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Impact of erroneous station coordinates on the estimation of UT1-UTC with VLBI Intensive sessions

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Sharing is encouraged

Motivation

- erroneous station coordinates
  - **gross errors** in a priori data
  - un- or mis-modeled **antenna deformations**
  - un- or mis-modeled atmosphere/ ocean/ hydrology **loading effects**
  - un- or mis-modeled **troposphere**

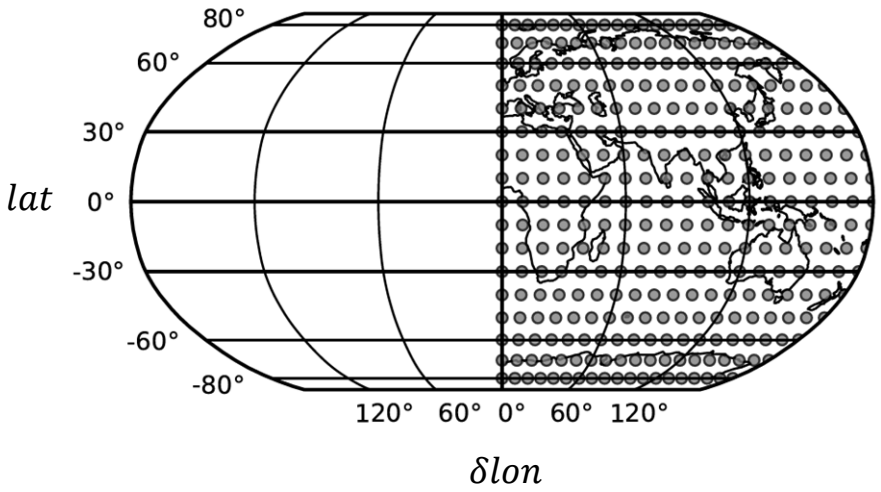
__1 mm__ tropospheric gradient ≈ __7 mm__ station displacement ≈ __15 µs__ dUT1 error

Böhm et al (2010)

Experiment setup *(Schartner et al., 2021)*

- **artificial VGOS stations** placed on a **10° x 10° global grid**

- **~ 3000 Intensive single baselines** between a reference station and any other station



- scheduling (VieSched++) and simulation (VieVS)
  - reduced source list, focus corner scheduling algorithm*
  - monthly simulated schedules per baseline → **monthly dUT1 values**

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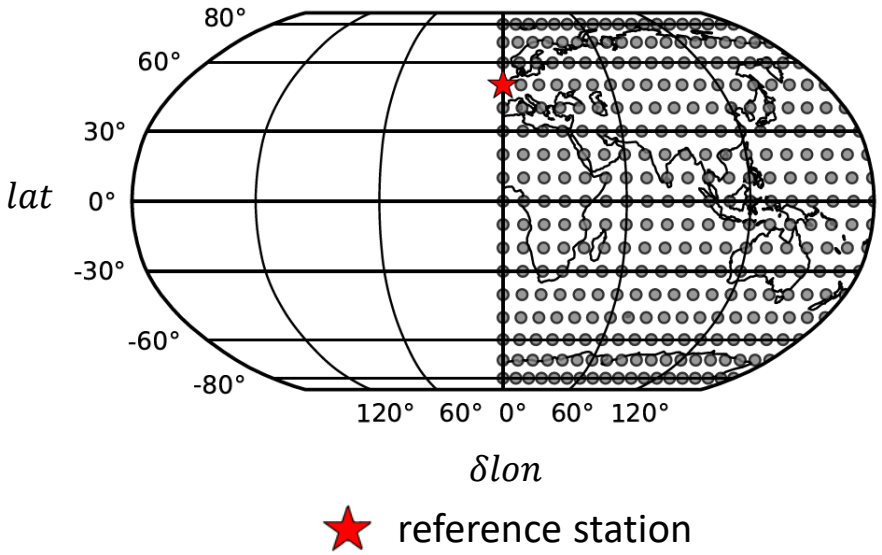

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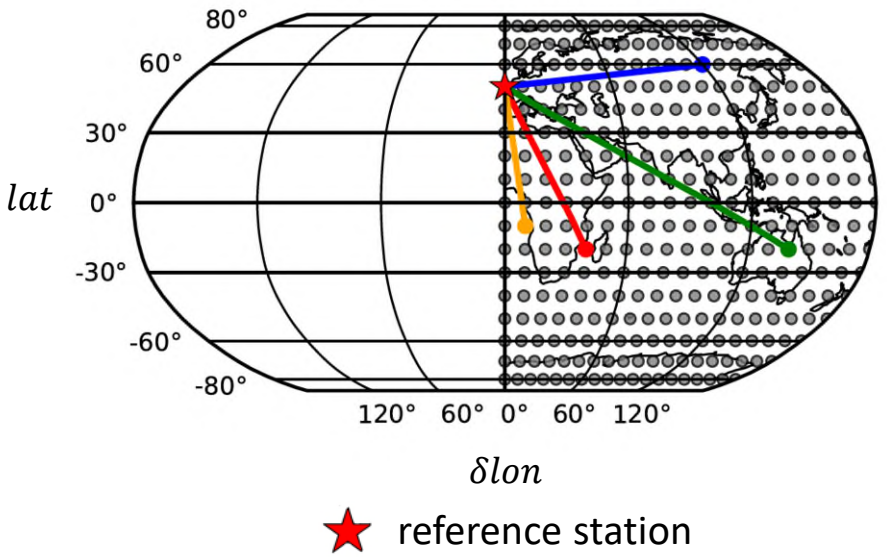

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* *(Nothnagel and Campbell, 1991) (Uunila et al., 2012) (Gipson and Baver, 2015) (Schartner et al., 2021)*

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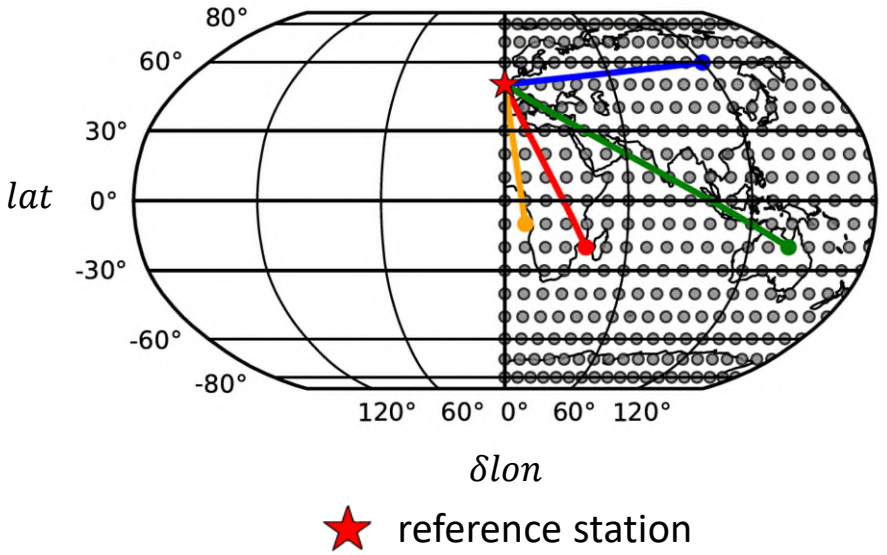


- scheduling (VieSched++) and simulation (VieVS)
  - reduced source list, focus corner scheduling algorithm*
  - monthly simulated schedules per baseline → **monthly dUT1 values**

→ unaltered evaluation

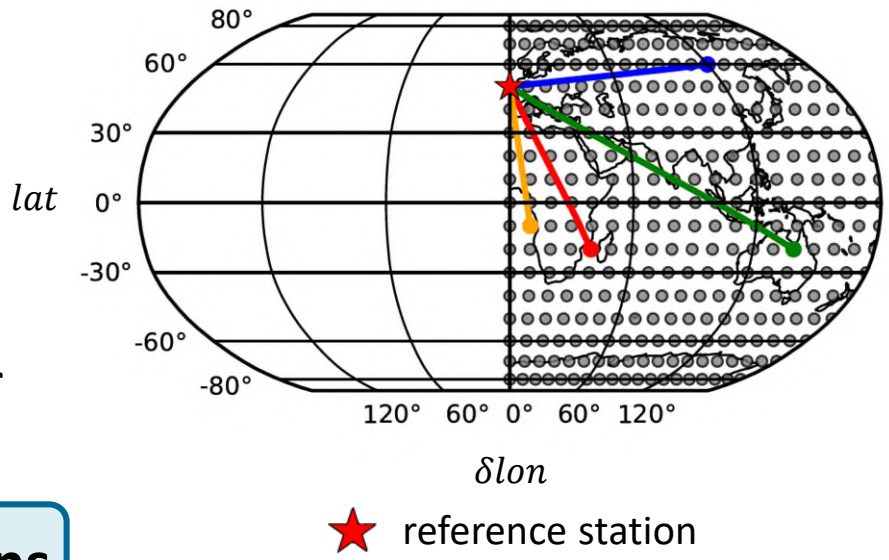
* *(Nothnagel and Campbell, 1991) (Uunila et al., 2012) (Gipson and Baver, 2015) (Schartner et al., 2021)*

Experiment setup *(Schartner et al., 2021)*

- introducing **realistic errors (*5 mm*) in the a priori information** of the topocentric station coordinates (UEN)

- monthly simulated schedules per baseline and error source → **monthly dUT1 values**

→ modified evaluations



Experiment setup *(Schartner et al., 2021)*

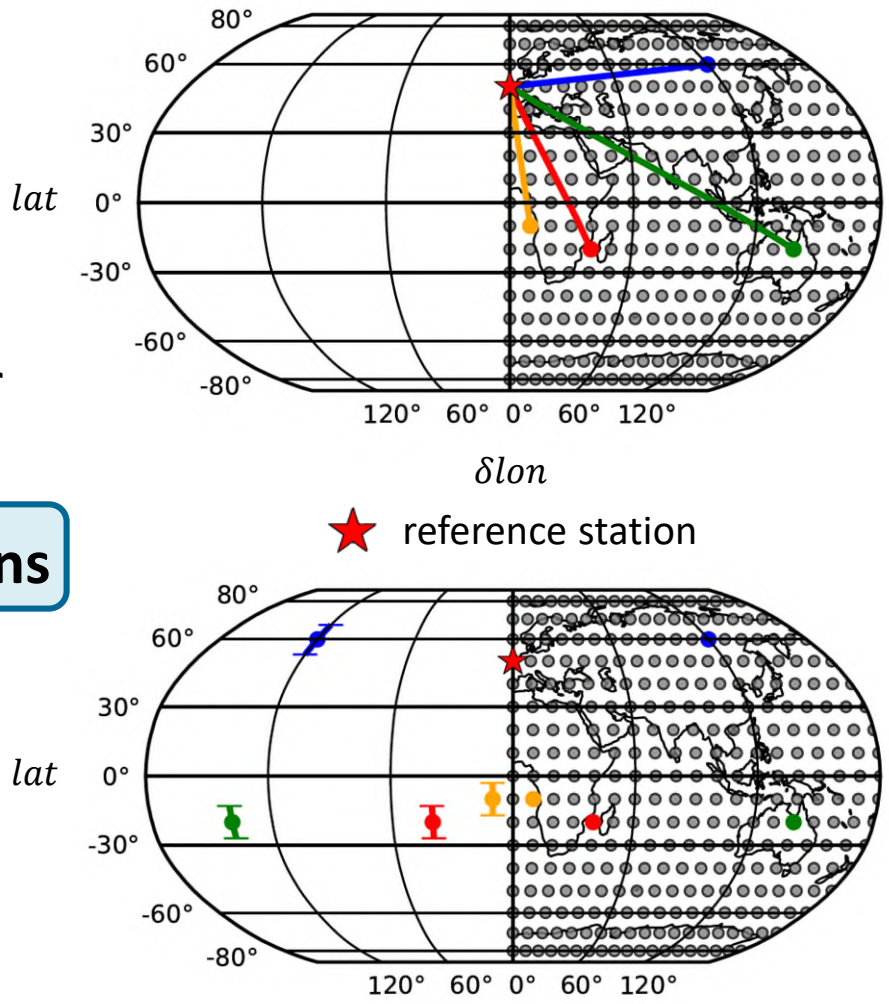
- introducing **realistic errors (*5 mm*) in the a priori information** of the topocentric station coordinates (UEN)

- monthly simulated schedules per baseline and error source → **monthly dUT1 values**

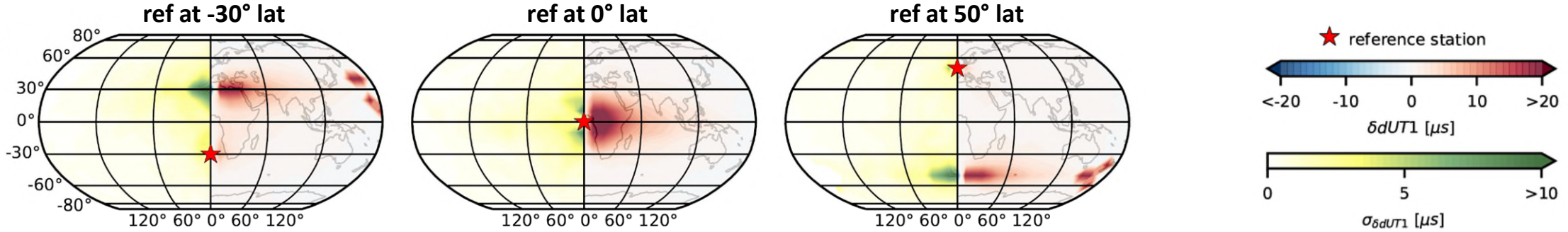
→ modified evaluations

→ mean difference in dUT1 $\boldsymbol{\delta dUT1}$ $[\boldsymbol{\mu s}]$

→ standard deviation $\boldsymbol{\sigma_{\delta dUT1}}$ $[\boldsymbol{\mu s}]$



Impact of erroneous station coordinates on dUT1



error in Up direction:

- high resistance against error (= low $\boldsymbol{\delta dUT1}$ values)

$$\boldsymbol{\delta dUT1} \begin{cases} > 5\ \mu s\ (8\%\ of\ baselines) \\ > 20\ \mu s\ (2\%\ of\ baselines) \end{cases}$$

- ***most affected***:
  - baselines with a midpoint close to equatorial plane
  - short baselines

(Kern et al., 2022) – submitted to JOGE

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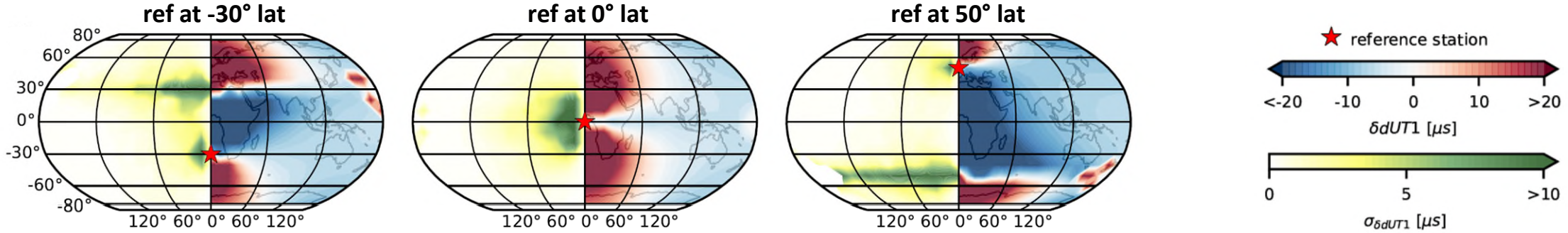

error in East direction:

- low resistance against error

$$\boldsymbol{\delta dUT1} \begin{cases} > 5\ \mu s\ (84\%\ of\ baselines) \\ > 20\ \mu s\ (22\%\ of\ baselines) \end{cases}$$

- ***most affected***:
  - baselines with a midpoint close to equatorial plane
  - short baselines
  - N-S oriented baselines
- ***least affected***:
  - long E-W baselines between a reference and another station at mid-latitudes of same hemisphere

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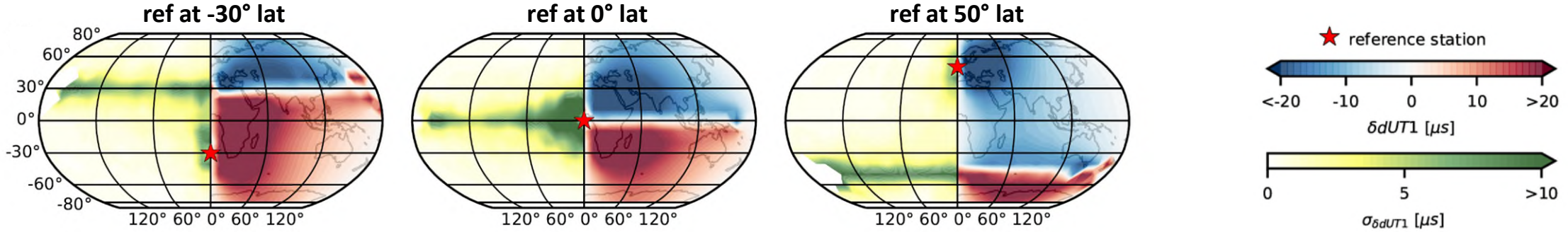
Impact of erroneous station coordinates on dUT1



error in North direction:

- low resistance against error

$$\boldsymbol{\delta dUT1} \begin{cases} > 5\ \mu s\ (64\%\ of\ baselines) \\ > 20\ \mu s\ (16\%\ of\ baselines) \end{cases}$$

- ***most affected***:
  - baselines with a midpoint close to equatorial plane
  - short baselines
  - N-S oriented baselines, which are close to being parallel to the Earth‘s rotation vector
- ***least affected***:
  - long E-W baselines between a reference and another station at mid-latitudes of same hemisphere

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Conclusion

- ✓ provided a **global evaluation of the impact of errors in the a priori information of the station coordinates** on the determination of dUT1 through Intensive sessions
- ✓ almost **3000 baselines** investigated
- ✓ baselines with midpoint close to equatorial plane/ baselines close to parallel to Earth‘s rotation vector lead to **high variations** in the dUT1 differences → **high sensitivity to errors**
- ✓ long east-west baselines between a station and another station at mid-latitudes of the same hemisphere are **most resistant** against errors
- ✓ impact of errors in the a priori information **have to be taken into account for a proper accuracy assessment**!

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References:

Böhm J, Hobiger T, Ichikawa R, et al (2010) Asymmetric tropospheric delays from numerical weather models for UT1 determination from VLBI Intensive sessions on the baseline Wettzell-Tsukuba. Journal of Geodesy 84:319-325.

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