Australian Government
Geoscience Australia

Geoscience Australia Antenna Calibration Facility Results

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Abstract

Geoscience Australia (GA)'s antenna calibration facility has been operating since the end of 2014. During this period GA has calibrated over 92 individual antennas, and performed a number of studies on the impact of near-field effects. This poster will detail results on the repeatability of different antenna types, and offer insights into how well the GA calibration facility compares to those currently in operation..

GNSS antenna calibration facility at GA

The Geoscience Australia GNSS antenna calibration facility was funded under AuScope's Australian Geophysical Observing System (AGOS). The aim of this funding was to calibrate AGOS GNSS antennas that were to be used to establish permanent reference stations, and to be used in deformation zone surveys. It is expected that the development of antenna type mean calibrations will be provided to the IGS Antenna Working Group for antenna and dome combinations that do not currently exist in the IGS Antenna Exchange file (ANTEX). In addition we will release individual antenna calibrations for antennas that are to be installed on new CORS stations, and for historic antennas.

GEO++ robot

The system was purchased from Geo++ which includes both the robotic arm hardware and pre-programmed software to complete an absolute field antenna calibration (Figure 1). The robotic system has been successfully used by Geo++, University of Hannover and the Berlin Senate Department for Urban Development and Environment for over a decade. The system has been operation since early 2015, and has now calibrated over 92 antennas (see Table 1).

Figure 1: Geo++ system at GA.

Antenna Type	Dome	# Antennas Calibrated
AOAD/M_T	NONE	5
ASH700936E	NONE	2
ASH701945C_M	NONE	3
ASH701945C_M	SCIS	1
ASH701945E_M	NONE	3
ASH701945G_M	NONE	1
JAVRINGANT_DM	NONE	22
JAVRINGANT_DM	SCIS	13
LEIAR10	NONE	1
LEIAR25	NONE	1
LEIAT504	NONE	2
LEIAT504GG	NONE	1
LEIMNA1202GG	NONE	1 (alias LEIAX1202GG)
TPSG3_A1	NONE	6
TRM57971.00	NONE	17
TRM59800.00	NONE	13
TOTAL		92

Table 1: Antennas calibrated at Geoscience Australia.(as of Sept 2015)

Validation and benchmark of the robotic calibration system

To characterise the performance of the geo++ calibration system installed at Geoscience Australia we have performed three different types of comparisons:

1. Individual antenna calibrations at GA with individual antenna calibrations from other facilities (Geo++ and Bonn).
2. Comparison of GA type means with IGS type means
3. Individual antenna calibrations obtained at GA with the current IGS type mean.

Individual antenna comparisons

The most direct way to assess the performance of a new calibration facility is to perform a calibration of the exact same antenna at different facilities, and compare the solutions. We can then asses if the results obtained at the new facility agree within the expected tolerances for absolute calibrations. For the L1 observable the agreement between calibrations should be less than 1 mm down to 10 degrees in elevation. For the L2 observable there is a higher tolerance of 1.5 mm down to 10 degrees in elevation. Geoscience Australia has three antennas that are primarily for the purpose of validating and benchmarking the robotic calibration system:

- Trimble chokering (TRM59800.00 NONE, sn: 4938353442);
- Javad chokering (JAVRINGANT_DM NONE, sn: 00711);
- Leica chokering (LEIAR25.R3 NONE, sn: 09330003).

Each of the above antennas has been sent to at least one other facility for calibration at Geo++ and/or the Bonn anechoic chamber in Germany.

Figures 2 and 3 show the repeatability of robotic calibrations for the Trimble reference antenna. The repeatability of the calibrations is within ± 0.5 mm for GPS L1, and within ±1.0 mm for GPS L2, of the original calibration provided by Geo++.

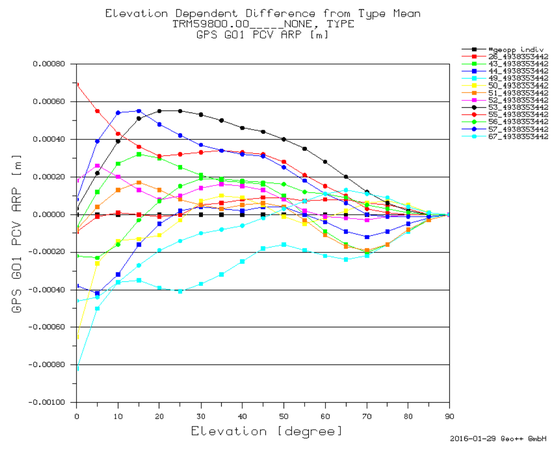

Figure 2: The GPS L1 repeatability of the calibrations for the Trimble reference antenna TRM59800.00 NONE, sn: 4938353442, compared with the original calibration provided by Geo++.

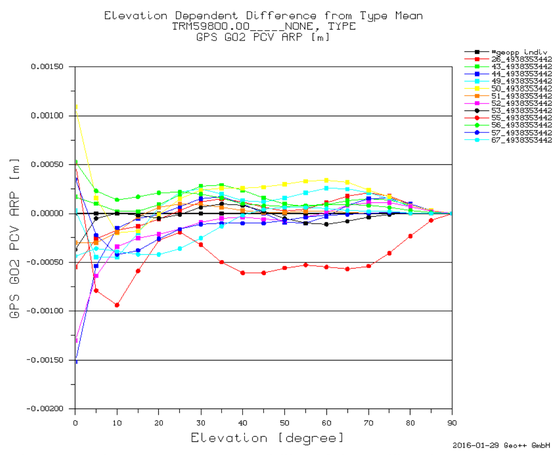

Figure 3: The GPS L2 repeatability of the calibrations for the Trimble reference antenna TRM59800.00 NONE, sn: 4938353442, compared with the original calibration provided by Geo++.

Individual antenna calibrations vs IGS Type Mean

By the end of 2015, GA had calibrated over 20 individual JAVRINGANT D_M antennas. Figures 4 and 5 show the differences between individual calibration and the IGS type mean for twelve JAVRINGANT_DM antennas. The JAVRINGANT_DM individual antenna calibrations in Figure 4 are within ±1 mm of the IGS type mean calibration for elevation-only dependent differences above 10° elevation for GPS L1. However, for the GPS L2 elevation dependent differences (see Figure 5) the departure is larger than the expected variability of ±1.5 mm. Despite this the calibration results are internally consistent, and are comparable to calibrations performed at Geo++. For this antenna type the IGS type mean has been based upon only five different antennas. Our results indicate a larger sample size may be required to obtain a more reliable type mean to ensure the variation with individual antenna calibrations is within ±1.5 mm.

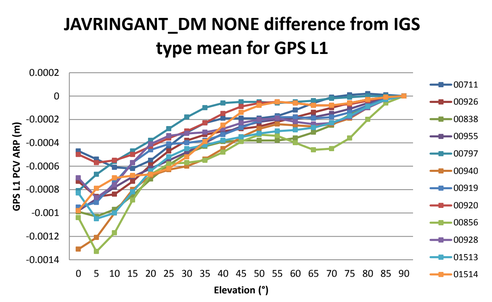

Figure 4: Individual calibration (denoted by serial number) elevation dependent differences from the IGS type mean for 12 JAVRINGANT_DM NONE antennas for GPS L1.

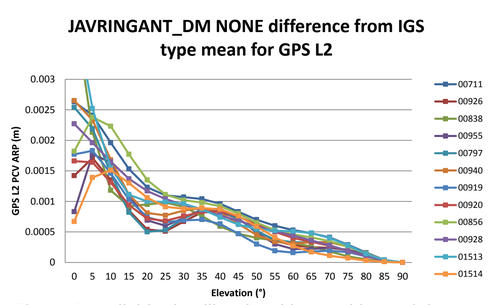

Figure 5: Individual calibration (denoted by serial number) elevation dependent differences from the IGS type mean for 12 JAVRINGANT_DM antennas for GPS L2.

IGS Type Mean vs GA Type Mean

For a number of antennas in the IGS ANTEX file have been converted from relative calibrations to absolute. When we compare the type mean derived from individual absolute antenna calibrations with the IGS type mean there are significant difference between the two type means (see Fig 6, and Fig 7 below).

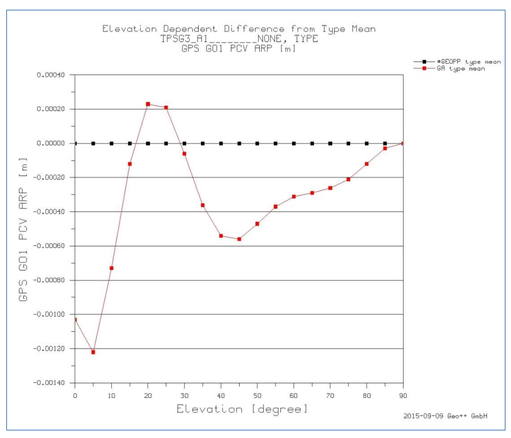

Figure 6 Elevation dependent difference of the GA constructed type mean from the Geo++ type mean for "TPSG3_A1 NONE" on GPS L1 (G01).

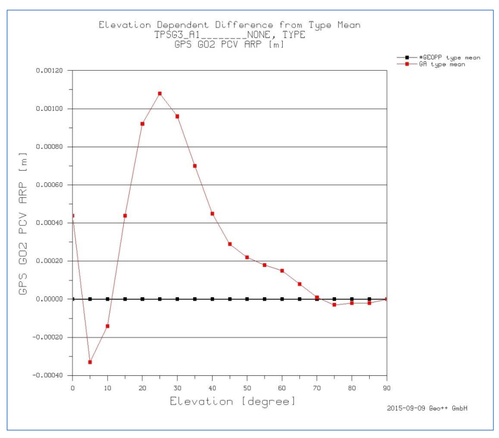

Figure 7 Elevation dependent difference of the GA constructed type mean from the Geo++ type mean for "TPSG3_A1 NONE" on GPS L2 (G02)

This could be due to a different sample of receiver used to derive the type mean, or errors in the underlying assumption of the AOAD calibration used to convert the relative calibration to absolute.

Conclusion

The results of the comparisons of three individual antennas with other calibration facilities indicate that the Geo++ robot installed at Geoscience Australia are within the tolerances expected for calibrations of individual antennas. The repeatability of the robot has been verified through the comparison of the individual antenna calibration results with the IGS type mean, and the very close fit of the individual calibration to the GA derived type mean.

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