# 3.4 Technique Centres

## 3.4.1 International GNSS Service (IGS)

### General

From its mission statement, the IGS is committed to provide the highest quality GPS+GLONASS observation data and products, openly and readily available to all user communities, as the standard for global navigation satellite systems (GNSS) in support of Earth science research, multidisciplinary applications, and education. The IGS products support scientific objectives including realization of the International Terrestrial Reference Frame (ITRF) and its easy global accessibility, monitoring deformation of the solid Earth, monitoring Earth rotation, monitoring variations in the hydrosphere (sea level, ice-sheets, etc.), satellite orbit determination, ionosphere monitoring, climatological research, and time and frequency transfer. Table 1 gives an overview of the estimated quality of the IGS core products at the end of 2006.

*Table 1: Quality of the IGS Core Products as of December 2007 (for details and further products see <http://igscb.jpl.nasa.gov/components/prods.html>)*

| Product | IGS Final | IGS Rapid | IGS Ultra Rapid | |
|---|---|---|---|---|
| | | | Adjusted | Predicted |
| Updates | Weekly | Daily | Every 6 h | Every 6 h |
| Delay | ~13 days | 17 hours | 3 hours | Real-time |
| Orbits | 2 cm | 3 cm | < 5 cm | <10 cm |
| Satellite Clocks | 0.05ns | 0.1 ns | ~0.2 ns | ~5 ns |
| Station Clocks | 0.05ns | 0.1 ns | | |
| Polar Motion | 0.05 mas | <0.1 mas | 0.1 mas | |
| LOD | 0.02 ms/day | 0.03 ms/day | 0.03 ms/day | |
| Station Coordinates (h/v) | 2 mm / 6 mm | | | |

### Tracking network & station issues

In 2006, 10 IGS sites were decommissioned and 12 sites were added to the network, bringing the total at the close of the year to 380 sites. A subset of the network provides meteorological data, and more than 200 stations provide data hourly in addition to daily. Another subnetwork provides data at a 1-second sampling interval in addition to the usual 30-second data type. The station data and IGS products are available freely to all users from 4 global data centers and additional regional and operational data centers.

### Analysis Issues

The IGS Analysis Centers (AC) have steadily improved their precision/consistency for the IGS Final and Rapid products (see Fig. 2 for the orbits). The orbit agreement is now at a level of 2 cm for the best ACs and the combined IGS Rapid and Final orbits agree better than 1 cm.

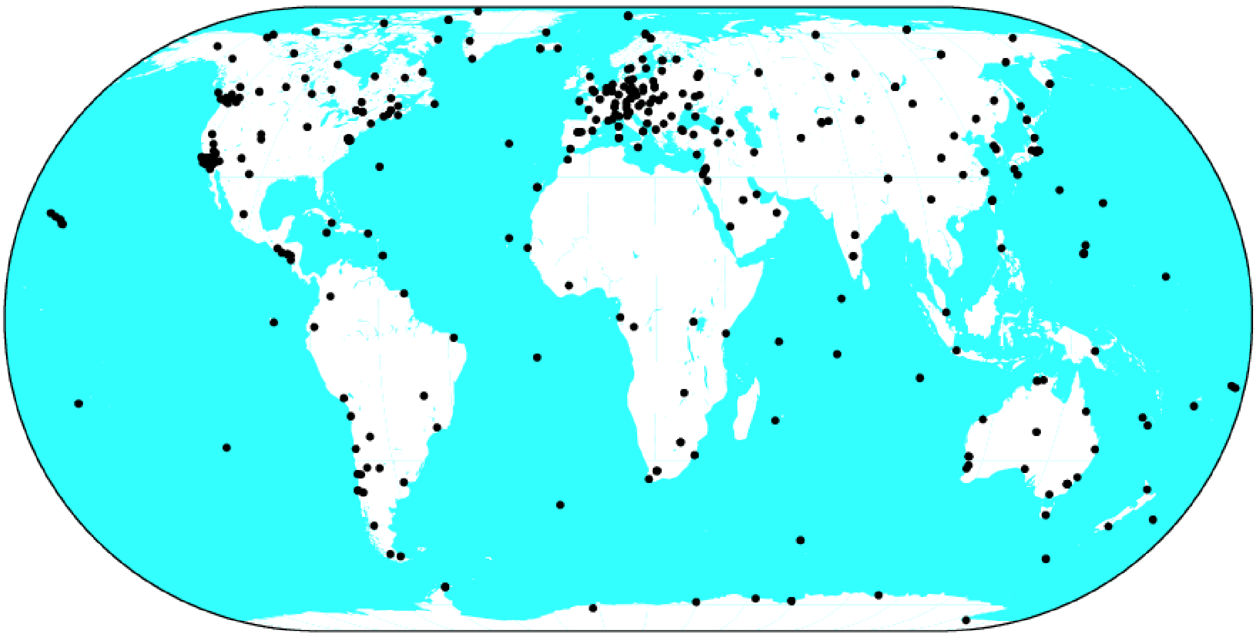

*Fig. 1: IGS tracking network*

Four ACs are contributing with GLONASS products based on microwave data – BKG, COD, ESA, IAC – and MCC with products based on SLR data. The SLR solution is used for comparison only. COD is the only AC analyzing combined GPS and GLONASS data in a rigorous way. The consistency of the GLONASS Final orbits is at a level of 5 to 10 cm.

Three ACs (COD, JPL, MIT) are providing clock solutions with a 30 s sampling rate. Since December 2006 (GPS week 1406) combined clock products are provided with a sampling rate of 30 s in addition to the usual 5-min products (names: *.clk; *.clk_30s).

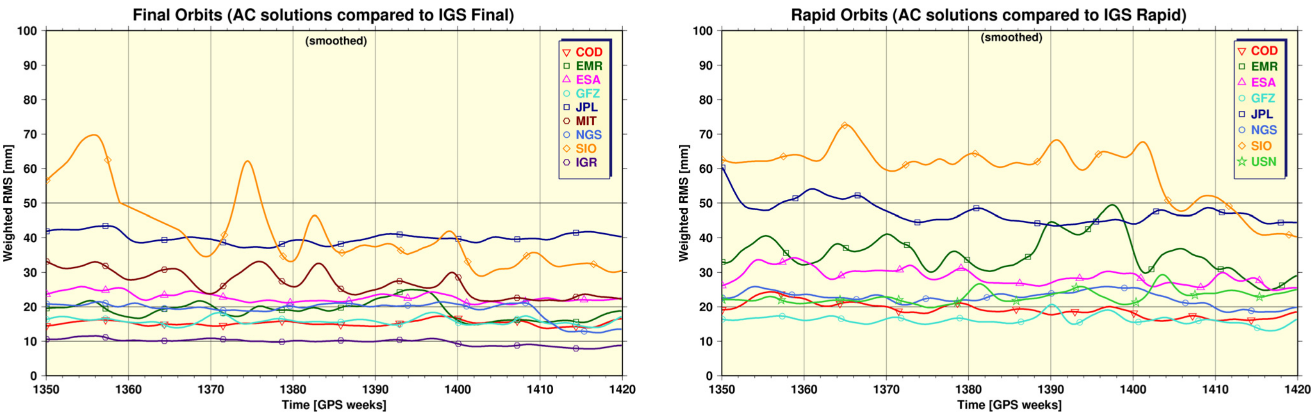


*Fig. 2: Weighted RMS differences of all AC's (and IGS Rapid) orbits to the IGS Final (left) respectively IGS Rapid (right) combined orbits.*

**Switch to new absolute antenna models**

To prepare for the introduction of the new absolute antenna model for the GNSS receivers and satellites the IGS Final products were generated with the new model in parallel to the routine products based on the relative antenna models. The goal was (1) to test the implementation in the software packages, (2) to test the effects on the IGS products and (3) to generate a new compatible reference frame IGc00. Comparisons showed a high quality of the parallel results and no significant biases, except of those in station positions and troposphere parameters which are directly connected to the new antenna models. Comparisons of the new satellite antenna model, which was derived from a mean of TUM and GFZ results using 11 years of data, to estimates from COD using one year of data showed no significant discrepancies, and so COD's antenna patterns for the GLONASS satellites were added to the new model, which completed the APCV model.

The IGS satellite antenna model was compared to the JPL model, which is derived fully independent from GRACE data. The characteristics of block specific antenna phase center variations are in a reasonable agreement. However, there exists an overall bias of 90 cm for the JPL satellite antenna z-offsets, the reason for that is not clear at the moment and is under investigation.

The IGS switched to the new antenna model after the release of the ITRF2005 in November 2006 (GPS week 1400). For the new IGS realization of the ITRF2005, the IGS05, differences between the absolute and the relative antenna models, obtained by the parallel products, were applied to the IGS station positions.

**Network Combination**

At the end of 2006, the IGS reference frame realization was updated including the following three aspects: 1) the switch from relative to absolute phase center, 2) the update from the realization ITRF2000 to ITRF2005, and 3) the update of the station selection for the realization. The effect of the antenna phase center change affects mainly the height component, which maps into the estimated scale offset. This effect in shown in Figure 3, where the AC's weekly average scale bias for about one year before and after the reference frame realization update is shown. The average bias goes from about +3.0 ppb to about –0.5 ppb. The nominal number of stations selected also went from 99 to 132.

The consistency of the AC's weekly solutions with respect to the IGS weekly combined is generally at the 1 to 3 mm in the horizontal components and 3 to 4 mm for the height component. Similarly, when the AC's weekly solutions are compared to the IGS cumulative solution, the consistency is at the 2 to 4 mm in the horizontal components and 4 to 6 mm in the vertical component. For the pole position and pole rate, the consistency is about 0.03 mas and 0.20 mas/d. The apparent geocenter consistency is 5 to 10 mm for the X and Y components, and 10 to 20 mm for the Z component.

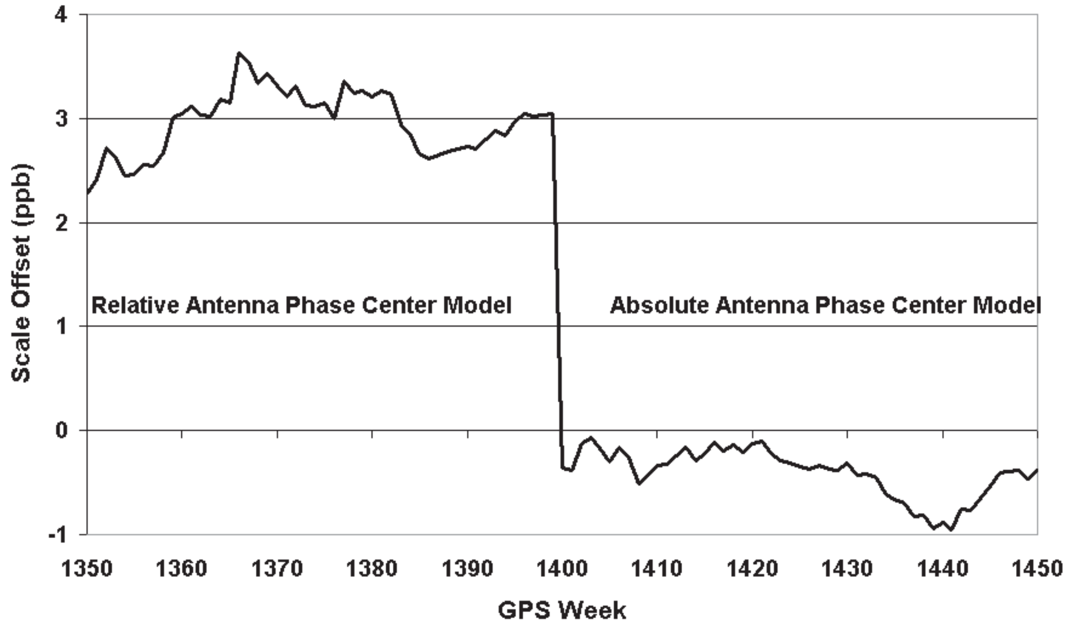


*Fig. 3: Weighted average AC's scale offset with respect to the IGS realization of ITRF before and after (wk 1400) the reference frame realization change.*

**IGS reprocessing activity**

As contribution to the next realization of the ITRF, the IGS is planning for a reprocessing of all historical data since 1994. The reprocessing will solve the problem of inconsistencies in the existing IGS station time series caused by many model and parameter changes in the past, especially by the introduction of the new absolute antenna model.

## Summary

In 2006, as in the previous years, the IGS contributed significantly to the IERS activities like maintenance and extension of the International Reference Frame and provision of highly-accurate, daily-sampled Earth Rotation Parameters. The quality of the IGS products has further improved. The IGS has finished the transition from the relative to the absolute antenna models and is preparing for the reprocessing of historical IGS data. For more detailed information on further IGS activities visit the web site at the Central Bureau at JPL (<http://igscb.jpl.nasa.gov>) or the Analysis Coordinator web pages at GFZ (<http://www.gfz-potsdam.de/igsacc>).

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