

# Status and Plans at the JPL IGS Analysis Center



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S. D. Desai, W. Bertiger, M. Garcia-Fernandez, B. Haines, D. Murphy, C. Selle,  
A. Sibois, A. Sibthorpe, and J. P. Weiss

Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, U.S.A.

## Abstract

We present an overview of the activities being performed by the Jet Propulsion Laboratory (JPL) in support of the International GNSS Service (IGS). We present results from our contribution to the 2014 IGS reprocessing campaign, discuss our plans for our operational contributions to the IGS, and present the status and plans for JPL's GIPSY/OASIS software package. Our contribution to the most recent IGS reprocessing campaign will be the second time that we have generated and released products using the IGS08 reference frame and associated antenna calibrations, and the IERS2010 standards. In this most recent reanalysis, version 2.1, we made the following changes: an updated solar radiation pressure model (GSPM13), IGS recommendations for modeling antenna thrust, the GPT2 troposphere model, a model for the second-order ionosphere effects, elevation-dependent data weighting, a new model for ocean tide loading and geopotential (GOT4.8ac), and a model for the ocean pole load tide.

As usual, our contributions to the IGS include the orbit positions and clock biases of the GPS constellation of satellites, Earth Orientation Parameters, troposphere observations, yaw rates of the GPS satellites, and daily SINEX files with station positions. Our clock products include 5-minute solutions for the full reanalysis period, and new to JPL's contribution to the IGS are 30-second clock solutions for May 5, 2000-present. Our native GIPSY/OASIS format products from this reanalysis also include information that enables GIPSY/OASIS users to perform single-receiver precise point positioning for the entire reprocessing period (August 16, 1992-present). New to our GIPSY/OASIS-formatted product suite are so-called no-net-rotation orbit and clock products. In this new GIPSY/OASIS product, station positions are constrained to have no net rotation with respect to the specified reference frame, while translations and scale are free.

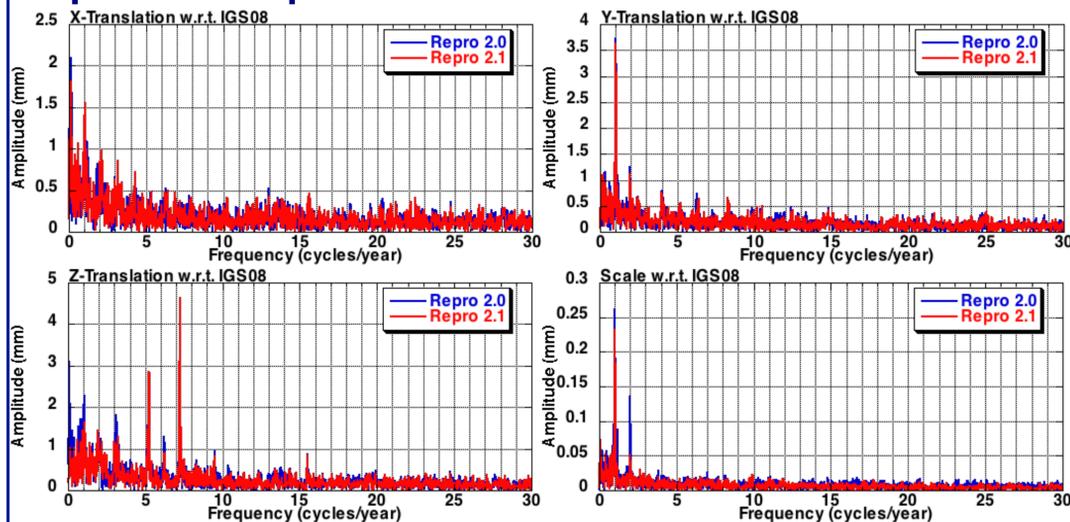
## GIPSY/OASIS Status

- **Current released version is GIPSY 6.3 (March 26, 2014).**
  - Added GPT2 troposphere model.
  - Added ocean load pole tide model.
  - Added GPS transmitter antenna thrust model.
  - Added GSPM13 GPS satellite solar radiation pressure model.
    - Block I and IIF show significant improvements. (See poster by Sibois et al.)
  - Updated GLONASS satellite solar radiation pressure model.
- **Single receiver ambiguity-resolved PPP available with GIPSY 6.3 and "Repro 2.0" and "Repro 2.1" orbit and clock products.**

## JPL Reprocessing Campaigns

- **Repro 1.0** = Contribution to IGS "Repro-1" campaign using IGS05.
- **Repro 2.0** = First reprocessing of IGS08-based products, using GIPSY 6.0.
  - Completed in 2012, used for operations since then, and spans 1992-present.
  - Released to GIPSY users in 2012.
- **Repro 2.1** = Contribution to IGS "Repro-2" campaign, using GIPSY 6.3.
  - Operations will transition to this standard by August 2014.

## Impact of "Repro 2.1" on Reference Frame Realization



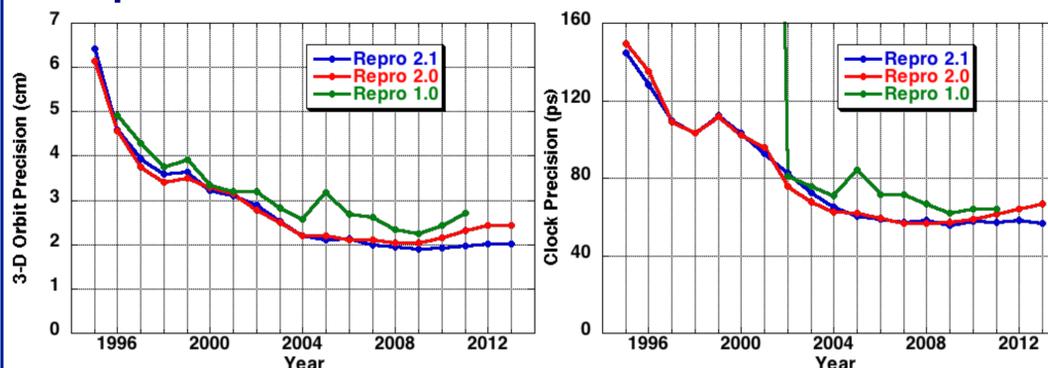
	Bias (Epoch=2005.0, mm and ppb)				Drift (mm/yr and ppb/yr)			
	TX	TY	TZ	Scale	TX	TY	TZ	Scale
Repro 1.0	-1.1	-4.0	-9.1	1.1	-0.4	-0.1	0.2	-0.03
Repro 2.0	0.1	-4.4	-12.8	-0.2	-0.4	0.2	0.3	0.00
Repro 2.1	0.7	-5.9	-8.9	-0.3	-0.3	0.4	0.3	0.00

- Most noticeable impact on Z-Translation and Scale (Draconitic/annual frequencies, stability.)
  - New solar radiation pressure force model (GSPM13 vs. GSPM10, e.g., Sibois et al, poster)
  - Repro 2.1 uses second order ionosphere model (primarily impacts long-period Z-translation, e.g., Garcia-Fernandez et al, poster).
  - Repro 2.1 has larger amplitude at 5<sup>th</sup> and 7<sup>th</sup> draconitic harmonics, compared to Repro 2.0.

## GPS Orbit/Clock "Repro 2.1" Reprocessing Strategy

Software	GIPSY/OASIS 6.3
Orbit Arc	30 hours
Number of Stations	80 (40-80 before 1995-04-17)
Elevation Angle Cutoff	7 degrees
Station Information	IGb08 SINEX and Discontinuity
Receiver/Transmitter Antenna Calibrations	igs08.atx
Troposphere Mapping Function	GPT2
A Priori Dry and Wet Troposphere Model	GPT2
Solid Earth Tide (Geometric and Gravity)	IERS2010
Pole Tide (Geometric and Gravity)	IERS2010 (IERS2010 Mean Pole, including ocean load pole tide)
Ocean Tide Loading Model	GOT4.8ac with harddisp.f
Earth Orientation	IERS 2010 Tidal Model, EOPC04 (ITRF08)
Nutation	IAU2006A
Static Gravity Field	EGM2008 (12x12, C20, C30, C40, C21, S21 per IERS 2010)
Ocean Tide Gravity Field	GOT4.8ac (convolution)
Solar Radiation Pressure	GSPM13 (JPL)
Albedo Model	Knocke (1989)
Antenna Thrust	IGS Recommendation
Transmitter Clocks	5-minute and 30-second Products
Second Order Ionosphere Model	Modeled with ionosphere model IONEX (>= 1999), IRI2012 (<= 1998)
Yaw Rates	Estimated
Data Weighting	sin(elevation)/σ <sup>2</sup>

## Repro 2.1 GPS Satellite Orbit and Clock Precision



- Precision is measured using annual median of daily RMS of differences during middle 5 hours of 6-hour overlapping period of adjacent-day solutions.
- Most noticeable improvements from Repro 2.1 versus 2.0 are after 2008.
  - Operational period, elevation-dependent weighting, updated solar radiation pressure model.

## Transition of JPL Operations to Modernized GIPSY

- Modernized GIPSY is the C++ replacement for both GIPSY and Real-Time GIPSY (RTG).
  - Supports both post-processing and real-time applications.
- Development and testing of software to generate Rapid GPS orbit and clock solutions in progress.
- Development of software to generate Final orbit and clock solutions started.
- Transition JPL orbit and clock product operations to Modernized GIPSY in 2015.
  - Backward compatibility of GIPSY products for user community.

