TANYA: New developments at Newcastle and the combination of the IGS Reprocessing campaign

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1. Introduction

The International GNSS Service (IGS) reprocessing campaign uses the latest operational models and techniques to reprocess the entire GPS data back catalogue. This has lead to the production of a homogeneous time series of station coordinates and Earth rotation parameters (ERPs). Reprocessing using the latest models will help to remove spurious transient signals in the operational processing allowing for the accurate detection of true seasonal and long term signals caused by deformation. Weekly station coordinates and daily ERP solutions from 11 analysis centers (ACs) have been aligned to the IGS05 and combined using the TANYA software.

From TANYA's initial construction [Davies, 1997] work has continually been carried out to ensure that the software meets the present day requirements of the geodetic community. The most recent developments by the authors are:

- Fully loosened solution, with applied minimum rotation constraints for inversion [Davies and Blewitt, 2000].
- Ability to process SINEX normal equation format.
- Fully integrated station and ERP combination modules.

2. Processing Strategy

For the results presented the full 11 analysis center solutions were utilized from GPS week (1000-1459). TANYA processes both station coordinates and ERPs in a rigorous least squares solution. An AC solution is rejected if there are more than 20 station solutions or 4 ERP parameters rejected after the initial round of processing. Good agreement between results from the TANYA solution nc1 and the solution from ig1 [Ferland and Piraszewski, 2009] are obtained. The solution can be aligned to a preset reference frame, in this case IGS05 [Altamimi *et al.*, 2007]. A 7 parameter Helmert transformation is computed between AC solutions, nc1 and IGS05. Spectral analysis of the parameters provides insights into any periodic signals present, as seen below.

3. Results

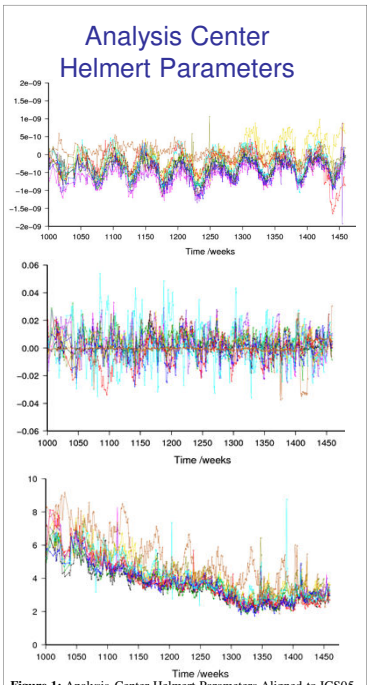


Figure 1: Analysis Center Helmert Parameters Aligned to IGS05. Top – Scale, Middle – Translation in Z, Bottom – Weighted Root Mean Square error.

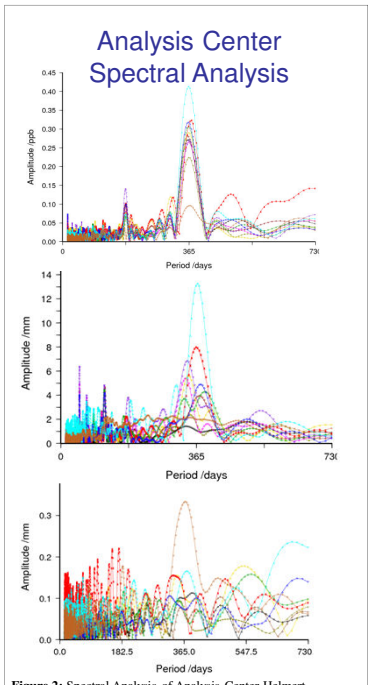


Figure 2: Spectral Analysis of Analysis Center Helmert Parameters. Top – Scale, Middle – Translation in Z, Bottom – Weighted Root Mean Square error.

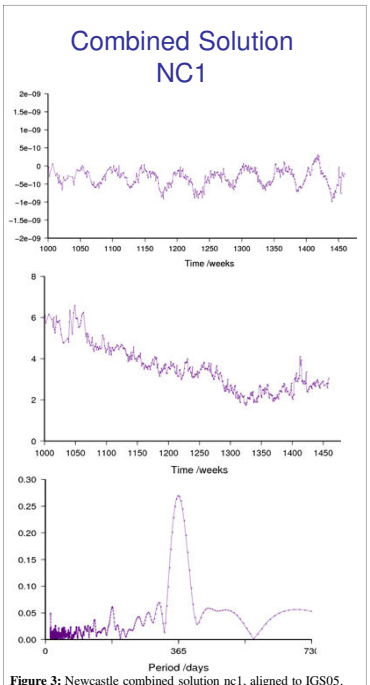
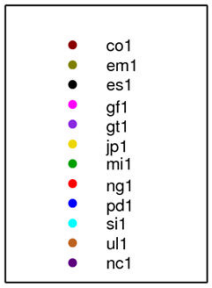


Figure 3: Newcastle combined solution nc1, aligned to IGS05. Top – Scale, Middle – Weighted Root Mean Square error, Bottom – Spectral Analysis of Scale Parameter.



Inspection of the Helmert parameters over a significant period of time enables the stability of the reference frame to be determined. Figure 1 shows the time series without major offsets or discontinuities which were present in the operational time series. Figure 1 (bottom) shows the gradual decrease in weighted RMS as the sizes of the network and GPS constellation increase.

Spectral analysis of the 7 estimate Helmert parameters to IGS05 and weighted residual of the 11 input solutions and the combined solutions will provide an insight into periodic signals present in the solution. Figure 2 shows a clear annual signal in the scale parameter (top) which can also be seen in the Z translation (middle).

Figure 3 shows the combination of all 11 solutions, nc1. The signals present in the AC Helmert parameters and spectral analysis are echoed in the nc1 combination.

4. Conclusions and Future Work

- Testing of recent changes to TANYA shows good agreement to both the published station coordinates and Earth rotation parameters from the IGS release ig1.
- Spectral analysis of the various parameters extracted from the time series shows that there is a clear annual and a smaller semi-annual signal which are expected regular signals; however there may still be artifacts at these periods.

- For secular deformation it is possible to distinguish between surface mass loading caused by tectonics and Glacial Isostatic Adjustment (GIA).
- Current models of GIA will be tested and the best model or combination of models will be used to remove signals present in station velocities.
- We will develop of a new plate model to remove signals from station time series.
- Removal of these signals should allow for the detection of any secular signals remaining due to long-term surface mass loading of the solid Earth.

References

Davies, P. (1997). *Assembling the IGS Polyhedron; A densified weekly GPS terrestrial reference frame*. Ph.D. thesis, University of Newcastle upon Tyne.

Davies, P. and G. Blewitt (2000). Methodology for global geodetic time series estimation: A new tool for geodynamics. *J. Geophys. Res.*, **105**(B5), 11083-11100.

Ferland, R. and M. Piraszewski (2009). The IGS-combined station coordinates, Earth rotation parameters and apparent geocenter. *J. Geodesy*, **83**, 385-392, DOI 10.1007/s00190-008-0295-9.

Altamimi, Z., X. Collilieux, J. Legrand, B. Garayt, and C. Boucher (2007). ITRF2005: A new release of the International Terrestrial Reference Frame based on time series of station positions and Earth Orientation Parameters. *J. Geophys. Res.*, **112**, B09401, doi:10.1029/2007JB004949.

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