

IGS Antenna Working Group

R. Schmid

Deutsches Geodätisches Forschungsinstitut
Alfons-Goppel-Str. 11, 80539 München, Germany
E-mail: `schmid@dgfi.badw.de`

1 Updates and content of the antenna phase center model

Table 1 lists 15 updates of the absolute IGS antenna phase center model `igs08_www.atx` for 2013. Nine of them are related to changes of the satellite constellation, and four times an update of the model was released, when new receiver antenna calibrations became available. With the update in GPS week 1734, erroneous spikes were removed from the GLONASS calibrations of nearly 50 different receiver antenna types.

In GPS week 1745, the satellite antenna phase center variations (PCVs) of GPS Block II, IIA, IIR-A, IIR-B, IIR-M and IIF were extended with correction values for nadir angles between 15° and 17° provided by CODE (see Fig. 1 and Tab. 2). Those are based on ionosphere-free GPS data of the low Earth orbiter (LEO) missions Jason-2, GRACE-A, GRACE-B, GOCE, and MetOp-A and are mainly relevant for the analysis of LEO data. Further details on all model changes can be found in the corresponding IGSMails whose numbers are also given in Tab. 1.

Table 3 gives an overview of the data sets contained in the IGS phase center model. The numbers refer to `igs08_1771.atx` that was released in December 2013. For GPS and GLONASS, there are 77 and 89 file entries, respectively. These numbers are bigger than the number of actual satellites, as certain satellites were assigned with different PRN codes or almanac slots, respectively.

During the IGS Workshop 2012 in Olsztyn, it was recommended to adopt conventional phase center offset (PCO) values for Galileo, BeiDou and QZSS. As the update of the ANTEX format w.r.t. manufacturer-defined spacecraft body frames and attitude modes is still pending, the IGS phase center model does still not provide any information on the new GNSS. For the time being, conventional PCO values can be found on the web pages of the IGS Multi-GNSS Experiment (<http://www.igs.org/mgex/>).

Apart from the satellite antennas, the IGS model meanwhile contains phase center calibration values for 255 different receiver antennas. 84 of them are certain combinations of

Table 1: Updates of the phase center model `igs08_www.atx` (`www` being the GPS week of the release date) in 2013. Model updates restricted to additional receiver antenna types are only announced via the *IGS Equipment Files* mailing list.

week	date	IGSMAIL	change
1722	07-JAN-13	6711	Added R743 (R08), R801 (R08) Decommission date: R712 (R08), R743 (R08), R801 (R26)
1730	05-MAR-13	6743	Added R743 (R08), R801 (R26) Decommission date: R801 (R08)
1731	14-MAR-13	—	Added TRMR10 NONE
1734	05-APR-13	6753	Spikes removed from GLONASS calibrations of 46 receiver antenna types
1735	12-APR-13	—	Added TPSCR.G5 TPSH TRMR4-3 NONE TRMR6-4 NONE TRMR8-4 NONE TRMSPS985 NONE
1737	26-APR-13	—	Added ITT3750323 SCIS
1739	10-MAY-13	6771	Added G049 (G30) Decommission date: G035 (G30), G049 (G27) Spikes removed from GLONASS calibrations of 2 receiver antenna types
1740	16-MAY-13	6775	Added G066
1745	20-JUN-13	6786	PCVs of GPS Block II/IIA/IIR-A/IIR-B/IIR-M/IIF satellites extended to a maximum nadir angle of 17 degrees
1748	08-JUL-13	6789	Added R747 Decommission date: R728
1755	27-AUG-13	6818	Added NOV703GGG.R2 NONE Added G032 (G30) Decommission date: G049 (G30)
1758	18-SEP-13	6825	Added G037 (G30) Decommission date: G032 (G30)
1764	29-OCT-13	—	Added CHCX91+S NONE LEIICG60 NONE NOV750.R5 NOVS TIAPENG2100B NONE TIAPENG2100R NONE
1769	06-DEC-13	6843	Added G027 (G30) Decommission date: G037 (G30)
1771	20-DEC-13	6845	Added G049 (G30) Decommission date: G027 (G30)

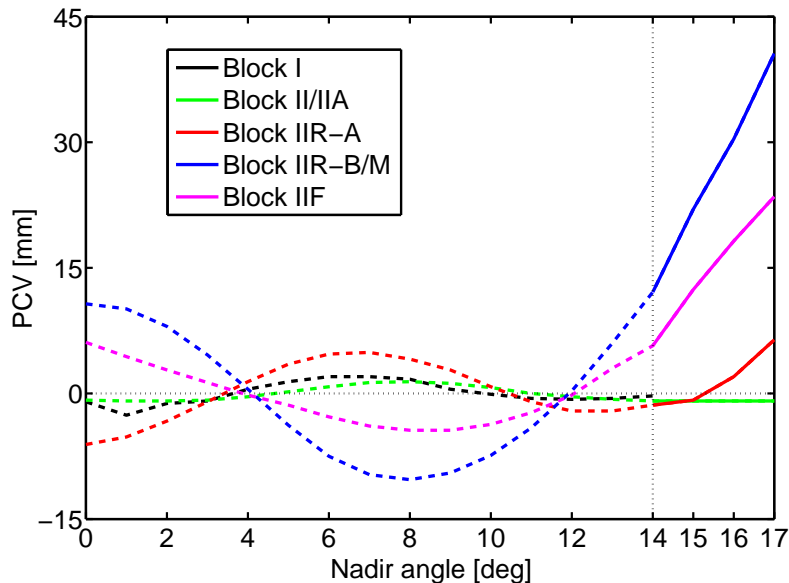


Figure 1: Extension for the GPS satellite antenna PCVs as provided by CODE. PCV values for nadir angles $\leq 14^\circ$ (dashed lines) are identical with the original `igs08.atx` values, whereas those for nadir angles $> 14^\circ$ (solid lines) were derived from LEO data. Block IIA PCVs (green) were extended with constant values and had to be constrained. Block I (black) could not be considered, as all Block I satellites already had been decommissioned when the first GPS-based LEO mission was launched.

Table 2: GPS satellite antenna PCV values [mm] for nadir angles between 14° and 17° in use since GPS week 1745.

Nadir angle	14°	15°	16°	17°
Block I	-0.30	-	-	-
Block II/IIA	-0.90	-0.90	-0.90	-0.90
Block IIR-A	-1.40	-0.80	+2.00	+6.40
Block IIR-B/M	+12.10	+22.00	+30.40	+40.60
Block IIF	+5.70	+12.40	+18.20	+23.50

Table 3: Number of data sets in `igs08_1771.atx` (released in December 2013).

satellite antennas	number	receiver antennas	number
GPS	77	ROBOT	119
GLONASS	89	FIELD	90
Galileo	0	COPIED	32
BeiDou	0	CONVERTED	14
QZSS	0		

Table 4: Calibration status of 437 stations in the IGS network (`logsum.txt` of 15 January 2014, `igs08_1771.atx`) compared to former years.

date	absolute calibration (azimuthal corrections down to 0° elevation)	converted field calibration (purely elevation-dependent PCVs above 10° elevation)	uncalibrated radome (or unmodeled antenna subtype)
DEC 2009	61.4%	18.3%	20.2%
MAY 2012	74.6%	8.2%	17.2%
JAN 2013	76.8%	7.7%	15.5%
JAN 2014	78.7%	7.8%	13.5%

an antenna and a radome, whereas the remaining 171 antenna types are not covered by a radome. As Tab. 3 shows, `igs08_1771.atx` contains, among others, 119 absolute robot calibrations and 90 converted field calibrations.

As elevation- and azimuth-dependent calibration values down to 0° elevation are mandatory for new or upgraded IGS stations, 154 different antenna types (119 `ROBOT` + 32 `COPIED` + 3 `CONVERTED`) are currently approved for installation. The remaining 101 types are no longer allowed, but their calibration values are still necessary for existing installations (see Sect. 2) as well as for reprocessing purposes.

2 Calibration status of the IGS network

Table 4 shows the percentage of IGS tracking stations with respect to certain calibration types. For this analysis, 437 IGS stations as contained in the file `logsum.txt` (available at <ftp://igs.org/igscb/station/general/>) on 15 January 2014 were considered. At that time, 103 different antenna/radome combinations were in use within the IGS network. The calibration status of these antenna types was assessed with respect to the phase center model `igs08_1771.atx` that was released in December 2013.

Seven years after the adoption of absolute robot calibrations by the IGS in November 2006, state-of-the-art calibrations comprising elevation- and azimuth-dependent PCVs down to the horizon are available for nearly 80% of all IGS stations. Whereas the portion of stations with phase center corrections derived from relative field calibrations (purely elevation-dependent) hardly changed in recent years, a steady decrease of IGS stations covered by uncalibrated radomes can be noticed.

This decrease results from an upgrade of the equipment at operational stations or from the decommissioning of stations with outdated equipment, but also from an extension of the network with properly calibrated antennas. In order to reach a coverage of 100%, IGS Site Guidelines do not allow converted field calibrations or uncalibrated equipment “at new or upgraded stations”.