IGS Antenna Working Group

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1 Generation of the absolute phase center model igs08.atx

On 17 April 2011 (GPS week 1632), the IGS adopted an IGS-specific realization of the ITRF2008, called IGS08, together with an updated antenna phase center model called igs08.atx. Details can be found in the IGSMAILs 6355 and 6374.

Main reasons for the update:

- scale difference of -0.94 ppb between ITRF2008 and ITRF2005 corresponding to a change of about $+12.2$ cm in the satellite antenna z-offsets
- lack of satellite-specific z-offset estimates for all satellites launched since the release of igs05.atx (affected about one quarter of the GPS constellation and more or less the complete GLONASS constellation)
- receiver antenna calibrations had not been updated since the release of igs05.atx

Main contributors:

- Martin Schmitz (Geo++ GmbH): preparation of type mean robot calibrations including GLONASS-specific correction values
- Paul Rebischung (IGN): investigation of the impact of receiver antenna calibration updates on station coordinates; compilation of IGS08
- Xavier Collilieux (IGN): compilation of GPS z-offset time series derived from reprocessed AC SINEX files
- Rolf Dach (CODE) and Florian Dilssner (ESOC): estimation of GLONASS satellite antenna corrections from combined GPS/GLONASS long-term solutions

- Ralf Schmid (TUM): coordination, estimation of mean GPS z-offsets from IGN time series, compilation of final model

Major changes of igs08.atx with respect to igs05.atx:

- satellite antenna z-offsets from igs08.atx are consistent with IGS08, whereas those from igs05.atx were approximately consistent with IGS05
- improved redundancy of satellite antenna z-offsets: GPS values contained in igs08.atx are based on results of 5 ACs (igs05.atx: 2), GLONASS values on those of 2 (igs05.atx: 1)
- preliminary block-specific z-offsets for satellites launched since the release of igs05.atx replaced by satellite-specific estimates
- z-offsets no longer trend-corrected due to improved quality of the ITRF vertical rates (ITRF2008 compared to ITRF2000)
- increased maximum nadir angle for GLONASS satellite antenna phase center variations (PCVs; 15° instead of 14°)
- availability of information on historical (GPS Block I and GLONASS) satellites
- availability of GLONASS-specific receiver antenna corrections from robot calibrations
- additional and updated robot calibrations
- conversion of relative receiver antenna corrections with updated `AOAD/M_T` values

2 Updates and content of the antenna phase center model

In case the satellite constellation changes or new receiver antenna calibrations become available, the absolute antenna phase center model of the IGS has to be updated. The GPS week of the release date is coded in the model name (igs08_wwww.atx). Table 1 lists 14 updates in 2011. Further details can be found in the corresponding IGSMAILs whose numbers are also given. Until GPS week 1631, igs05.atx was in use, on 17 April 2011, the IGS switched to igs08.atx.

Table 2 gives an overview of the data sets contained in the IGS phase center model. The numbers refer to `igs08_1685.atx` that was released in April 2012. For GPS and GLONASS, there are 68 and 81 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.

Table 1: Updates of the phase center models igs05.atx and igs08.atx in 2011.

week	date	IGSMAIL	change
			igs05.atx
1617	04-JAN-11	6324	Added R714 (R17), R722 (R14), R727 (R03) Decommission date: R715 (R14), R718 (R17), R722 (R03), R727 (R04) Corrected date: G010
1627	15-MAR-11	6365	Added R715 (R03) Decommission date: R727 (R03)
			igs08.atx
1629	29-MAR-11	6374	first release of igs08.atx (used as of week 1632; see Sect. 1)
1633	28-APR-11	6396	Added R801 (R04) Added JAVRINGANT_DM JVDM NAX3G+C NONE STXS9SA7224V3.0 NONE
1636	19-MAY-11	—	Added APSAPS-3 NONE LEIGG02PLUS NONE LEIGS08 NONE LEIGS12 NONE TPSPG_A1+GP NONE
1639	06-JUN-11	6409	Added G035 (G01) Decommission date: G049
1643	30-JUN-11	6418	z-offset updated: R801 Added TRM59900.00 NONE TRM59900.00 SCIS
1644	14-JUL-11	6428	Decommission date: G035 (G01) Added ASH701946.2 SNOW
1645	18-JUL-11	6433	Added G063
1648	11-AUG-11	6450	Added G035 (G30) Decommission date: G030
1657	13-OCT-11	6474	Added R715 (R14), R742 (R04), R801 (R03) Decommission date: R715 (R03), R722 (R14), R801 (R04)
1664	01-DEC-11	6496	Added R744 Decommission date: R801 (R03) Added SEPCHOKE_MC NONE SEPCHOKE_MC SPKE
1666	14-DEC-11	6506	Added R745 Decommission date: R712
1667	20-DEC-11	6507	Added R746 Decommission date: R714 (R17)

Table 2: Number of data sets in `igs08_1685.atx` (released in April 2012).

satellite antennas	number
GPS	68
GLONASS	81
Galileo	0
Compass	0
QZSS	0
receiver antennas	**number**
ROBOT	96
FIELD	90
COPIED	31
CONVERTED	14

For Galileo, Compass and QZSS, the IGS model does not provide any information so far. On the one hand, the system providers didn't make official phase center offset values available and on the other hand, there is not enough observation data to get reliable satellite antenna offset estimates from terrestrial data. During the IGS Workshop in Olsztyn the adoption of conventional IGS offset values will be discussed.

Apart from the satellite antennas, the IGS model also contains phase center calibration values for 231 receiver antennas. 151 of them are certain combinations of an antenna and a radome, whereas the remaining 80 antenna types are not covered by a radome. As Tab. 2 shows, `igs08_1685.atx` contains, among others, 96 absolute robot calibrations and 90 converted field calibrations.

As the IGS Site Guidelines ask for elevation- and azimuth-dependent calibration values down to 0° elevation, 130 different antenna types (96 ROBOT + 31 COPIED + 3 CONVERTED) are currently approved for the installation at new or upgraded IGS stations. The remaining 101 types are no longer allowed, but their calibration values are still necessary for existing installations (see Sect. 3) as well as for reprocessing purposes.

3 Calibration status of the IGS network

Table 3 shows the percentage of IGS tracking stations with respect to certain calibration types. For this analysis, 441 IGS stations as contained in the file `logsum.txt` (available at `ftp://igs.org/igscb/station/general/`) on 30 May 2012 were considered. At that time, 99 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_1685.atx` that was released in April 2012.

For three quarters of the IGS stations absolute robot calibration results are available

Table 3: Calibration status of 441 stations in the IGS network (`logsum.txt` of 30 May 2012, `igs08_1685.atx`).

absolute calibration (azimuthal corrections down to 0° elevation)	converted field calibration (purely elevation-dependent PCVs above 10° elevation)	uncalibrated radome (or unmodeled antenna subtype)
74.6%	8.2%	17.2%

comprising elevation- and azimuth-dependent PCVs down to the horizon. 8% of the stations are equipped with antenna types for which purely elevation-dependent PCVs derived from relative field calibrations have to be applied. The latter is not ideal, but also not a dramatic problem.

Really problematic are the remaining 17% of the stations. Their antennas are either covered by uncalibrated radomes, or there are subtypes of the antenna that are not properly modeled so far. The latter problem is currently known for two Javad antennas (`JPSREGANT_DD_E`, `JPSREGANT_SD_E`) and could be corrected soon. Deficiencies in the phase center modeling are especially disadvantageous at co-location sites where the absolute antenna position is important for comparisons with local tie measurements.

In December 2009, the percentages for the three categories shown in Tab. 3 were 62%, 18% and 20%, respectively. The improvement after 2.5 years could mainly be achieved by the switch from igs05.atx to igs08.atx (see Sect. 1). However, part of the improvement is also due the fact that old installations were upgraded or even decommissioned.