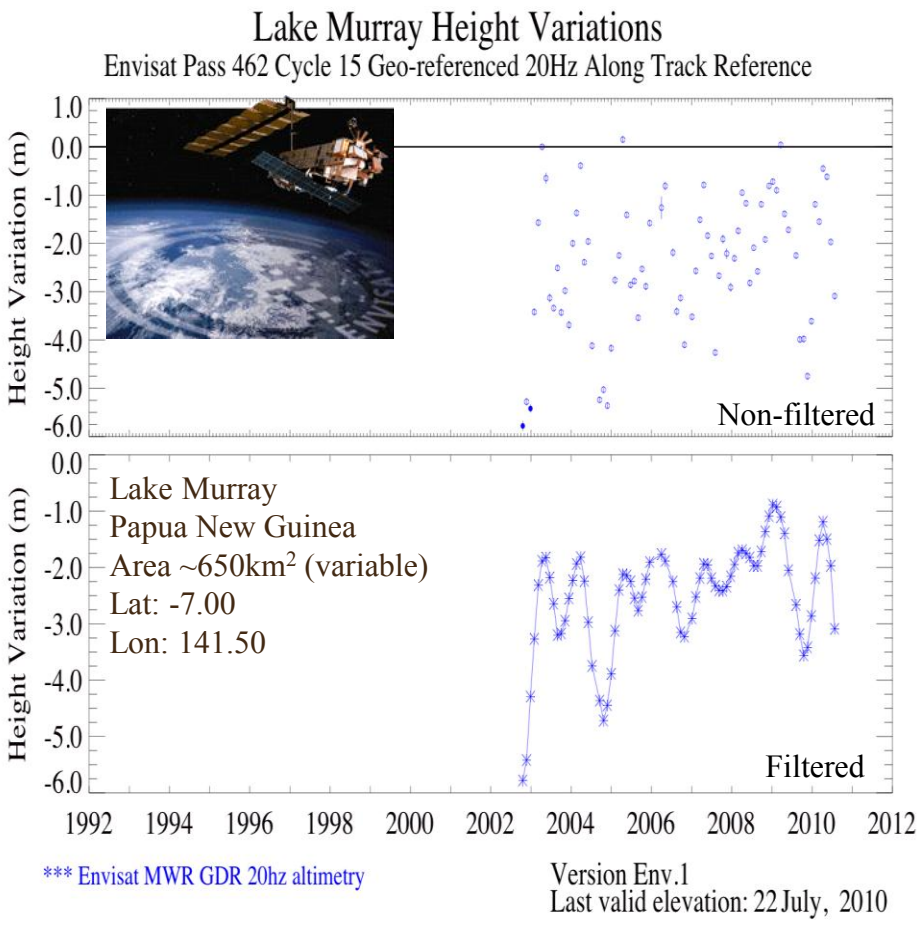




Global Reservoir and Lake Monitor Phase IV

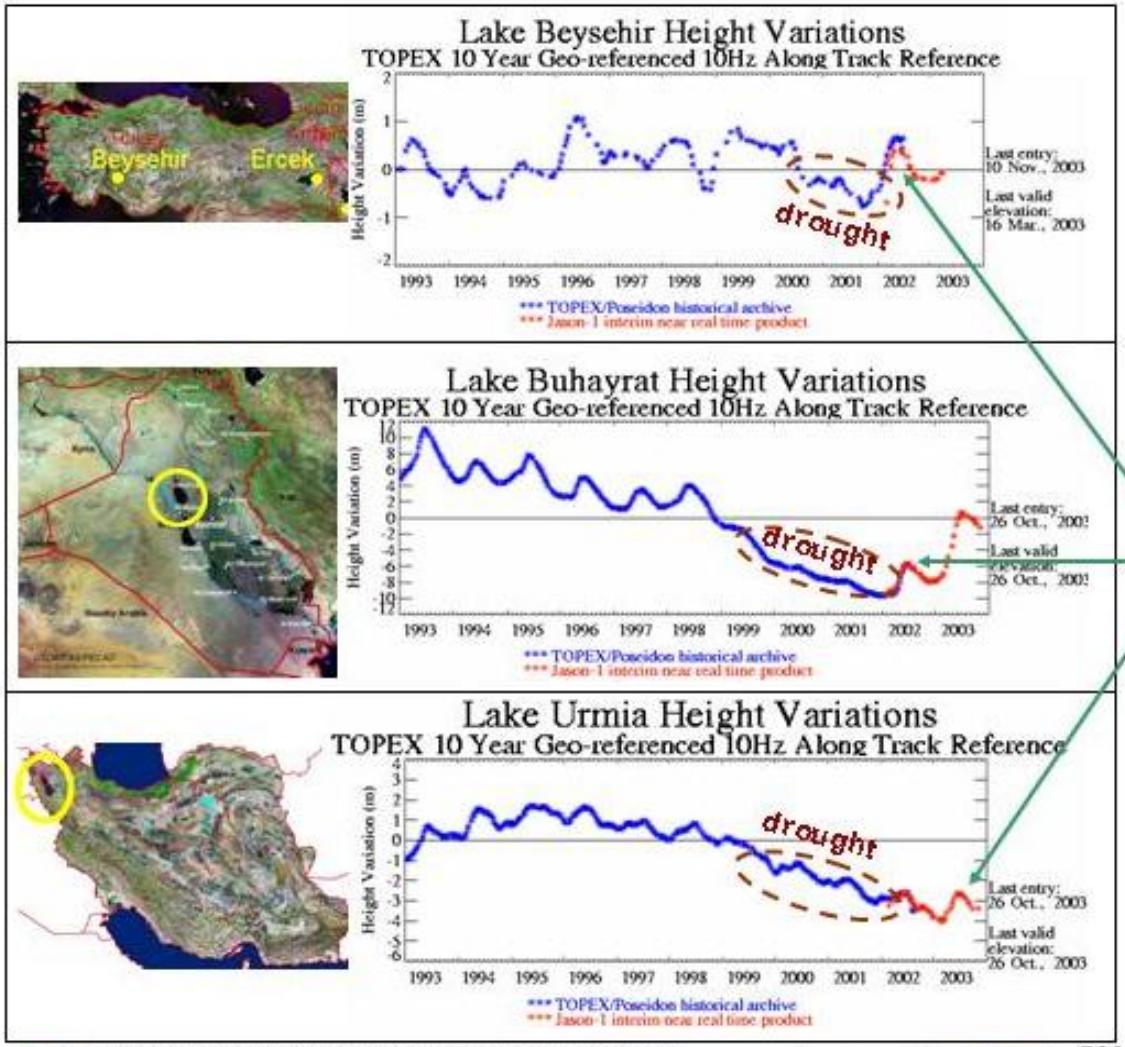
Summer 2011 launch of the new archive products from the ESA/ENVISAT (2002-2010) mission. (C. Birkett and C. Reynolds)





Product Application

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.

Production Estimates & Crop Assessment Division (PECAD)
Foreign Agricultural Service (FAS)
U.S. Department of Agriculture (USDA)
http://fas.usda.gov/pecad/pecad.html

ESSIC (Earth System Science Interdisciplinary Center), University of Maryland, College Park
NASA Goddard Space Flight Center, Greenbelt, Maryland

Venezuela to Ration Water Because of Low El Nino Rainfall

October 22, 2009

Venezuelan President Hugo Chavez urged citizens to cutback on showering time as the country's electric and water supply problems mount.

Venezuela will enact n
methods, including red
until May, because of lo
Hugo Chavez announc

The drier cycle has cau
the country's hydroelec
water reserves, includir
the world's largest dam
located on the Caroni R
percent of Venezuela's
River, located in the Or
discharge rate, but it ha
itself lately.

This drought has aggra
fragile situation. Growing demand for and under-investment in water lead to se
Venezuela earlier this year.

Power cut of 2,000 MV if Guri dam level reach meters

The largest power reduction must be made in ce
Venezuelan Guayana's Corporation (CVG)

ENERGY

Government authorities believe that the water level of the Guri reservoir will reach the critical level of 240 meters above sea level by June, and at point additional power rationing will be required.

The Executive branch of government has already outlined two scenarios for operating the Guri hydroelectric plant if the reservoir drops level. According to a report prepared by National Electric Corporation (Corpoelec two options: operating the electricity gr without the addition of the new generat

Higher water level in Guri Dam fails to solve power crisis

The water level of the reservoir is growing but thermoelectric generation has not expanded

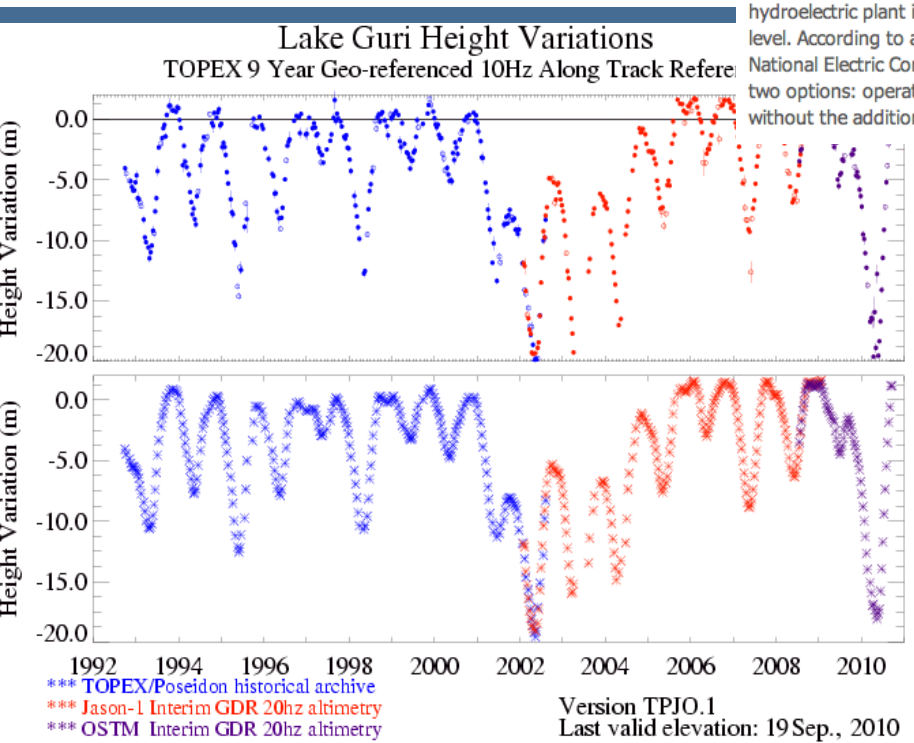
ENERGY

The rainy season is arriving in Venezuela and the water level of the Guri reservoir is starting to increase, but concerns about the serious power crisis facing the country remain.

Following rains, the water level of the Guri Dam has increased by 13 centimeters in two days (File photo)

In fact, the National Electricity Corporation (Corpoelec) informed the authorities of state-run steelmaker Siderúrgica del Orinoco (Sidor) that electricity rationing in the main Venezuelan mill would be implemented throughout the year. This means that the steelmaker company will have to maintain its current production level. That is, a maximum power consumption of 300 megawatts, which allows for operation of one furnace only.

The level of the Guri reservoir is declining over



The peak oil crisis: countdown at the Guri

by Tom Whipple

☆☆☆☆☆

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Most Americans have never heard of Venezuela's great Guri dam. Completed in 1978 with 20 generators and 10,200 MW of generating capacity, at one time it had the most generating capacity of any hydro dam in the world.

By way of comparison, the Three Gorges dam in China is to produce 22,500 MW when completed next year and the U.S.'s Grande Coulee which dates back to 1942 can produce 6,800 MW. If you disregard the ecological damage caused by great dams, they can be wonderful things for they produce prodigious amounts of emissions-free energy at very low cost --- provided, of course, it keeps raining in the dam's watershed. Until recently nobody gave this much thought until last summer when El Niño, and perhaps a touch of global warming, started doing funny things to Venezuela's weather.

The rainy season in Venezuela which refills the reservoirs runs from June to October. The summer of 2009 it was a catastrophe. Rainfall was only about one third of normal so that by last fall alarm bells began sounding as it looked as if the water could fall to the level where the dam would have to shut down most of its generating capacity. The Guri dam has a lower and older generating hall with much less capacity than the main hall and there are two smaller dams located downstream from the Guri. The problem is that if they have to stop letting water through to the turbines in the main Guri dam, the water is no longer available to the downstream plants so their output drops markedly too.

Reservoirs in the News

Additional End Users

GRLM users span all *.edu, *.mil, *.com, *.gov, *.org, including, FAS foreign resource analysts, international governments, lake development agencies and networks, humanitarian organizations, conservation groups….

With interests/applications such as lake surveys and impoundment effects, water resources, drought effects and energy supply, fish productivity, water security, vegetation and surveillance ecology, basin or continental-scale hydrological modeling, climate change, and a validation tool for other remote sensing data sets.

Phase V: 2012-2013
New Requirements and Expectations

NEW Requirements

"Level variations in near-real time for a designated set of large lakes and reservoirs"

Continuity of current time series, operational with faster delivery time, greater number of lakes, greater number of smaller water bodies, better and more informative datum, single-satellite series only, additional basin products, [global 1-click access].

NEW Expectations

Final Number of targets	>500
Elevation Accuracy	= 20cm rms, or 10% of maximum seasonal amplitude
Min Temporal Sampling	= monthly
Product Access	= Via html for open and free access
Time Period Coverage	= Variable Archive with appended Near Real Time
Product Update Search	= Daily
Product Latency	= 3 days after satellite overpass

Year 1 : Approach, Tools, Datasets

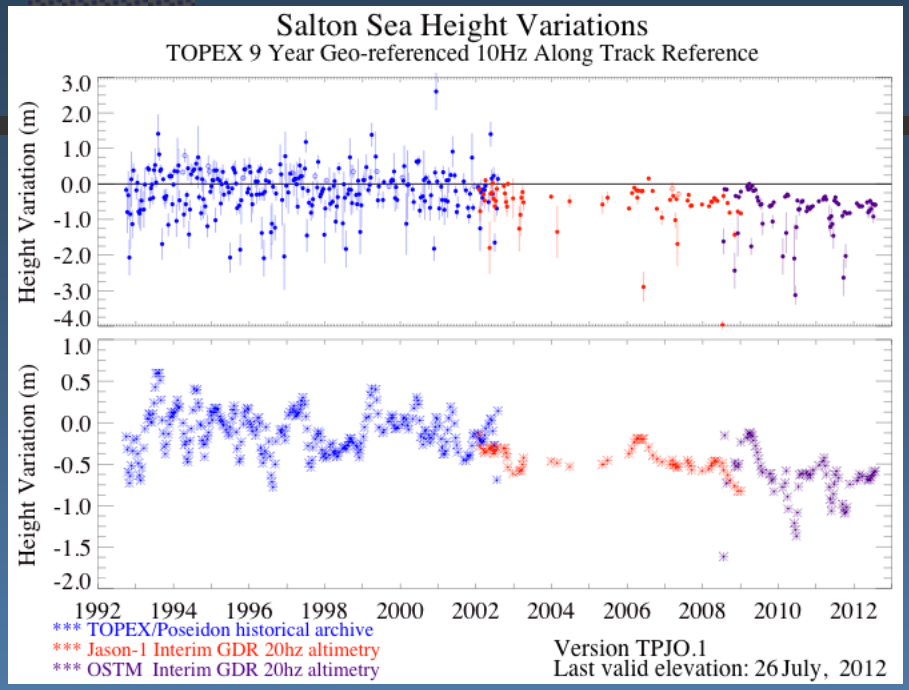
NASA Funded:

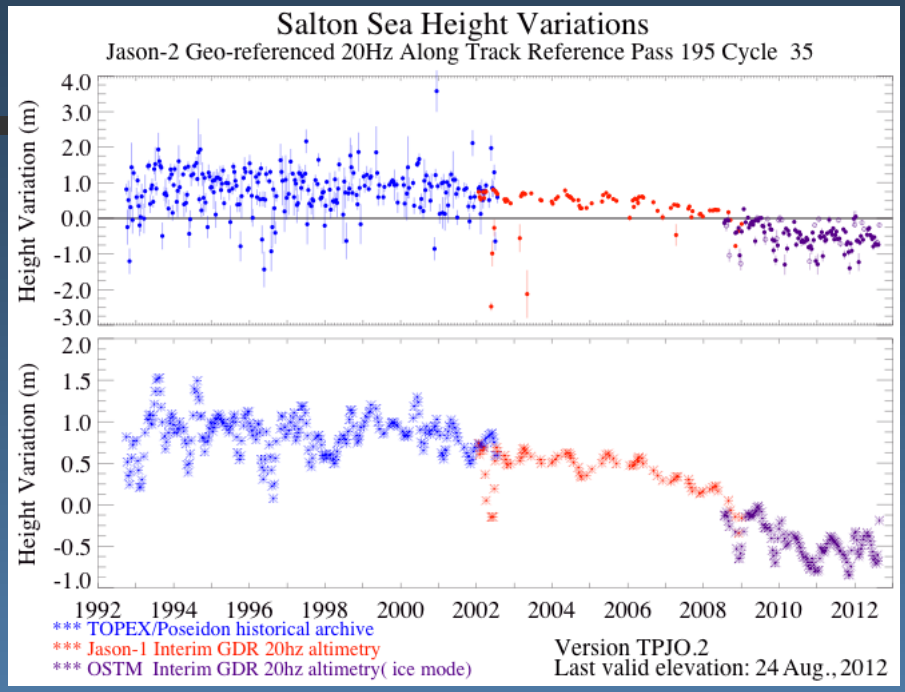
- Same approach but a revised system with a greater level of automation for faster product delivery.
- Investigation of ENVISAT, ERS, SARAL, Geosat, CRYOSAT-2 data feasibility studies for archive expansion, continuity, target size, includes validation or new test-case products (ARL=1)
- Benchmarking tasks, general user response, specific test-case studies with specified end-users (feasibility of new products and quantifying potential impacts)
- Forward look to additional lake/basin products – summary focusing on stakeholder drought monitoring interests e.g., areal extent (standalone or as proxy to water level), volume change, irrigation tanks, river channel, ….

USDA Funded:

- TPJO.1 upgrade to TPJO.2 (new and improved datum with additional datum products online)
- Weekly updates of TPJO products – via Jason-2/OSTM (Years 2-4: Operational products from SARAL, Jason-2/Jason-3, additional ENVISAT, ERS archive products).

TPJO.1 upgrade to TPJO.2

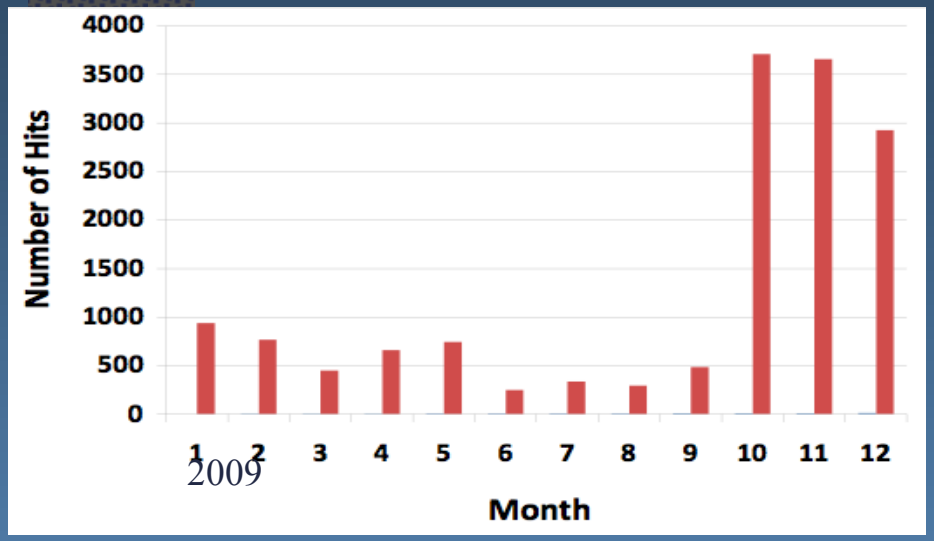


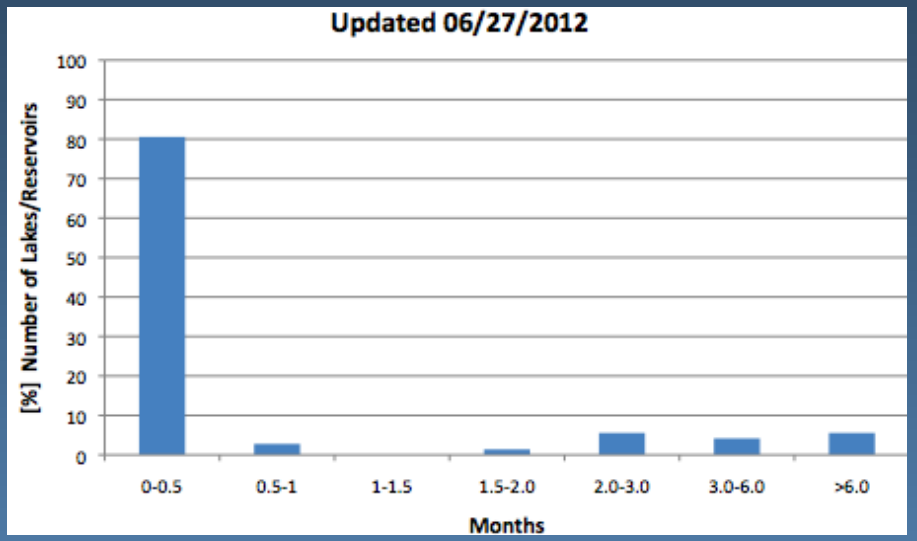


TPJO.1 : T/P ***10hz*** 9-yr mean reference profile; Jason-2 ocean retracking

TPJO.2 : Jason-2 ***20hz*** mean reference pass profile; Jason-2 ice retracking

Benchmarking: Recording statistics of end user hits, product latency and global distribution of monitored targets – testing feasibility of daily product updates, and meeting target requirements.





35-day repeat data sets: ENVISAT (~618 lakes in range 40.99S<lat<52.99N)

	Res	Lake	Size1	Size2	USA	DC	NAm	SAm	Eur.	Afr.	Asia	Aust
Required	171	447	283	335	82	103	186	71	57	77	215	12
Quarter 1	65	85	109	41	24	36	42	19	10	33	42	4

Existing and New Partners: Current requirements, end-user feedback re current product use and quantifying impacts.

USDA/FAS/OGA: 40°S-52°N lakes+reservoirs ≥100km^2, archive+NRT(weekly). Impact of GRLM difficult to quantify – need to separate from all other RS inputs.

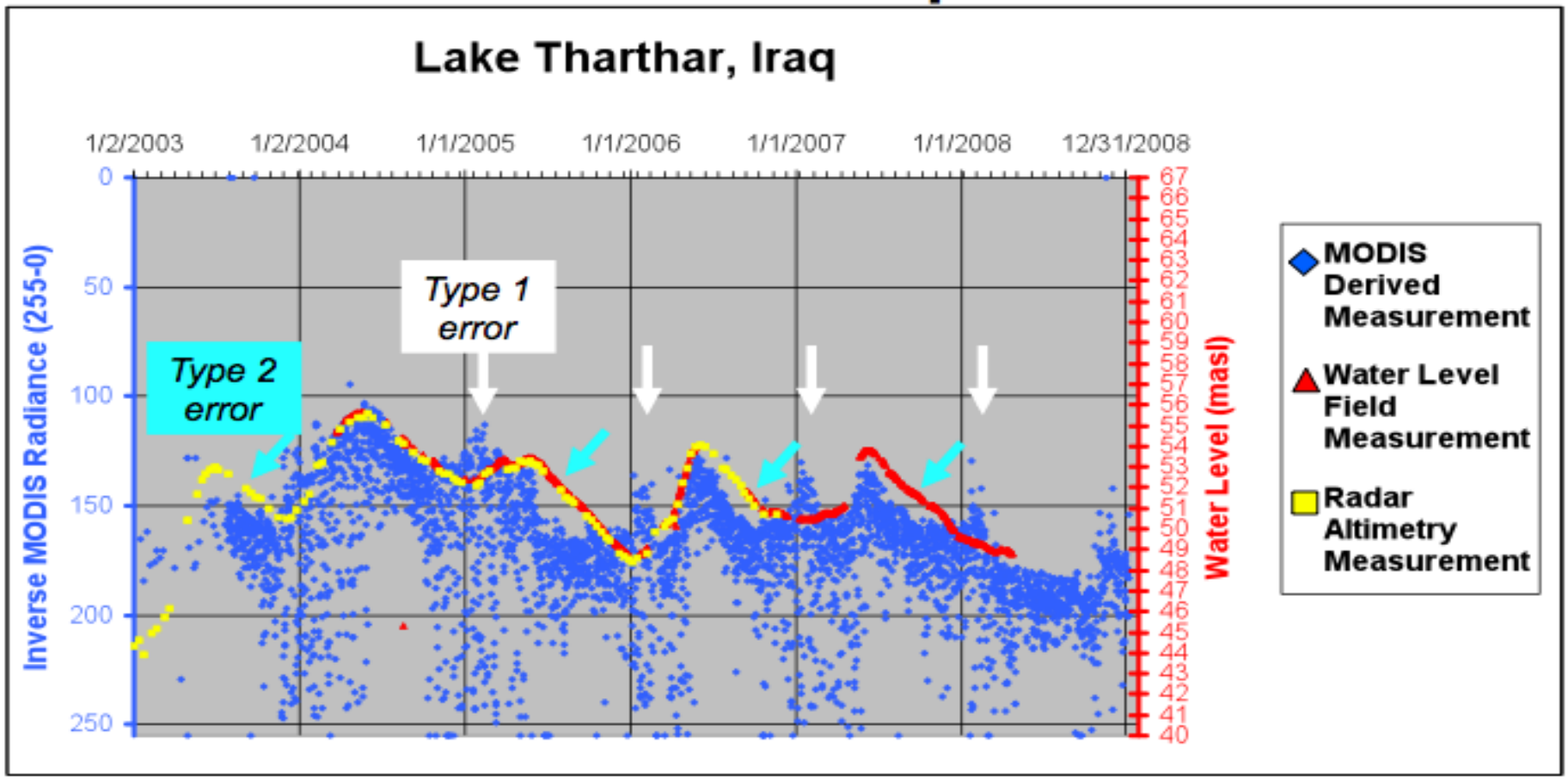
USGS FEWS-NET: Sub-Saharan Africa, Central Asia, Central America/Caribbean. Increase in number of current monitored bodies (e.g. Kajakai). GRLM is just one input on convergence of evidence re agricultural drought.

NGA: Increase in number of current monitored bodies and improved product latency, particularly Kajakai/Afghanistan, Keban/Turkey, GRLM utilized to validate other sources so a) improved confidence of 'level', b) characterization of level errors in other methods, c) improved speed of analytical judgments, d) improved modeling of overall watershed wrt early warning of drought and 'dead levels' (HEP) and predicting future risks (GRLM levels only 1 of several inputs).

ERDC: Socio-cultural impacts of drought (DoD), targets and impacts TBD

*.com/engineers: Africa/Lakes Turkana (hydrological impacts of dam construction and LCLUC) and Tana (irrigation schemes and Hydropwer project commission), impacts TBD

Method Comparison

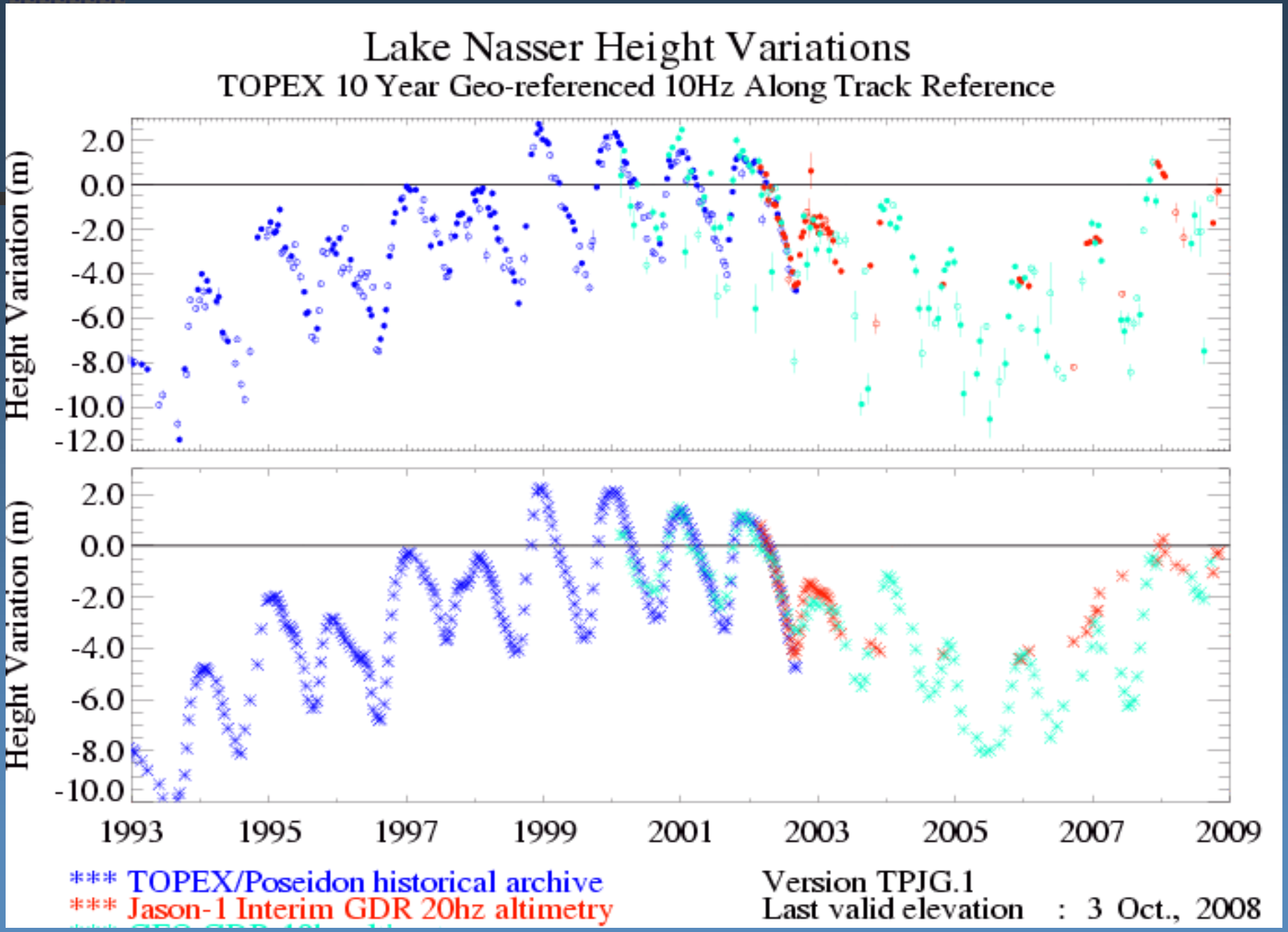


Two independent datasets were compared to the results from this technique: directly observed water levels, and radar altimtery of the water surface. These two methods agree quite well with each other. Two types of flaws appear in our method: the MODIS data indicate an annual peak, typically early in the year, not observed using the other two methods (indicated here by the white arrows), and the water levels during the summer months appear to be underestimated in some years (shown by the light blue arrows).

Altimetric Data Sets

Table 1: Satellite Altimeter Repeat-Mission Data Sets

Mission	Agency	Frequency	Time Period	Resolution	
				Spatial(m)	Temp(days)
TOPEX/Poseidon (T/P)	NASA/CNES	Ku	1992-2002	580	10
Jason-1	NASA/CNES	Ku	2002-2008	290	10
Jason-2/OSTM	NASA/CNES	Ku	2008-present	290	10
Jason-3	*NASA/CNES*	*Ku*	*launch 2013*	*290*	*10*
Geosat	NRL	Ku	1986-1990	670	17
GFO	NRL	Ku	2000-2008*	670	17
ERS1	ESA	Ku	1992-1995	350	35
ERS2	ESA	Ku	1995-2002*	350	35
ENVISAT	ESA	Ku	2002-2012	350	35
SARAL	*ISRO/CNES*	*Ka*	*launch 2012*	*350*	*35*
Sentinel-3	*ESA*	*Ku*	*launch 2013*	*350*	*35*
T/P Tandem/Interlvd**	NASA/CNES	Ku	2002-2005	580	10
ICESat-1**	NASA	(laser 1064nm)	2003-2009	175	91/33
Jason-1 Tandem/Interlvd**	NASA/CNES	Ku	2009-2011	290	10
CRYOSAT-2**	ESA	Ku	2010-present	250	369/29


Lake Nasser Height Variations
TOPEX 10 Year Geo-referenced 10Hz Along Track Reference
Height Variation (m)
2.0
0.0
-2.0
-4.0
-6.0
-8.0
-10.0
-12.0
Height Variation (m)
2.0
0.0
-2.0
-4.0
-6.0
-8.0
-10.0
1993
1995
1997
1999
2001
2003
2005
2007
2009
*** TOPEX/Poseidon historical archive
*** Jason-1 Interim GDR 20hz altimetry
Version TPJG.1
Last valid elevation : 3 Oct., 2008