

PROPOSED INTERNATIONAL INSTITUTE FOR SPACE GEODESY AND EARTH OBSERVATION (IISGEO)

L.Combrinck (1), A. Combrink (1), D Carter (2), M Pearlman (3), P. J. Shelus (4), J.Györgyey-Ries (4), R.R Ricklefs (4), J. R.Wiant (4), R Eanes (4), W. Gurtner (5), K. Nordtvedt (6), E. Samain (7), B.Engen (8), W Schlueter (9).

(1) Hartebeesthoek Radio Astronomy Observatory. (2) NASA GSFC. (3) Harvard-Smithsonian Center for Astrophysics. (4) University of Texas at Austin. (5) University of Berne. (6) Northwest Analysis. (7) OCA-CERGA. (8) Geodetic Institute, Norwegian Mapping Authority. (9) Fundamental Station Wetzell.

ludwig@hartrao.ac.za/Fax: +27-12-3260756/Tel: +27-12-3260742

Abstract

This proposal tables the transformation of the HartRAO Space Geodesy Programme into a joint HartRAO/SAAO/NASA/OTHER_PARTNERS international facility, dubbed the International Institute for Space Geodesy and Earth Observation (IISGEO). We propose that the main observing site of IISGEO be located at a suitable location (possibly Lesotho or the Sutherland site of SAAO in the Northern Cape). Equipment at HartRAO which in the future will become redundant due to old technology and inferior specifications will be phased out without losing valuable scientific collocation advantages.

IISGEO will be a node of the proposed Global Geodetic Observing System (GGOS) and will have a large capacity building component, locally and regionally, with the production of high quality PhDs as target. Due to its multi-disciplinary nature, space geodesy is ideally suited for a diversity of projects which crosses the floor between astronomy, navigation, mathematics, geophysics, geology, orbital dynamics and space exploration. The development of IISGEO will aid in global earth stewardship and will be an important component of South Africa's contribution to the Global Earth Observation System of Systems.

Introduction

HartRAO currently has three main divisions: radio astronomy, space geodesy and science awareness. The space geodesy programme was a progeny of radio astronomy, as there is much synergy between geodetic Very Long Baseline Interferometry (VLBI) and radio astronomy techniques. The [Space Geodesy Programme](#) developed considerably during the last few years. With the addition of Satellite Laser Ranging (SLR) and Global Positioning System (GPS) to HartRAO, the facility has become one of only five fiducial geodetic sites in the world.

Projects operate within the standards and guidelines of internationally recognised bodies, such as the International Association of Geodesy ([IAG](#)), International Astronomical Union ([IAU](#)) and their related services and commissions.

The scenery of space geodesy is **changing** however as the need has been identified to improve the geometrical distribution of fundamental stations and to improve the accuracy and sampling rates of instrumentation. The location of space geodesy equipment at HartRAO is partially a spin-off from the NASA deep space tracking programme, the consequent CSIR establishment of radio astronomy utilising the tracking antenna, and the efforts from the space geodesy programme to collocate GPS and SLR with the telescope.

The HartRAO site was never “selected” in terms of scientific requirements in a way to optimize output based on astronomical seeing and cloud coverage criteria, so is not optimally located for scientific output, especially considering SLR or LLR.

The future of space geodesy globally, is in the development and installation of dedicated geodetic VLBI antennas, ([VLBI2010 project](#)), KHz satellite laser ranging ([SLR2000](#)), denser GPS networks ([AFREE](#)) and the dissemination of data in near real-time. This concept is termed GGOS, an acronym for Global Geodetic Observing System, which is the first and only project of the newly restructured International Association of Geodesy (IAG).

Basically GGOS views the Earth system holistically by including the solid Earth, the fluid components and static and time-varying gravity field in its products. This concept combines different techniques, models, and approaches in order to achieve a better understanding of geodetic, geophysical and geodynamical processes. GGOS will provide the scientific and infrastructural basis for all geodetic global change research. This IAG Project commenced with the definition phase in 2003 and is based on the IAG Services.

VLBI 2010 will operate at S, X and Ka bands. The present HartRAO telescope cannot operate efficiently at Ka band (32 GHz). VLBI2010 requires dedicated, 24 hour geodetic measurements monitoring earth rotation to find sub-diurnal rotational variations on the micro-arcsecond level as well as dedicated equipment to monitor Total Electron Content of the ionosphere, maintenance and expansion of the ICRF etc. Currently only 15 % of the HartRAO telescope is allocated to space geodesy which is a fraction of what is required. Opportunities for obtaining VLBI2010 radio telescopes could be had by collaboration with SKA/NASA DSN technology and projects.

Air pollution, proximity of large cities and industrial areas impose severe restrictions on HartRAO as a facility to expand and improve its activities in SLR and to develop LLR capability. Considering the suitability of the current SAAO Sutherland Observatory for optical astronomical observations, the existing infrastructure and synergistical benefits which can be had, it makes sense to locate the proposed International Institute for Space Geodesy and Earth Observation (IISGEO), which will be South Africa’s component of GGOS, at the Sutherland site of the South African Astronomical Observatory (SAAO) site.

The sister of the Hobby Eberly telescope (HET,) named [SALT](#) (Southern African Large Telescope), has just been built on the [SAAO](#) site. Other sites have been considered, such as a high elevation site located in Lesotho (elevation 3400 m), but logistical problems will be problematic and expensive.

SLR/LLR

HartRAO supports the ILRS through operating MOB LAS6 as part of the NASA SLR network. A host of scientific disciplines are being investigated using these data. NASA has agreed to provide an SLR2000 unit for the new station which will eventually phase out MOB LAS6. A new LLR station (and the only one in the southern hemisphere) will be developed in collaboration with Observatory Cote D’Azur (OCA, France),

McDonald Observatory (NASA, USA), Fundamental Station Wettzell (BKG, Germany) and other partners. Discussions are in progress to move the OCA 1 meter SLR telescope to South Africa, in collaboration with OCA and CNES, where it will be refurbished and converted to a SLR/LLR unit, to be located at Sutherland. Co-authors of this proposal has shown interest and support for the development of IISGEO and a southern-hemisphere Lunar Laser Ranging system.

Site Selection at Sutherland

The SAAO Sutherland site was considered during an evaluation of possible locations for a future geodesy site which would be suitable for SLR, LLR and VLBI. Collocation benefits already exist. We established an IGS GPS station during 1997 on the site. GFZ (Potsdam) has installed a superconducting gravimeter as part of their Geodynamics Observatory. An appropriate location was found which is shielded from the possible adverse effects of microwave radiation from the on-site housing (criteria for VLBI) and which will shield the optical telescopes from any direct laser emission from the SLR or LLR facilities. This site is located towards the south of the main hill where the optical telescopes are located. From within this small valley, a relatively open sky is available, with a 12 degree elevation cut-off towards the north and 11 degree cut-off towards the south. The east and west have low horizon cut-offs. This site is suitable in many respects and it would be very suitable to use as a location for IISGEO.

Figure 1 provides a near birds-eye viewpoint of the proposed site. As it is envisaged that a complete geodetic station will be built here, the whole area within the photo will be required to house SLR, LLR and VLBI instrumentation plus necessary short term accommodation, control room and laboratory facilities. The relatively dry air at Sutherland will be advantageous to SLR and LLR as well as VLBI due to reduced absorption of light and radio waves. In addition the characterisation of parameters such as Love numbers to enable accurate modeling of earth-tide movements at Sutherland will be possible using the GFZ Superconducting Gravimeter data. This will facilitate the removal of vertical movement of the site as a diurnal effect during observations. Earth-tide causes the surface at Sutherland to move up and down with an amplitude of about 35 cm.

Management Structure

We propose a management structure for IISGEO which will consist of a board made up of representatives of its major stakeholders. This should include NASA, other foreign partners, the NRF and university representatives.

Site Features

Several features of the SAAO Sutherland location make it a preferred site:

- Collocation with existing GPS, SG and wideband seismometer
- Accessibility is excellent as it is flanked by an existing tar road
- Water and power tap-off point only 1.5 km away
- Low horizon, no topographical barriers with elevation higher than 15 degrees
- Astronomical seeing is approximately one arc-second
- Secluded valley shields site from radio frequency interference
- Mirror re-aluminising facility on-site
- Collocation with a major international optical observatory



• Figure 1. View of the proposed site for IISGEO observatory as seen from the southern side of the SAAO main observing hill. The tar road leading up towards the SAAO site is visible on the right-hand centre. Access to the IISGEO site is directly off this road.

Summary and Conclusion

IISGEO will be an investment in the future of Space Geodesy and will ensure continued participation in the global networks of VLBI, SLR and GPS from the southern part of Africa.