In-situ tide gauge/GPS stations for monitoring the temporal drift of satellite altimeters

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The University of Hawaii has installed continuous GPS receivers at 6 tide gauges distributed around the globe. These stations provide in-situ sea level measurements corrected for vertical land motion, which are used to monitor temporal drifts in satellite altimeter observations. The first stage of this project has focused on station selection and installation. The next stage will emphasize maintaining these stations in order to achieve long enough time series for vertical rate estimates with 1 mm/year uncertainties.

Continuous GPS (CGPS) stations have been installed at 6 tide gauges in the Pacific, Indian, and Atlantic Oceans (figure 1). Each installation features an Ashtech CGRS or a Leica CRS-1000 GPS receiver and an IGS-compatible DM choke ring antenna. The receivers are attached to specially designed monuments positioned adjacent to the tide gauge (figure 2). A Paroscientific MET-3 sensor pack also is logged by the GPS receiver so as to provide the temperature and pressure measurements required to enable GPS meteorology at each site [Foster et al., 2000]. All data are archived at the SOPAC facility (Scripps Institution of Oceanography) and are freely available.

The goal of this project is to estimate vertical land movements at each tide gauge to a 1 mm/yr accuracy for calibration of the Jason-1 and subsequent altimeter missions. Given current estimates of the variability in the CGPS measurements, at least several years of data are required to achieve this goal. Our longest running station at Honolulu, Hawaii is approaching this record length.

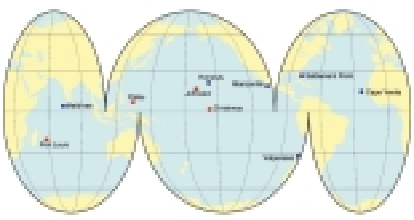

Figure 1: Co-located CGPS - tide gauge stations. Red: stations in operation, blue in preparation.

The stations were selected in coordination with Gary Mitchum of the University of South Florida to provide both optimal global coverage as well as good correspondence between the tide gauge and altimeter measurements. At most stations, the water level is measured with Aquatrak acoustic sensors. Water level switch and tide staff observations are also made to monitor the stability of the tide gauge measurement. Annual surveys tie the GPS antenna, the tide gauge, and the tide staff to a network of benchmarks.

Our own preliminary attempts to process the CGPS data for vertical rates have highlighted several issues necessary for an appropriate analysis framework:

• Redundant processing – different groups using different GPS software packages and processing schemes are needed for intercomparison of vertical rate estimates.
• Global rather than regional – while regional densification of the ITRF polyhedron may be an acceptable approach in some regions (e.g., Europe), it cannot be applied at the majority of open ocean tide gauge stations.
• Post-processing – data transfer from many CGPS@TG stations takes months rather than days. Operational orbit analysis centers of the IGS as currently configured are not the appropriate processing groups.
• Re-analyses – a homogeneous and consistent set of orbital solutions and a consistent reference frame on a global scale requires a reanalysis of the IGS data set.
• Core stations for tide gauge positioning – many of the stations used to establish ITRF were chosen without consideration for vertical stability or low satellite elevation angles. A new core set should be established.

Figure 2: CGPS@tide gauge installation at Settlement Point, Bahamas.
The GPS receiver is to the triangular shaped object to the left of the picture. The acoustic tide gauge sensor is directly behind the GPS monument.

Our immediate goals for this project are to maintain the current network and possibly expand by several stations in the coming year, to contribute to the community task of processing CGPS@TG data, and to evaluate trend rates at each site in relation to local oceanographic and geodetic considerations.

References

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