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Comparison between VLBI and other space geodetic techniques for determining Earth orientation parameters

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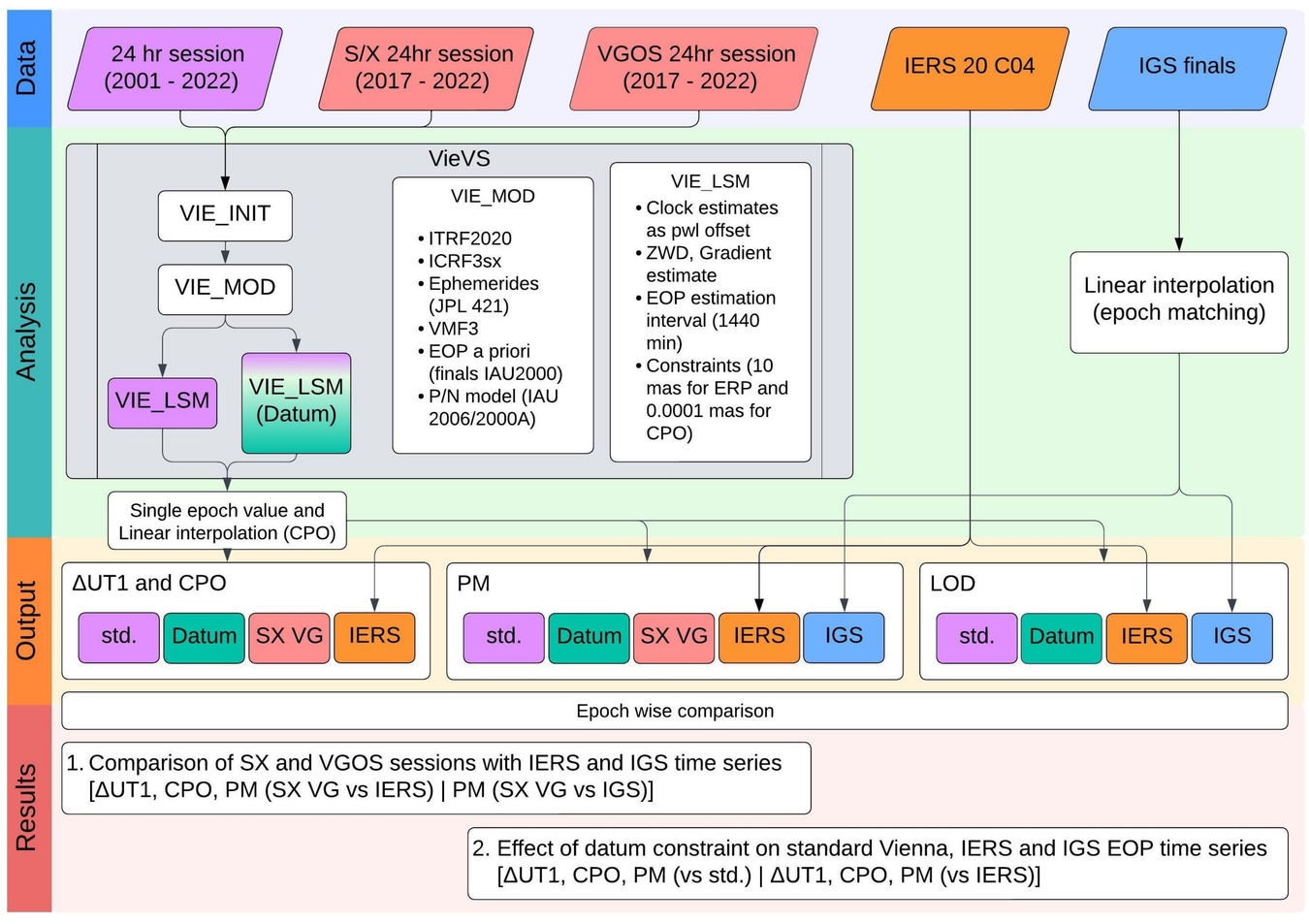
Introduction

Earth Orientation Parameters (EOP) are required for the accurate transformation between celestial and terrestrial reference frame, and VLBI is the only space geodetic technique capable of providing the full set of EOP.

- Between legacy (SX) and VGOS antennas, VGOS have more observations and smaller post fit residuals[1], and will have high accuracy observations[2]. Does it improve the accuracy for EOP estimation?
- When estimating EOP, stable positions of the stations and sources are included in the respective datum[3]. How and which stations effect the EOP after removing from terrestrial datum?

Data and Methodology



Result and Discussion

1. Comparison of SX and VGOS sessions

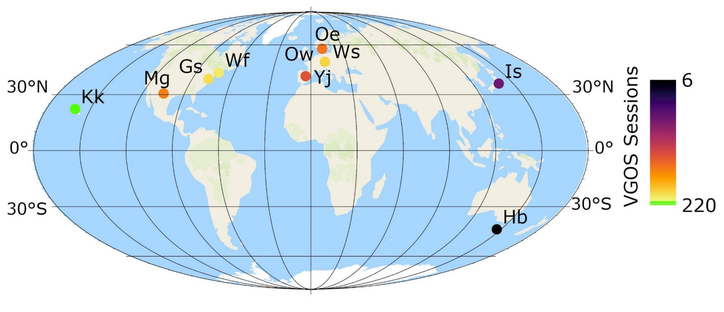


Fig 1. Distribution of VGOS network (2017 - 2022). SX sessions contain network with more than 15 stations, situated all over the Earth.

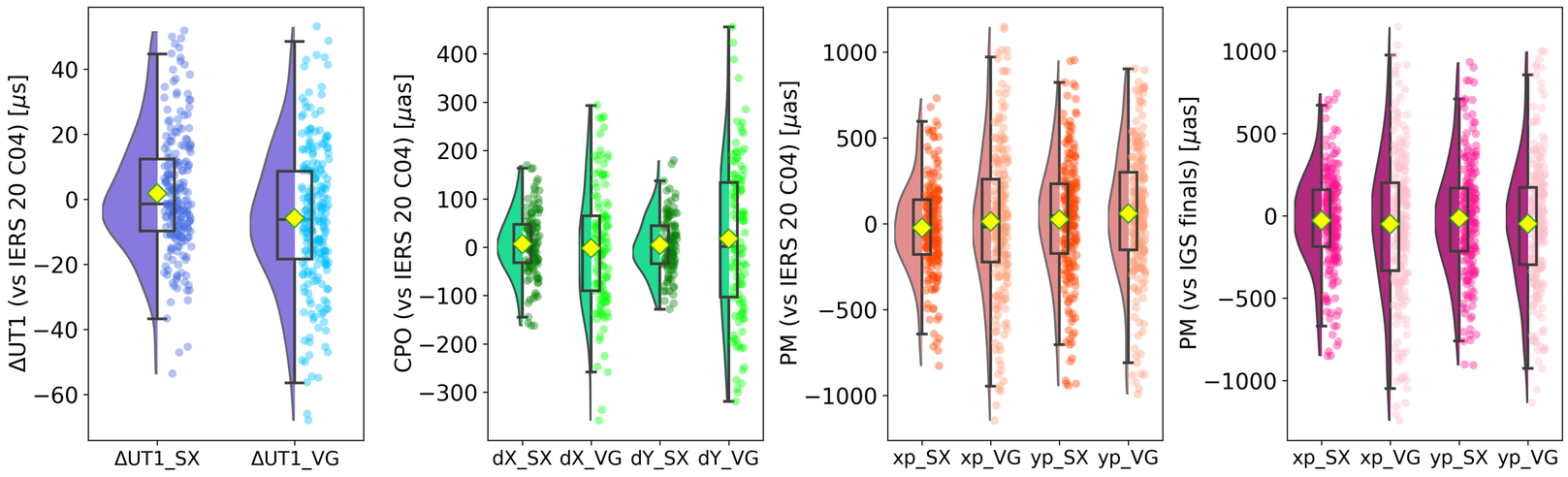


Fig 2. Distribution of SX & VG session shown as violin plot, and the difference of each session is shown as strip plot. Yellow shows the mean of the difference.

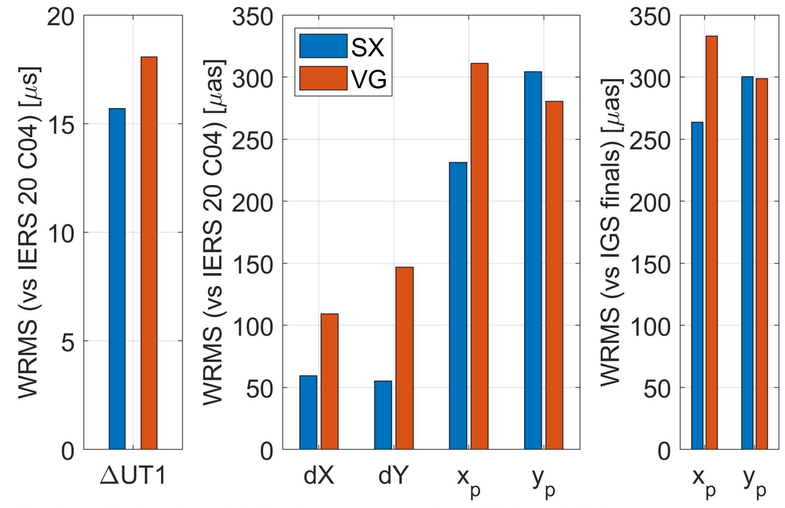


Fig 3. WRMS value of EOP when compared to IERS and IGS.

The distribution of VGOS is larger than that of SX sessions, which reflects that the epoch wise difference between VGOS sessions and IERS is larger in most of the sessions (Fig 2). This can be due to few and inhomogeneous distribution of VGOS network (Fig 1). While comparing ΔUT1 (Fig 3a), it can be inferred that WRMS for VGOS is slightly higher (~2μs) due to absence of stations in southern hemisphere (SH). CPO (dX and dY) shows better accuracy for SX sessions by ~40μas (dX) and ~90μas (dY) (Fig 3b), because of availability of more sources in SH. PM (x_p and y_p) shows mixed accuracy when compared to IERS and IGS (Fig 3b and 3c). y_p shows better accuracy in VGOS sessions by ~20μas (IERS), while x_p shows better accuracy in SX sessions by ~70μas (IERS). In summary, despite of less and heterogeneous distribution of VGOS stations, VGOS sessions provide comparatively good accuracy.

2. Effect of datum constraint

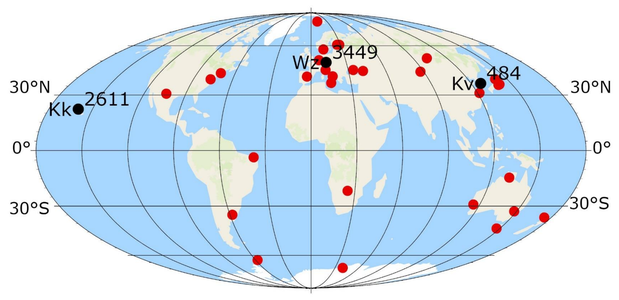


Fig 4. Distribution of VLBI stations (red), whereas black represent the stations removed one at a time from datum. Numbers denote the participation in sessions (2001 – 2022).

	ΔUT1	xp	yp	dX	dY
Wz	-34	-31	5	1	-1
Kv	-31	-31	5	1	-1
Kk	-39	-30	8	1	-1

Table 1. WM (μas) between IERS and datum estimates. Blue and gray represent highest and lowest value, respectively.

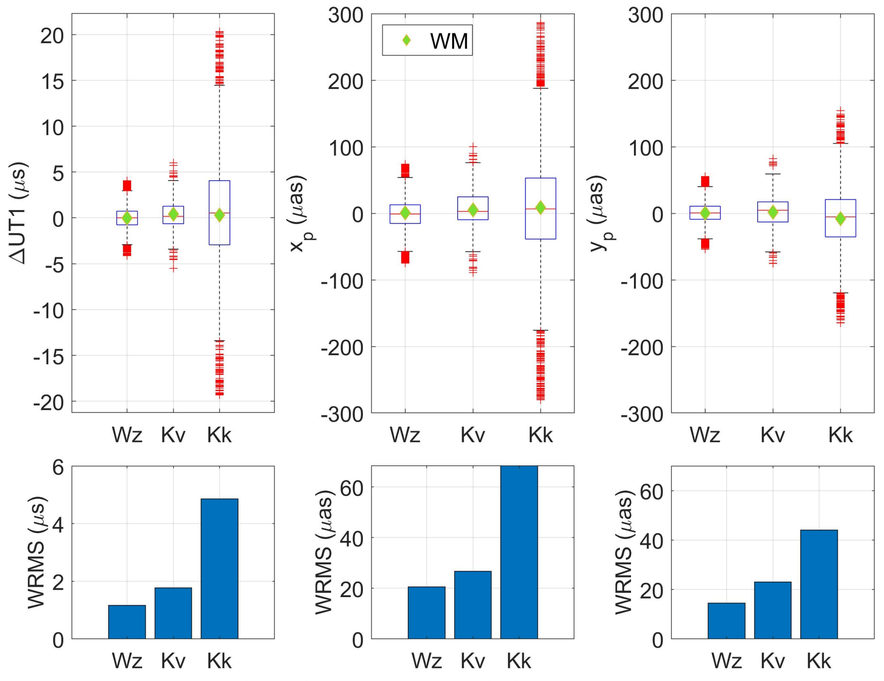


Fig 5. Comparison of standard timeseries with datum estimates.

Removing Kokee (Kk) has a greater impact on EOP followed by removing Sejong (Kv) & Wettzell (Wz) (Fig 5); due to availability of other stations near Wz and Kv. However, removing these stations from datum affects E-W baseline, resulting in more variation in x_p (Fig 5b & 5e) than y_p (Fig 5c & 5f). Despite Wz having more sessions than Kv, WM with respect to IERS shows similar value (Table 1). Conversely, CPO remains unaffected.

References

1. Glomsda et al., 2023. Comparison of simultaneous VGOS and legacy VLBI sessions. IVS 2022 General Meeting Proceedings.
2. Niell et al., 2018. Demonstration of a broadband very long baseline interferometer system: a new instrument for high-precision space geodesy. Radio Science, 53(10), pp.1269-1291.
3. Raposo-Pulido et al., 2016. Impact of Celestial Datum Definition on EOP Estimation and CRF Orientation in the Global VLBI Session IYA09. Proceedings of the IAG Scientific Assembly.

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SUGGESTIONS ARE WELCOME

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