

# Global Navigation Satellite Systems (GNSS) Activities at Geoscience Australia

G. Hu, N. Brown, N. Dando, J. Dawson, C. Harrison, M. Jia, G. Johnston, M. Moore, S. Nancarrow, A. Riddell, R. Ruddick, B. Twilley and T. Zhou

## Introduction

This poster overviews the GNSS related activities at Geoscience Australia (GA), which includes four key programs:

- 1) Cooperative operation and maintenance of a GNSS network of approximately 135 geodetic quality Continuously Operating Reference Stations (CORS) across Australia, Antarctica and the South Pacific, including a core 30 station network that is contributed to the International GNSS Service (IGS)
- 2) Central Bureau of the Asia-Pacific Reference Frame (APREF), which now acquires data from a CORS network of approximately 450 stations, contributed by 28 countries in the Asia Pacific region
- 3) Providing a free online GPS data processing facility - AUSPOS, which provides access to the Geocentric Datum of Australia 1994 (GDA94) and the International Terrestrial Reference Frame (ITRF)
- 4) Operating a state-of-the-art GNSS antenna calibration facility

## Operation of a geodetic GNSS network

Initially through the IGS Epoch92 pilot project, GA has been a significant contributor to the global GNSS community since 1992. Starting with 15 GPS stations, GA has further developed its GNSS national infrastructure through development programs, such as AuScope, into a multi-GNSS network of approximately 135 geodetic quality CORS across Australia, Antarctica and the South Pacific, of which 30 stations contribute to the IGS, as shown in Figure 1.

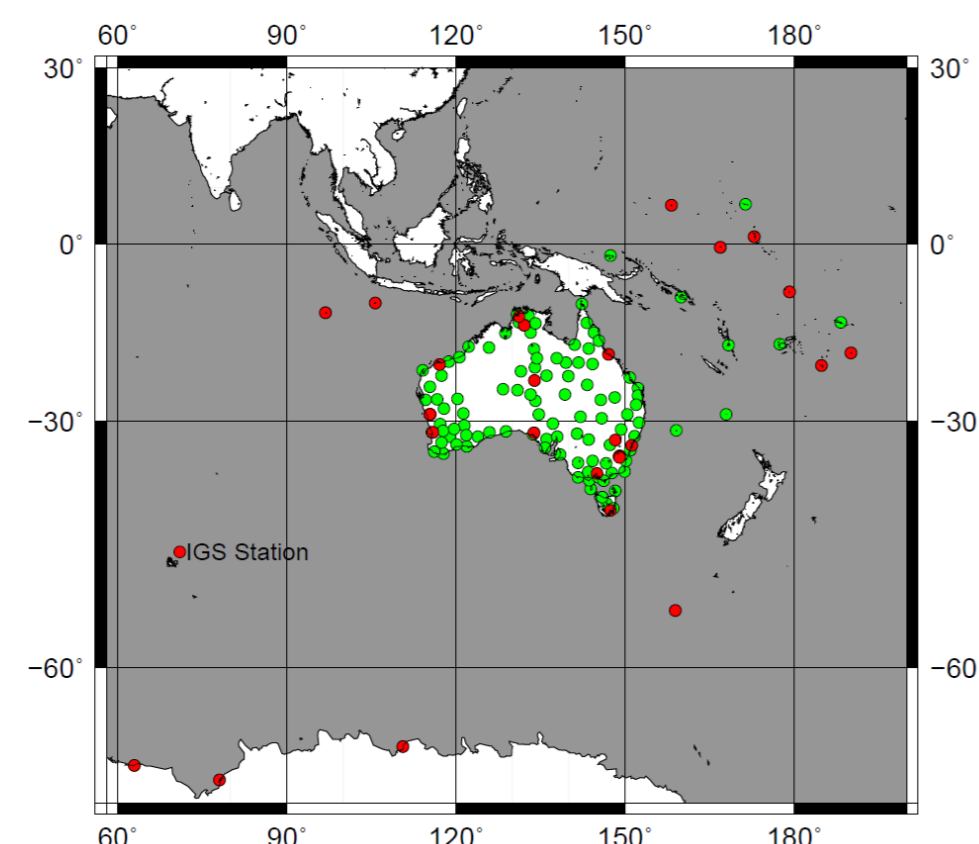


Figure 1: The distributions of GNSS CORS network operated by Geoscience Australia.

The associated data products are available for download through GA's ftp sever, <ftp://ftp.ga.gov.au/geodesy-outgoing/gnss/data/>. The data products include daily and hourly 30 second RINEX files, high rate (1 second) RINEX files and real-time streams. The primary objectives of the GNSS network are to: a) provide the fundamental geospatial framework for Australia; b) provide legal traceability for GPS measurements in Australia; c) act as Australia's contribution to global geodesy programs and the study of Earth processes, including geodynamics, weather forecasting and sea level monitoring; and d) underpin Australia's Online GPS Processing service – AUSPOS. For more details, please refer to GA's website: <http://www.ga.gov.au/earth-monitoring/geodesy/gnss-networks.html>.

## Asia-Pacific Reference Frame (APREF)

As the APREF Central Bureau (CB), GA is responsible for the management of GNSS data from a CORS network of approximately 450 stations, contributed by 28 countries, and processed by three Analysis Centres (ACs) as shown in Figure 2.

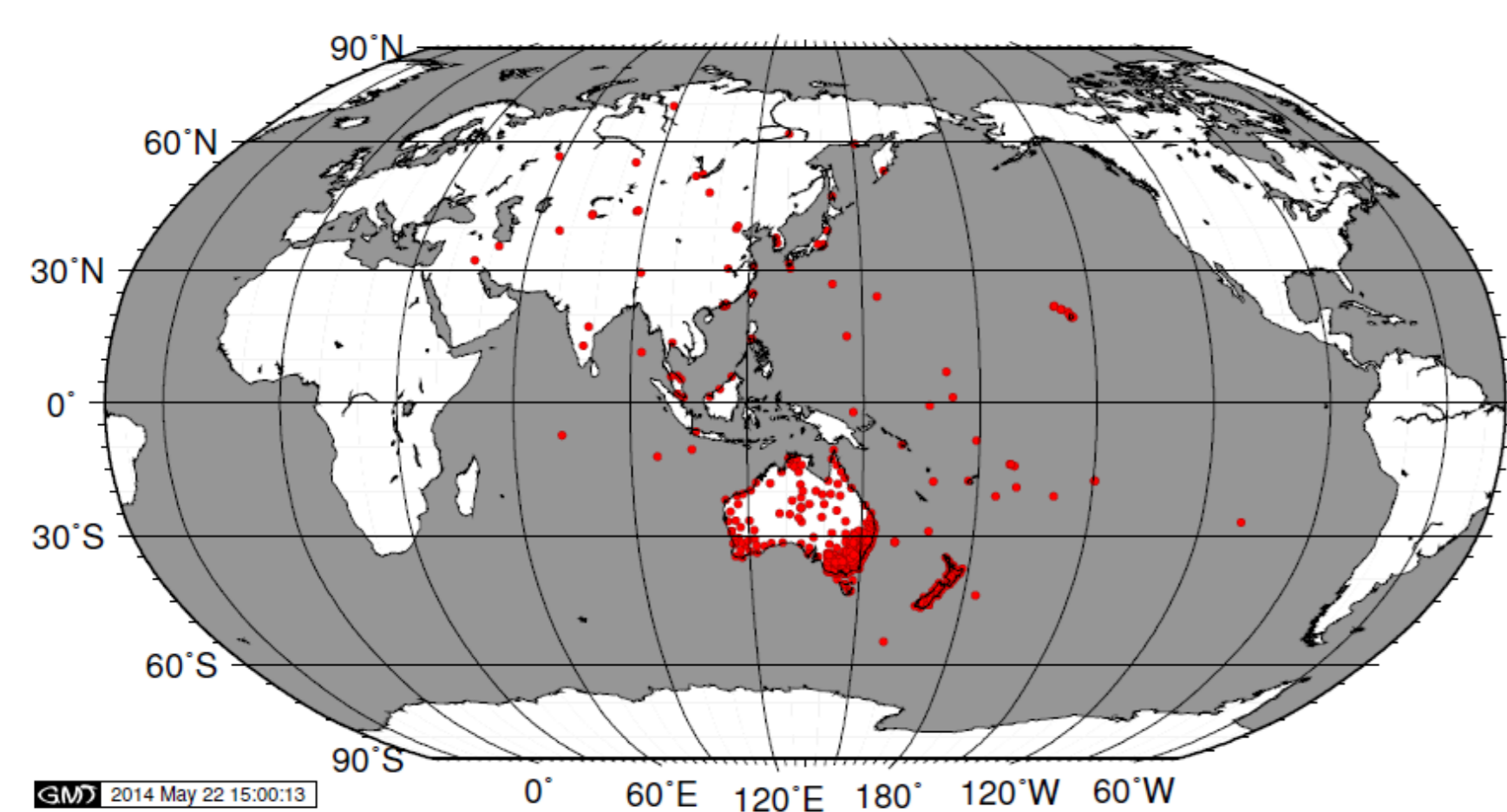


Figure 2: APREF GNSS CORS Network.

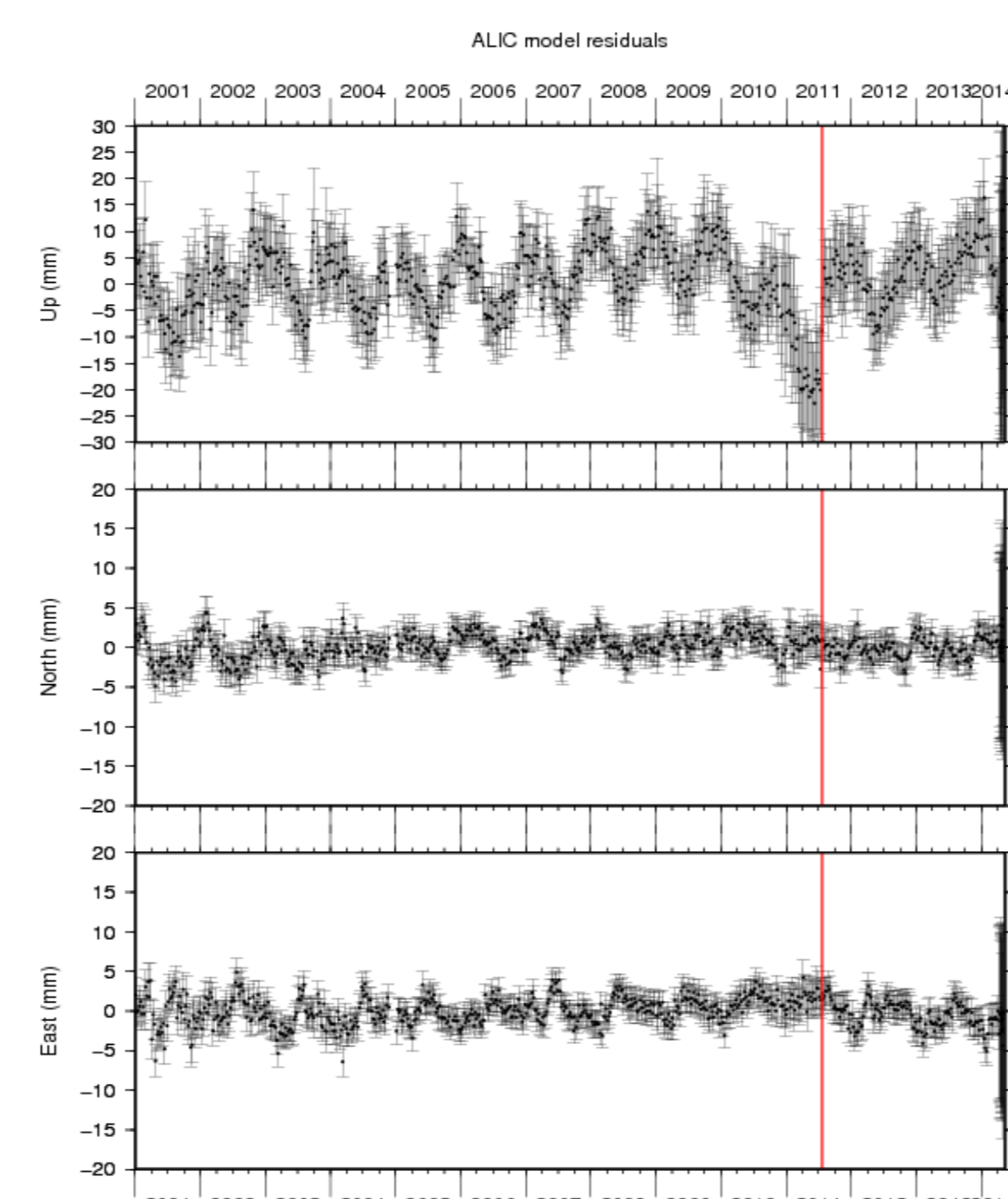


Figure 3: The coordinate time series for the station ALIC in Alice Spring, Australia.

APREF products include Asia-Pacific station coordinates and velocities at higher densities than those currently provided by the IGS, rapid daily solutions which are produced using IGS rapid products, final daily solutions which are produced using IGS final products, and the weekly combined solutions. The weekly SINEX files and updated ITRF coordinate, velocity solutions and coordinate time series are published on the APREF website (<http://www.ga.gov.au/earth-monitoring/geodesy/asia-pacific-reference-frame.html>). A representative example of the coordinate time series of the CORS site at Alice Springs (ALIC) is shown in Figure 3, after outlier and linear trend removal.

## AUSPOS – Australia's online GPS processing service

GA provides a free online GPS data processing service, AUSPOS. This service provides users with precise coordinates in ITRF anywhere and GDA94 coordinates within Australia, which takes advantage of both the IGS products and the data from the IGS and regional GNSS network. Users can submit their dual frequency GPS data observed in a 'static' mode via the simple web interface to receive rapid turn-around precise coordinates through E-mail. The AUSPOS service can be found at: <http://www.ga.gov.au/earth-monitoring/geodesy/auspos-online-gps-processing-service.html>.

AUSPOS is used extensively by the Australian geospatial, mining, construction industries, and defence to establish precise survey control for their projects. It is widely used also in GNSS applications and research around the world. More than 46,000 AUSPOS jobs were processed successfully in 2013, as shown in Figure 4. More recently, in April 2014, there were more than 6000 AUSPOS solutions within one month as indicated in Figure 5.

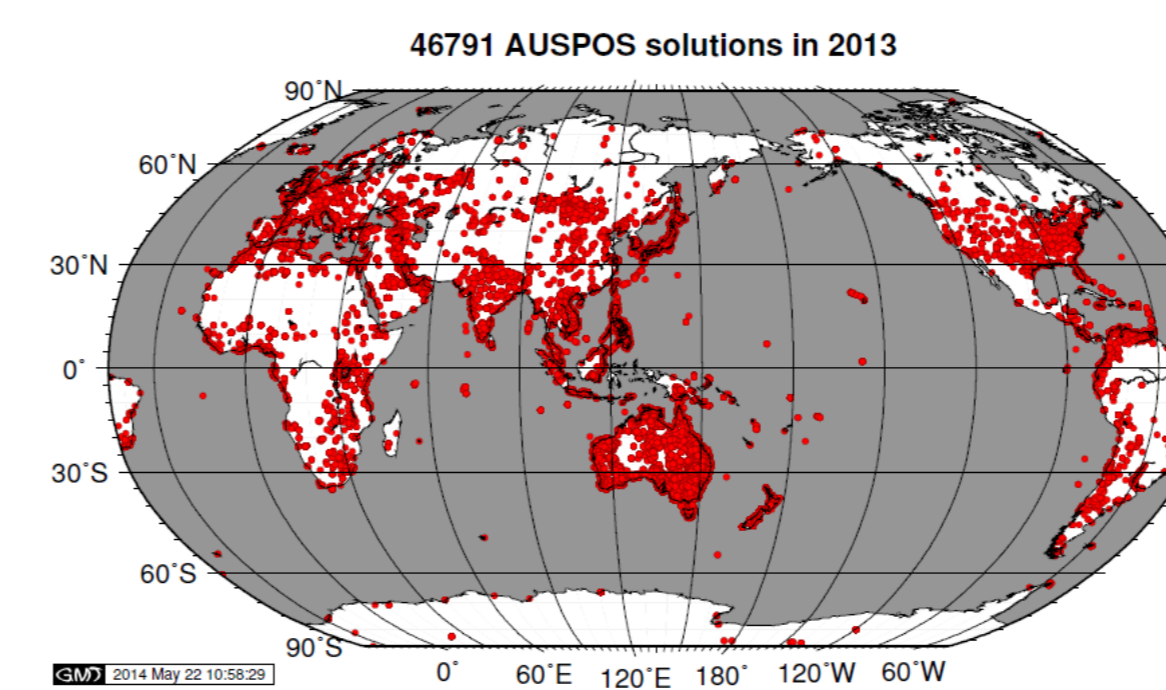


Figure 4: Number of AUSPOS solutions for global users in 2013.

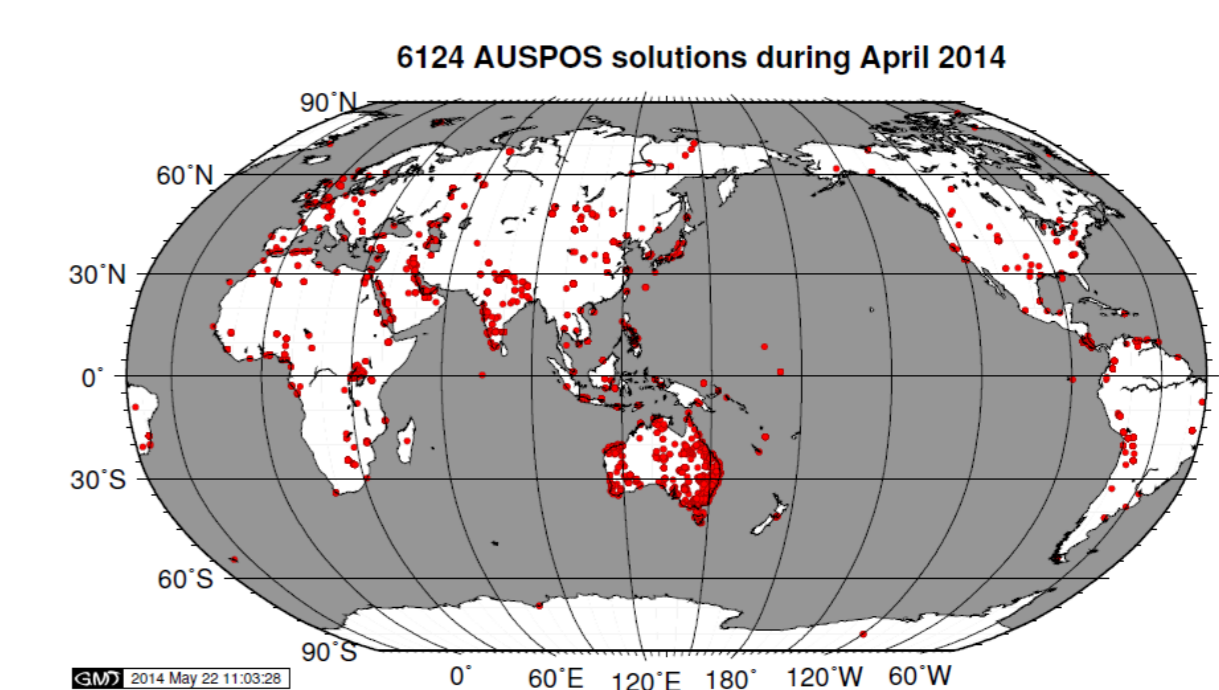


Figure 5: Number of AUSPOS solutions for global users in April 2014.

## GNSS antenna calibration facility

The antenna calibration facility at GA includes a Geo++ robotic calibration system (Figure 6, left) and an industrial robot arm ('Kuka') (Figure 6, right). Both robotic systems will be used to derive individual antenna characteristics and phase centre corrections, which will improve the accuracy of GNSS positioning to meet the ever growing accuracy requirements of GNSS users. The antenna calibration facility is in the testing phase to ensure that its operation is consistent with other international facilities. The initial results show that there is very good agreement between the calibrations obtained at Geo++ in Hannover and GA on all frequencies, as shown in Figure 7, taking TRM59800.00 NONE antenna as an example.



Figure 6: GNSS antenna calibration facility at Geoscience Australia.

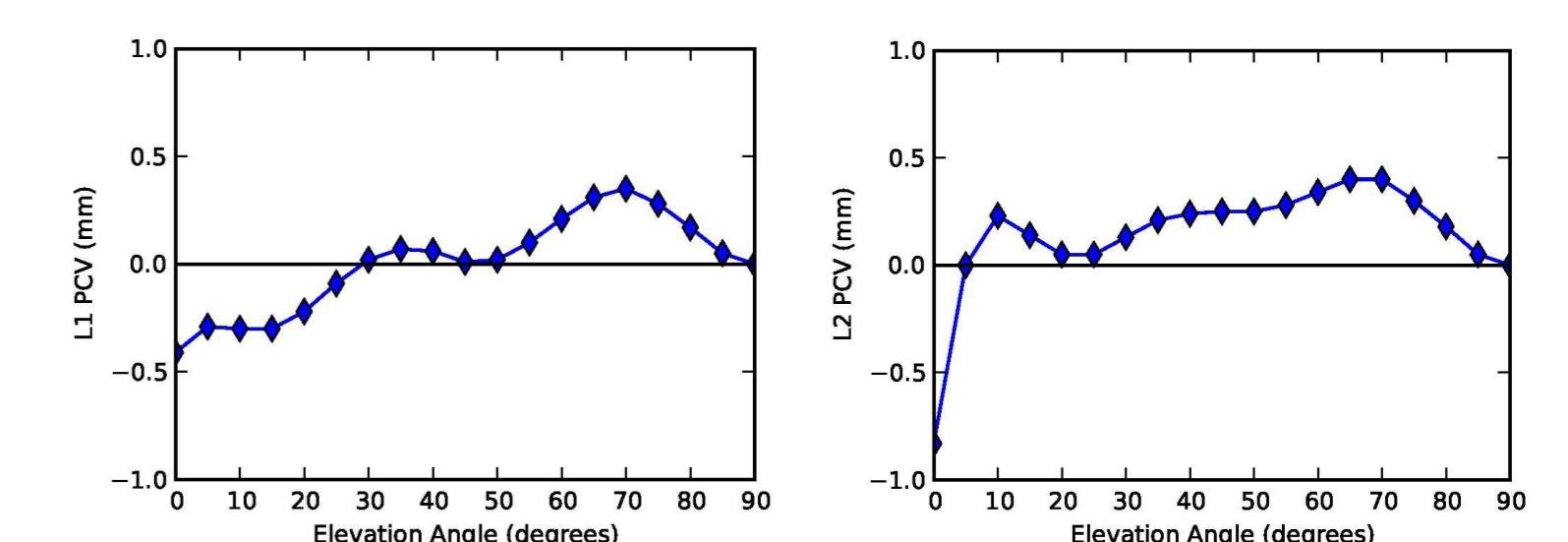


Figure 7: The difference between the calibrations obtained at Geo++ in Hannover and Geoscience Australia for the antenna TRM59800.00 NONE.

## Concluding remarks

With the modernisation of GPS and GLONASS as well as the development of other GNSS Systems like Galileo and Beidou, and further regional navigation satellite systems like QZSS and IRNSS, GA is addressing a range of new challenges, such as how to upgrade current GPS-only sites to multi-GNSS network, how to prepare a strategy for participating in the mid to long term exploitation of the next generation of GNSS. Australia is in the fortunate position to be one of the few regions in the world to see all the above new and emerging navigation satellite systems. GA is currently upgrading our multi-GNSS tracking and analysis capabilities and we are also closely watching the development of non-GNSS based positioning capabilities like Locata.

