Near-Real Time Altimetric Monitoring of Lake and Reservoir Surface Elevations

A semi-automated system with global outlook, using the Jason-1 and TOPEX/POSEIDON satellite radar altimeters

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ABSTRACT: . Satellite radar altimetry has the ability to monitor variations in surface water height (stage) for large lakes and reservoirs. A clear advantage is the provision of data where traditional gauges are lacking or where there is restricted access to ground-based measurements. As part of a USDA-funded program, near-real time altimetric monitoring of the largest lakes and reservoirs began in October, 2002. Data ingestion and manipulation closely follows the path of the NASA Ocean Altimeter Pathfinder Project with some modifications for inland water considerations. The program utilizes incoming data from the Jason-1 mission (near-real time, post 2002) and data from the TOPEX/POSEIDON archive (1992-2002). Focus was initially on the African continent but is currently progressing to other targets including reservoirs in Turkey, Afghanistan, Pakistan, India, Kyrgyzstan, Iran and Iraq. The project began by utilizing the IGDR data with its expected <10cm orbit accuracy and delivery time of <4days after satellite overpass. The team produce graphic and text products, revealing the variation in lake height, within 24hrs of data availability. These are delivered to the Foreign Agricultural Service's, Precipitation Estimation and Crop Assessment Division for observation of flood/drought conditions, and for analysis of reservoir volume and irrigation potential.

Introduction

This project centers on the proven ability of satellite radar altimeters to monitor the variation of surface water height for large inland water bodies. The aim is to utilize near-real time altimetric data from the Poseidon-2 instrument on-board the Jason-1 satellite to construct time series of surface water height variations.

A semi-automated data ingestion and analysis system has been constructed which outputs time series variation products which are directly delivered to the United States Department of Agriculture. The Foreign Agriculture Service utilizes the products for flood and drought applications, while the Precipitation Estimation Crop Assessment Division utilizes the data for the determination of reservoir storage and irrigation capacity. This project is unique, being the first of its kind to utilize near-real time altimeter data over inland water in an operational manner.

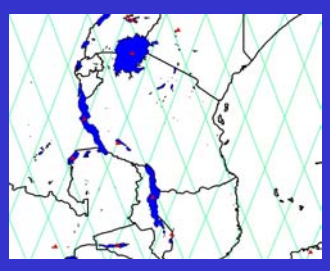
Targets

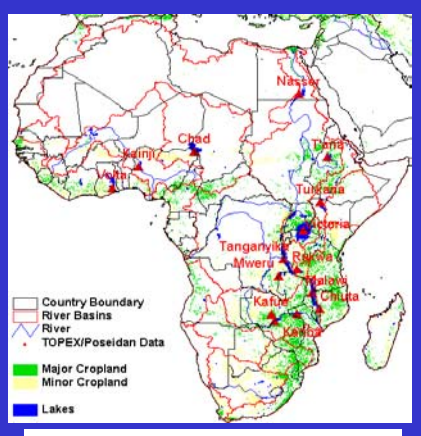
Initially the African continent was under consideration with focus on 4 major basins:

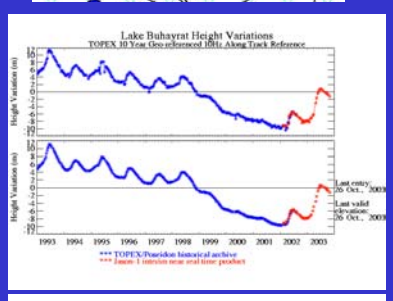
1) Nile Basin:
   Lakes Nasser, Tana, Victoria
2) Niger Basin:
   Lakes Chad, Kainji, Volta Reservoir
3) Rift Valley Basin:
   Turkana, Victoria, Tanganyika, Rukwa, Mweru
4) Zambezi Basin:
   Lakes Chiuta, Nyasa, Kariba, Cabora Bassa and Kafue

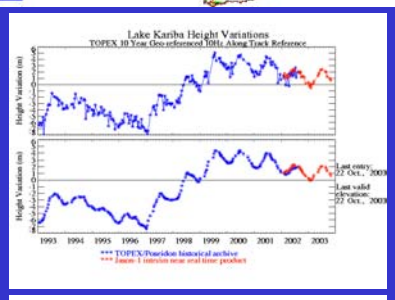
..although ultimately all global large lakes and reservoirs crossed by Jason and T/P are under consideration. With the near-real time requirement and in consideration of an acceptable height accuracy, the IGDR (Interim Geophysical Data Record) data stream is employed.

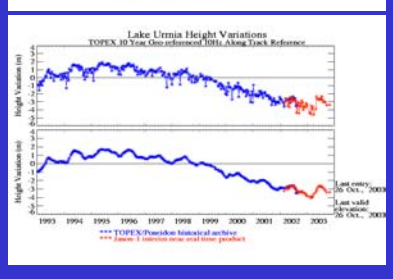
Jason-1

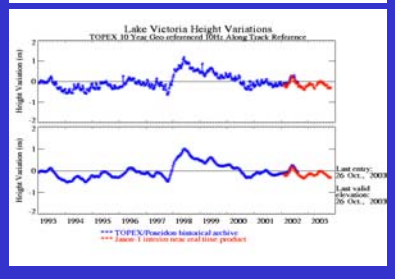


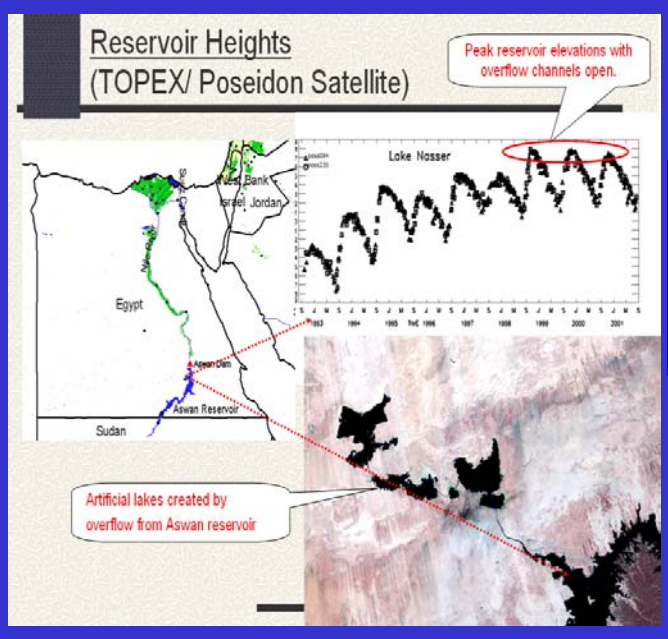


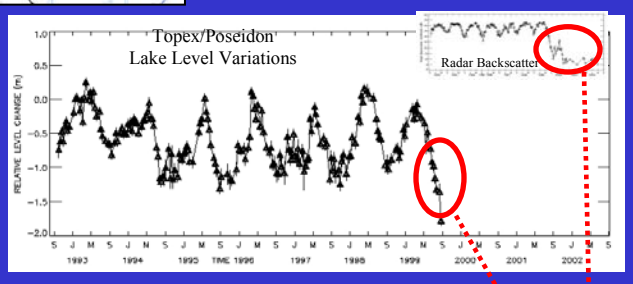






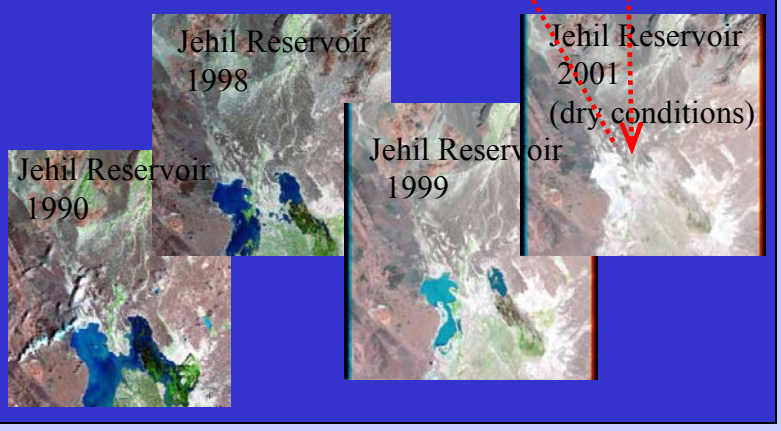






Jason Data

a) OSDR:
height accuracy 30-40cm, 3hr data delivery delay
b) IGDR:
height accuracy 10cm, 4day data delivery delay
c) GDR:
height accuracy 2-3cm, 1-2month data delivery delay



Deliverables

For each lake the deliverables consist simply of graphics plot and ASCII text file revealing the relative change in surface elevation as the Jason-1 mission progresses. Products are delivered to a dedicated server and public-accessible website within 24hrs of data delivery.

Where possible, elevations from multiple differing Jason-1 overpasses will be combined to form composite time series i.e. with potential ability to reduce the 10-day temporal resolution. As the project progresses, new targets observed by T/P from its new ground-track location will be added. It is hoped that with ESA permission, more targets can also be considered using data from the ENVISAT radar altimeter, RA-2 and the ERS-2 archive.

Examples

Examples shown here depict targets situated within drought stricken areas. Also shown are those lakes within regions that suffered high economic and financial losses during some of this decade's major flooding events. Observation of all reservoirs where water resources and agriculture are of prime importance, is a priority.