THE HARVEST EXPERIMENT: TOPEX/POSEIDON ABSOLUTE CALIBRATION RESULTS FROM FIVE YEARS OF CONTINUOUS DATA

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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 Chevron) Harvest oil platform located off the coast of central California. Data from tide gauges and a GPS receiver on the platform have been combined to yield an accurate record of the geocentric sea level spanning the last 5 years. Over the same time period, the 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 5-year time series of absolute calibration estimates for the T/P sensors (altimeter and radiometer) and the overall measurement system.

Shortly after the T/P launch, results from Harvest suggested that the TOPEX altimeter range measurements were short by -145 ± 29 mm [Christensen et al., 1994]. With data from additional overflights and improved GPS-based determinations of the platform geocentric height and velocity, Haines et al. [1996] reported a TOPEX bias of -125 ± 20 mm at the conclusion of the 3-year primary mission. The bias is now recognized as a consequence of an error in the software used to produce the TOPEX data for the mission scientists [Zanife et al., 1996]. The close agreement between the mean value of the software error (-133 mm) and the bias estimates testifies to the ability of the Harvest configuration to support detection of spurious signals in the T/P altimeter measurement systems.

The current Harvest calibration time series are depicted in Figure 1. Accounting for systematic errors, the altimeter bias estimates for both measurement systems are consistent with zero bias. For the T/P Extended Mission, our attention has turned to improving estimates of measurement system drift in order to corroborate continually updated measurements of the change in global mean sea level [see also Mitchum, 1997]. Both the TOPEX and POSEIDON systems show signs of a slight positive drift, but the Harvest result is not currently significant in a statistical sense. We note that comparisons of simultaneous observations from the TOPEX and platform radiometers show a drift in the differenced zenith wet delay (ZWD) of -1.7 ± 0.6 mm/yr. If attributable to the TOPEX microwave radiometer (TMR), this could provide a partial explanation for the small drift observed in Figure 1. To lend further insight on the source of this drift, we have compared the TMR readings with ZWD inferred from GPS data collected at selected stations in the vicinity of T/P ground tracks. The ensemble GPS results suggest the TMR is drifting in the range of -0.6 to -1.5 mm/yr, and contribute to an emerging consensus that the T/P derived estimates of the change in global mean sea level

should be adjusted upward to offset an erroneous drift in ZWD measured by the TMR [Nerem et al., 1997; Zlotnicki et al., 1997].

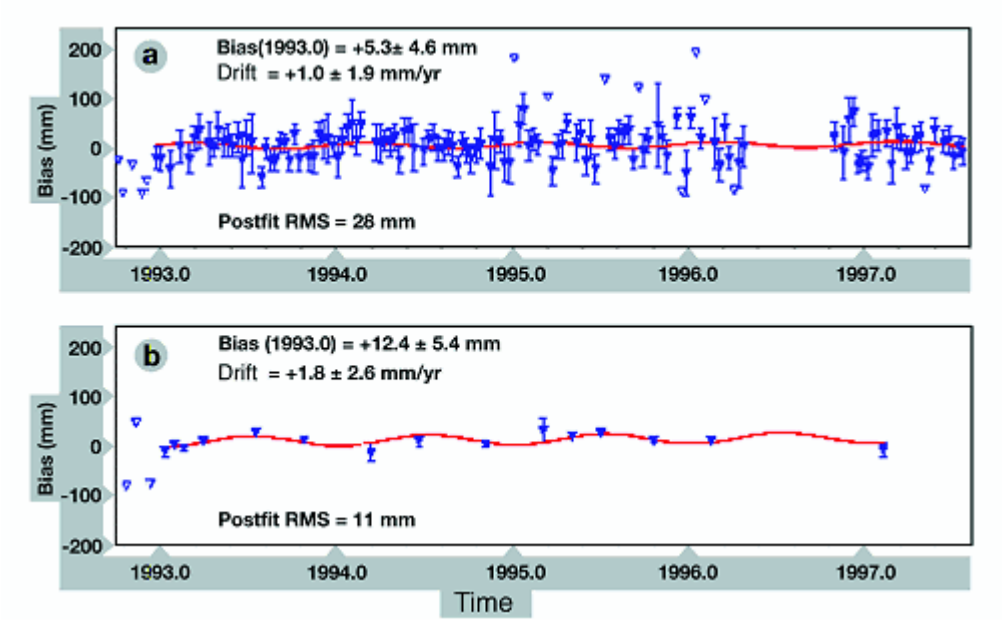

Figure 1

Calibration time series for the TOPEX (a) and POSEIDON (b) measurement systems at Chevron Platform Harvest. Each point represents the instantaneous difference between in situ and T/P sea level for a single overflight. A positive bias (slope) implies the satellite is measuring the range to the sea surface long (longer). Error estimates account only for data scatter, and do not reflect systematic contributions such as the uncertainty in the platform subsidence.

Statistical projections of the present Harvest results suggest that we could discriminate secular changes in the global mean sea level from absolute drift in the altimeter measurement systems at the level of 1 mm/yr or better by the end of the Extended Mission. Meeting this projection will be contingent on understanding and reducing systematic contributions to the time series, a goal to which significant effort is being devoted during the extended mission. Particular emphasis is being placed on monitoring the platform vertical position and velocity (Figure 2), and on mitigating the systematic effects of the sea state on the tide gauge and altimeter data. In the Extended Mission, we will work closely with other T/P Extended Mission investigators overseeing additional regional calibration sites, as well those performing drift calibrations using global tide gauges, to reach a consensus on the application of calibration corrections to the T/P global mean sea level record. We will also continue to exploit the collocation at Harvest to separate the various potential sources of bias and drift (i.e., radiometer vs. altimeter).

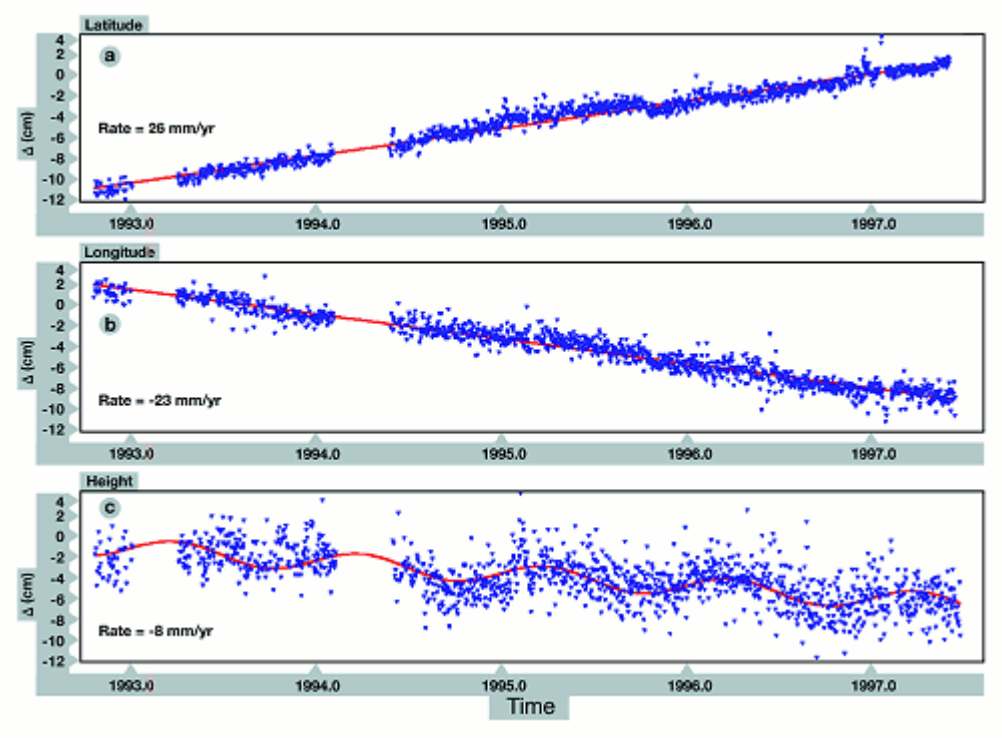

Figure 2

Time series of variations in the 600 km baseline between GPS stations at Quincy, California, and the Harvest platform since 1992. Horizontal components show the effects of tectonic motion, as Quincy is located on the North America plate and Harvest on the Pacific plate. (a) Latitude, (b) Longitude, (c) Height. The vertical component shows evidence of subsidence at Harvest. (Satellite laser ranging data suggest Quincy is stable in the vertical.) The origin of the annual signal is under investigation.

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