The Harvest Experiment: Towards Joint Calibration of Topex/Poseidon and Jason-1

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Abstract

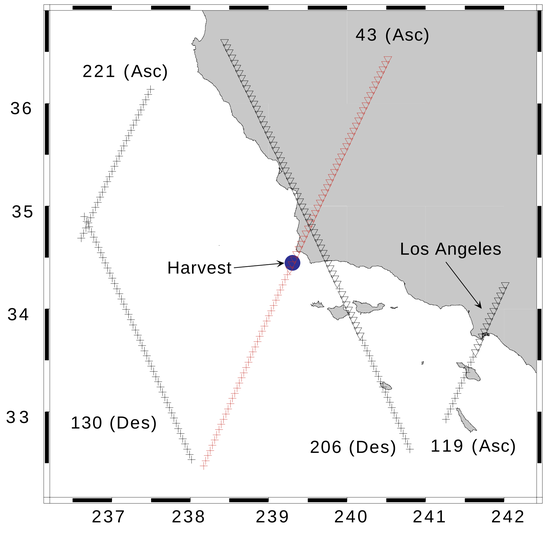
Prior to the launch of Topex/Poseidon (T/P) in August, 1992, NASA established its primary in situ verification site for the mission on the Texaco (now Plains Resources) Harvest oil platform located off the coast of central California. Data from a suite of instruments attached to the platform have been combined to yield a highly accurate record of the geocentric sea level spanning the last seven years. Over the same time period, the Topex/Poseidon (T/P) satellite has passed directly over the platform (± 1 km) every 10 days as it traced out its repeat orbit. Direct comparisons of the sea level and ancillary measurements derived independently from the satellite and platform data have been used to create a 7-yr time series of absolute calibration estimates for the Topex/Poseidon sensors (altimeter and radiometer) and the overall measurement system.

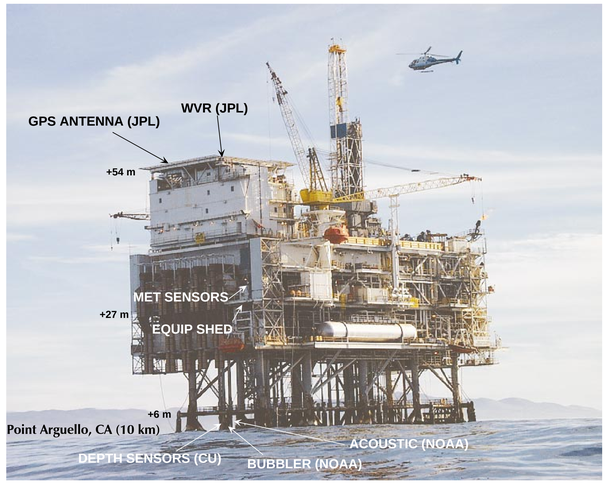
In this paper, we present current results from various elements of the Harvest closure analysis. Data from global positioning system (GPS) receivers are used to provide measurements of the platform subsidence, and estimates of both the columnar water vapor and total electron content at overflight times. We provide the latest GPS calibration results, and discuss the impact of recent upgrades to the platform GPS configuration on the overall performance of the Harvest experiment. With the February, 1999, activation of Side B of the Topex altimeter (ALT-B), efforts to validate the wind/wave and sea-surface height (SSH) measurements have intensified. The overall ALT-B SSH bias is estimated to be –5 ± 8 mm (1 standard error), compared to –7 ± 3 mm for ALT-A (prior to degradation of point target response). Biases in the wind and wave measurements are also statistically indistinguishable from zero. In this paper, we update the ALT-B results and present accompanying estimates of the ALT-A and Poseidon calibration time series.

Implications of the Topex/Poseidon Harvest experience on Jason-1 and other future missions will also be discussed. With the purchase of the platform by Plains Resource, the future of the Harvest experiment is more assured. The GPS receiver has been replaced with an advanced codeless model. We plan to upgrade the platform tide gauges and re-deploy the radiometer in anticipation of the Jason-1 launch in 2000. This mission will benefit significantly from the long occupation history at Harvest, as potential systematic error sources in the existing 7-yr calibration record have undergone extensive evaluation.

Harvest Verification Experiment

The Plains Resources Harvest Oil Platform is located about 10 km off the coast of Central California near Vandenberg Air Force Base (about 230 km west of Los Angeles). The TOPEX/POSEIDON repeat orbit is designed so that the platform is overflown every 10 days as the satellite radar footprint traces out ascending track 43. To date, over 260 overflights of the platform have occurred.



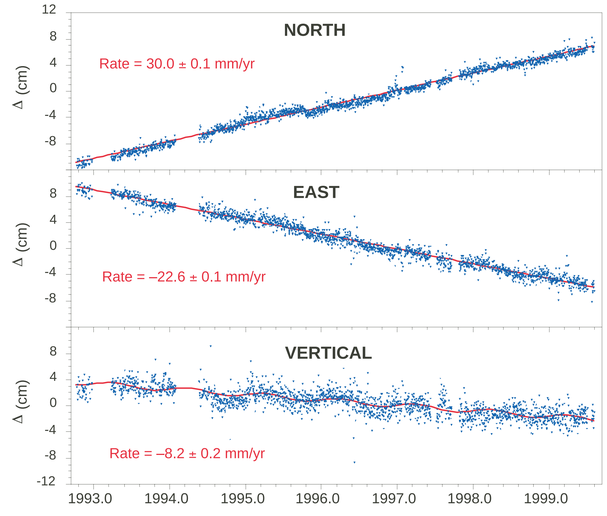


Shown above is a schematic picture of the platform with locations of the instruments used to support the verification experiment. Three independent sea level systems, along with an advanced GPS receiver and met sensors are presently on the platform.

Current Results

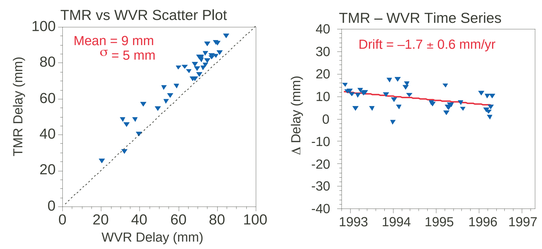
PLATFORM POSITION AND VELOCITY

Shown in the panels below are time series of the platform coordinates (N, E, V) in relation to the Quincy, California, GPS station (located about 600 km North of Harvest in the Sierra Nevada). The effects of the motion of the Pacific plate relative to the North American Plate are clearly seen. Historic satellite laser ranging and GPS observations suggest that Quincy experiences little or no vertical motion. The Harvest vertical subsidence of nearly –1 cm/yr is probably due to the extraction of oil from the Point Arguello offshore field.



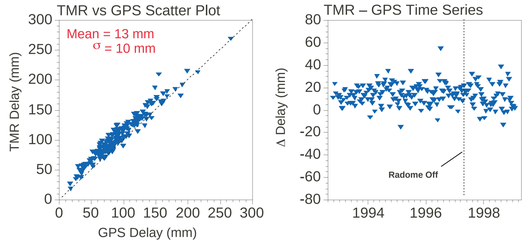
WATER VAPOR

Columnar wet path delay measurements from the up-looking platform water-vapor radiometer (WVR) and down-looking Topex Microwave Radiometer (TMR) can be compared as the T/P satellite approaches the platform (dry overflights shown):



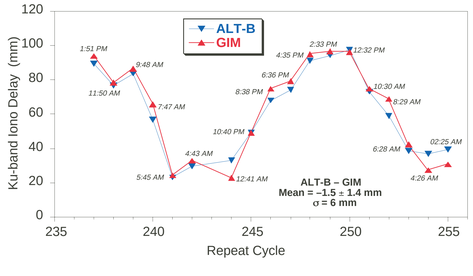
Although the WVR was removed in 1996, the results were crucial in helping to identify a spurious drift in the TMR measurements of path delay [*Keihm et al.*, 1999]. A refurbished WVR will be returned to the platform to support calibration of the Jason Microwave Radiometer.

Columnar wet path delay is also estimated from the GPS data collected at Harvest (below). Please see the poster "Calibrating Spaceborne Microwave Radiometers Using GPS" by *Haines et al.* for comprehensive results and discussion.



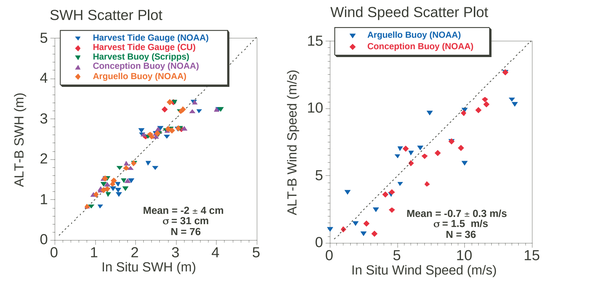
ALT-B IONOSPHERE

Efforts to calibrate the ionosphere delay have intensified since the switch to Side B of the TOPEX altimeter (ALT-B) in February, 1999. The time series plot (below) shows columnar ionosphere delays determined independently from JPL's GPS ionosphere maps and the dual-frequency ALT-B over Harvest. No bias between the estimates is discernable.



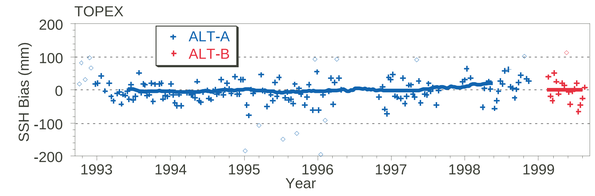
ALT-B WIND/WAVE

Based on preliminary comparisons with in-situ data from the platform tide gauges and nearby buoys, there is no evidence of bias in the ALT-B estimates of wind speed (at the 1 m/s level) and SWH (at the 10 cm level).

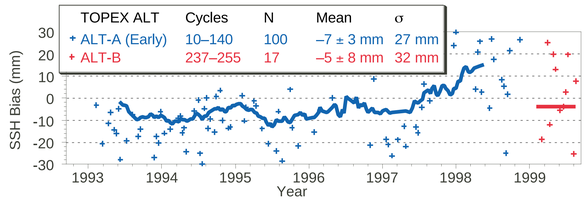


SEA SURFACE HEIGHT

A time series of ALT-A and ALT-B sea-surface height (SSH) bias estimates is given below. The solid line represents a 1-yr moving average for ALT-A (1992-99) and a simple average for ALT-B (1999).



Magnifying the vertical scale reveals that ALT-B data are in excellent agreement with the ALT-A data collected prior to the gradual degradation in the Point Target Response (beginning mid-1996). The relative bias (ALT-A vs ALT-B) computed in this fashion is not statistically distinguishable from zero.



Bias estimates from the CNES Poseidon-1 altimeter have also been updated, and are shown below.