3.4 Technique Centres

3.4.1 International GPS Service (IGS)

General Since 1994, the IGS is committed to provide the highest quality GPS+GLONASS observation data and products, as the standard for global navigation satellite systems (GNSS) in support of scientific activities such as improving and extending the International Terrestrial Reference Frame, monitoring deformations of the solid Earth, variations in the liquid Earth (sea level, ice sheets, etc.) and in Earth rotation, determining orbits of scientific satellites, and monitoring the troposphere and ionosphere. Table 1 gives an overview of the estimated quality of the IGS products at the end of 2003.

Table 1: IGS Products (the GPS broadcast values are included for comparison). The accuracy limits, except for predicted orbits, are based on comparisons with independent laser ranging results. The accuracy of all clocks is expressed relative to the IGS timescale, which is linearly aligned to GPS time in one-day segments.

		Accuracy	Latency	Updates	Sample Interval
GPS Satellite Ephemerides/Satellite & Station Clocks					
Broadcast	Orbits	~ 200 cm	Real time	--	Daily
	Sat. clocks	~ 7 ns			
Ultra-Rapid (predicted half)	Orbits	~ 10 cm	Real time	Twice daily	15 min
	Sat. clocks	~ 5 ns			
Ultra-Rapid (observed half)	Orbits	< 5 cm	3 hours	Twice daily	15 min
	Sat. clocks	~ 0.2 ns			
Rapid	Orbits	3 cm	17 hours	Daily	15 min
	Sat.& station clocks	0.1 ns			5 min
Final	Orbits	2 cm	~13 days	Weekly	15 min
	Sat.& station clocks	0.05 ns			5 min
GLONASS Satellite Ephemerides					
Final	Orbits	30 cm	~ 4 weeks	Weekly	15 min
Geocentric Coordinates of IGS tracking stations (> 130 sites)					
Final positions	Horizontal	3 mm	12 days	Weekly	Weekly
	Vertical	6 mm			
Final velocities	Horizontal	2 mm/y	12 days	Weekly	Weekly
	Vertical	3 mm/y			
Earth Rotation Parameters : Polar Motion (PM), Polar Motion Rates (PM rate), Length-of-day (LOD)					
Ultra-rapid (predicted half)	PM	0.3 mas	Real time	Twice daily	Twice daily (00 & 12 UTC)
	PM rate	0.5 mas/day			
	LOD	0.06 ms			
Ultra-rapid (observed half)	PM	0.1 mas	3 hours	Twice daily	Twice daily (00&12 UTC)
	PM rate	0.3 mas/day			
	LOD	0.03 ms			
Rapid	PM	< 0.1 mas	~ 17 hours	Daily	Daily (12 UTC)
	PM rate	< 0.2 mas/day			
	LOD	0.03 ms			
Final	PM	0.05 mas	~ 13 days	Weekly	Daily (12 UTC)
	PM rate	< 0.2 mas/day			
	LOD	0.02 ms			
Atmospheric parameters					
Final tropospheric zenith path delay		4 mm	< 4 weeks	Weekly	2 hours
Ultra-rapid tropospheric zenith path delay		6 mm	2-3 hours	Every 3 hours	1 hour
Ionospheric TEC grid		2-8 TECU	~ 11 days	Weekly	2 hours ; 5°x2.5°

All products are based on a combination process of the individual IGS Analysis Center (AC) solutions to gain highest quality and to ensure reliability. During 2003 the quality of the products were further enhanced (see Figure 1 as example). A significant improvement could be obtained for the Ultra Rapid products, where the prediction for the majority of the satellites has reached a level of 6 cm. The observed part of the ultra rapid products has a high quality and is available already after three hours (twice daily), so that for special applications it can be used instead of the Rapid product.

Mid 2003, the responsibilities of Analysis Coordinator were switched from R. Weber to G. Gendt (GFZ).

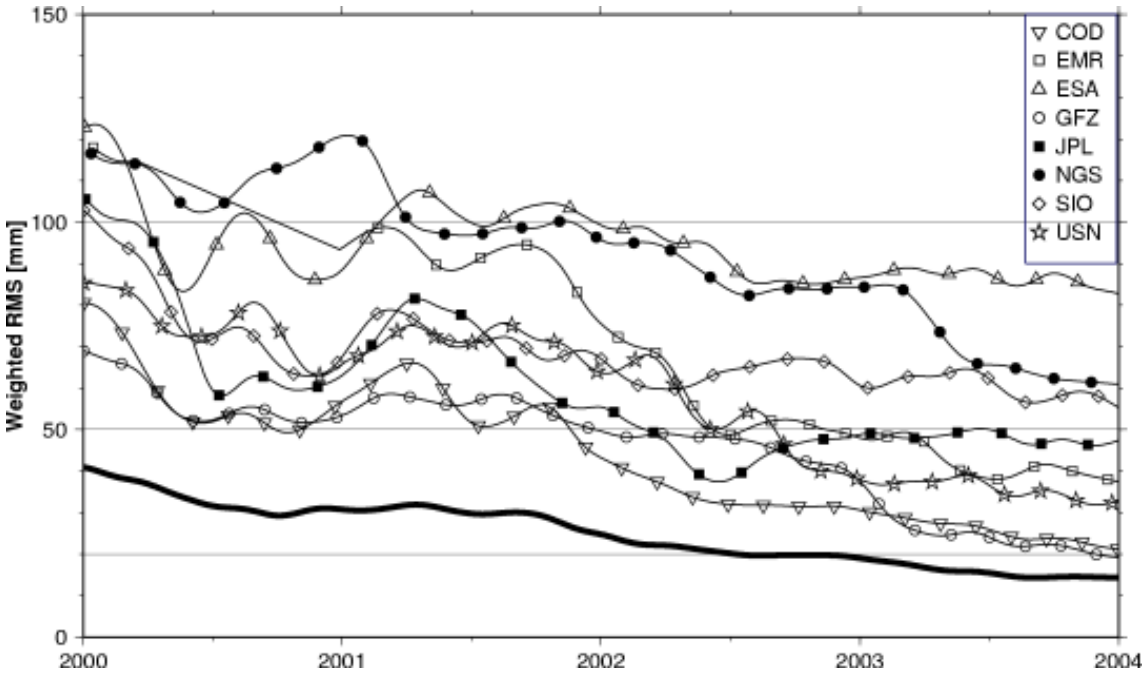

Fig. 1: Weighted orbit RMS of the Analysis Center orbits with respect to the IGS Rapid orbits (smoothed). The thick line shows the IGS Rapid orbits compared to the IGS Final orbits.

Tracking Network and its Coordination

In 2003, the IGS network (Figure 2) grew with 23 new sites to reach a total of 362 sites. 128 of these sites are global stations which means that their data are regularly analyzed by at least three different Analysis Centers, one of which must be located on another continent from the station.

The IGS Central Bureau improved its monitoring of the IGS sites by adding to the station web pages change point analysis which flags potential incidents based on data characteristics. Other enhancements to the station web pages are graphs of the SINEX residuals as calculated by the Reference Frame Coordinator, and tables indicating which Analysis Centers have chosen that site for which products.

In addition, a full revision of the IGS site guidelines was started.

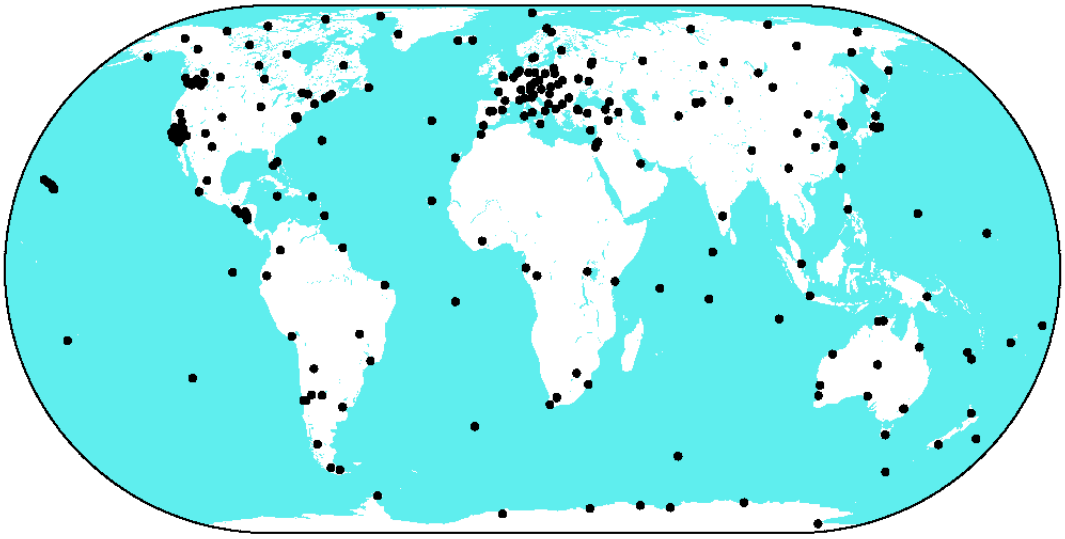

Fig. 2: IGS tracking network

IGS Working Groups/Pilot Projects

Within the IGS a number of Working Groups (WG) focus on selected topics related to the IGS components. Furthermore Pilot Projects have been launched to develop new products and services. The activities of a few of them are briefly presented below. For a complete list and descriptions see http://igscb.jpl.nasa.gov/projects/projindex.html.

Galileo/GNSS Working Group

This WG is presently concentrating on two studies related to GPSIIF/GPSIII and Galileo: the anticipated improvements in the IGS products, and the standardization of products. Draft recommendations on signal tracking will be provided to manufacturers as well.

Real-time Working Group

Under the initiative of this WG, an initial set of about 10 IGS stations has been running with at least 98% of data arriving with less than 2 seconds latency. An expanded prototype network of 20-30 stations is hoped for March 2004.

LEO Working Group

The Associate Analysis Centers attain LEO orbits of 3-4 cm precision, but improvements are still needed. Integrated GPS+LEO processing will be utilized to assess the impact of LEO data on IGS products. However, presently the IGS Analysis Centers do not have the capacity to include LEOs in their GPS processing.

Ionosphere Working Group

The individual ionospheric maps obtained by the WG members have been calibrated using Envisat altimeter data. These maps are the basis for a new official IGS product: the IGS combined ionospheric maps (TEC grid) targeting users from the science community, SCAR, and ESA (for EGNOS comparisons).

Time Transfer Pilot Project

Ken Senior (Naval Research Laboratory, US) has been appointed as Product Coordinator. In 2003, the robustness of the IGS timescale products has improved.

Troposphere Working Group

The chair of this WG switched from G. Gendt (GFZ) to J. Bar-Sever (JPL), who is now also responsible for the generation of the IGS combined troposphere product.

Reference Frame Working Group

The current IGS reference frame realization "IGS01P37_RS54.snx", which starts to degrade the realization, was reviewed. Since its creation two years ago, almost a dozen of stations had to be discarded for various reasons. Therefore a new improved realization "IGS03P33_RS106.snx" will be introduced starting 2004.

Summary

In 2003, as in the previous years, the IGS contributed significantly to the IERS activities like maintenance and extension of the International Reference Frame and in the highly accurate, daily sampled Earth Rotations Parameters.

The accuracy of the IGS products has further improved and approaches for the orbit already the 1 cm level and the mm level for other parameters. For the future the focus will therefore be on the integrity for all the IGS products, 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://igscb.jpl.nasa.gov) or the Analysis Coordinator web pages at GFZ (http://www.gfz-potsdam.de/igsacc).

References

2002 Ottawa "Towards Real-Time" Workshop. IGS Central Bureau, eds. Pasadena, CA: Jet Propulsion Laboratory, 2003.

2001 IGS Technical Reports. IGS Central Bureau, eds. Pasadena, CA: Jet Propulsion Laboratory, 2003

2001 IGS Annual Report. IGS Central Bureau, eds. Pasadena, CA: Jet Propulsion Laboratory, 2003

A Guide to using International GPS Service (IGS) Products. Jan Kouba, Geodetic Division, NRCan, Feb. 2003. IGS Central Bureau, Pasadena, CA: Jet Propulsion Laboratory

These documents are also available via FTP at <ftp://igscb.jpl.nasa.gov/igscb/resouces/pubs/>.

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