GRGS-CLS GNSS Precise Orbit Determination

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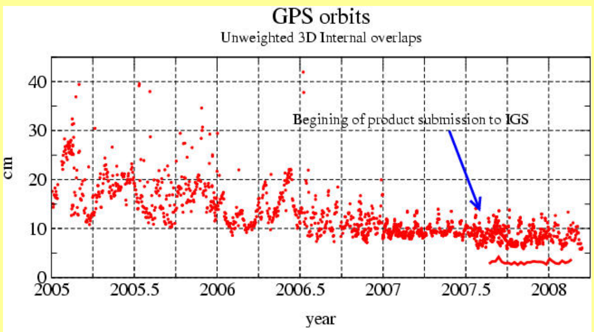
GRGS and CLS teams process regularly GPS data from a worldwide network of IGS permanent stations. We compute precise GPS orbits together with Earth rotation parameters and stations coordinates at the sub-centimeter level. Our solutions have been submitted since January 2004 to the International Earth Rotation Service in the framework of the Combination Research Centre experiment. We present here the method used as well as the evaluation of the derived products in comparison to IGS. Our capability to compute IGS-like products at the same level of precision and delay as any Analysis Centre is demonstrated. Galileo data will be used for the same applications in the future.



Internal 3D unweighted overlaps since 2005 (1 point per day). IGS weekly 3D Weighted RMS are also shown (red line starting in September 2007).

GINS/DYNAMO software

- CNES/GRGS POD software under development for more than 30 years
- Multi technique (SLR,VLBI,DORIS,GPS,..)
- Regular exploitation for :
  - GRACE (Eigen time variable gravity field models)
  - Campains
- See :
  - EGU2008-A-12066; G4-1TU1O-002; **Biancale, R.**; Marty, J-C.; Perosanz, F.; Loyer, S.; Melachroinos, S.
    Surface load models and validation by space geodesy techniques
  - EGU2008-A-06608; G3-1WE5P-0366; Poster Area: Halls X/Y
    Biancale, R; Lemoine, J-M; Bruinsma, S; Gratton, S; Bourgogne, S
    Reiteration of the CNES/GRGS 10-day series of gravity field models from GRACE and LAGEOS data
  - EGU2008-A-06755; G7-1WE5P-0399; Poster Area: Halls X/Y
    Perosanz, F.; Biancale , R.; Melachroinos , S.; Loyer, S.; Marty , J.C.
    Investigation of vertical displacements due to loading effects with the GINS CNES/GRGS

Method

We use GINS software for satellites orbit integration and for the computation of one-day NEQ residuals. Weekly station positions and daily ERP are solved together from the 7-day NEQ systems.

Dynamical and Measurements models

Data Preprocessing: Preprocessing of the GPS data at the undifferenced and single-difference level to determine cycle slip remove outliers and eliminate short passes.
Basic Observables: Undifferenced ionosphere-free linear combination on carrier phase and code (for clocks determination) from IGS network. Elevation angle cut-off : 10 degrees ; Sampling rate: 15 minutes. Weighting: 3.5 mm for undifferenced ionosphere-free phase observations at zenith; elevation-dependent weighting function 1/cos(z)**2
Geometric model: Ground antenna phase center : Absolut Elevation-dependent phase center corrections are applied according to the absolute model IGS05.atx.
Satellite center of mass offsets and phase center calibration taken from IGS05.atx
Troposphere: Met data input: ECMWF (6 hours maps). Estimation: 1 zenith delay/2 hours
Ionosphere: Not modeled (first-order effect eliminated with the ionosphere-free linear combination of L1 and L2).
Site displacement: Stations velocities fixed to ITRF2005 values, weekly coordinates estimated. Tidal displacement: Solid earth tidal displacement: complete model from IERS Conventions 2003. Pole tide : applied (IERS, 2003) nominal mean pole: m1=0.065;m2=0.330 arcsec. Ocean loading: Amplitudes and phases by FES2004. Atmospheric loading: Applied using ECMWF 6h pressure fields.
Relativity corrections: Periodic, -2(R*V/c): applied; Dynamical: applied (IERS, 1996, Ch.11, Eq.1).

Geopotential: EIGEN_GL04S_annuel model up to degree and order 12.
(http://bgi.cnes.fr:8110/geoid-variations/README.html)
Third-body: Sun, Moon and major planets as point masses (Ephemeris: JPL DE405; GMsun=132712440018 km3/sec2 ; GMmoon=4902.7991 km3/sec2)
Solar radiation pressure: Direct solar pressure + albedo
Tidal forces: Solid earth tides: frequency independent (Love's number K2=0.3)
Ocean tides: FES2004 up to degre and order 12.
Relativity: Applied (IERS 1996, Chapter 11, Eqn.1)
Numerical Integration: Cowell order 8 with 10 minutes for integration step ; Arc length: 48 hours (Current Day – 1, 12H at Current Day +1,12H) used to compute one day overlaps.

Estimated Parameters

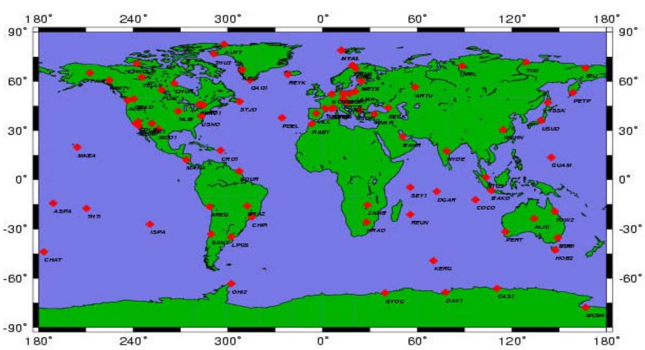
Stations coordinates (1 set/week)
Polar coordinates (1 set/day)
Troposphere (1ZTD/2hours/station)
Clocks (1 per sat./sta. per epoch)
Ambiguity (1 per pass)
Dynamical parameters:
-initial state vector per sat.
-1 set of empirical acceleration per sat.
(1 scale of solar pressure force, 1 Y-bias, & periodic terms in the orthogonal plane).

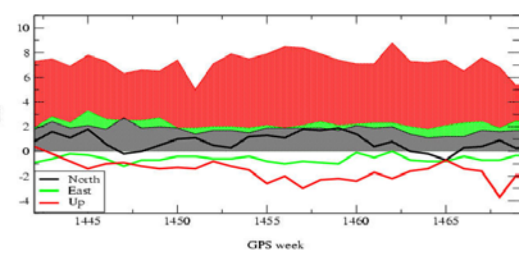
Products Quality

GPS Orbits:
25-40 mm 3D WRMS

Weekly Stations Coordinates
< 3 mm horizontal
< 8 mm vertical

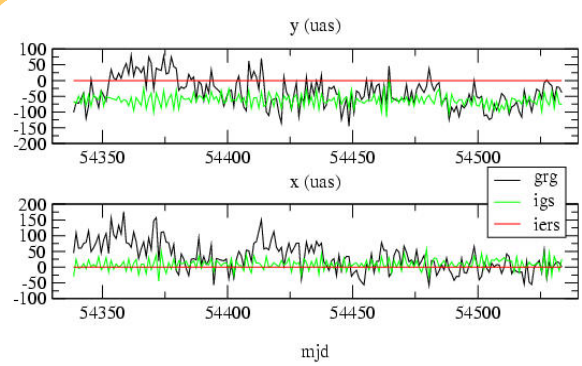
Diurnal Pole Coordinates
10-20 microarcseconds





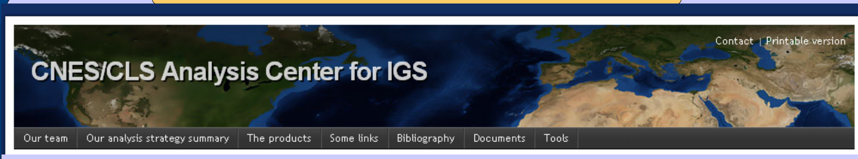
North East Up systematic biases (thin lines) and std. deviation (filled) of the coordinates differences between our weekly network solution and IGS solution.

← The 90 stations of the IGS network used today in our weekly processing (left). We plan to process up to 150 stations in the near future.



ERP estimates compared to IGS and IERS values over the past 200 days. Our solution agrees with IGS and IERS series within a few tens of uas.

Conclusions & Perspectives



Gins software demonstrates his capabilities to process routinely precise GPS produtcs.
We will continue to submit these products to IGS as an Analysis Center.
Future developments include:
- **Processing of more IGS-stations**
- **Routine production of 30s clocks**
- **Computation of Glonass ephemeris**

Acknowledgments : Many thanks to R. Ferland, G. Gendt, T. Nishan and J. Ray for their help and usefull suggestions.