Spectral analysis of GPS-based station positioning time series from PPP solutions

Christina Selle, Shailen Desai, Miquel Garcia Fernandez, Aurore Sibois
Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA
Contact: christina.selle@jpl.nasa.gov

2014 IGS Workshop
Pasadena, CA, USA

Abstract

We used spectral analysis to investigate periodic signals in GPS station position time series obtained using single receiver precise point positioning (PPP). In particular, we examined a feature of excess power with a 5.5 day period (66 cycles per year) in the JPL GPS PPP time series [1] that was previously noticed by Amiri-Simkooei [2] and Ray et al. [3]. We found the strength of this signal to be station-dependent, with many stations not exhibiting it at all. We studied the geographic distribution of stations with a strong 5.5 day signature and found it to be somewhat uneven. Southern California had a particularly high concentration of stations with a strong 5.5 day feature, while the feature was not found for stations in East Asia, Oceania and Australia.

We also reprocessed point positioning time series for six stations with a very strong 5.5 day feature using the same JPL orbit and clock products and GIPSY-OASIS software, but with a processing strategy that differs from that used to generate the JPL GPS PPP time series [1]. The resulting spectra from our reanalysis show a significant reduction in the strength of the 5.5 day feature.

Our results demonstrate that the power of the signal at 5.5 days is both station-dependent and may be related to the PPP processing approach used to generate the station position time series, rather than the JPL orbit and clock products or GIPSY-OASIS software.

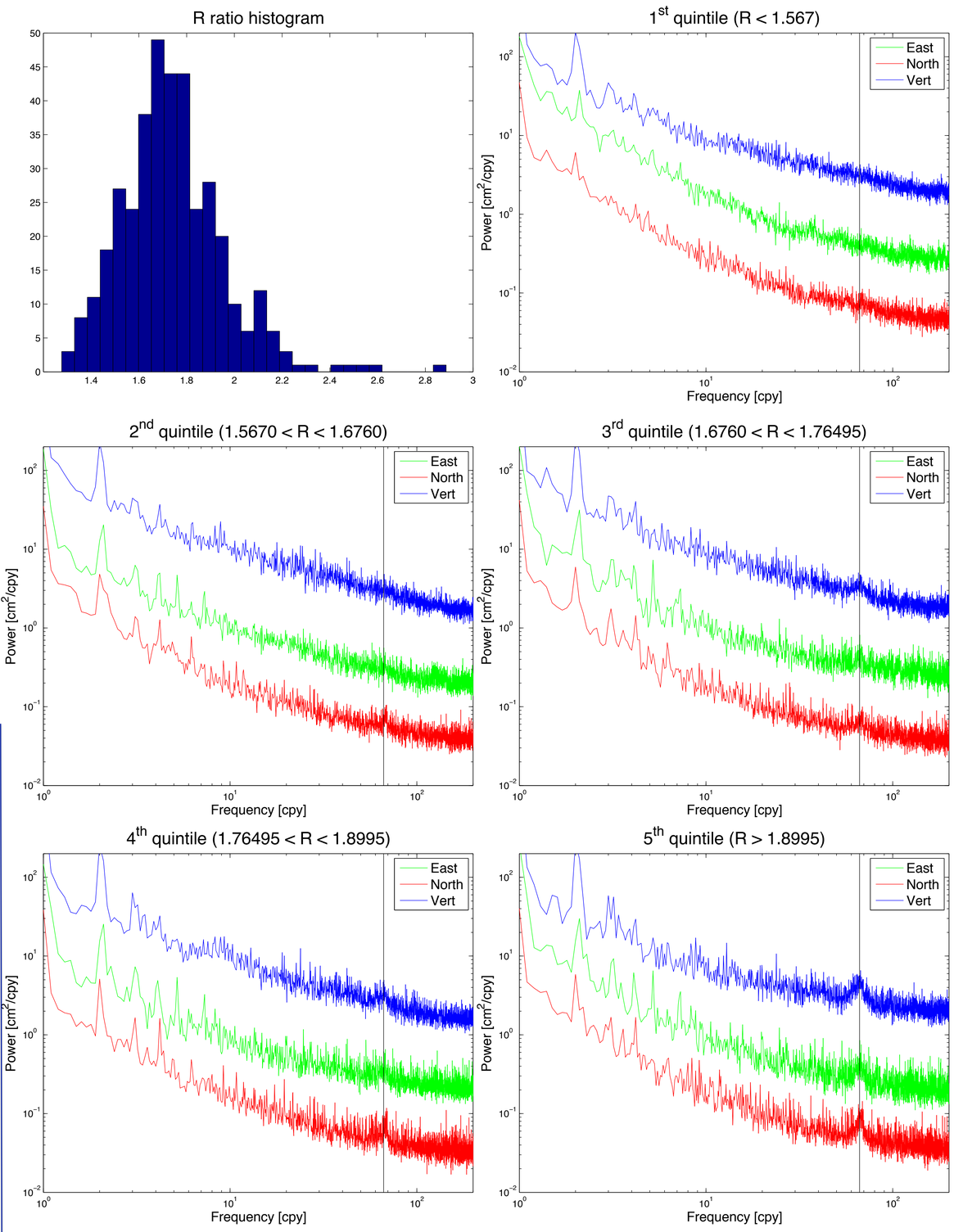
Spectral analysis

- Used PPP time series available at [1]
- Included stations for which data are available on 80% of days in 1998-2011
- 382 stations included (16 outlier stations were excluded based on spectra)
- Computed Lomb-Scargle periodogram for each station after removing linear fit
- Computed ratio indicating the magnitude of the feature for each station:

$$R = \sum_{E,N,V} \left(\frac{\sum_{60 \le \omega \le 70} P(\omega)}{\sum_{50 \le \omega < 60} P(\omega) + \sum_{70 < \omega \le 80} P(\omega)} \right)$$

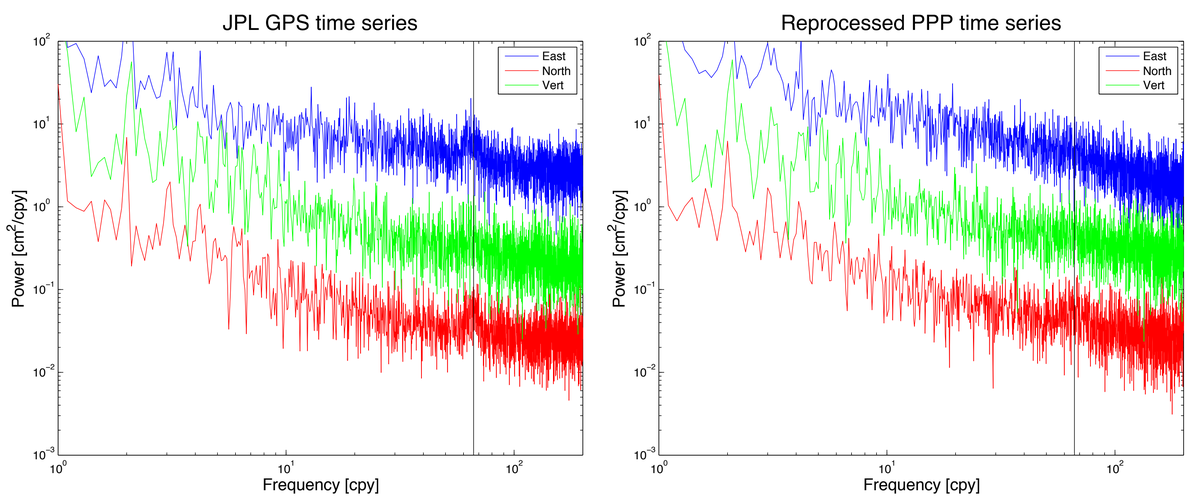
P: periodogram power at given frequency
ω: frequency in cycles/year
E,N,V: East, North, Vertical components

- No apparent correlation of R with time frame used or receiver type
- Divided stations into five groups based on distribution of R
- For each group, stacked and averaged individual station periodograms
- The East and vertical components were multiplied by 5 to prevent visual overlaps.
- The power of the 5.5 day feature varies from zero in the 20% of stations with lowest R ratio to very strong in the 20% of stations with highest R ratio



Reprocessed time series

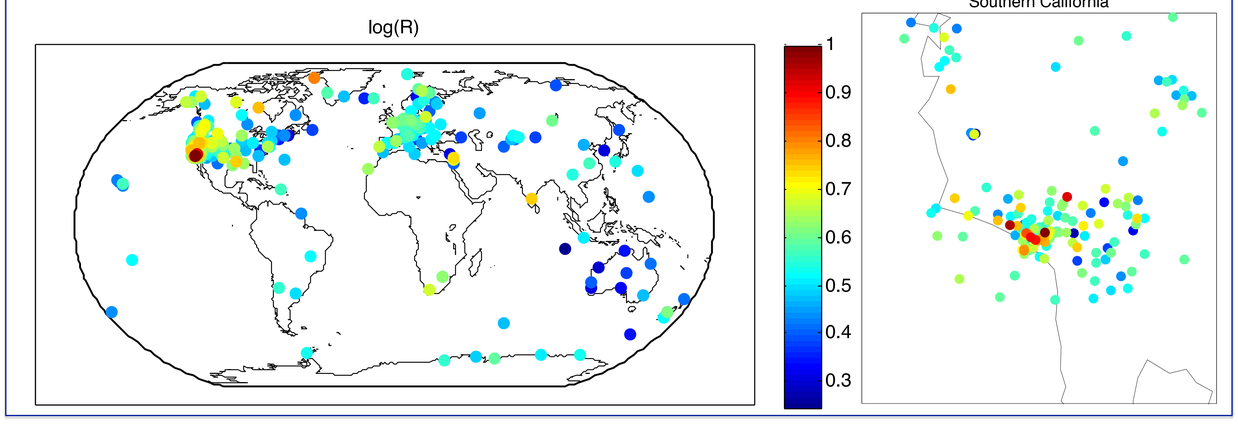
- Compared two time series:
  - JPL GPS PPP time series [1]
  - Reprocessed time series using the same orbits, clock products, and GIPSY software, but different settings
- Stacked periodograms for six sites with a large 5.5 day signal, time frame 1998-2011
  - CHUR, ROCK, THU2, TORP, USC1, WHC1
- Stacked values were normalized, and the East and North components were multiplied by 10 to separate them in the figure



- **Further research is necessary to investigate the source of the 5.5 day feature in the JPL GPS time series and to determine which modification in the PPP settings led to the decrease in prominence of the feature in the reprocessed time series.**
- **Results suggest that the 5.5 day signal does not originate with JPL orbit and clock products or GIPSY-OASIS software.**

Geographic distribution

- High R ratio (red) indicates strong 5.5 day feature
- 5.5 day feature especially visible for some sites in the Los Angeles area
- Feature is weak or not present in IGS08 frame sites and sites along the Western Pacific Rim



References

1. JPL repro2011b time series accessed from ftp://sideshow.jpl.nasa.gov/pub/JPL_GPS_Timeseries/repro2011b/post/
2. Amiri-Simkooei, A. R. (2013), On the nature of GPS draconitic year periodic pattern in multivariate position time series, J. Geophys. Res. Solid Earth, 118, 2500–2511
3. Ray, J., J. Griffiths, X. Collilieux, and P. Rebischung (2013), Subseasonal GNSS positioning errors, Geophys. Res. Lett., 40, 5854–5860