NOAA/CWCP, College Park, Maryland,
March 3-4th, 2015

The Global Reservoir and Lake Monitor (G-REALM): Expansion and Enhancement of Water Height Products

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[Richard Ray, Planetary Geodynamics Lab, NASA/GSFC]

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Project Initialization, Hardware, Product Operations and Upgrades

Product Data Investigation, Validation and Application,
Product Expansion and Program Enhancement

USDA/FAS/OGA Crop Production Estimates
Problem and Opportunity

USDA integrates a wide variety of data sets.

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Input into a monthly ‘lockup’ process which sets global Crop Condition/Production numbers

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

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Estimates drive or influence markets, trade, foreign policies, farm and food programs.

Missing Input - the VOLUME of stored water for irrigation potential considerations.

The Solution – use LAKE LEVELS as a proxy, obtained from satellite radar altimetry data sets.

Allowing observation of Agricultural Drought (weeks-months, crop season) and Hydrological Drought (months-years, water supplies)

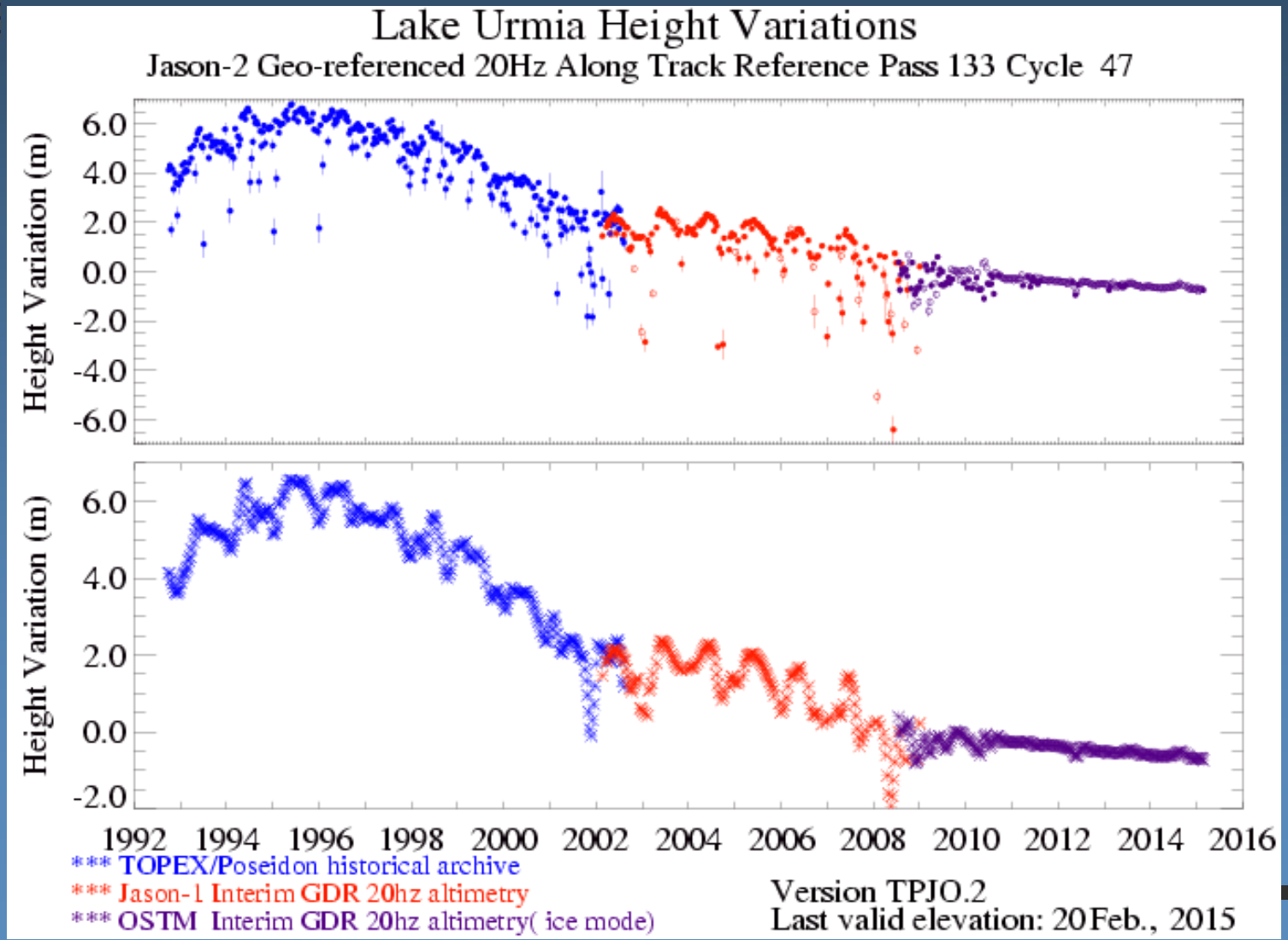
The Global Reservoir and Lake Monitor

(Technology already demonstrated, transitioned to operations in 2003, products accessed via CropExplorer web portal.

Archival and Near Real Time water-level variations as observed by the NASA/CNES radar altimetry instruments, 10day resolution, single-date datum.

Lake Level Products – TPJO.2

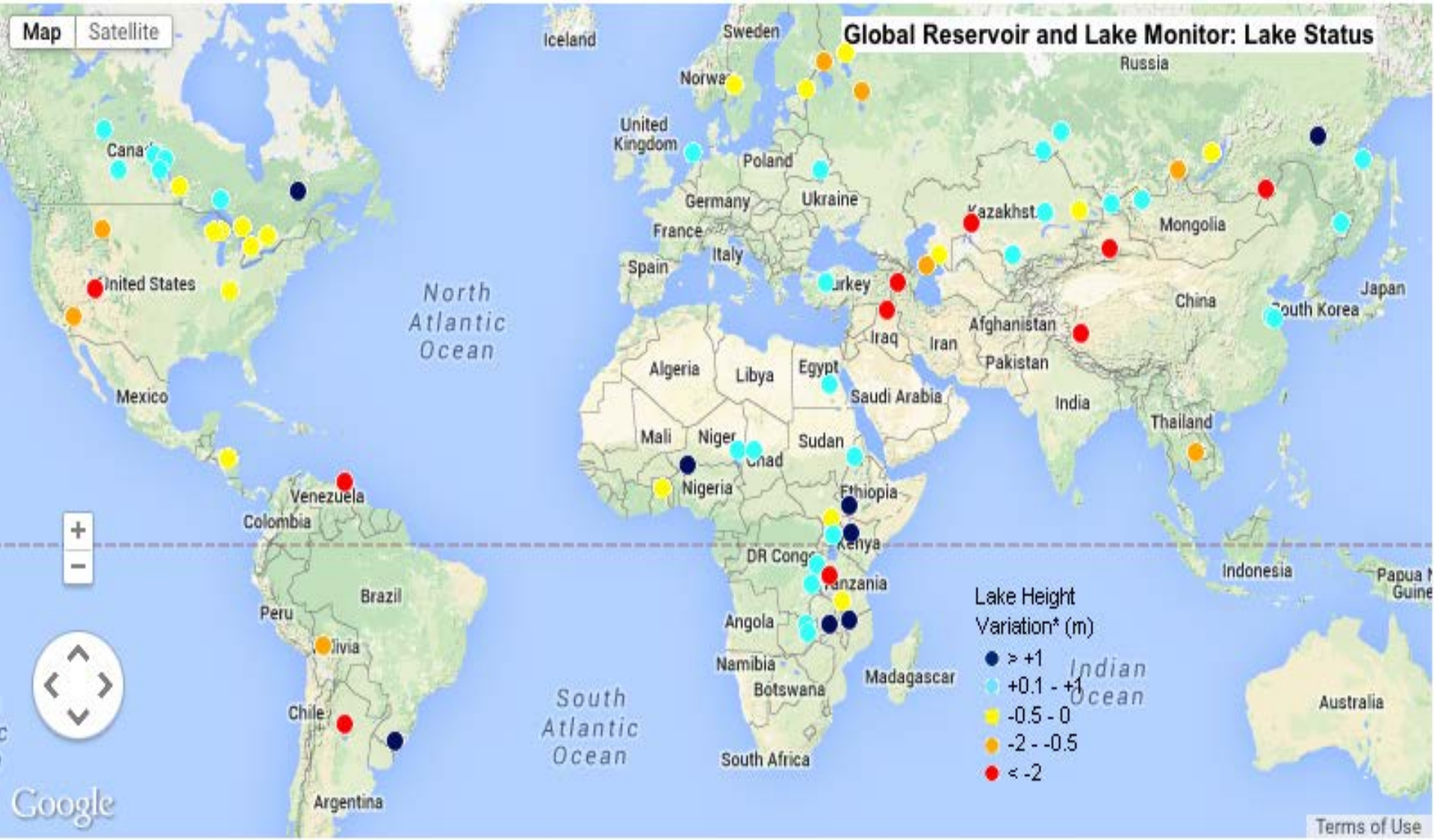
Relative variations in surface water level over the lifetime of the missions, variable accuracy roughly 5-30cm rms, for up to 35% of the world's largest water bodies (>100km^2) at 10-day resolution. Emphasis on NRT for agricultural drought.



Lake Level Products – TPJO.1

Emphasis on long-term mean for hydrological drought.

A 9yr datum enables a Lake Status indicator. At any given time, roughly one third of the monitored lakes have current water levels 0.5 to 2m below their long-term mean.



Application Readiness Levels

Each new mission data set, whether offering NRT or Archive observations, starts at ARL=1 for performance, validation, potential integration and merger checks. Products with ARL=10 are updated bi-weekly, have <2week delay after satellite overpass, and undergo periodic upgrades.

10-day restn products (Topex/Poseidon, Jason-1, Jason-2 ARL=10, *Jason-3 2015*)

35-day resolution products (ERS-1, ERS-2, ENVISAT , SARAL ARL=3)

(Problem) Bridging the ENVISAT/SARAL Data Gap via Jason-1/Interlvd, Cryosat-2

Future Mission Technologies
offering new time series
resolutions, enhancements
and cross-validations

Sentinel-3 2015, ICEsat-2 2016 Jason-CS 2020, SWOT 2020

Changing Product Requirements

USDA/FAS:

lakes/reservoirs -40°S to 52°N, ≥100km^2,
archive AND near real time, relative datum

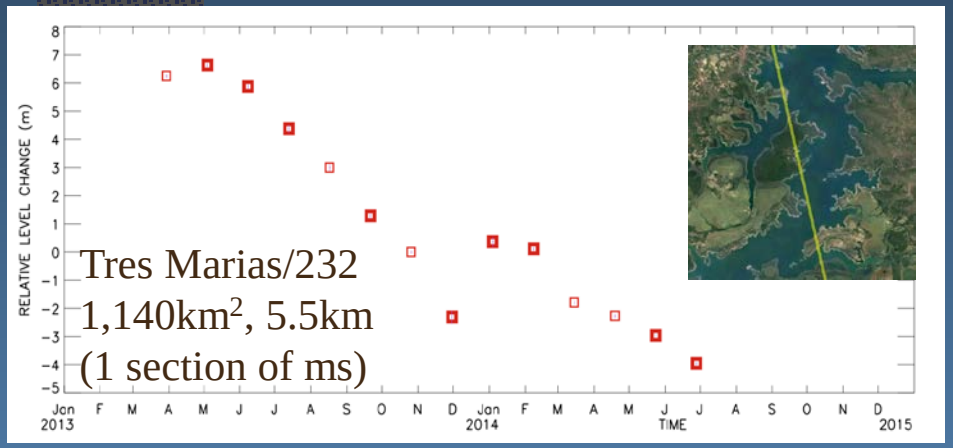
Additional end-users with multi-disciplinary interests e.g.
Reservoirs <100km^2 NRT(water resources, security, agriculture)
Or all globally distributed water bodies (climatic index)
Or surrounding marsh/wetland regions (fisheries)

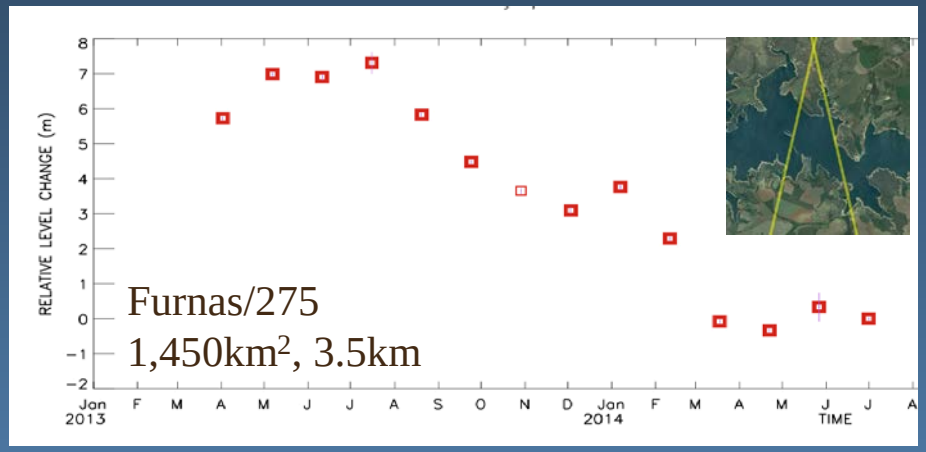
Additional requirements:
Identification of ALL water bodies particular focus on new reservoirs
Enabling datum translations – to orthometric or WGS84 (primary)
Improving temporal resolution and delivery time
Providing additional basin parameters

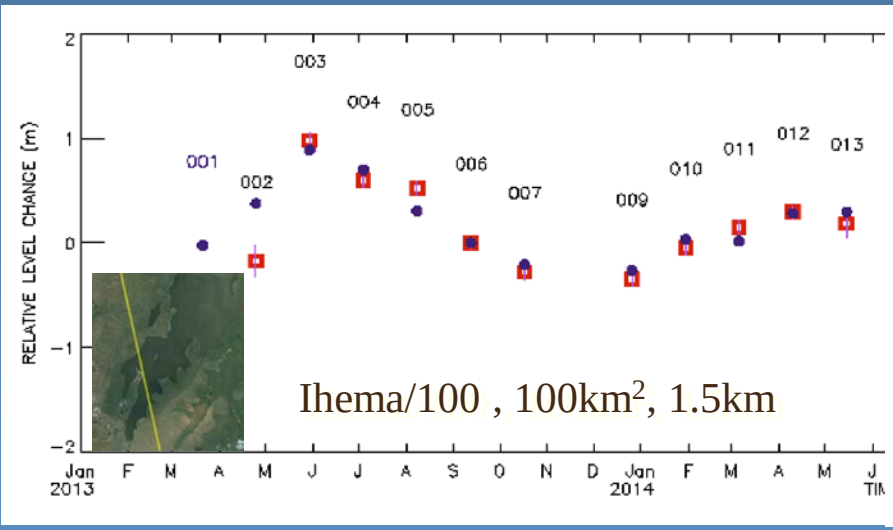
Project Status - 2015

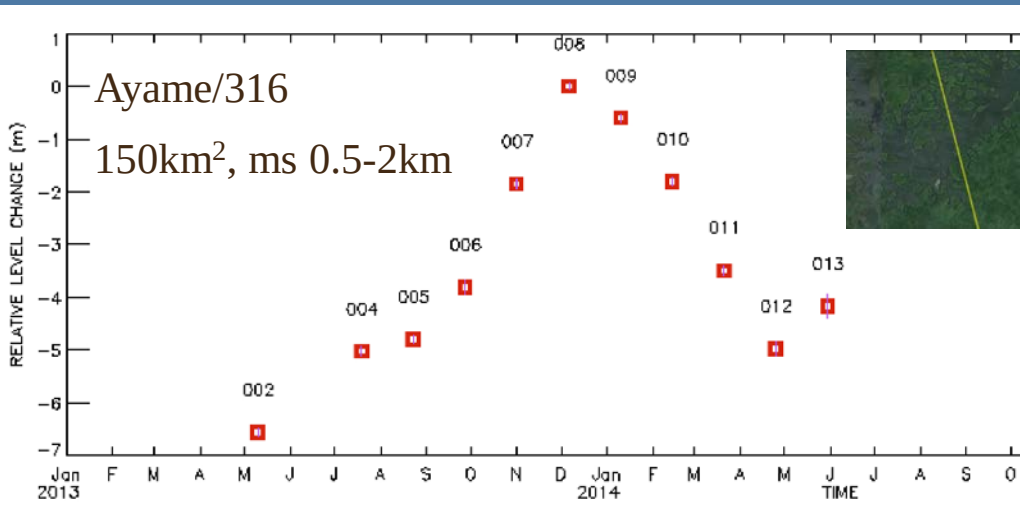
Current:	~80 lakes/reservoirs TPJO 10-day resolution ~150 lakes/reservoirs ENVISAT archive 35-day restn
Spring 2015	Upgrade of TPJO and datum translation factors
Summer/Fall 2015	~ add 100-200 @ 10-day restn, NRT Jason-2/3 Increase ARL for SARAL
Fall/Winter 2015	~ ARL=10 for 200 water bodies @ 35-day restn, NRT SARAL
2016	Additional SARAL products

ARL=3 Preliminary Results from the new ISRO/SARAL mission, 35-day temporal resolution, 40Hz along track resolution, 1400 water bodies, new Ka-band technology



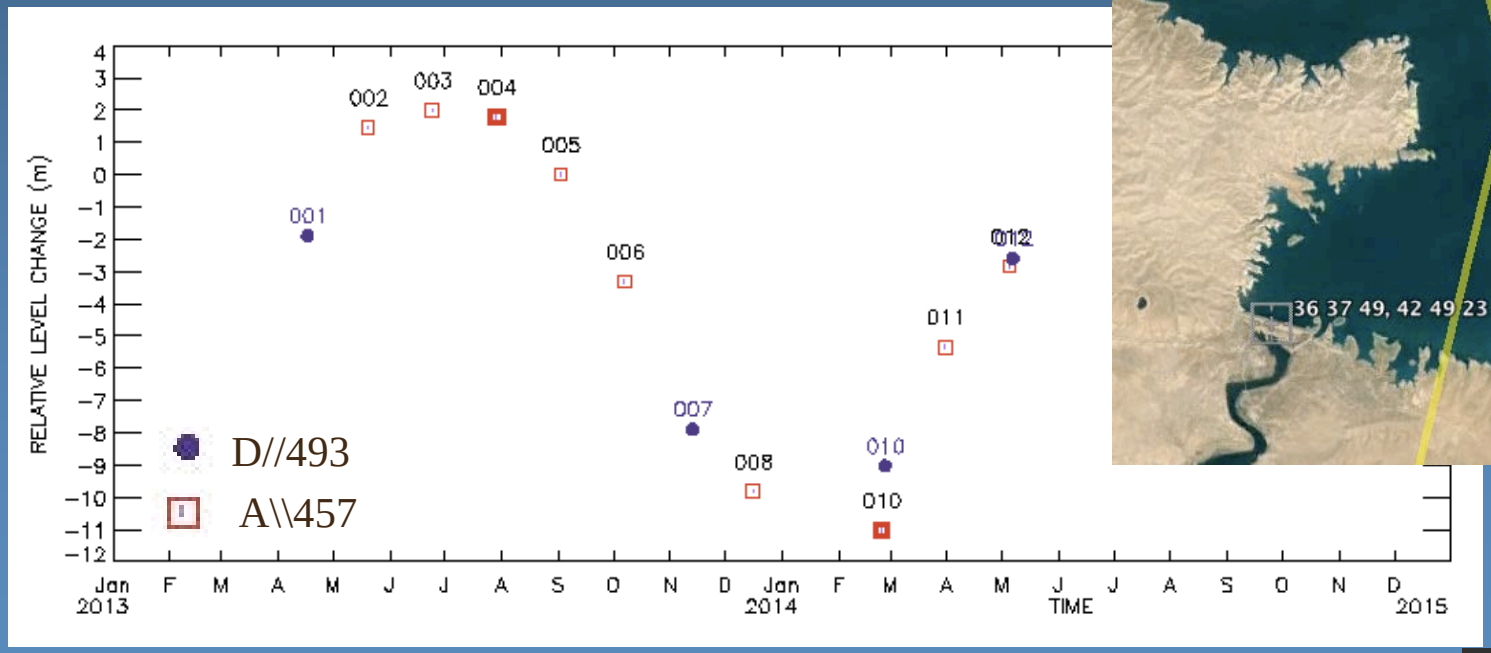






ARL=3 Preliminary Results ISRO/SARAL Combined results from multiple satellite overpasses for improved time series of water level variations

Mosul Dam (36N, 43E) Iraq
SARAL, Ice1 retracker



Product Application

Small-scale Inland Capture Fisheries in Africa

Applies to many countries, little understanding of the drivers and trends.

Simple models developed, fish yields related to mean depth, water chemistry, etc.

Kolding+Zwieten (2012) introduced “The Relative Lake Level Fluctuation Index”

RLLF =(mean lake amp/mean depth)*100

…the more lakes fluctuate the higher the yields (kg/ha/yr)
…fishing effort is partly regulated by productivity
…RLLF may serve as a proxy for stability and resilience.

Requirements: Both current and archival time series of water levels

Investigations underway on the role of remote sensing combined with RLLF

Water Dynamics and Fisheries

(O. Magnus, 1555)

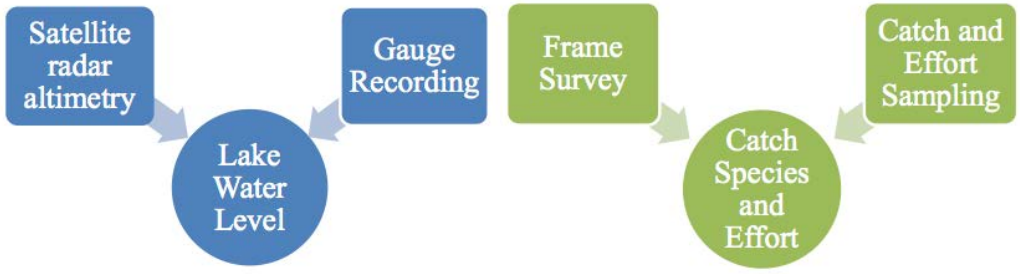
"Fish come with the rains"

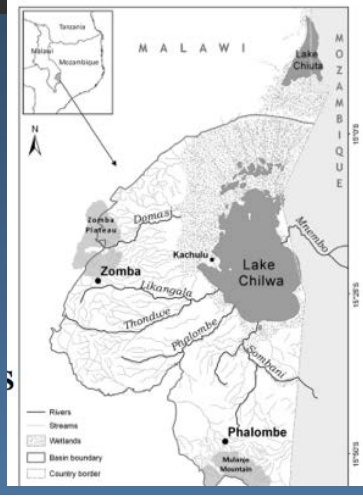
F. Simmance; A. Simmance; J. Kolding; G.M. Poppy; K. Schreckenberg; C. Birkett

Case Study: Endorheic Lake Chilwa, Malawi

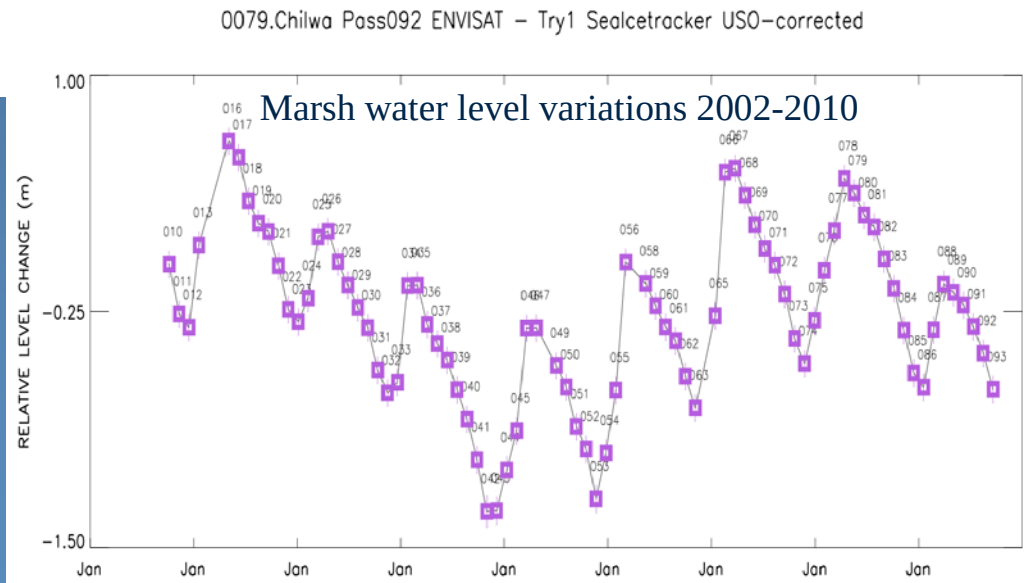
Unstable, highly fluctuating, shallow, complex socio-ecological system. Van Zwieten (2003) determined lake level fluctuation significant factor governing catch.

Presented at the Global Conference on Inland Fisheries, FAO HQ, Rome, January 2015





Time Series Multiple Regresssion: between RLLF, fishing effort and catch by species



Non G-REALM wetland product showing 1m seasonality, general decline 2002-2007 followed by recovery. Consistent with historical gauge data. "Cost-effective, timely and reliable monitoring, combined with RLLF may provide a deeper understanding of drivers and trends". Smaller lakes included in G-REALM program in Years 3+4. Inclusion of marsh/wetlands – a future direction?

Research and Product Gains Analysis
Search for additional funding for collaborators

Jeppe Kolding and Paul van Zweiten
Univ. Bergen (Norway) and Wageningen(Netherlands)

Application for additional funding (including social sciences aspect for G-REAL product gains analysis) in 2013/2014.

"From pattern to process and prediction - Understanding and Mitigating the impacts of Climate Change of Africa's fisheries ICCSAF"

Submission to SANCOOP Sept 2013
Submission to USAID/Malawi/FISH May 2014

Continuing…..