Stability of the Herstmonceux space geodetic site from multi-technique analyses

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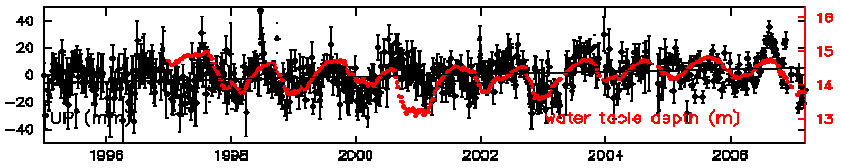
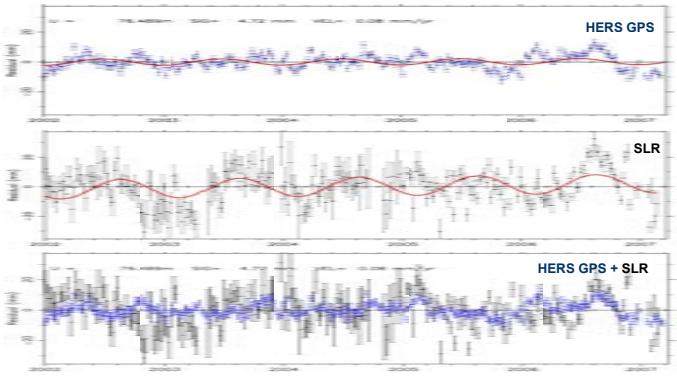
It is very important to monitor and quantify observational precision, local site stability and the quality of inter-technique site-ties at space geodetic observatories that contribute observations that are used to maintain the ITRF. Full geophysical utilization of the data requires separating complicating effects such as highly localized motions from truly global, seasonal effects, for instance. The Space Geodesy Facility (SGF) at Herstmonceux, UK, operates a highly precise and prolific ILRS satellite laser ranging station, two IGS GNSS receivers (GPS and GLONASS) and associated environmental monitors including an automatic ground-water-level measurement system. From November 2006 an absolute gravimeter has been added to the permanent on-site geodetic equipment in collaboration between SGF and the Proudman Oceanographic Laboratory and University College London. In this poster we report results of laser ranging, global and differential GPS, and preliminary absolute gravimetry analyses carried out primarily to investigate on site vertical stability and local loading effects. Present in the results are strong correlations between local hydrological variations and vertical seasonal signals whose magnitudes suggest that they are driven by a combination of local loading and global Earth mass-centre variations.

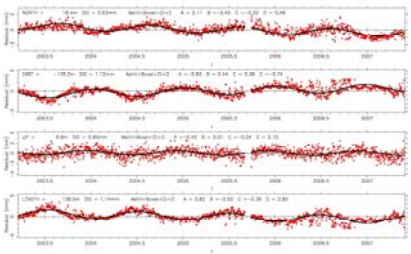
NSGF Height Variations



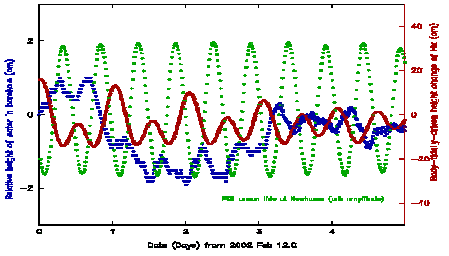
SGF analysis of laser range measurements to the primary geodetic satellites LAGEOS and ETALON determines coordinates of SLR stations to mm accuracy. The UP component of these solutions reveals height variations with seasonal and non-seasonal time periods. To better understand these variations it is crucial to study all effects impacting on the site stability. Pictured above right is the height component from the 7-day SGF laser solutions for the Herstmonceux SLR station. It is likely that local loading effects driven by hydrological variations will be present, since these are not modelled during the analysis. Therefore included on the plot, in red, are measurements of the water table level made directly beneath the site. Shifting these measurements in time by 50 days and scaling gives a good correlation with the laser solutions.



The SGF manages two IGS GPS sites, HERS and HERT. Our on-site GPS analysis uses the GAMIT software and a limited global network of sites followed by over 50 pre-processed site solutions for GLOBK stabilisation. This produces daily solutions for both sites which are monitored for site stability and used for quality control. Annual variations can be seen in the height component time series of the HERS site from 2002 to the present day, plotted right (top). The plot includes a fitted annual term of amplitude 2.5mm in red. Below, for comparison, is the SLR height results and a fitted annual term of amplitude 6.4mm. Removing the fitted annual terms results in greater agreement between the two techniques in the height variation at the of the Herstmonceux site, shown right (bottom).



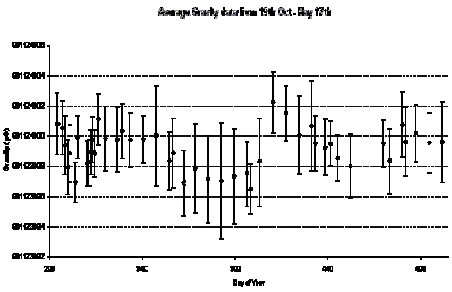
The HERS site is separated from the HERT site by a distance of 136.5m. This baseline is calculated daily in a differential GAMIT solution using only the L2 GPS frequency and the results are resolved into North, East, Up and Length components. Shown left is a four-year time series of results. Fitting an sinusoidal curve confirms a periodic millimetre level variation with an amplitude of 0.94mm. The period of this variation was numerically solved for and found to be close to annual at about 358 days.



Watertable Monitoring

The local water table depth measurements used in the comparison above are routinely collected at the SGF in support of the space geodetic work. These data are automatically recorded every few minutes. Plotted left is a five-day span of water table depth measurements (blue curve), showing tidally-driven effects of a few cm amplitude, which are present along with two-metre seasonal variations. Shown for comparison are computed body-tide (red) and nearby ocean-tide (green) amplitudes. The water table variations are seen to be in (anti) phase with the local body tide height variations, not with the ocean tide signal. This implies that the water table is a constrained aquifer, which is useful information when we consider modelling local loading effects.

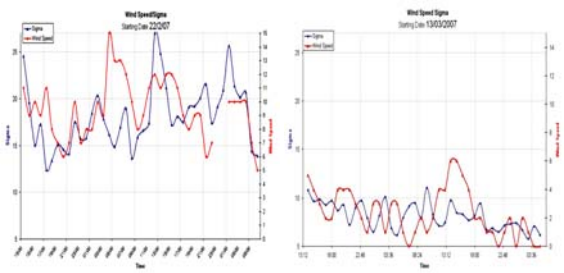
Local Gravimetry



Since October 2006 the SGF has been running in the facility basement an FG5 Absolute Gravimeter supplied by Micro-g Lacoste. The gravimeter is currently being operated to determine a midweek average value of gravity which can be found to an accuracy of ± 2 µGal. This routine observational programme will build up a long time series of local gravity at this important co-located site. Presented right is the time-series gravity data obtained to date with the standard deviation.

The gravimeter is situated above one of four available location studs which have been surveyed into the NSGF network by the UK's Ordinance Survey. The remaining studs allow visiting gravimeters to be run along side the SGF gravimeter for the purpose of inter-comparison studies.

The magnitude of the error associated with the gravitational value has been seen to be affected by such things as local weather conditions, earthquakes and much smaller seismic activity caused by weather systems over the Atlantic/coastal regions. Early data was also affected by renovations to a local building. A comparison with local wind speed recorded during two experiments is shown left and demonstrates an increased RMS with greater wind speed.



In the coming months we aim to run a two – four week 'error determination' period with the goal of isolating any local signatures inherent to the site. We also plan to investigate the correlation from the gravimetry vertical displacement with data obtained from SLR, GPS and the height of the water table.