IUGG BERLIN 2023

THE 28TH GENERAL ASSEMBLY OF THE INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS

IUGG23-1671

Determination of Earth orientation parameters from VLBI and comparison with other space geodetic techniques

A. Laha[1]*, J. Böhm[2], S. Böhm[2], H. Krásná[2], B. Nagarajan[1], O. Dikshit[1]

[1] Geoinformatics, Dept. of Civil Engineering, IIT Kanpur, India

[2] Department of Geodesy and Geoinformation, TU Wien, Austria

Introduction

Earth's rotation is non uniform and given in terms of *Earth Orientation Parameters* (EOP). The precession-nutation model adopted by IAU integrates the effect of geophysical phenomena. However, the wobble of axis motion can be measured by VLBI and termed as *celestial pole offsets* (CPO). The reason can be due to *free core nutation* (FCN). FCN is a retrograde motion due to misalignment of rotation axes of the mantle and the core. The IAU model needs to be complemented with the FCN model, otherwise residuals of Celestial Intermediate Pole (CIP) would be large (~400μas)[1]. This poster answers two questions in regard to effect of FCN model on EOP.

- Is there any effect of FCN model on EOP?
- How it effects the EOP obtained from legacy (S/X) and VGOS instruments?

Data

The VLBI nutation time series contains the FCN components, along with other astronomical components. The contribution of the FCN to the CPO can be computed by;

$$X_{FCN} = A_C \cos(\sigma_{FCN}\, t) - A_S \sin(\sigma_{FCN}\, t) \qquad X = X_{FCN} + X_0$$

$$Y_{FCN} = A_S \cos(\sigma_{FCN}\, t) - A_C \sin(\sigma_{FCN}\, t) \qquad Y = Y_{FCN} + Y_0$$

To test the impact, modified empirical FCN model [X and Y] (Fig 1) is used in CPO with a sliding window of 400 days[1].

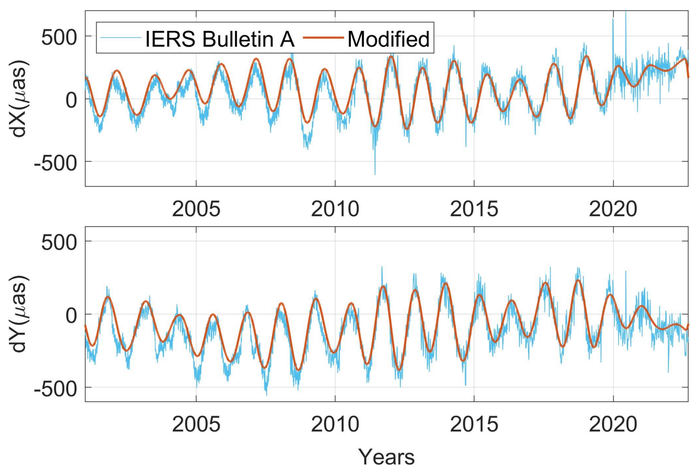


Fig 1. Comparison of CPO between IERS Bulletin A and modified FCN model.

Methodology

We have estimated Earth Rotation Parameters (ERP) from 24 hr and Intensive sessions between 2001 – 2022 in VieVS using apriori EOP values obtained from IERS Bulletin A and replacing the CPO obtained from the modified FCN model. We compared the ERP obtained from both the solutions against IERS Bulletin A. The model is also implemented on the SX and VGOS sessions between 2017 – 2022 (Fig 2).

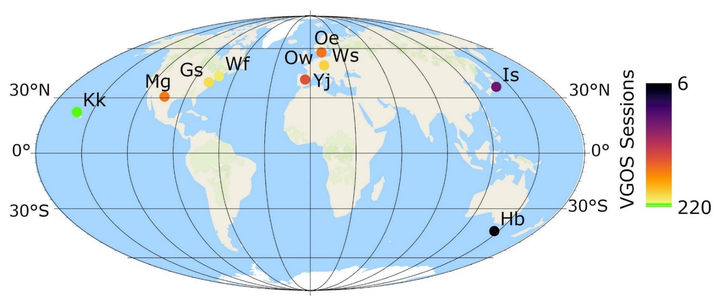
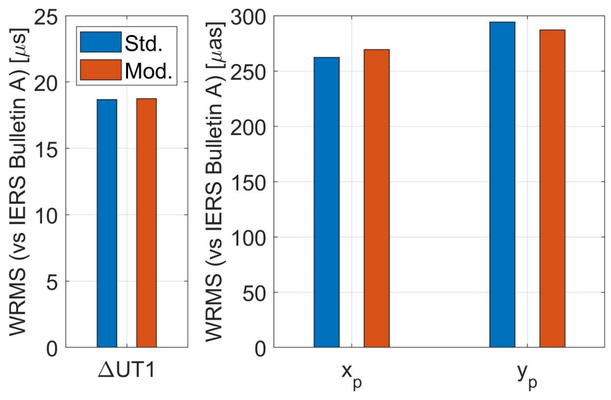


Fig 2. Distribution of VGOS network (2017 - 2022). SX sessions contain network with more than 15 stations, situated all over the Earth.

Results and Discussion

A. Effect of FCN model on ERP (24hr sessions)



While comparing ΔUT1, it is observed that WRMS of modified FCN model is negligibly higher (~0.5μs) than standard solution. However, PM has slight variation, but opposite in nature. x_p shows high WRMS value (~10μas) for the modified FCN model, whereas y_p shows high value for the standard solution. The magnitude of the difference for x_p and y_p remains same.

Fig 3. Comparison of WRMS value w.r.t IERS Bulletin A.

B. Effect of FCN model on UT1-UTC (Intensive sessions)

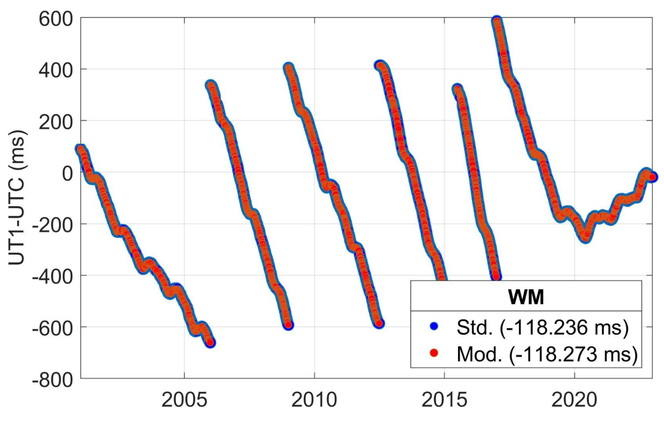


Fig 4. ΔUT1 estimated from standard solution (blue) and modified FCN model (red).

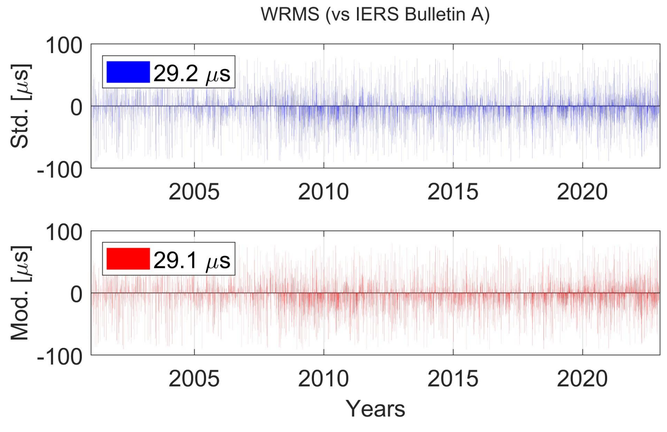


Fig 5. Comparison of standard solution and modified FCN model against IERS Bulletin A.

ΔUT1 estimated from intensive sessions does not have any effect of modified FCN model. Weighted Mean for the standard solution is higher than modified FCN model by ~30μs (Fig 4), whereas WRMS value against IERS Bulletin A for both solution doesn't have much variation (Fig 5).

C. Comparison of ERP obtained from SX and VGOS 24 hr sessions

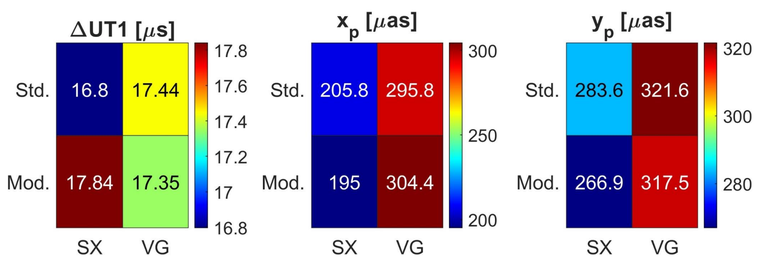


Fig 6. WRMS value of SX and VGOS session with standard and modified FCN model w.r.t IERS Bulletin A.

ΔUT1 doesn't show any significant variation. However, for PM, VGOS shows high WRMS value than SX sessions for standard and modified FCN model due to heterogenous and limited number of stations. On the other hand, modified FCN model has less WRMS value for SX sessions (Fig 6).

Distribution in SX is smaller than VG for both the scenario, which signifies that VG sessions varies more w.r.t to IERS Bulletin A. Fig 7 also shows that SX sessions shows normal distribution, which means that the differences are not large. x_p shows less and y_p shows similar distribution for SX and VGOS sessions in standard and modified FCN model.

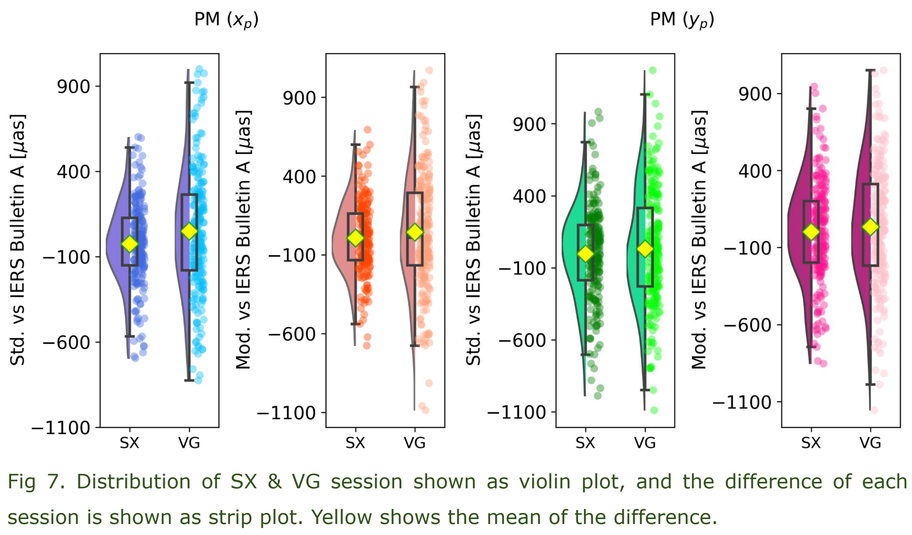


Fig 7. Distribution of SX & VG session shown as violin plot, and the difference of each session is shown as strip plot. Yellow shows the mean of the difference.

Conclusion

- UT1-UTC doesn't change after implementing modified FCN model, both in 24 hr and intensive sessions.
- PM shows slight variation using FCN model.
- While comparing SX and VGOS, no significant difference is observed for UT1-UTC, except PM.

Reference

1. Belda, S., Ferrándiz, J. M., Heinkelmann, R., Nilsson, T., & Schuh, H. (2016). Testing a new free core nutation empirical model. *Journal of Geodynamics*, *94*, 59-67.

*Arnab Laha

alaha@iitk.ac.in

SUGGESTIONS ARE WELCOME

Acknowledgement

I extend my heartfelt appreciation to the research team from TU Wien for giving necessary research insights and Santiago Belda for providing the FCN model. I am thankful to OeAD, Austria, for providing me monetary support through Ernst Mach Grant to pursue research at TU Wien. I also express my gratitude to NCG, IITK, for valuable support.