Preliminary Analysis of IGS 2nd Reprocessed Orbits

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Abstract

International GNSS Service (IGS) has contributed to the International Terrestrial Reference Frame by reprocessing historic GPS network data and submitting Terrestrial Reference Frame solutions and Earth Rotation Parameters. For the 2nd reprocessing campaign, Analysis Centers (ACs) used up to 21 years of GPS observation data with daily integrations. IERS2010 conventions are applied to model the physical effects of the Earth. Total nine solutions have participated (7 Global AC solutions, and 2 Tide Gauge solutions) by reprocessing entire time series in a consistent way using the latest models and methodology. IGS combined daily SINEX TRF and EOP combinations have already been submitted to the IERS for ITRF2013. This presentation mainly focuses on the preliminary quality assessment of the reprocessed AC orbits. Quality of the orbit products are examined by examining the repeatability between daily AC satellite ephemeris. Power spectral analysis shows the background noise characteristics of each AC products, and its periodic behaviors.

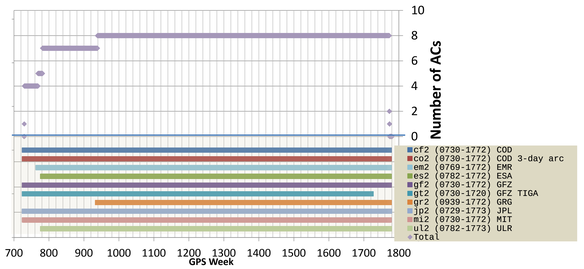
IGS Reprocessing Campaigns

	1st Reprocessing	2nd Reprocessing
Duration	1994 - 2007	1994 - 2014
Reference Frame	IGS05 (aligned to ITRF2005)	IGb08 (aligned to ITRF2008)
IERS Convention	IERS 2003	IERS 2010
Geopotential Field	EGM96	EGM2008 • time-variations of low-degree coefficients • mean pole trajectory model
Antenna calibration	IGS05 ANTEX (absolute calibration)	IGS08 ANTEX (absolute calibration)
Tropospheric delay model	GPT / GMF	GPT2 / VMF1_HT
Higher order Ionosphere	Not applied	IERS 2010 & IGRF11 (2nd order)
Ocean Pole Tide (Station Displ.)	Not applied	IERS 2010
Orbit Dynamics	No Earth Albedo model	Earth Albedo model [1][2][3] Block specific SV thrusting (ERPFBOXW.f)

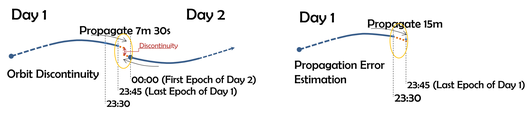
- *Full list of recommendations are described n IGS ACC webpage [4].*

Repro2 Contributions

	AC Contribution	Info
Orbits	Daily sp3c format	15-min sampling rate
Clocks	Daily SV and station clocks	5-min rate 30-sec rate for SV clocks
Earth Rotation Parameters (ERP)	Pole X, Y coord. Pole X, Y rates Excess length-of-day	Official product from SINEX combination
Terrestrial Coordinates	Daily SINEX	With full variance-covariance matrix SV antenna Z-offset



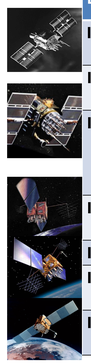
Orbit Discontinuity at Day Boudary



- Orbit files (sp3 format) have 15-minute interval.
- Propagate orbits with BERNE 6+9 orbit model.
- Orbit discontinuity at day boundary
  - Propagating orbit forward from 23:45 with 450 sec interval.
  - Propagate backward from 00:00 of the next day file.
  - Then the positional difference at the mid-point (23:52:30) is calculated.

- Determining model errors
- Propagating the orbit 15 min to the known epoch (23:30 to 23:45) will give us the baseline error estimation for each SV. Since this propagation time is twice as long as the actual discontinuity experiment, it has to be adjusted.
- Followed steps described in Griffiths and Ray (2009) [5] for fair comparison.

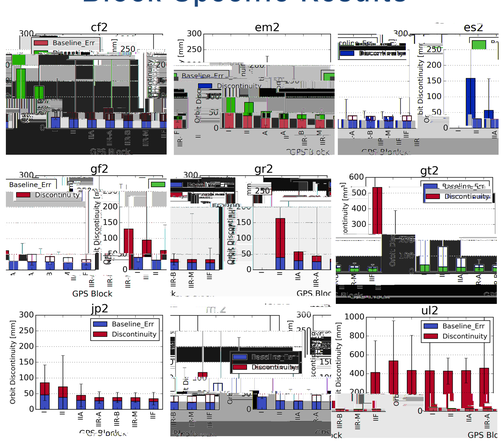
GPS Satellites in Repro2



BLOCK	SV Numbers	Duration in Repro2
I	SV09 SV10 SV11	Beginning - 1996
II	SV13 SV14 SV15 SV16 SV17 SV18 SV19 SV20 SV21	Beginning - 2007
IIA	SV22 **SV23** SV24 SV25 SV26 **SV27** SV28 SV29 SV30 SV31 SV32 SV33 **SV34** SV35 SV36 SV37 **SV38** SV39 **SV40**	Beginning - Present
IIR-A	**SV41** **SV43** **SV44** **SV45** **SV46** **SV51** **SV54** **SV56**	1997 - Present
IIR-B	**SV47** **SV59** **SV60** **SV61**	2004 - Present
IIR-M	**SV48** SV49 **SV50** **SV52** **SV53** **SV55** **SV57** **SV58**	2005 - Present
IIF	**SV62** **SV63** **SV65** **SV66** SV67 SV68 SV64 SV69	2010 - Present

Color index: **Currently operational**
Currently Operational but not in Repro2

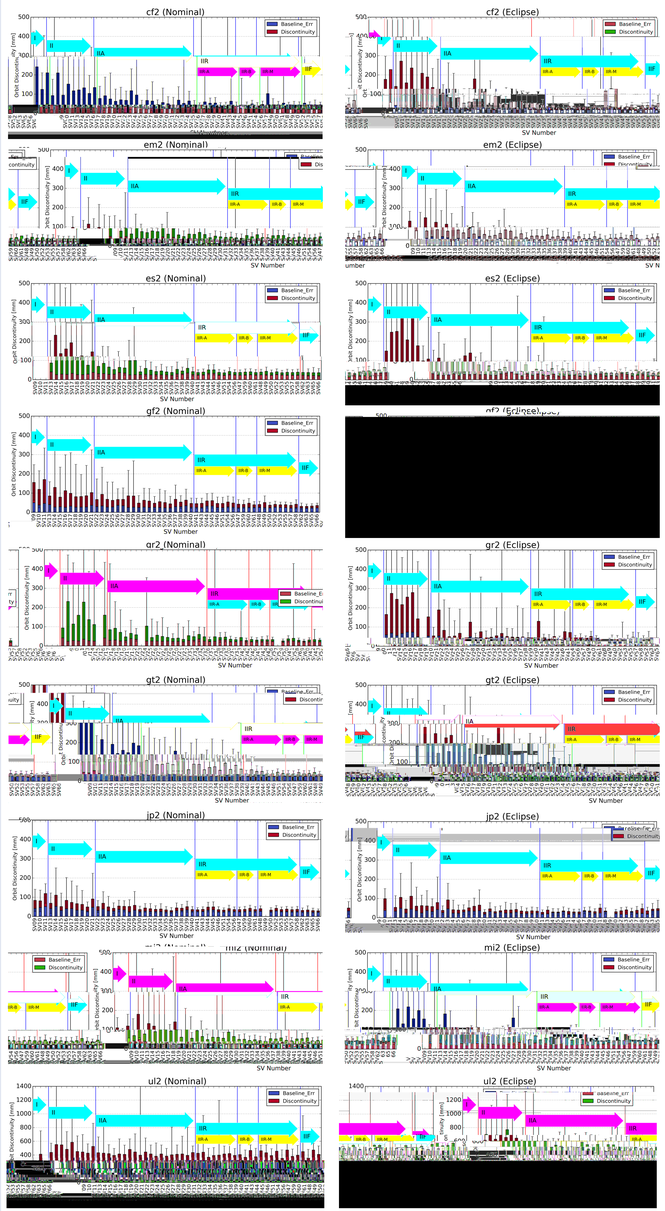
Block Specific Results



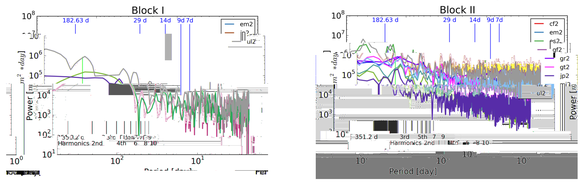
SV Specific Results

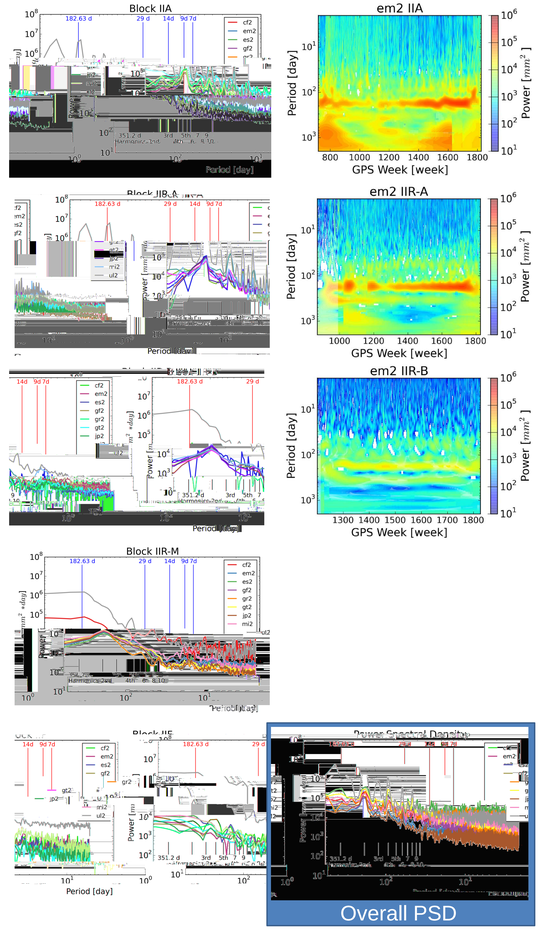
- CODE (cf2), ESA (es2), GRGS (gr2), GFZ TIGA (gt2), and MIT (mi2) solutions show much higher orbit jump during eclipse mostly on Block II and IIA SVs
- JPL (jp2) shows smallest orbit discontinuity (due to 3+24+3 arc length?)
- Y-axis scale of ULR (ul2) plots are much bigger than other plots.
- Some ACs show increased orbit jump for Block IIF SVs during eclipse season.

SV Specific Results (Cont'd)



Power Spectral and Wavelet Analysis





- Power Spectral Density is computed for each SV's orbit discontinuity and stacked for each block type.
- 2nd harmonic of draconitic year signal (Semi-annual) is clearly visible in all of the SV blocks (IIF spans too short to detect).
- Older blocks (Block I to IIR-A) show stronger harmonics.
- Semi-annual signals for block IIA and IIR-A are getting clearly stronger since ~wk1200.
- Overall, JP2 shows very stable and low orbit discontinuity at day boundary. Extra 3 hours of orbit fitting at each day boundary (3 hr before and 3 hr after) must have contributed to the results.
- UL2 shows most significant harmonic signals as well as higher orbit discontinuity at day boundaries.

References

- *[1] C.J.* Rodríguez Solano, (2009) Impact of Albedo Modelling on GPS Orbits, Master Thesis, Technische Universität München
- *[2] U. Hugentobler et al., (2009)* Impact of Albedo Modelling on GNSS Satellite Orbits and Geodetic Time Series, AGU 2009
- [3] *C.* Rodríguez Solano, (2011) Earth Radiation Pressure Model for GNSS Satellites, EGU 2011
- [4] http://acc.igs.org/reprocess2.html
- [5] J. Griffiths and J. Ray (2009) On the Precision and Accuracy of IGS Orbits, J Geod.