

## 3.4 Technique Centres

### 3.4.1 International GPS 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 2004.

*Table 1: Quality of the IGS Core Products as of December 2004 (for details and further products see <<http://igscb.jpl.nasa.gov/components/prods.html>>)*

| Product                   | IGS Final   | IGS Rapid   | IGS Ultra Rapid Adjusted | IGS Ultra Rapid Predicted |
|---------------------------|-------------|-------------|--------------------------|---------------------------|
| Updates                   | Weekly      | Daily       | Every 6 h                | Every 6 h                 |
| Delay                     | ~13 days    | 17 hours    | 3 hours                  | Real-time                 |
| Orbits                    | 2cm         | 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) | 3 mm / 6 mm |             |                          |                           |

**Tracking Network** In 2004 another 20 sites were added to the IGS network reaching now a total of 383 sites (<<http://igscb.jpl.nasa.gov/network/netindex.html>>). In addition to the usual data transfer in daily batches, more than 170 sites (see Fig. 1) have already set up an hourly data transfer to support the IGS Ultra Rapid products and products for e.g. regional applications of various user groups, especially for near-real time tropospheric and ionospheric monitoring. A network of high-rate stations supporting Low Earth Orbiter missions (like CHAMP and GRACE) is also available for the scientific user community.

**Analysis Issues** The number of usable stations in the IGS realization of ITRF2000, named IGS00, decreased since its inception in December 2002 from 55 to about 45 stations. Therefore, a new realization IGB00 with 99 stations (IGS03P33\_RS99.snx) was introduced in January



2004 and will allow for a much more stable realization of the reference frame. As of February 2005, 85 reference frame stations are still defining the IGB00 realization. A reanalysis of most of the AC solutions was carried out to improve the weekly/cumulative IGS combined solutions in preparation for the upcoming ITRF.

The number of stations in the weekly SINEX products increased steadily and comprises now up to about 260 sites. Figure 2 shows the evolution of the number of stations used in the weekly AC/GNAAC/IGS analysis.

After comprehensive checking of their submitted products over several months, two new analysis centers were included in the official product combinations – Massachusetts Institute of Technology (MIT) for the Final products and Geodetic Observatory Pecny (GOPE) for the Ultra Rapid products.

Any user can directly and easily access to the reference frame by applying the Precise Point Positioning (PPP) technique based on the IGS orbits and clocks. To check the realized accuracy, a PPP is performed with each IGS Product (Rapid and Final) for all those stations included in the IGB00 reference frame definition. The stations' repeatability and the Helmert transformation parameters to IGB00 are computed and publicized at <<http://www.gfz-potsdam.de/igsacc>>.

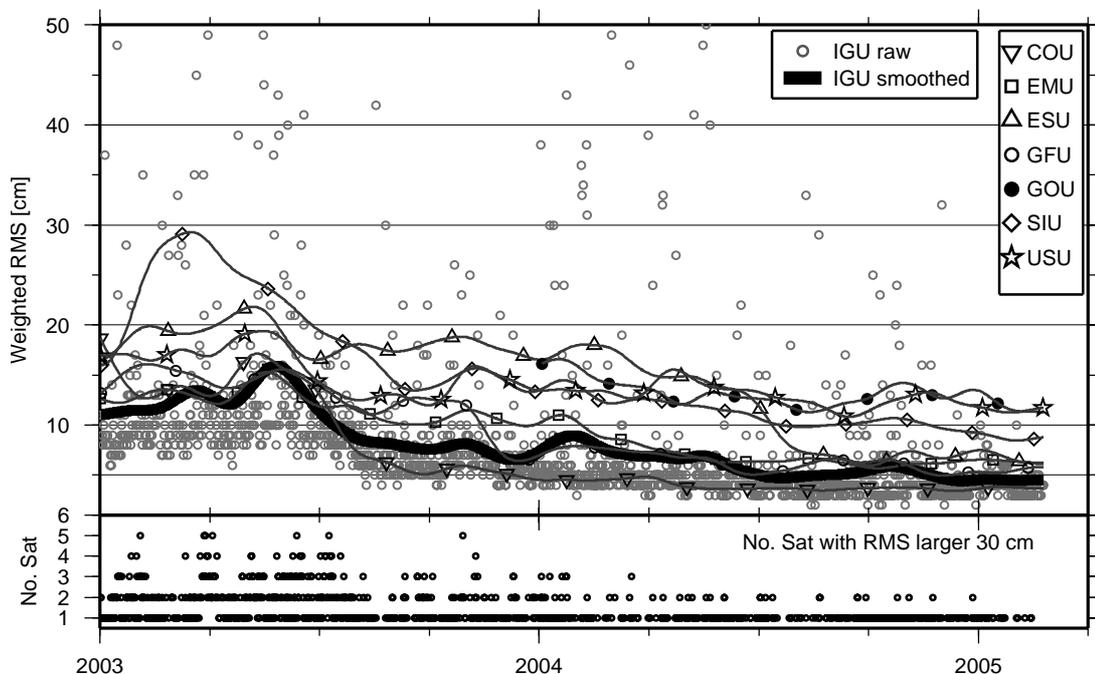


Fig. 3: Weighted orbit RMS of the Analysis Centers' Ultra Rapid orbits with respect to the IGS Rapid orbits (smoothed). The thick line shows the IGS Ultra Rapid orbits (smoothed), and the circles the daily RMS that is in a few cases affected by single bad satellites the number of those are given in the bottom plot.

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Since May 2004 the update cycle for the Ultra Rapid product was increased from twice to four times per day. This way the nominal prediction interval, necessary for real time applications, could significantly be reduced from 15 to 9 hours, resulting in better predictions and, most of all, in a reduction of outliers for the not-so-well-predictable satellites (see Fig. 3).

#### **IGS 10th Anniversary Symposium and Workshop, March 1-5, 2004**

A one-day symposium was held aimed at celebrating the history, development and accomplishments of the IGS over the last decade and how this has benefited multi-disciplinary applications. A view of the evolution and future of Global Navigation Satellite Systems was provided, and the future of international cooperation, use of GNSS, and the evolving role of IGS explored. The establishment of an International GNSS Committee as a mechanism to further cooperation among system providers, international GNSS organizations, and users was strongly encouraged. The IGS and the IAG will support and contribute to the successful realization of such an effort.

The technical workshop set the stage for the future directions and developments of the IGS. The sessions were devoted to specific topics related to IGS components:

- IGS Reference Frame Maintenance
- Reference Frame Issues
- Network Issues
- Data Transfer and Data Centers
- Real-time Aspects
- Integrity Monitoring of IGS Products
- Global Navigation Satellite Systems
- Precise Orbit Determination
- Antenna Effects
- Ground Based Neutral Atmosphere and Ionosphere Sounding

For each session, a Position Paper was the basis for discussion. The workshop generated numerous recommendations in each session, which could not all be listed here.

Some of the key issues are:

- Stabilization and improvement of the reference frame
- Ways how the IGS can move towards real-time processes
- Adoption of absolute antenna calibrations including the derivation of absolute satellite antenna model
- Approach to generate a new IGS troposphere product based on PPP
- Positioning the IGS to influence and integrate future GNSS, as has been demonstrated with GLONASS.

A comprehensive list of all recommendations will be included in the proceedings.

**New Name for IGS**

In view of the increasing developments in the field of Global Navigation Satellite Systems (GNSS), the IGS Governing Board decided in March 2005 to modify the name of IGS. The acronym remains, but now stands for *International GNSS Service*.

**Summary**

The IGS celebrated its 10th anniversary by organizing a Symposium and a Workshop in March 2004. In 2004, as in the previous ten years, the IGS contributed significantly to the IERS activities like maintenance and extension of the ITRF and in the highly-accurate, daily-sampled Earth Rotations Parameters. The quality of the IGS products has further improved, especially for the low-latency products (Rapid and Ultra Rapid). For more detailed information on further IGS activities visit the web site at the Central Bureau at JPL (<<http://igs.cb.jpl.nasa.gov>>) or the Analysis Coordinator web pages at GFZ (<<http://www.gfz-potsdam.de/igsacc>>).

**References**

Dow, J., G. Gendt, A. Moore, R. Neilan, R. Weber: The International GPS Service – What's next? 10th Anniversary Assembly Charts Future Directions. Proceedings ION, 22 Sept 2004, Long Beach, USA

Celebrating a Decade of the International GPS Service, Workshop & Symposium 2004. Proceedings, Bern Switzerland, March 1-5, 2004, Astronomical Institute, University Bern, Switzerland, in print 2001-02 Technical Report. IGS Central Bureau, eds. Pasadena, CA: Jet Propulsion Laboratory, 2004.

2001-02 Annual Report. IGS Central Bureau, eds. Pasadena, CA: Jet Propulsion Laboratory, 2004.

These documents are also available electronically at <<http://igs.cb.jpl.nasa.gov/overview/pubs.html>>.

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