

Relative height surveying of geodetic monuments at the SGF, Herstmonceux, UK

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Introduction

A regular local site survey, incorporating markers on co-located geodetic monuments, can identify sub-mm height variations and thus enable long-term site-wide monitoring.

The Space Geodesy Facility (SGF) in Herstmonceux, UK, operates multiple geodetic techniques co-located on a single small site. These are a productive and precise GGOS 'next generation' satellite laser ranging station (HERL), two IGS GNSS sites (HERS, HERT) and a permanently situated absolute gravimeter. Instability at the local site level can affect results from geodetic techniques and directly impacts on the local ties between co-located techniques.

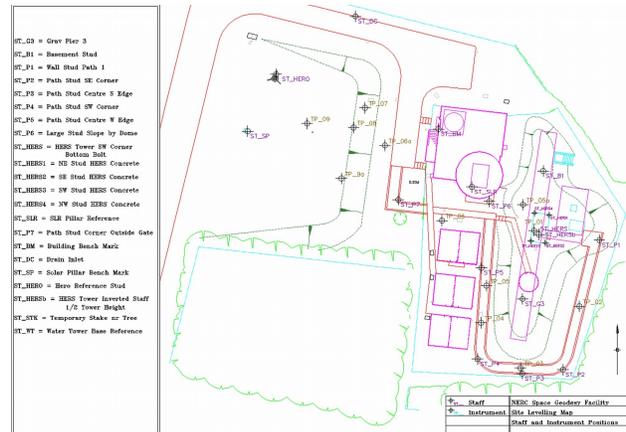
In 2010, the SGF began a campaign of fortnightly levelling surveys to monitor the relative heights of a series of monuments, incorporating markers for each geodetic technique. In total 22 relative heights are measured during an approximately two hour survey run, which involves two members of the SGF team.

Digital barcode reader

A Leica DNA03 bar-code level, with instrumental accuracy of 0.3mm is precisely levelled on a tripod and records its height position on a barcoded staff which is vertically placed on a reference marker. The staff is then moved and the DNA03 is rotated (but kept level) for a measurement of the barcode on a second reference point. This gives the height difference of the two markers. The operators of the staff and the DNA03 then leapfrog each other on a series of points and reference markers around the SGF site.

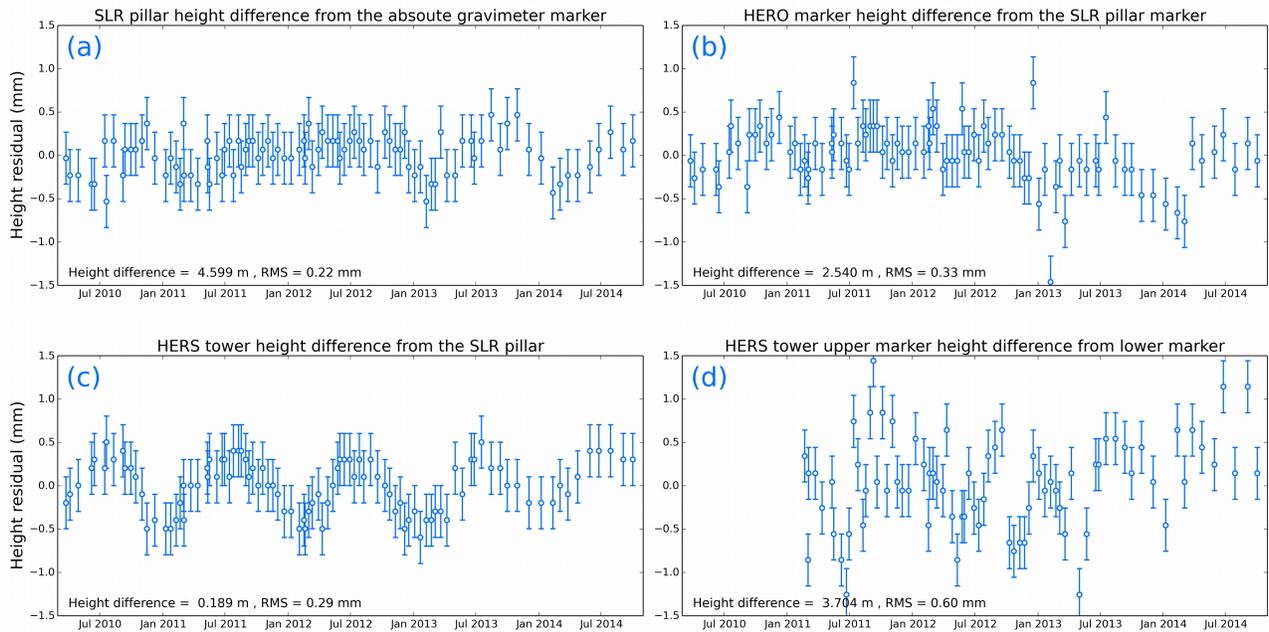
Relative height time-series

The most significant relative height time series from the four years of digital level surveying at the SGF are those between the stable monuments of the geodetic techniques. SLR and absolute gravimetry are the on-site techniques most sensitive to local height change and the time series of the monument height differences is plotted in chart (a). The height differences recorded show little variation over the time series, with a RMS of 0.22mm.



A map of the SGF site, indicating the staff and DNA03 positions during a survey.





A UK Ordnance Survey (OS) GeoNet GNSS reference site HERO is situated upon a sturdy structure constructed from a metal pole driven vertically in to the ground with three supporting poles. It has a marker on one leg and the relative height time-series from this point to the SLR pillar is shown in chart (b). The variation is again small with a RMS of 0.33mm.

The IGS GNSS site HERS is located on top of a latticed metal tower at a height of approximately 7 metres, situated close to the SLR dome. The levelling survey marker used is located at the bottom of the tower and the height difference time series between this point and the SLR pillar is plotted in chart (c). A well defined annual signal with an amplitude of $\pm 0.5\text{mm}$ is present. This variation would impact on the local tie between the on-site SLR and GNSS techniques. It is also a clear demonstration of the ability of regular digital levelling to uncover very small relative height changes.

The cause of this variation is motion in the HERS monument, possibly due to thermal expansion of the small section of tower measured by the survey and of the concrete base. To investigate the tower expansion further, an additional marker was fixed to an upper point, 3.7m above the lower marker. The height differences recorded between these markers are plotted in the time-series in chart (d). The series is less stable with an RMS of 0.6mm and no annual signal is visible. Thermal couples were also installed on the tower and in the concrete base and the results show a rapidly heating and cooling tower and a steady, daily and seasonally changing concrete base temperature.

Conclusions

These on-going levelling surveys lead us to conclude that the inter-technique ties at the Space Geodesy Facility are stable at the millimetre level in height on a timescale of 2 weeks between

surveys. A small annual variation in height of amplitude $\pm 0.5\text{mm}$ was detected in the HERS tower monument.

References

Wilkinson M., Appleby G., Sherwood R., Smith V.. *Monitoring Site Stability at the Space Geodesy Facility, Herstmonceux, UK*. REFAG, International Association of Geodesy Symposia Volume 138, 2013, pp 95-102, Nov 2012.

