What to do About Flex Power

Yoaz Bar-Sever, Bela Szilagyi, Larry Romans, Mark Miller

Jet Propulsion Laboratory, California Institute of Technology

The Challenge

Two types of Flex Power events have been characterized by the GDGPS System: CA and PY

- Real-time monitoring using a large ground tracking network of semi-codeless receivers

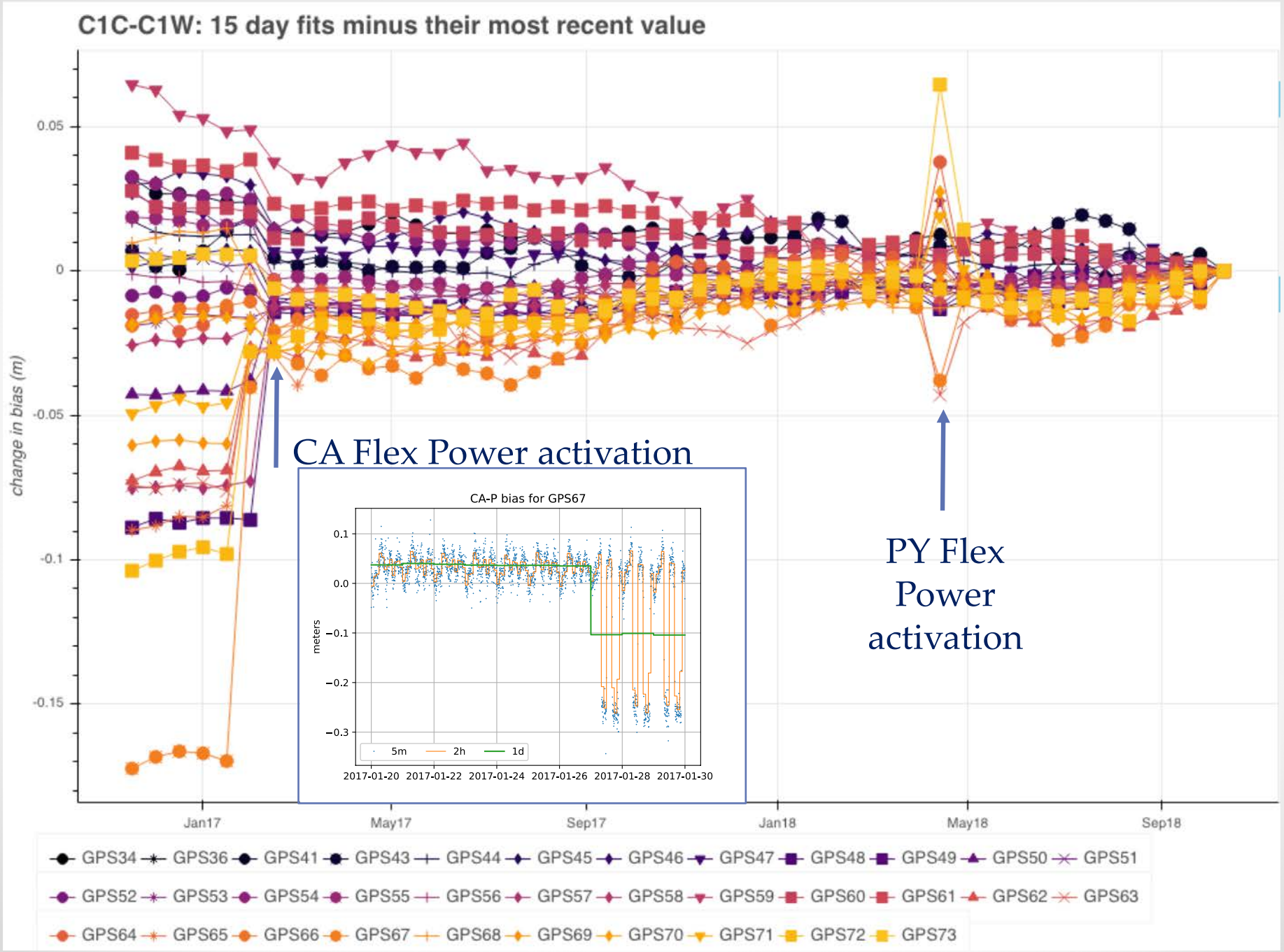
Flex Power is significantly and rapidly altering transmitter instrumental delays, resulting in:

- Change in inter-signal instrumental delay (differential code biases - DCB)
- Change in the primary pair pseudorange, and the primary clock solution

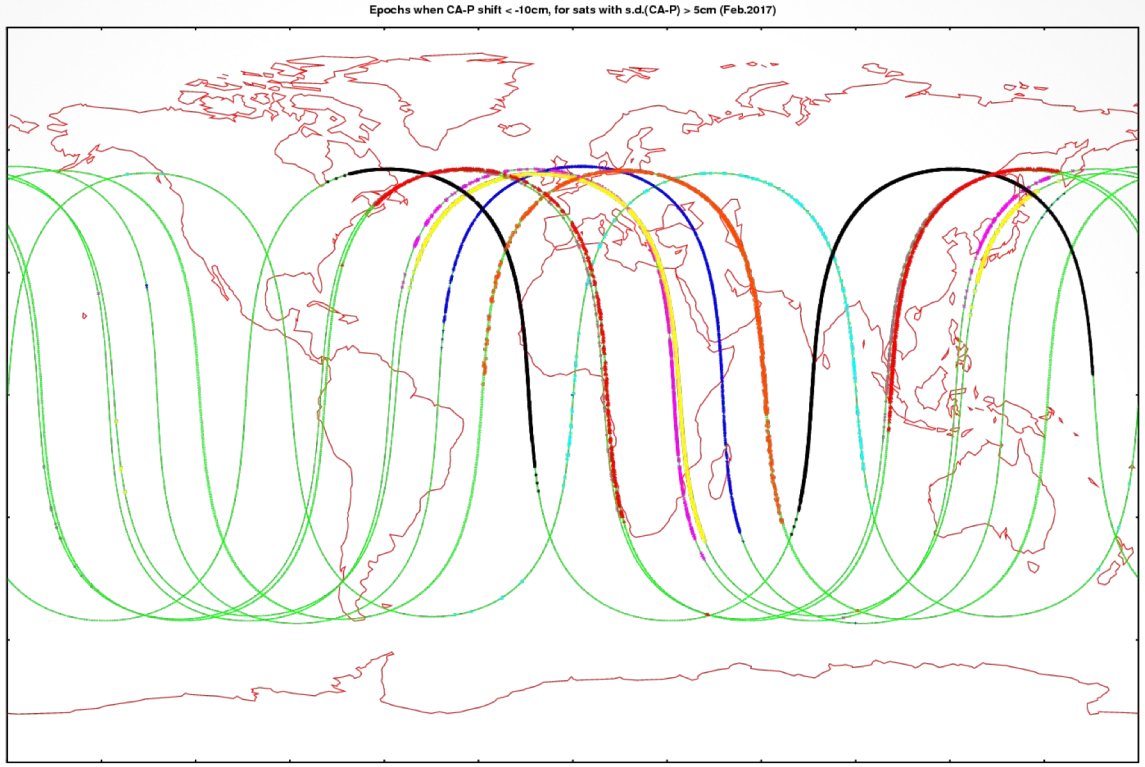
Impact on precision users:

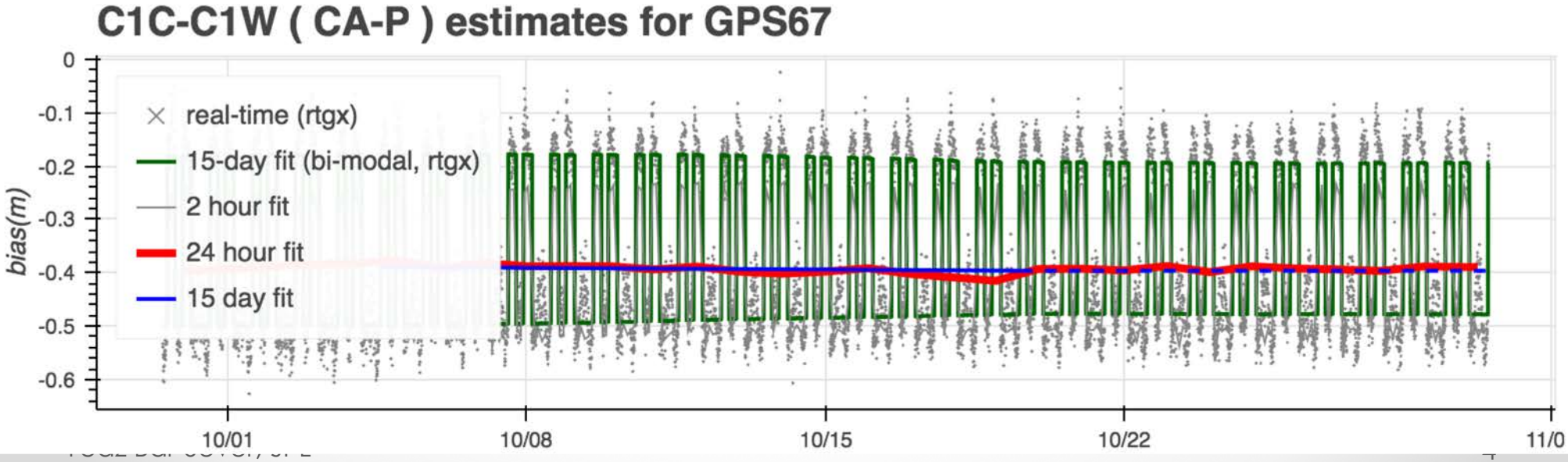
- Application requiring DCBs can no longer assume constant biases
  - Certain ambiguity resolution techniques
  - Network-based POD, mixing CA and PY observables
- *'Primary clock'* estimates are not well defined in the presence of rapid pseudorange fluctuations
  - Harder to compare clock solutions from different filters
  - Users are not likely to consistently apply the clock corrections to the pseuodrange and phase measurements

CA-P1 Bias Estimates and the Onset of Flex Powe



The Global Bimodal Pattern of CA Flex Power

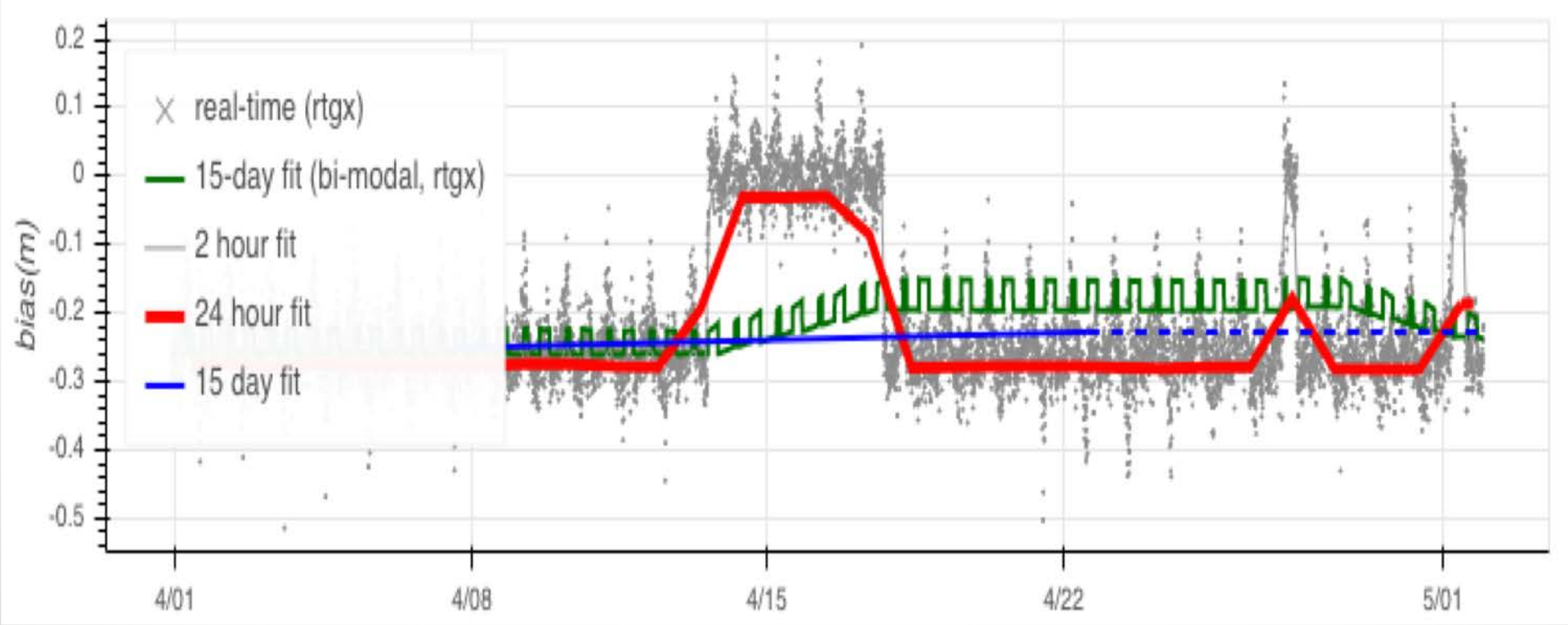




The PY Flex Power Event of April 2018

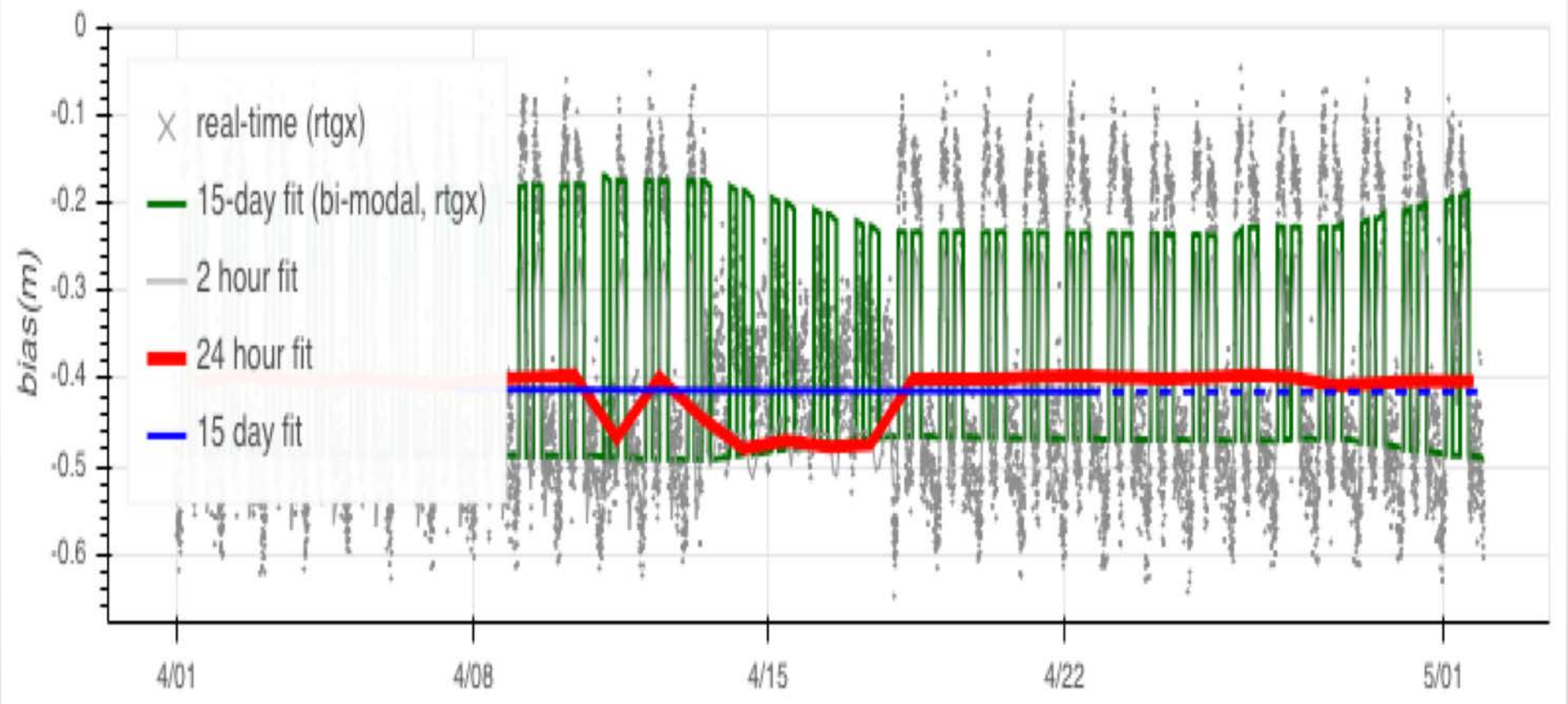
CA-P1 for SVN 73 during April 2018. This satellite experienced little or no CA Flex Power Mode (FPM) prior on April 13, as indicated by the low variability of the bi-modal (green) curve. The onset of PY FPM on April 13 is manifested by a large jump (~0.3 m) in CA1-P1 instrumental delay, persisting through April 17. Two additional sub-daily PY FPM events are evident on April 27, and on May 1.

(The bi-modal curve is designed to fit the twice-daily CA FPM)



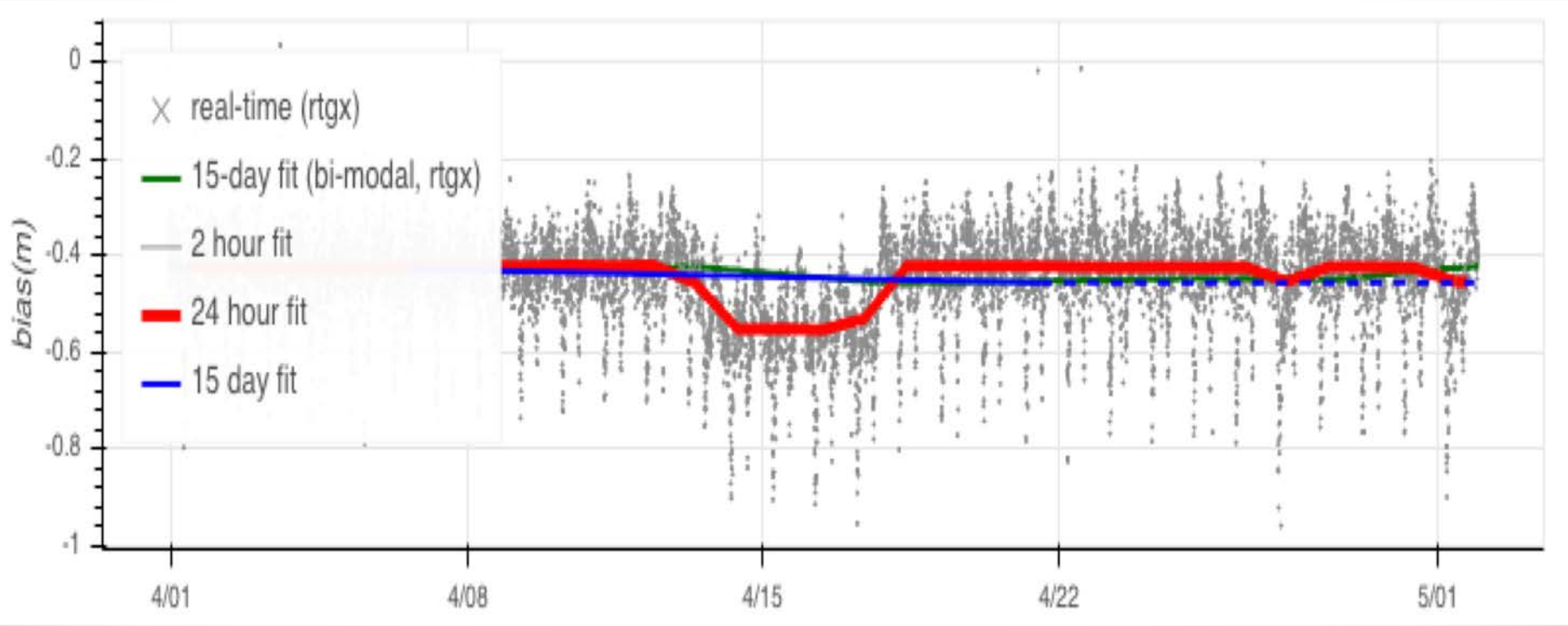
The PY Flex Power Event of April 2018

The manifestation of both CA FPM and PY FPM in the CA1-P1 DCB for SVN 67 during April 2018. The large twice-daily fluctuations (green curve) have been a staple of CA FPM. They appear to diminish during the PY FPM of April 13-17.



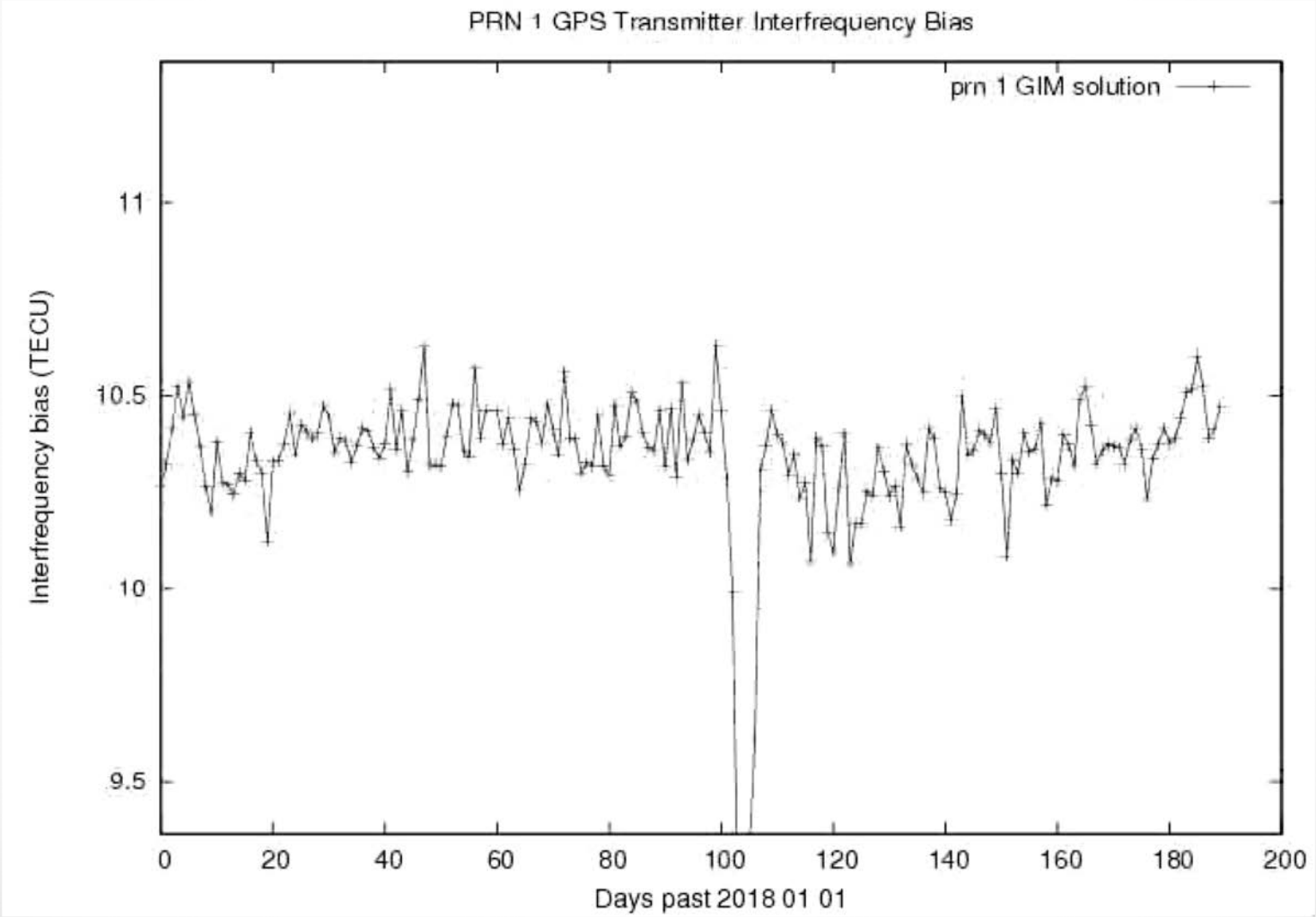
The PY Flex Power Event of April 2018

L2CA – P2 DCB for SVN 73 during April 2018. ~0.15 meter ramp is evident during April 13-17.

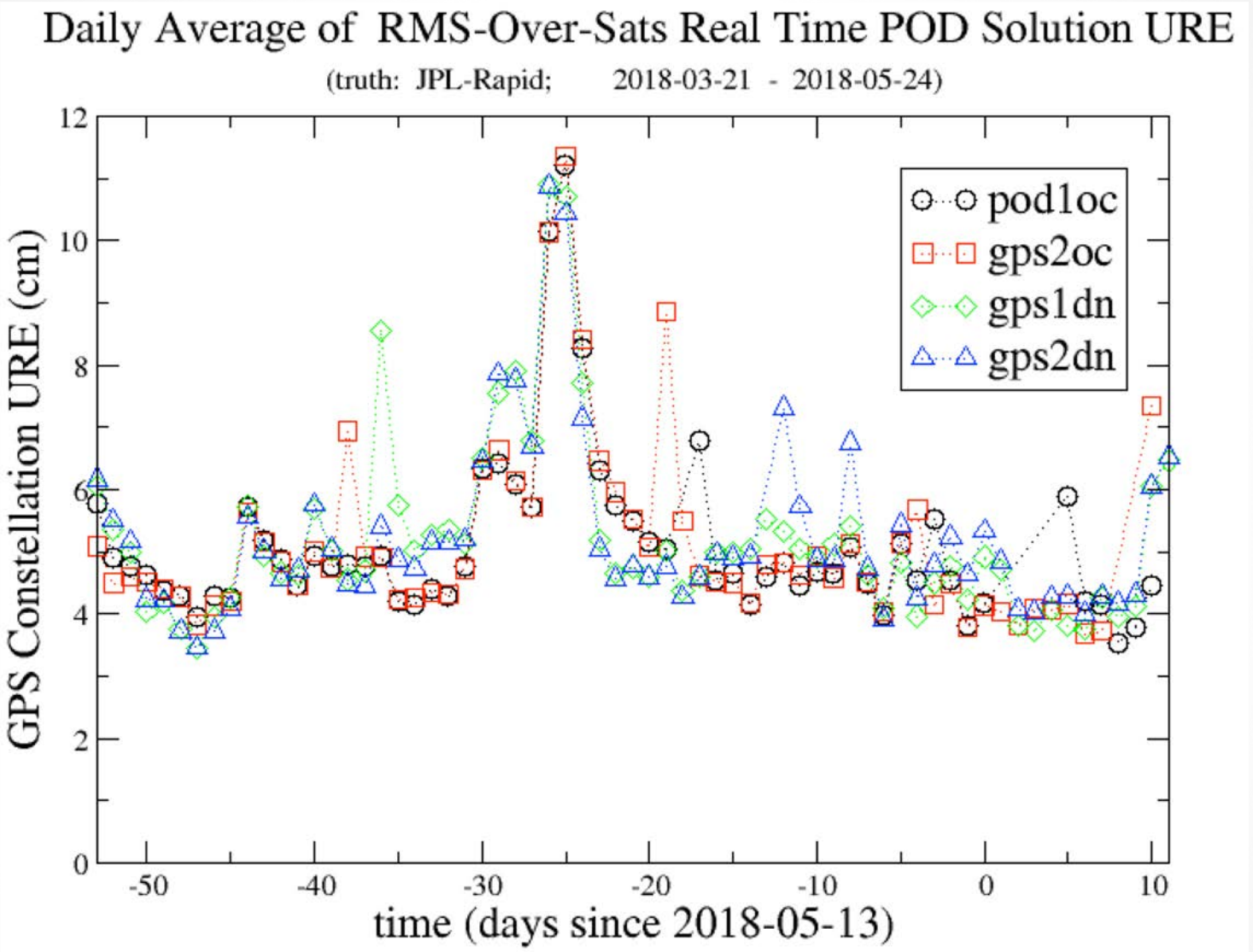


The PY Flex Power Event of April 2018

T_{GD} inter-signal delay for SVN 63 during Jan-Jun 2018. ~0.16 meter ramp is evident during April 13-17.



PY Flex Power Alters the Clock Solutions



URE spike is evident during April 13-17. All solutions mis-modeled the flex power event (did not detect phase break; did not bias the primary pair of pseudorange)

Recommendations

For GPS DCB monitoring:

- High rate estimation (hourly or faster)
- Jump detection and bi-modal smoothing

For network-based POD with mixed CA and P1 pseudoranges:

- Accommodate high-rate CA-P1 DCB ingestion/estimation to account for CA FPM
- Impact of mismodeling may be mitigated through deweighting of pseusoranges

For network-based post-processed POD in the presence of PY FPM

- Large pseudorange jumps may be detected in data editing
- Break phase on all links to satellites displaying PY FPM at the transition epochs to enable the (primary pair) clock solutions to jump with the PY DCBs
- Comparisons of solutions between ACs may show inconsistencies

For PPP or other user applications of network-based orbit and clock states in the presence of PY FPM

- Break phase to satellites displaying PY FPM at the transition epochs
- It will be hard for a user to detect PY FPM events from the data alone; provider of orbits and clocks may need to flag the epoch