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Matjiesfontein: A possible future for Space Geodesy in South Africa

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ABSTRACT

Space Geodesy provides many important products. These products are applicable in numerous scientific, industrial and commercial applications. The current hub for Space Geodetic activities is the Space Geodesy Programme at the Hartebeesthoek Radio Astronomy Observatory. A new fundamental space geodetic observatory for South Africa has however been proposed and various workshops were held to date in this regard. The main drivers for a new station are the ageing and subsequent breakdown of current equipment as well as deteriorating atmospheric seeing conditions at HartRAO. Current equipment that still functions also does not provide the resolution and sensitivity needed by modern techniques. Initial surveys highlighted Matjiesfontein as a very good option in terms of numerous factors. These factors will be discussed. The actual site is located about 4 km south of the village in a shallow valley in the mountains and is ideal to become a new fudicial site for Africa. A GPS Reference station as well as a weather station has already been installed on this site. Current equipment at the Matjiesfontein site as well as planned equipment and infrastructure will be discussed.

Key words: High-power, pico-second, laser, ranging, lunar

INTRODUCTION

A new fundamental space geodetic observatory for South Africa has been proposed and various workshops were held to date in this regard (Booth *et al*. 2007). The main drivers of this are the ageing and subsequent breakdown of current equipment as well as deteriorating atmospheric seeing conditions at the current centre of operations, HartRAO.

Geodesy is the scientific discipline that deals with the measurement and representation of the earth, its gravitational field, and other geodynamic phenomena. These include effects such as crustal motion, oceanic tides, and polar motion. For this geodesists design global and national control networks, using space and terrestrial techniques while relying on datums and coordinate systems.

In Geodesy, many techniques are employed, like:

- Global Navigation Satellite systems (GNSS) comprised of:
  - Global Positioning System (GPS),
  - Global Orbiting Navigation Satellite System (GLONASS),
  - Galileo currently being built by the EU and ESA.
- Very Long Baseline Interferometry (VLBI) using Radio Telescopes
- Laser Ranging to Satellites and the Moon (SLR and LLR), used for accurate orbit determination

These techniques are used both separately *and in conjunction* with each other in Geodesy (figure 1). The co-location of two pieces (or more) of position determination equipment demonstrates a very important concept in the geodetic field. For geodetic measurements to be useful it must be known accurately what was measured as well as in which reference frame. At Marion Island (figure 2), for example, a GPS and Tide Gauge are co-located. The dual system is to enable scientists to factor in vertical motion of the crust through the accurate GNSS measurements. This helps to differentiate between ocean level changes and earth level changes.

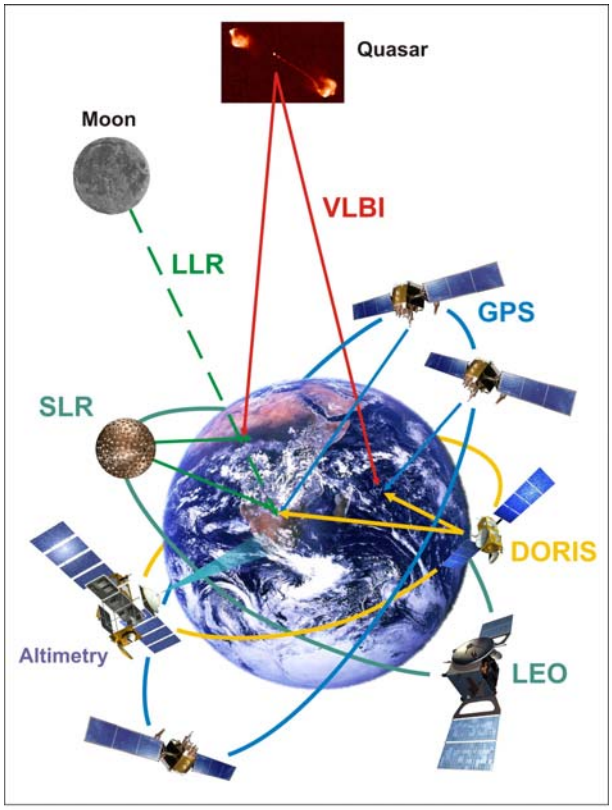

Figure 1: The combination of space geodetic techniques.

Figure 2: Marion Island: a tide gauge at the top and GPS at the right side of the photo.

Space Geodesy in South Africa is operated from Hartebeesthoek Radio Astronomy Observatory (HartRAO) as a base. We have 8 GNSS stations spread throughout South Africa, SADC countries, Marion Island and Antarctica, a Satellite Laser Ranger at HartRAO and till recently conducted VLBI using HartRAO's Radio Telescope. The unfortunate breakdown of the dish during 2008 marked an end in our status as a fundamental geodetic site. Only 6 other such sites exist in the world. Another drawback of the current site at HartRAO is the increased pollution from the ever advancing city-boundaries. This creates both Radio Frequency Interference (RFI) on the site, as well as deteriorates visibility of the sky and therefore limits Satellite Laser Ranging data quantity and quality. Regardless of this, current equipment is ageing and experiences more downtime than before. The need for a new site with new equipment is clear.

Investigations into a possible new location for a space geodetic observatory started in 2002. The first site identified and investigated was in Lesotho at 3300 m above sea level. The initial costs for infrastructure were far too high however. The SAAO site at Sutherland was also considered but too many concerns were raised about the laser (from the laser ranger) causing too much light pollution. A site just 4 km south of Matjiesfontein was identified next (figure 3). Preliminary tests revealed the site to be considered a serious possiblilty. Infrastructure is located nearby: the N1, railway and station, electricity, water and a small local community. The Matjiesfontein Village Eductional Trust indicated that they will donate this piece of land for the use of a Space Geodetic Observatory- the final agreements are near completion.

Figure 3: The GPS at Matjiesfontein. The proposed site is the valley in the background.

REFERENCES

Booth, R., Combrinck, W.L., 2007, White paper towards the establishment of the International Institute for Space Geodesy and Earth Observation (IISGEO), Draft v3, http://geodesy.hartrao.ac.za/