

Earth Orientation Parameter Estimation by Integrating VLBI and GNSS on the Observation Level

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Outline

Background and motivation

Data and methodology of GNSS+VLBI integrated processing

Earth Orientation Parameters (EOP) estimates from GNSS+VLBI solution

Conclusions and perspectives

Background: Why Combination?

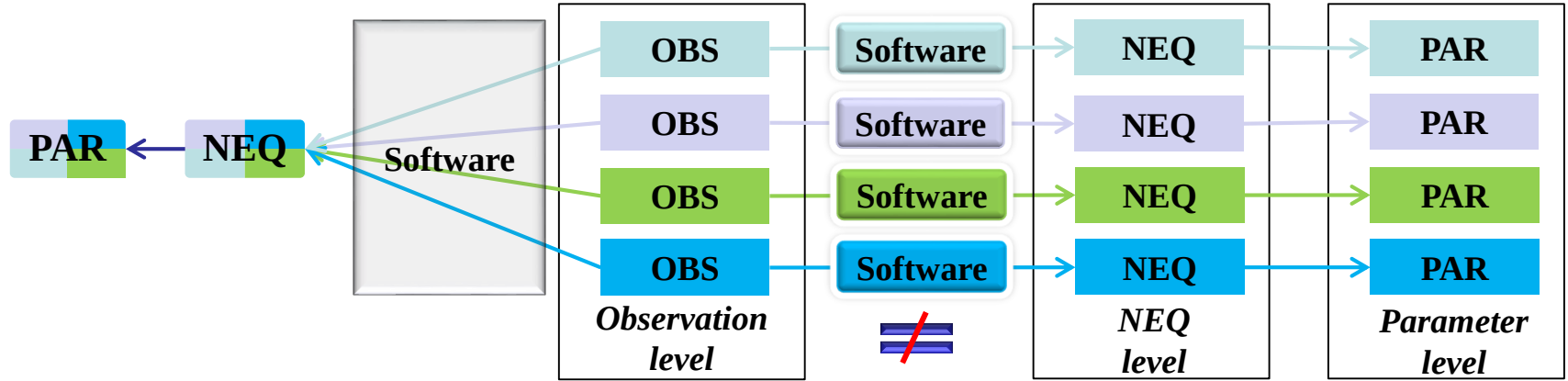
Consistent TRF, CRF, and EOP can only be achieved from multi-technique combination

	CRF	TRF		Earth Orientation Parameters (EOP)		
		Origin	Scale	PM	UT1-UTC	CPO
VLBI	✓	✗	✓	✓	✓	✓
SLR	✗	✓	✓	✓	(✓)	(✓)
GNSS	✗	(✓)	(✓)	✓	(✓)	(✓)
DORIS	✗	(✓)	(✓)	✓	(✓)	(✓)

Ties are available in combining the four techniques

	Global Tie (EOP)	Local Tie	Space Tie	Atmospheric Tie	Clock Tie
VLBI	✓	✓	✓	✓	✓
SLR	✓	✓	✓	(✓)	✗
GNSS	✓	✓	✓	✓	✓
DORIS	✓	✓	✓	✓	✓

Background: the Three Levels to Combine



Precision & robustness in consistent TRF, CRF, EOP

Software consistency
All possible ties
Parameter correlation
Datum consistency
+
Inter-technique outlier detection
Technique-specific biases

✓
✓
✓
✓
✓
✓

Obs=NEQ: given homogeneous NEQs with all necessary parameters kept.
hardly be achieved

✗
✗
✓
✓

DTRF
(DGFI-TUM)

✗
✗
✗
✗

ITRF (IGN)
JTRF (JPL)

Motivation and Objectives

Motivation

Consistent determination of **TRE, CRE, and EOP** by multi-technique integrated processing on the **observation** level

Objectives of this study

Integrated solution of **GNSS+VLBI** on the **observation level**: using VLBI CONT05-CONT17 campaigns as an example, focusing on the **Earth Orientation Parameters (EOP)**

- GNSS: precise polar motion from globally distributed stations
- VLBI: UT1-UTC and celestial pole offsets

Integrated Processing of GNSS and VLBI

	Station	Space part	EOP	TRF
GNSS	>200	Orbit estimated	PM, LOD	NNR+NNT (IGS14)
VLBI	< 20	NNR (ICRF3)	PM, UT1-UTC, CPO	NNR+NNT (ITRF14)

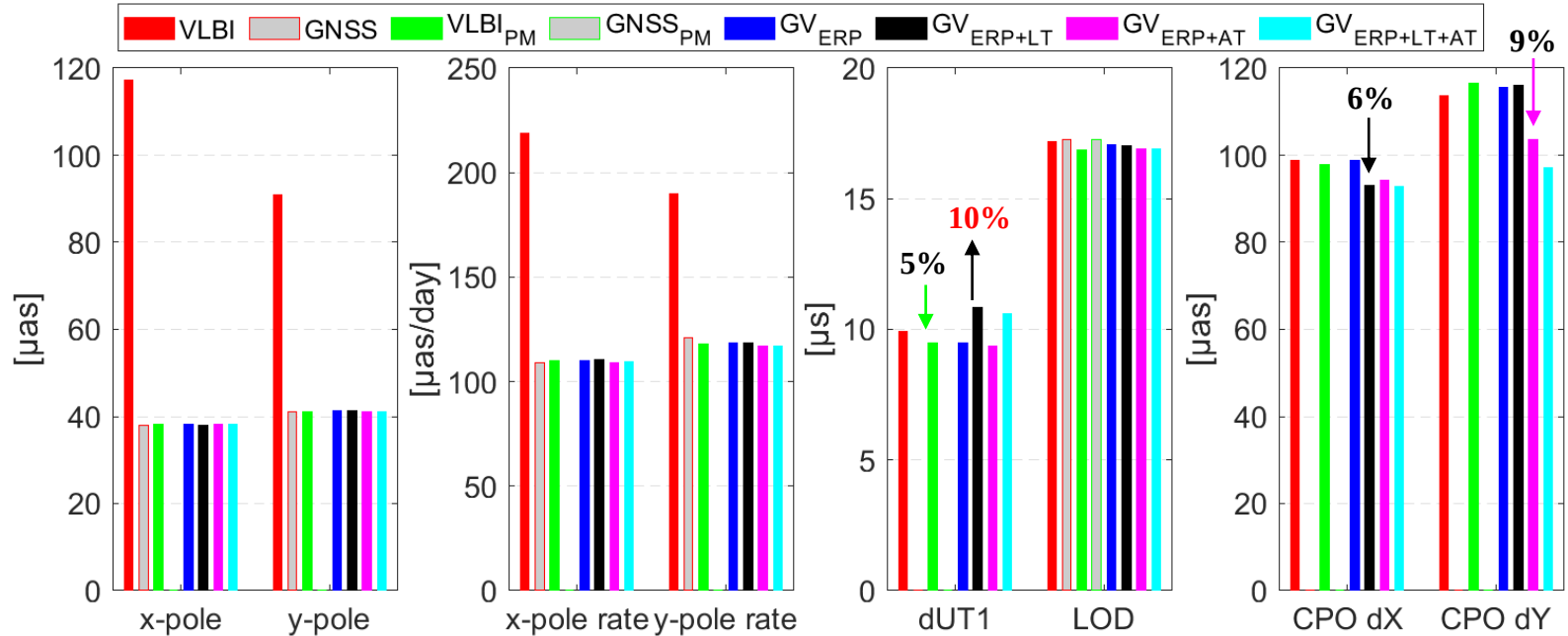
Daily solution of CONT05–CONT17, both techniques processed in the common estimator (PANDA).
 Local tie (LT) applied according to normalized residuals; tropospheric tie (AT) from Numerical Weather Model;
 relative weighting according to the ratio of station coordinate repeatability to the corresponding formal errors.

Solution (ties)	EOP	LT	AT	NNR+NNT GNSS	NNR+NNT VLBI
NONE	No EOP ties	✗	✗	✓	✓
PM	PM tie	✗	✗	✓	✓
ERP	PM+LOD ties	✗	✗	✓	✓
ERP+LT	PM+LOD ties	✓	✗	✓	✗
ERP+AT	PM+LOD ties	✗	✓	✓	✓
ERP+LT+AT	PM+LOD ties	✓	✓	✓	✗

LT transfers datum

GNSS+VLBI Integrated Solution: EOP WRMS

WRMS of EOP differences compared to IERS 14 C04 product, average values in CONT05–CONT17



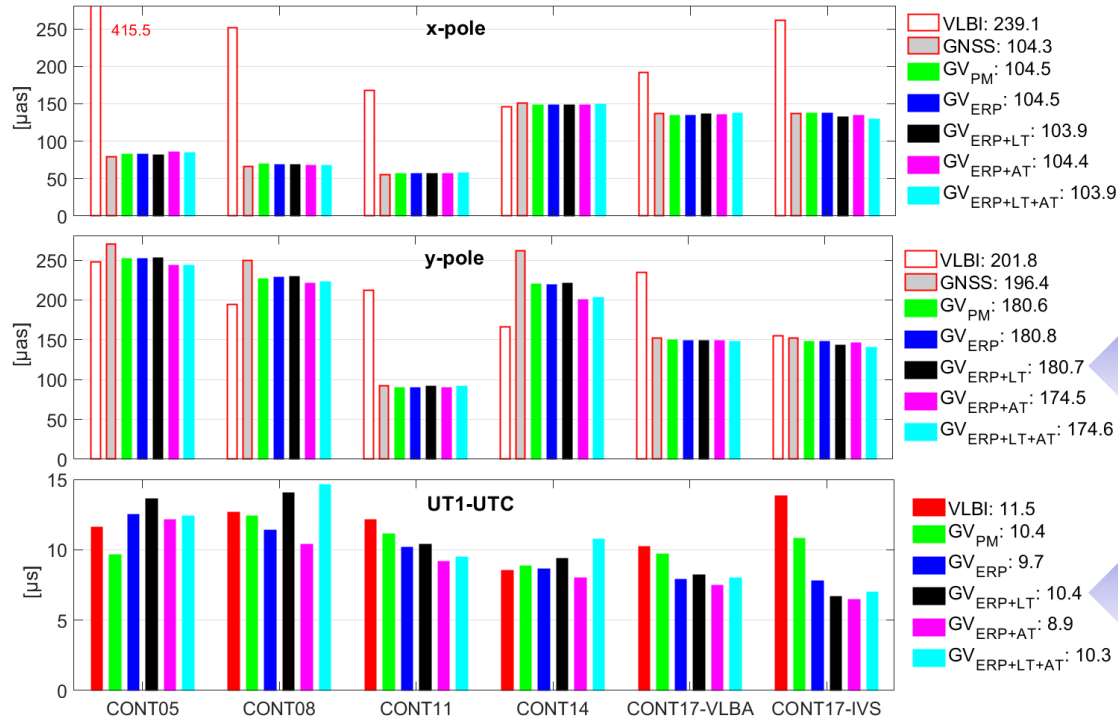
PM dominated by GNSS: better than VLBI-only

Slightly improved UT1-UTC & CPO

GNSS+VLBI Integrated Solution: ERP DBD

RMS values of ERP day-boundary-discontinuity (DBD) in CONT05–CONT17.

The average values are shown in the legend.

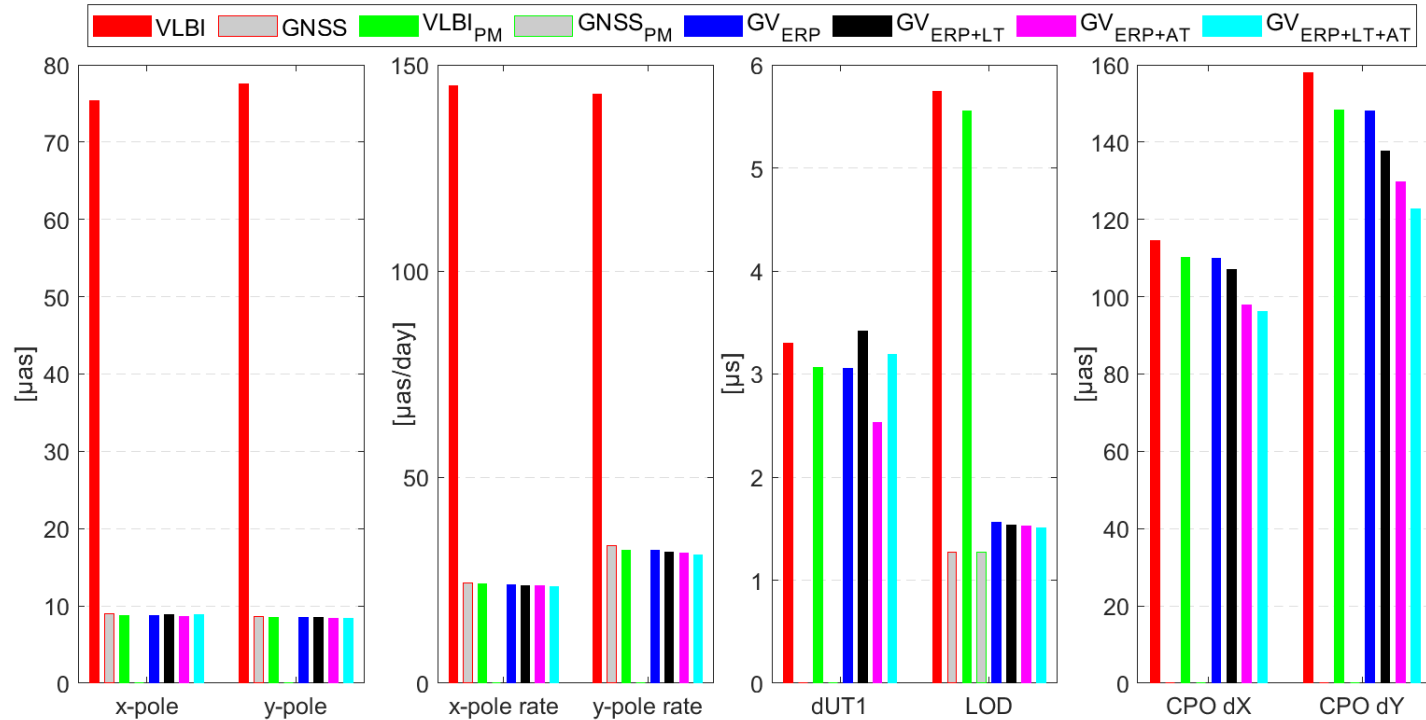


Better y-pole DBD in integrated solution than both GNSS and VLBI

Reduced UT1-UTC DBD in integrated solution than VLBI-only

GNSS+VLBI Integrated Solution: EOP Formal Error

Average values of EOP formal errors in CONT05-CONT17



Conclusions and Outlook

GNSS+VLBI provide full EOP set with better precision

Combination on the observation provides better consistency

Next step: long-term consistent TRF+CRF+EOP determination

Thank you for your attention

Any questions?

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