Activities at the CODE Analysis Center

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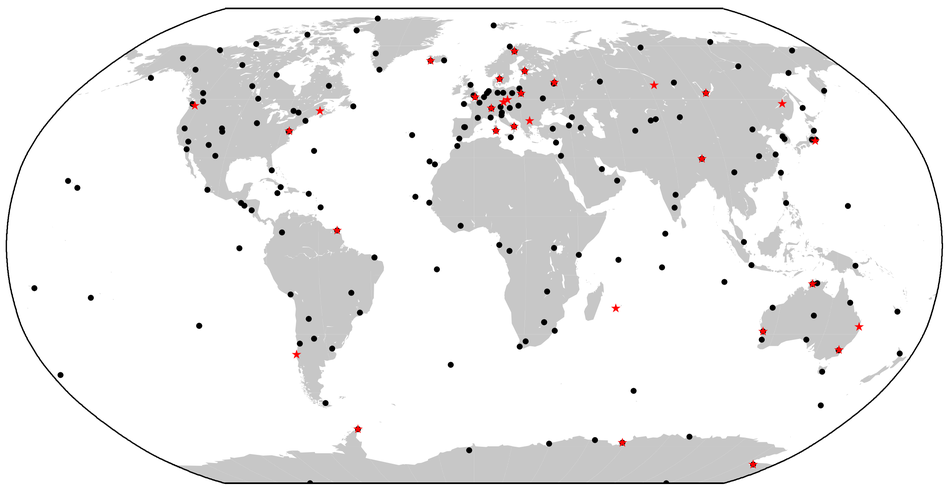
Stefan Schaer, Urs Hugentobler, Rolf Dach, Michael Meindl, Heike Bock, Claudia Urschl, Adrian Jaeggi, Andreas Gaede, Lars Prange, Martin Ploner, Pierre Fridez, Gerhard Beutler

Overview, New Developments, and Highlights

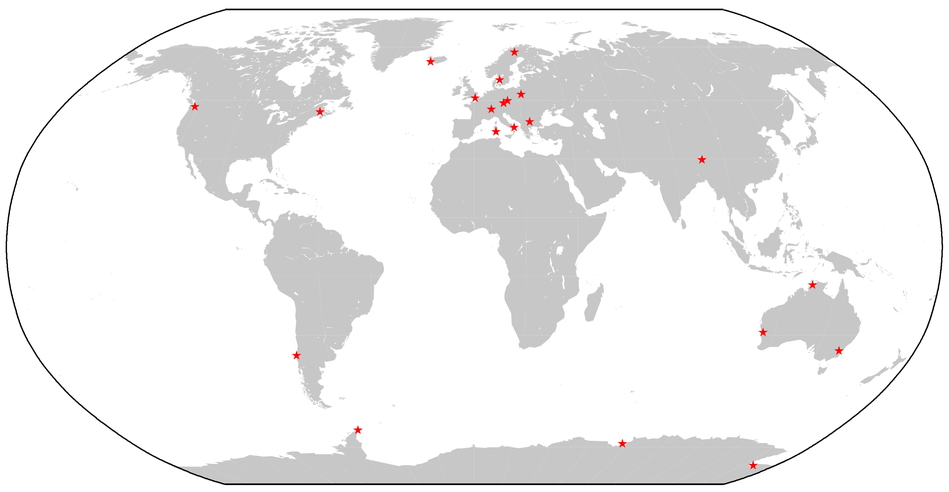
A number of important developments were made at the CODE analysis center of the IGS in the course of the last three years:

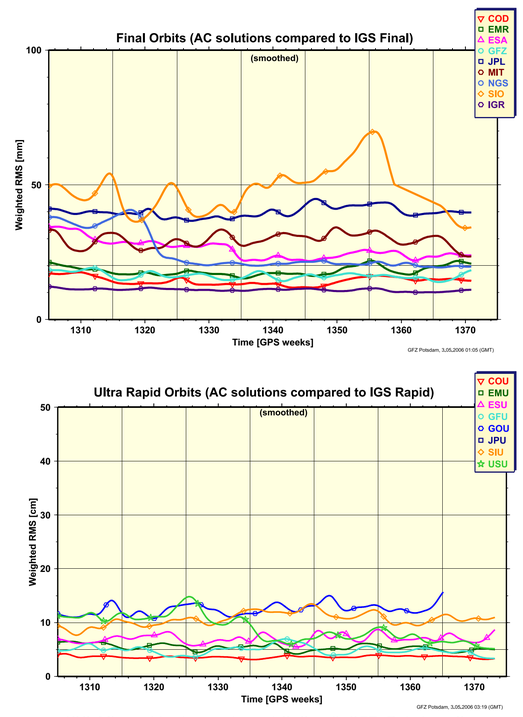
- Since the beginning of May 2003, CODE has been computing a rapid orbit product for both the GPS and the GLONASS satellite constellation. GPS and GLONASS orbits are generated at the same time in a rigorous GNSS analysis. This may be considered as essential step towards the analysis of multi navigation satellite systems, specifically in view of the upcoming European GALILEO system.
- Rapid as well as final ionosphere analysis in GNSS mode starting with April 27, 2003 (GPS week 1216). Retrieval of GLONASS group delay (GD), or P1-P2 DCB values established. Ambiguity-fixed GPS P1-C1 bias values are computed.
- Detailed monitoring concerning completeness and availability of IGS/IGLOS GNSS tracking data, with a main focus on combined GPS/GLONASS data. Corresponding charts are regularly posted to `http://www.aiub.unibe.ch/download/igsdata/`. A significant number of e-mails sent to achieve improvement in terms of both completeness and availability of GNSS data.
- Final analysis extended to GNSS on June 8, 2003 (GPS week 1222) for all products, apart from the clock product. Automatic verification of IGS00 fiducial sites for consistent datum definition.
- Production of ultra-rapid orbits commenced officially on July 30, 2003, now considering IGS/IGLOS NRT tracking data. This product also includes orbits for the GLONASS satellites. It is complete with respect to all transmitting GNSS satellites and has been available without exception since the beginning. Reliable accuracy code information is provided.
- Uninterrupted orbit generation for GPS satellites being repositioned. Corresponding events are identified with a maneuver flag in the SP3c orbit files.
- Orbit initialization procedure implemented for easy inclusion of brand new GNSS satellites, which do not provide broadcast navigation messages.
- External GNSS orbit validation on the basis of SLR data.
- Regular estimation of GNSS satellite antenna phase center patterns for GPS-II, GPS-IIA, GPS-IIR, GLONASS and GLONASS-M satellite types starting with GPS week 1254. Corresponding patterns are not only available for the ionosphere-free linear combination but also for the geometry-free (L1-L2) linear combination.
- Continuous parameterization, particularly for EOP, troposphere ZPD and horizontal gradient parameters, ionosphere parameters, allowing for connection of the parameters at day boundaries.
- Generation of final as well as rapid high-rate (30-sec) clock products.
- Use of new, powerful BPE (Bernese Processing Engine) V5.1 for automated and efficient GNSS data processing.
- Implementation of alerting via e-mail, computer terminal, and SMS messages in case of BPE processing failures, computer, or disk problems, ftp connection problems, general IGS/IGLOS data flow problems, GNSS satellite constellation changes, IGS/IGLOS tracking stations becoming active or inactive (concerning both hourly and daily data flow).
- Use of CODE solar radiation pressure a priori model for all GNSS data processing lines (now including final product).
- Consideration of antenna radome codes. Used PCV model file is consistent with (relative) igs_01.atx corrections. With this model change, CODE is ready to switch to an absolute model (igs05).
- Modeling according to latest IGS/IERS standards, e.g., IGb00 for geodetic datum definition, FES2004 as ocean tide model, IAU2000, etc.

IGS/IGLOS Tracking Network as Considered in CODE's Final GNSS Analysis

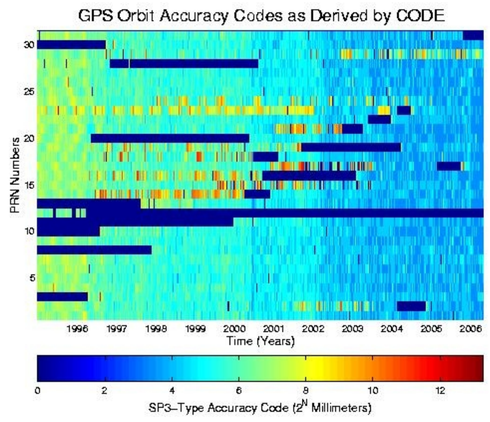


IGLOS Tracking Network as Considered in CODE's NRT GNSS Analysis

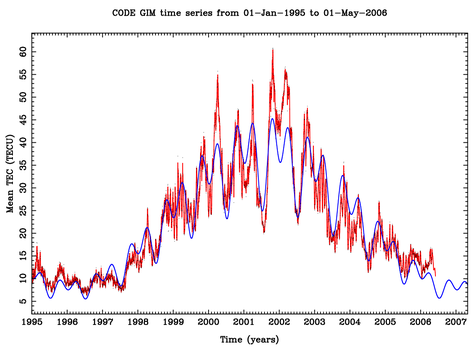




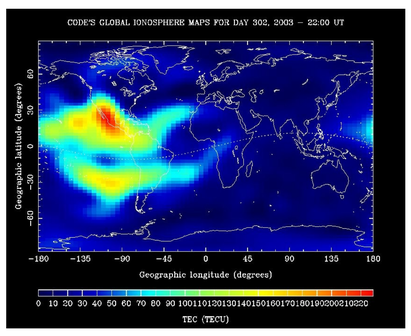
IGS AC graphics by courtesy of G. Gendt, GFZ, Potsdam, Germany



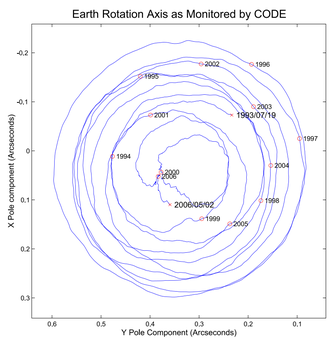
Global Mean TEC Covering One Solar Cycle



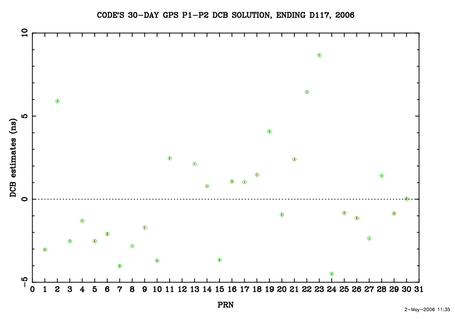
Exceptionally High TEC Levels due to X17.2 Solar Flare

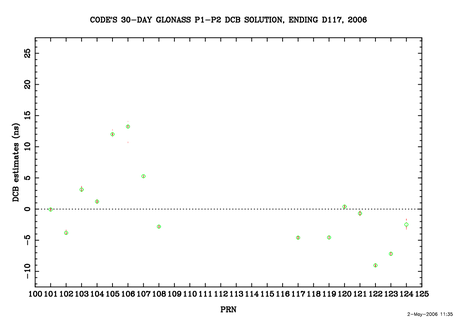


Polar motion as monitored by CODE

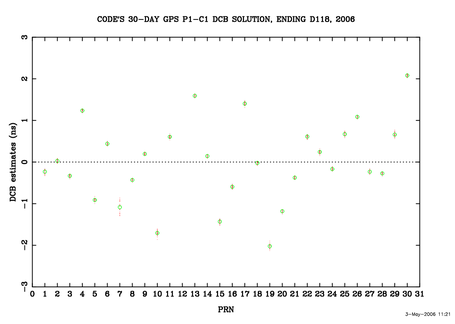


Group Delay (GD) Values Computed for Both GPS and GLONASS





P1-C/A Code Biase Values for GPS



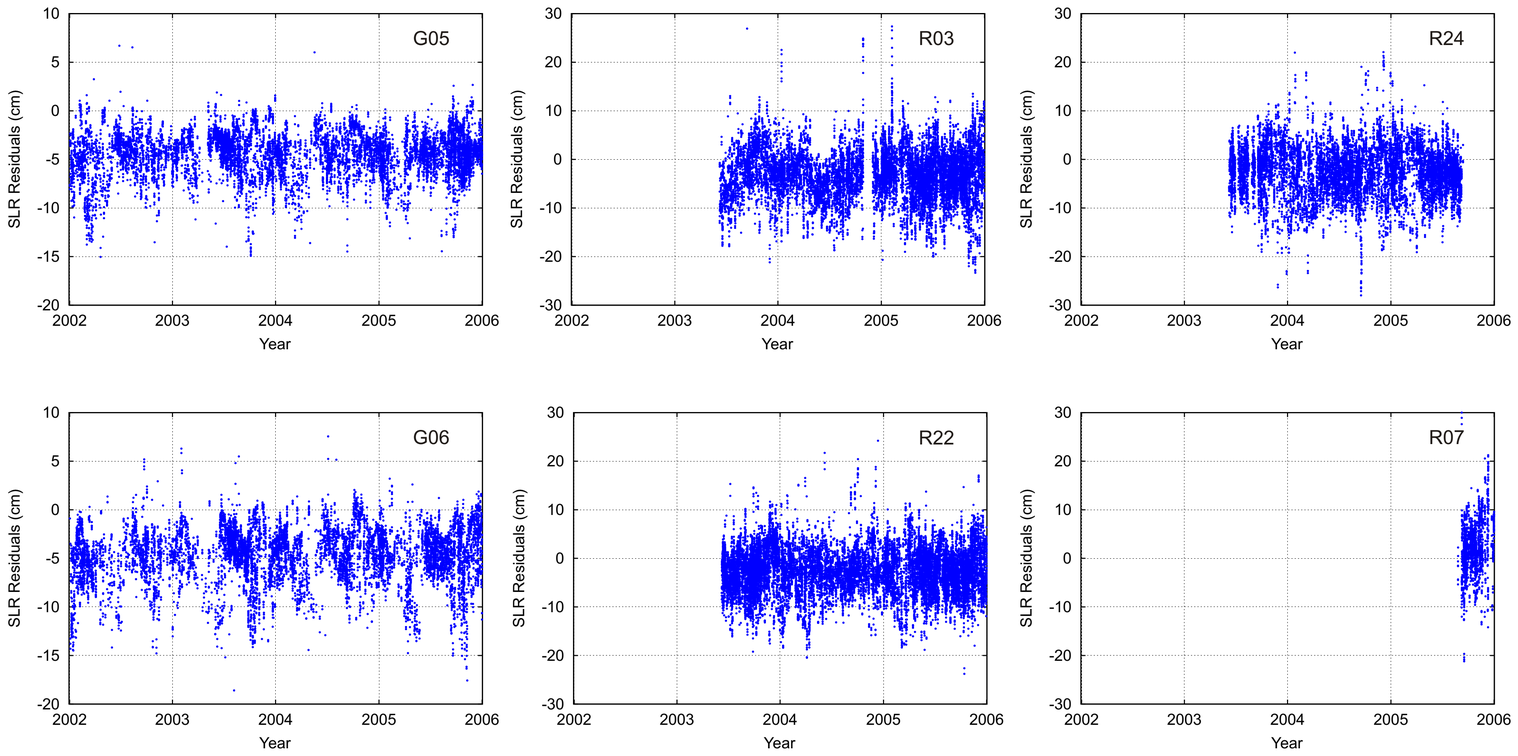
GNSS Orbit Valdation Using SLR Data

SLR observations allow for a completely independent validation of microwave orbits. Resulting range residuals provide useful information about the quality of GPS and GLONASS orbits derived from microwave observations. Due to the high altitude of GNSS satellites the resulting residuals are primarily an indicator for the radial accuracy of the validated orbits.
The table shows the mean and standard deviation for six GNSS satellites. R07 is a new GLONASS-M satellite. It shows a significantly different mean value than the other GLONASS satellites. The commonly known (but still unexplained) bias of about -5 cm for GPS satellites can nicely be observed.
The figures show a time series of range residuals for the six considered satellites. The periodic signal for GPS satellites is correlated with eclipsing seasons and the sun's elevation above the orbital plane. Recent studies indicate that this behavior may be atrributed to orbit model deficiencies (radiation pressure, attitude).

Mean and standard deviation of residuals (computed on the basis of CODE final orbits).

Sat	mean (cm)	std (cm)	# obs
G05	-4.4	2.2	10767
G06	-4.7	2.7	10272
R03	-3.2	4.0	15814
R07	2.4	5.9	1942
R22	-2.6	4.5	19419
R24	-2.5	5.1	12611

Observed - Computed Range Residuals(SLR data from 25 stations compared with CODE final orbit product)



Poster compiled by M. Meindl and S. Schaer, May 2006
Astronomical Institute of the University of Bern
michael.meindl@aiub.unibe.ch

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