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Insights into the IGS Master Antenna

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Abstract

We present some initial results on the calibration of the historic Dorne Margolin type T of Allen Osborne Associates (AOAD/M_T) antenna. The preliminary results indicate that there can be significant variation from the current IGS type mean, and the results indicate that there may be distinct sub groups for this antenna type. The reasons for this departure from the type mean remain unclear. It could be due to modifications made to the antenna during it's operation, aging of the antenna, normal variation in the manufacturing of the antenna, or the small sample size of individual antennas from which the type mean is based upon.

Background of the AOAD/M_T

The Dorne Margolin type T of Allen Osborne Associates (AOAD/M_T) is an important antenna type utilised by the IGS network. Before 2002 over 50% of the tracking network was equipped with this antenna type, it is also the reference antenna for relative antenna calibrations. Further understanding of the AOAD/M_T antenna's characteristics is important not only for the analysis of the IGS network today, but for future reprocessing of the IGS network.

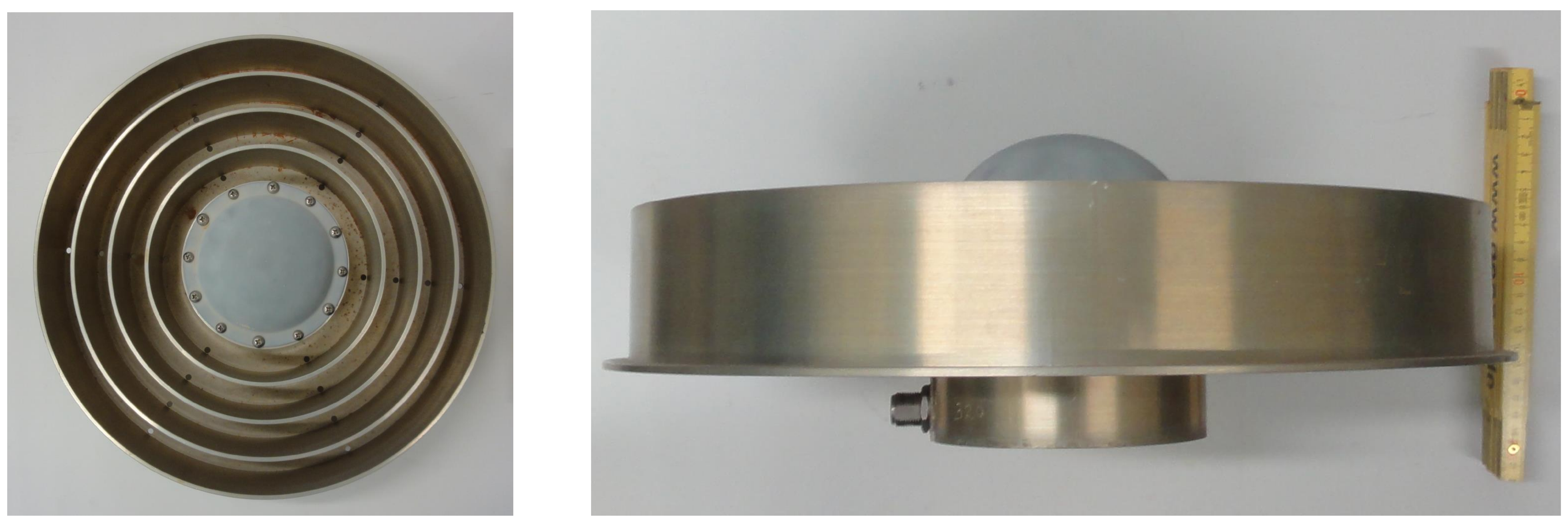

Figure # 1 Top and side view of the AOAD/M_T antenna

Although the AOAD/M_T antenna has been commonly used within the IGS network, the labelling and identification of these antennas is confusing as most of the labels (if they exist) are illegible due to aging and exposure. It was common practice for the serial number of the antenna to be scratched into the side of the pre-amplifier. This is the sole identification that remains on the majority of these antennas.

Figure #2: Different styles of serial number marking on AOAD/M_T antennas

The AOAD/M_T is made up by five different part numbers (PN) 7490400-1, 7490400-4, 7490582-1, 7490582-2 and 7490582-B. The issue is further complicated for the PN 7490400, this originally had a wideband low noise amplifier (LNA). Antennas with this LNA were having issues in tracking GPS signals when they were in a high radio frequency interference (RFI) environment. The LNA was redesigned to provide a filter between the L1 and L2 frequencies, these new antennas were given the part number 7490582-2. However the RFI kit was issued to a number of trained station operators to replace on existing antennas. For these antennas there is no clear discernible way to identify if there LNA has been replaced during it operation solely from its part or serial number (unless it has been recorded in the station log).

Importance of AOAD/M_T to IGS

During the early years of the operation of the IGS observation network, the majority of stations were using an AOAD/M_T antenna. In 2002 approximately 50% (more than 130 stations) were still equipped with this antenna type. Even today the AOAD/M_T antenna is operating at over 54 stations, and are more likely to belong to the core reference frame stations. Any significant mismodelling of the antenna PCVs at these stations could have an impact on the overall reference frame.

REFERENCES

Schmid, R., et al. (2015). "Absolute IGS antenna phase center model igs08.atx: status and potential improvements." Journal of Geodesy: 1-22. 10.1007/s00190-015-0876-3.

Recent results

Currently the absolute phase centre variation (PCV) model for the AOAD/M_T antenna used by the IGS relies upon calibration values obtained from a larger number of repeated calibrations of only two different individual antennas (serial numbers 393 and 404) (Schmid *et al.* 2015). Previously there have been no other antennas of this type available for calibration. Recently 7 AOAD/M_T antennas have recently been calibrated by Geoscience Australia and unexpectedly, this set of antennas displayed significantly different phase centre variations to the IGS type mean values. Recent results obtained from Geo++ and Geoscience Australia antenna calibration facilities have now identified at least two subgroups within this antenna type with different calibration characteristics.

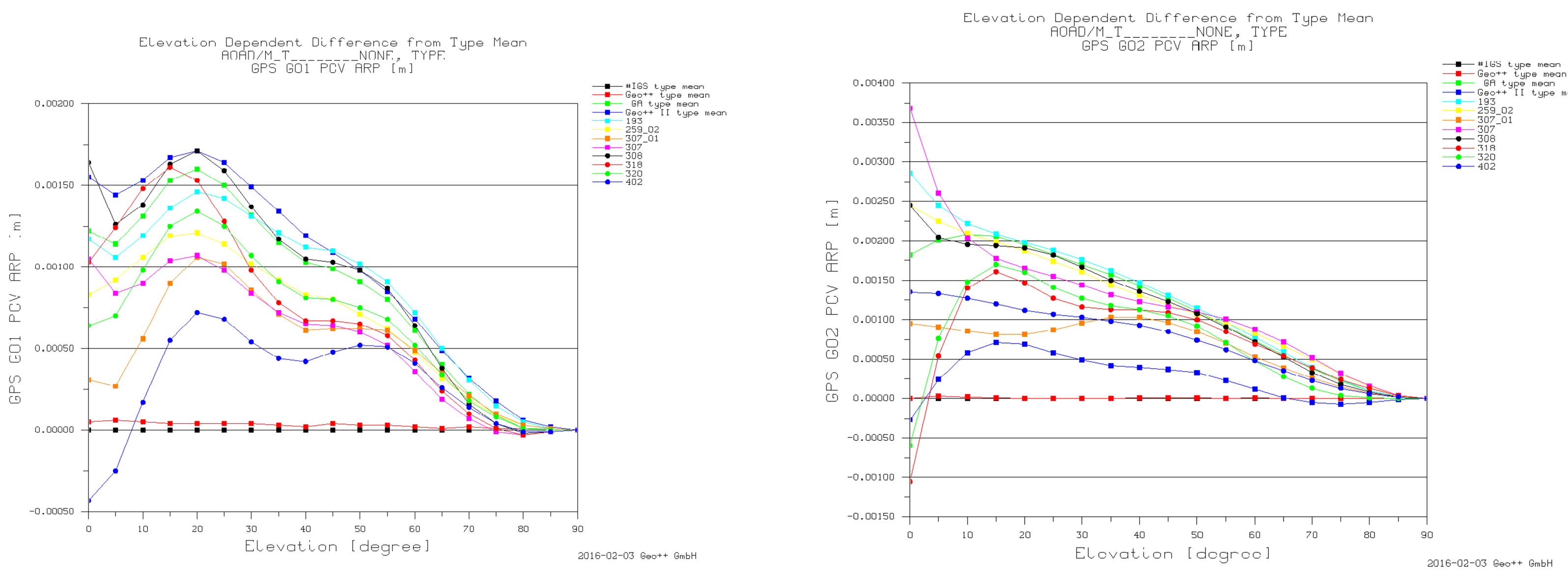

Figure #3: Individual calibrations (denoted by serial number), GA Type mean and GEO++ type mean elevation dependent differences from the IGS type mean for AOAD/M_T NONE antennas for GPS L1 (left), and GPS L2 (right)

Figure 3 shows the results of individual calibrations carried out at Geoscience Australia, a type mean compute from GA based calibrations, and a type mean computed from GEO++ calibrations compared with the current IGS type mean of the AOAD/M_T antenna. While there is one individual calibration which closely agrees with the IGS type mean, there appears to be a distinct differences in the PCV characteristics of individual AOAD/M_T antennas.

Impact of a ground plane and the AUST radome

The AUST radome has not previously been calibrated and as such, the current IGS type mean phase centre variation model for antennas with this radome are simply copied from the values for the antenna without the radome. As it is not possible to mount the AUST radome directly onto the antenna, a special ground plane had to be made, so that the AUST radome could be mounted over the antenna. At the Geoscience Australia calibration facility the impact of using the ground plane, and then the ground plane with the AUST radome has been assessed for the AOAD/M_T sn: 259 (see Figure 4).

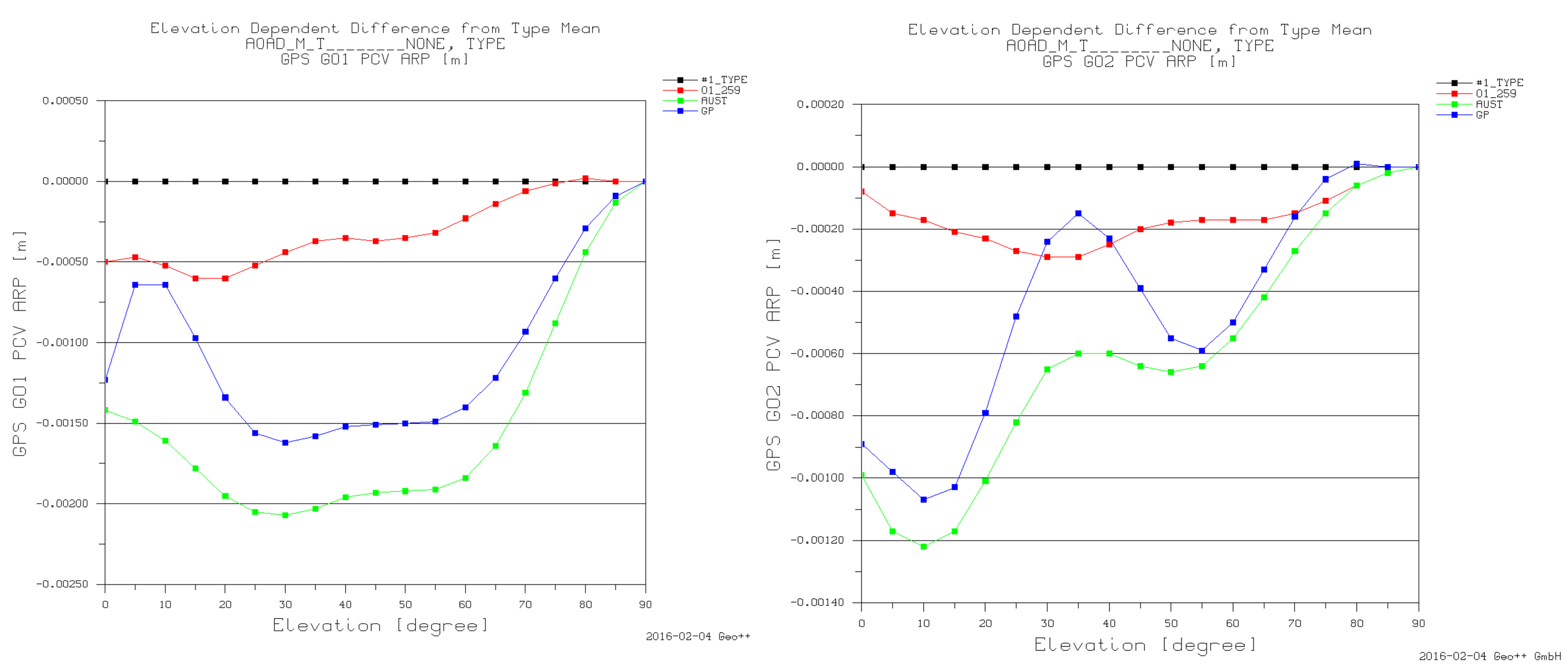

Figure #4: Individual calibrations of the AOAD/M_T NONE s/n 259 on its own, with a ground plane, and then with an AUST radome, compared to the IGS type mean, GPS L1 (left), and GPS L2 (right)

The addition of the ground plane has the largest impact upon on the PCV pattern of the antenna, adding the AUST radome adds an additional departure from the individual antenna calibration pattern. Clearly a type mean or individual calibration is not sufficient to accurately model the antenna PCV pattern for an antenna mounted close to a large ground plane. Adding the large unmodelled radome has less of an impact, but is still of significance.

Concluding remarks

Results obtained from the additional calibration of AOAD/M_T antennas highlight the importance of retaining and calibrating historic antennas. In order to ensure a consistent time series it would be preferable to obtain an individual antenna calibration of these antennas before they are no longer functional. It is important to record the height of the antenna and type of material of the nearest ground plane.

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