Impact of Absolute Phase Center Models on GPS Reference Frames

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Overview

• Examine effects of introduction of absolute phase center models

• Concentrate on two areas:
  – Scale variations
  – Estimates of satellite phase center locations using absolute models
    • Compare MIT and COD results (de-constrained SINEX)
  – Center of mass estimates and sensitivity to radiation parameter modeling
Approach

- Two types of MIT analyses:
  - Daily solutions with loose orbit constraints on constant and once-per-revolution radiation parameters in Direct, Y-bias and B-axis directions
  - Weekly solutions where the process noise on the radiation parameters is set by day-to-day scatter. Some parameters are constant of the week.
- Use results from 2005.5 to 2007.2 and the IGS test re-processing interval 2000-2000.3)
- Analysis of Center for Orbit Determination Europe (CODE) post-week 1400 sinex files with satellite antenna offset constraints removed (only center where we have successfully removed constraints but even with CODE there are numerical problems).
- Reference frames realized using ~80 stations from the IGS05 (0611 version) coordinate files
Typical recent MIT network
(156 stations per day)

Four sub-nets are used (different colors, yellow available but not used)
Results

• Scale estimates with satellite antenna offsets fixed to IGS values (relative to IGS05 reference frame)

• Scale results from relative phase center models

• Estimates of Z-coordinate of satellite antenna position from COD and MIT analyses.

• Z-translation estimates.
Scale estimates with satellite antenna offsets fixed

Daily and weekly consistent. Scale rate is 0.025 mm/year (rate could be biased by sampling) NOTE: Scale sign opposite normal.
Results using relative model and IGS05 reference frame
Scale rate here is 1.2 mm/yr height equivalent;
Results from SOPAC loose gamit h-files (available through anonymous ftp)

Scale (Relative) ppb
Linear Fit

Abs

Year

Fit Mean -0.25 ppb -0.182 ppb/year RMS 0.55/0.26 ppb
Absolute model estimates with satellite antenna offsets estimated
Offset: 13 mm; Rate 0.7 mm/yr
Weekly satellite antenna offset free and fixed estimates

Periodic signal nature is different between analyses
Estimate of annual and linear trend

Annual amplitudes: 0.28 ppb; semi-annual in free results amplitude 0.5 ppb
Estimates of satellite antenna Z-position

MIT and COD estimates. Error bars are RMS of values (weeks 1400-1421)
Estimates of adjustments to apriori satellite antenna Z-coordinates

Means: MIT 0.24 m, RMS 0.04 m; COD 0.11 m, RMS 0.05 m
Difference may be partly due to SINEX constraints. De-constained MIT Sinex files similar to COD result.
Estimates of terrestrial frame Z-translation (satellite antenna offsets free)

Mean: Day 4 mm, RMS 44 mm; week -5 mm, RMS 13 mm
Terrestrial Z-translation; Antenna offsets fixed

Mean: Day 10 mm, RMS 31 mm; Week -1.5 mm, RMS 7 mm

In 2000:
Mean -19 mm,
RMS 8 mm
Expanded view showing bias between daily and weekly analyses

Constraints from weekly averaging of radiation parameters causes systematic shift in frame center location. This does not happen with scale estimates.
Conclusions

• Applications of absolute phase center models have improved the consistency in IGS products for scale and Z-translation with ITRF 2005.

• Some dependence of treatment of radiation parameters on estimates especially seasonal signal in Z-translation.

• Both MIT and COD analyses still show systematic shift in mean satellite antenna locations when estimate allowed (only 21-weeks of comparison). However, there are issues here with deconstraining COD sinex files.

• There are also offsets in position time series to radome additions to phase center tables. Most of relative to absolute model change in from of scale.