Implementation and design of a web-based GNSS data management system at Hartebeesthoek Radio Astronomy Observatory (HartRAO)

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The Space Geodesy Programme of the Hartebeesthoek Radio Astronomy Observatory (HartRAO) is actively engaged in improving the African Earth and ocean monitoring network by installing stations across the Sub-Saharan regions. This forms part of the drive to monitor different geophysical parameters via denser network with increasing accuracies, as to better our understanding of the Earth system. The instruments being deployed include Global Navigation Satellite Systems (GNSS) reference stations, tide-gauges, seismic stations and meteorological units. The Space Geodesy Programme has four main space geodetic techniques collocated at HartRAO, making it a true fiducial site. These techniques are GNSS, Satellite Laser Ranging (SLR), geodetic Very Long Baseline Interferometry (VLBI) and Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS). This fudicial site acts as a reference for the data received from the network of instruments located elsewhere. It is important to avail all the collected raw scientific data as well as the derived data products, in a user friendly manner, to both the scientific community and general public for research and educational purposes. As part of ensuring data integrity a new data management system needs to be implemented at HartRAO. This project focuses on implementing the GNSS sub-section of this data management system. Data are required to be quality checked for errors, reworked into a specific format, and made available in near real-time. We present a model for the GNSS data management system, where all the archiving, station monitoring, pre-processing and processing of the raw data are automated. Furthermore, an automated system to produce GNSS data products such as Precipitable Water Vapour (PWV), positional time-series plots and quality check outputs are presented. These data products are then visualized utilizing an interactive web-based map.

Keywords: Space geodesy, GNSS data products, data management

Introduction

The Hartebeesthoek Radio Astronomy Observatory (HartRAO), located to the North-West of Johannesburg is the only observatory in Africa that has four main space geodetic techniques collocated (Figure 1). These are Satellite Laser Ranging (SLR), Lunar Laser Ranging (LLR-currently in development), Global Navigation Satellite Systems (GNSS) and Very Long Baseline Interferometry (VLBI). A French Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS) system is located nearby.

The Space Geodesy Programme of HartRAO is actively engaged in improving the African Earth and ocean monitoring network by installing stations across the Sub-Saharan regions. This forms part of the drive to monitor different geophysical parameters via denser networks with increasing accuracies to better our understanding of the Earth system. The geodetic instruments that are being installed include collocated GNSS and Tide-Gauges along the coasts (e.g., Simons Town, Cape Town, Gough Island and Marion Island) and GNSS instrumentation in the Sub-Saharan regions (e.g., Namibia, Botswana, Zambia, South Africa) which are utilised for the African Geodetic Reference Frame (AFREF) project, ITRF, IGS and other scientific projects [1].

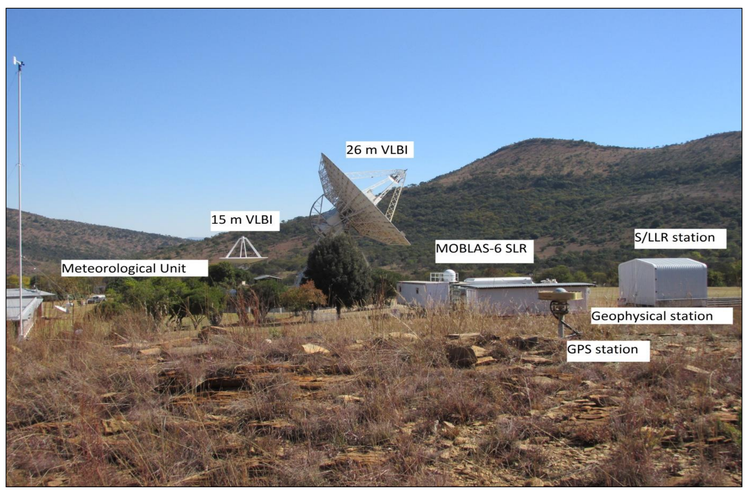

Figure 1. Collocated fundamental space geodetic techniques at HartRAO, South Africa.

Geodetic data collected by the instruments are required to be available in near-real time. Data latency is required to be minimal for near-real time data processing applications. It is therefore important to make all the collected raw scientific data as well as the derived data products available in a user friendly manner, to both the scientific community and general public for research and educational purposes. The GNSS technique is increasingly used for a broader range of projects than it was originally intended [2].

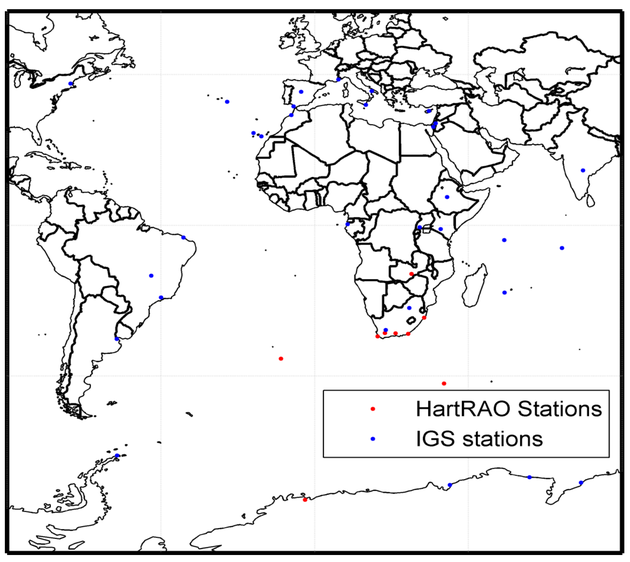

Figure 2. Regional GNSS station network data archived at HartRAO.

This project focuses on implementing the GNSS sub-section of this data management system. Data are required to be quality checked for errors, reworked into a specific format and made available in near real-time. Figure 2 depicts the regional GNSS network archived by HartRAO. We present a model for the GNSS data management system, where all the station monitoring, pre-processing, archiving and processing of the raw data are automated. The observatory is in the process of establishing an analysis centre that will continuously provide data products from all the space geodetic techniques in near-real time.

Methodology

The relationship between the three main servers is automated to do the data storage, data processing and data access for the end user [3]. The TEQC and GAMIT/GLOBK software are utilized at various steps as depicted in Figure 3. The files are then moved to the interactive web map. This process is designed to minimize human intervention and limit inconsistencies in data processing.

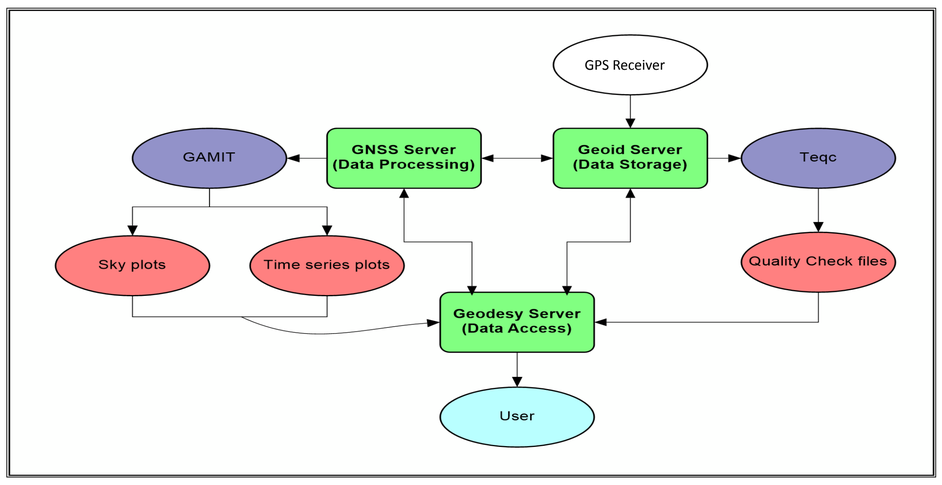

Figure 3. System architecture and the interaction between the three servers to produce data products.

Results and Discussion

The GNSS data products are visualized through an interactive web-based map (Figure 4). The technique has applications in determining geophysical and atmospheric parameters such water vapour, station positions, velocities, etc. [4]. The Implemented GNSS data management system integrates data archiving (ftp://geoid.hartrao.ac.za), pre-processing, processing and visualization of data products, which are useful to study the Earth System.

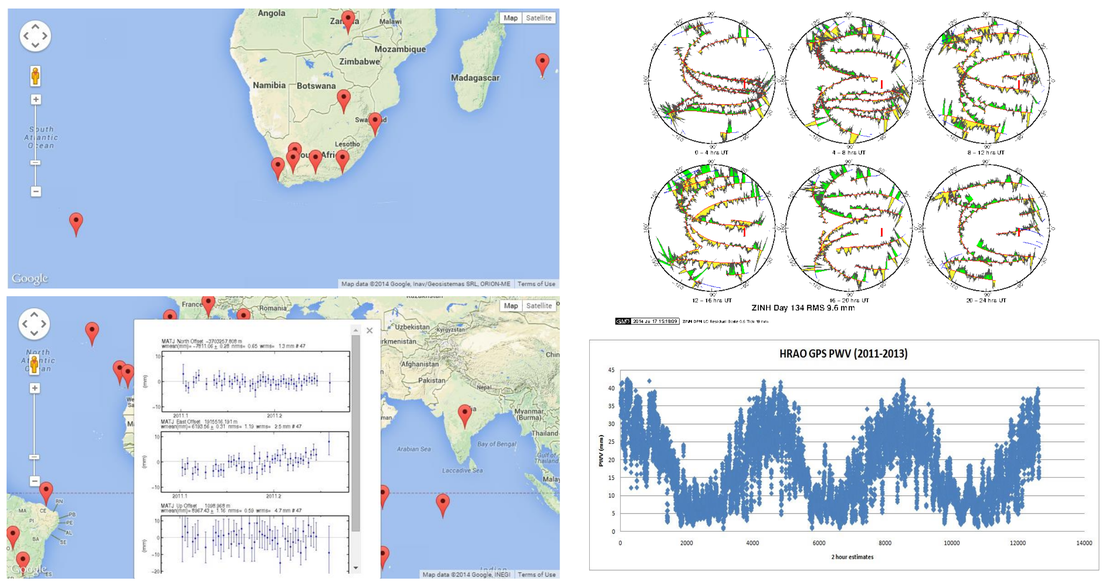

Figure 4. Left: final interactive web-map displaying GNSS stations with a time series plot link. Right: data products produced from automated data processing.

Acknowledgements

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