Consistent computation of ITRF and ICRF from homogeneously processed observation data

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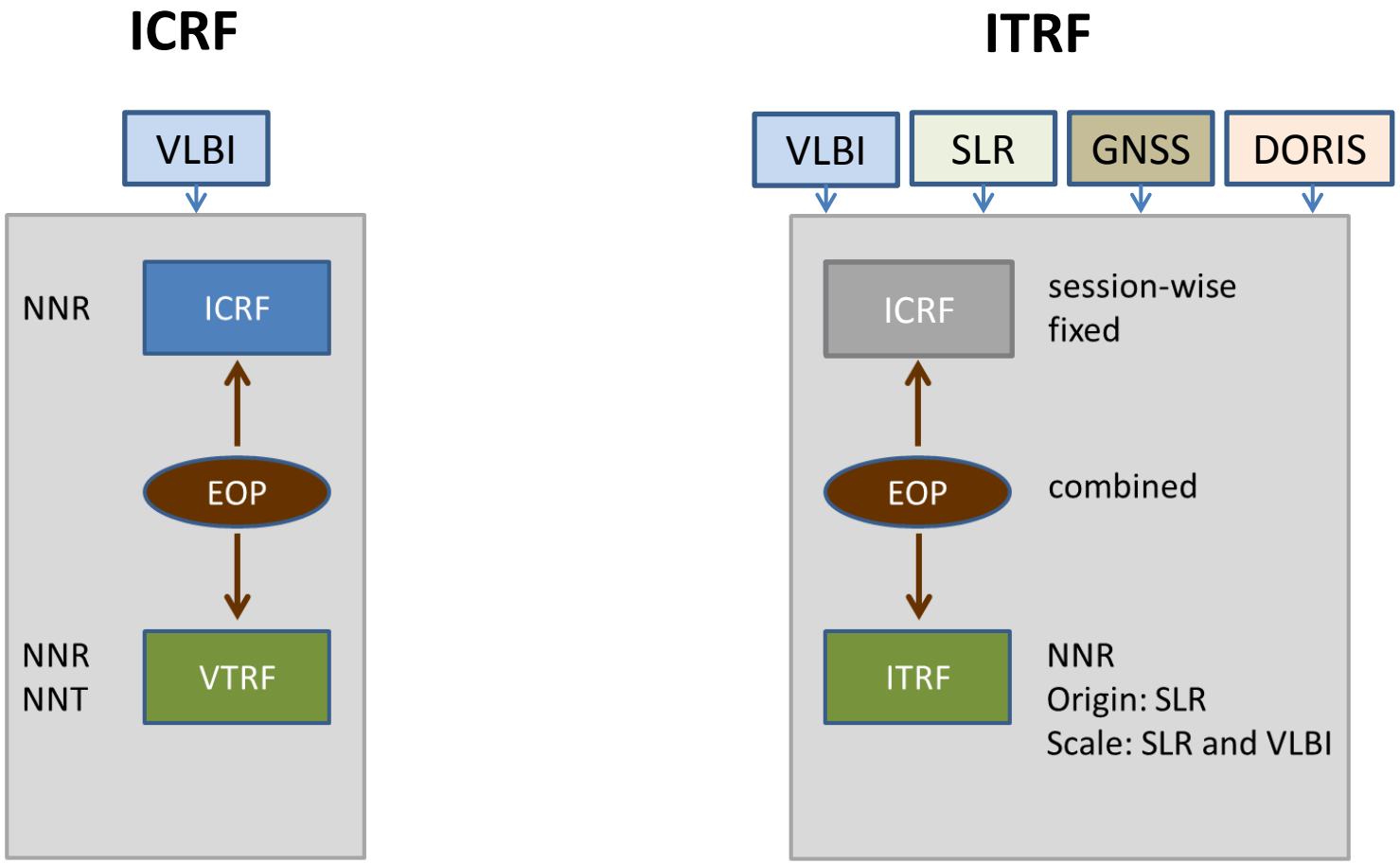
Motivation (I)

Current situation for ITRF / ICRF computation



Seitz et al.: Consistent computation of ITRF and ICRF

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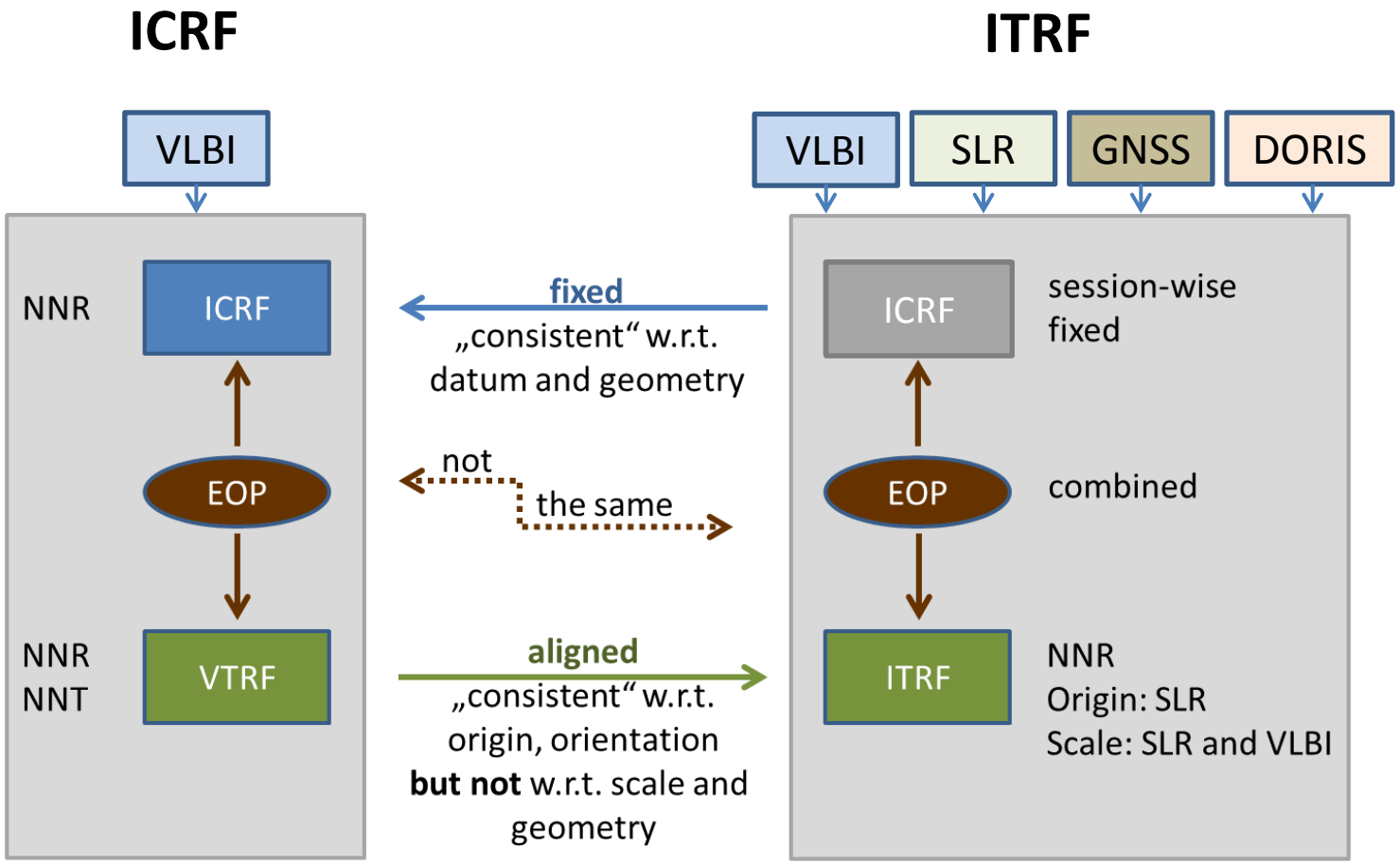

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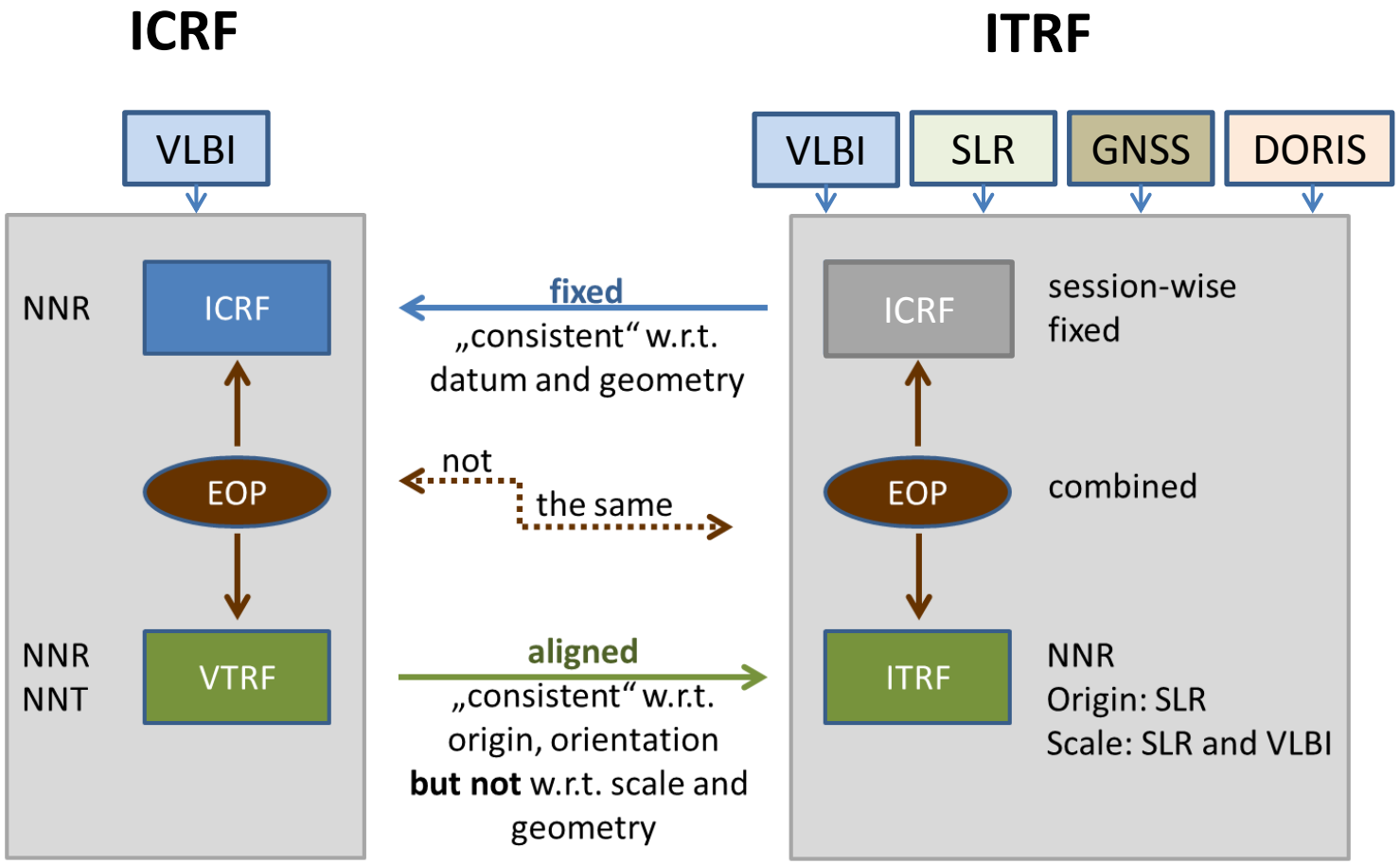

Lack of consistency for **VLBI station network (scale, network geometry)** and for **EOP.**

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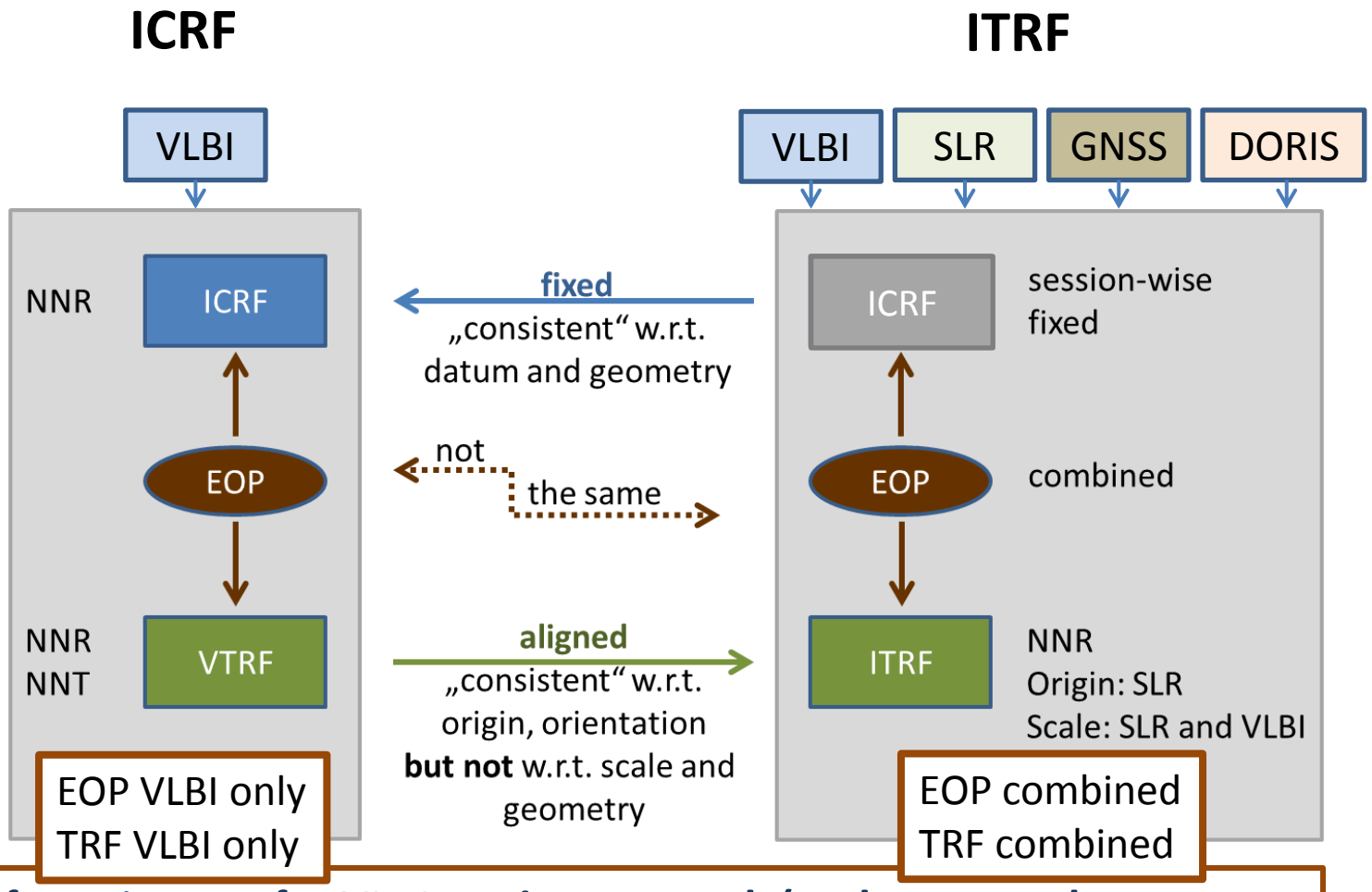
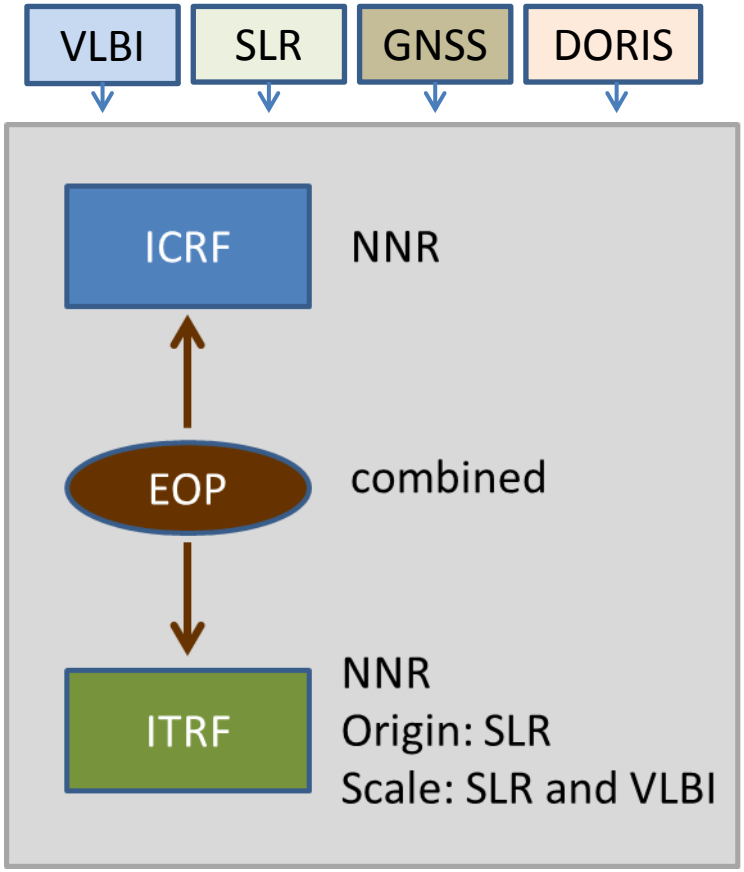
Current situation for ITRF / ICRF computation



Lack of consistency for **VLBI station network (scale, network geometry)** and for **EOP.**

Motivation (II)

Consistent realization of ITRS and ICRS



- TRF, CRF and EOP are simultaneously estimated in one adjustment
- Only minimum conditions are used for datum realization
- Origin and scale are realized according to IERS conventions

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Motivation (III)

What is expected from a common adjustment of CRF and TRF?

- Consistency between all parameters
- Improvement of the accuracy of EOP time series w.r.t. technique-specific series (motivated e.g. by IERS C04 series)
- Effects on CRF [positions and their standard deviations] due to
  - Combination of EOP
  - Combination of station coordinates

→ CRF should benefit from the combination of the different techniques (done for TRF and EOP).

Data used

- Time series of normal equations of VLBI, GPS and SLR data
- Based on consistent models and parameterizations

	time span	resolution	institution
VLBI	1984-2007	session-wise (24 h)	combined: IGG+DGFI
GPS	1994-2007	daily	GFZ
SLR	1993-2007	weekly	DGFI

- Common parameters (sum≈45,000)

	Station coord.	Source coord.	Terr. pole	Celest. pole	UT1-UTC	Origin	Scale
VLBI	x	x	x	x	x		x
GPS	x		x	(x)	(x)		
SLR	x		x		(x)	x	x

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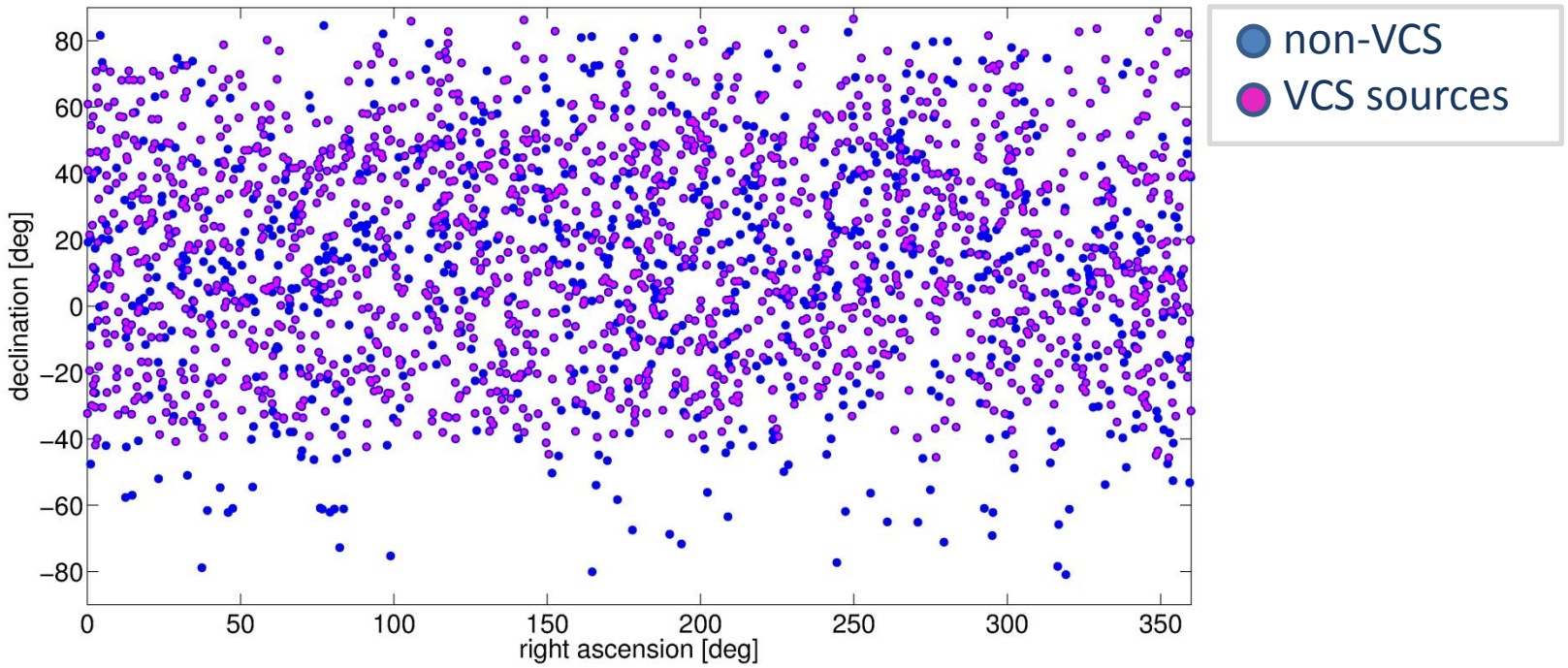
CRF: distribution of sources



Total	2967	
VCS	1657 (55.8 %)	

ICRF2	Total	3414
	VCS	2197 (64.4 %)

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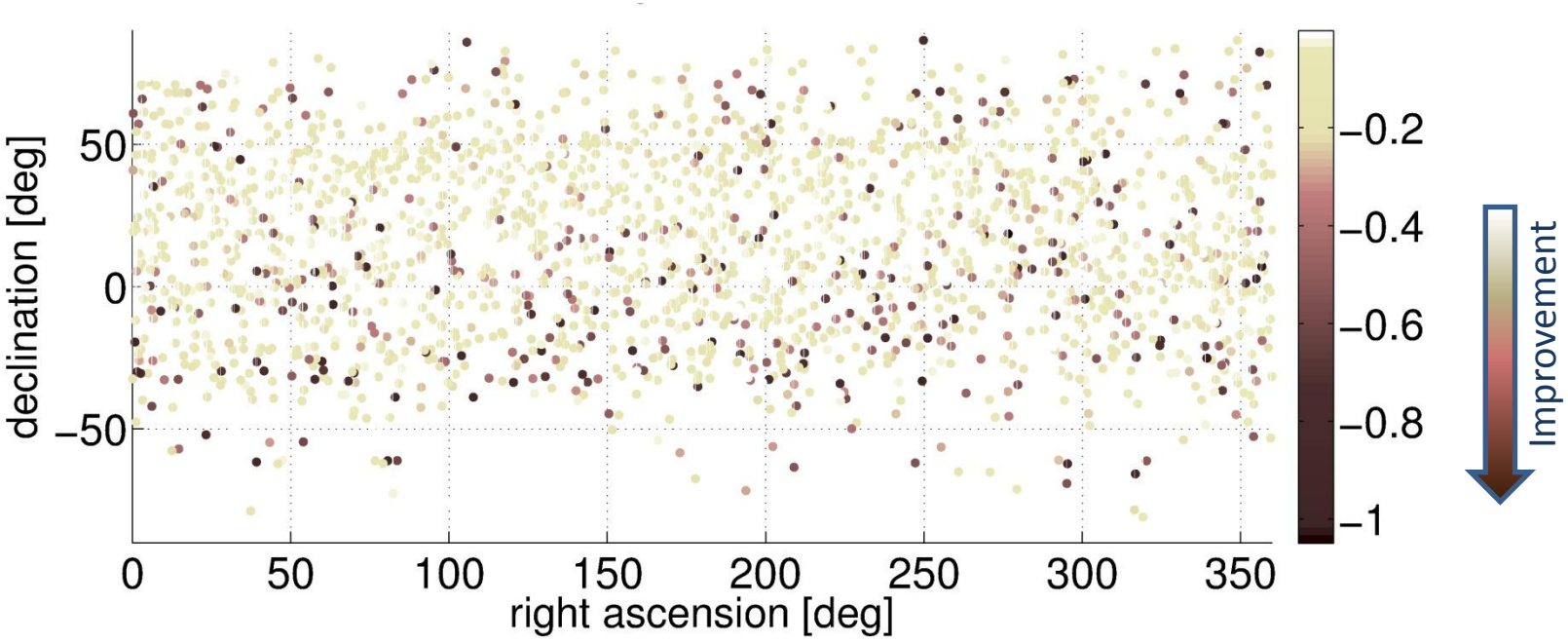
Standard deviations of source positions (I)

Change of standard deviation of declination w.r.t. VLBI-only
(sources with δ_{DE} <= 5 mas)



Standard deviations decrease in general.

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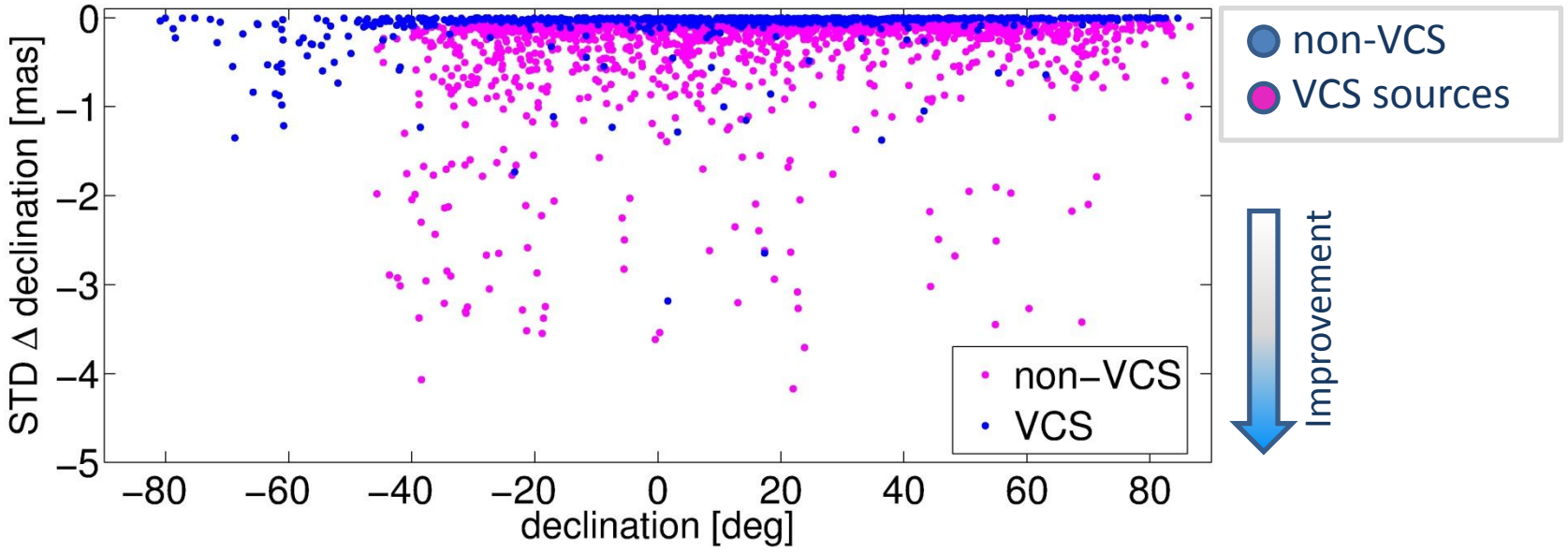
Standard deviations of source positions (II)

Change of standard deviation of declination w.r.t. VLBI-only



- Standard deviations decrease in general.
- Sources observed by VCS sessions only benefit most.
- About 90% of the decrease is caused by pole combination.

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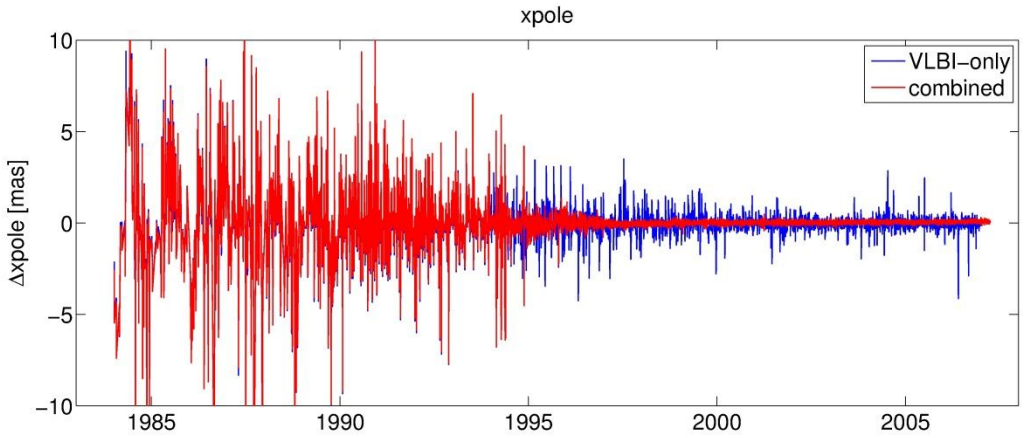
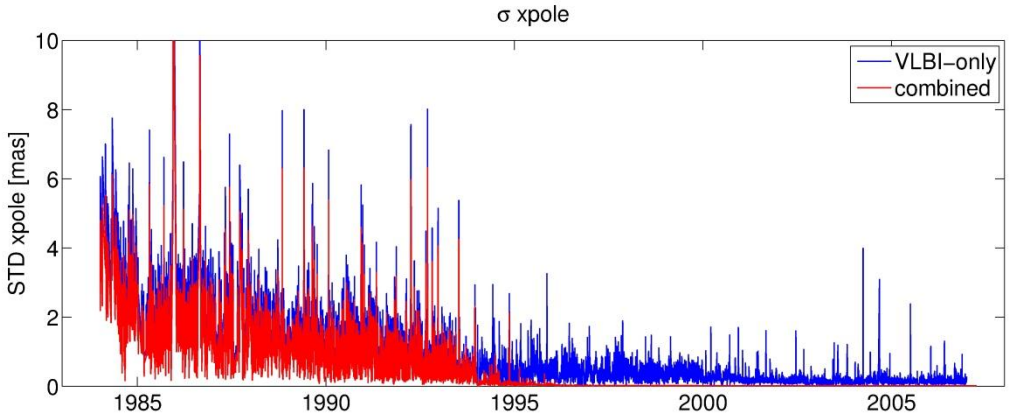
EOP results

X component of terrestrial pole

xpole w.r.t. IERS 08 C04 [mas]



standard deviation of xpole [mas]



Standard deviations decrease in general and significantly for the GNSS era.

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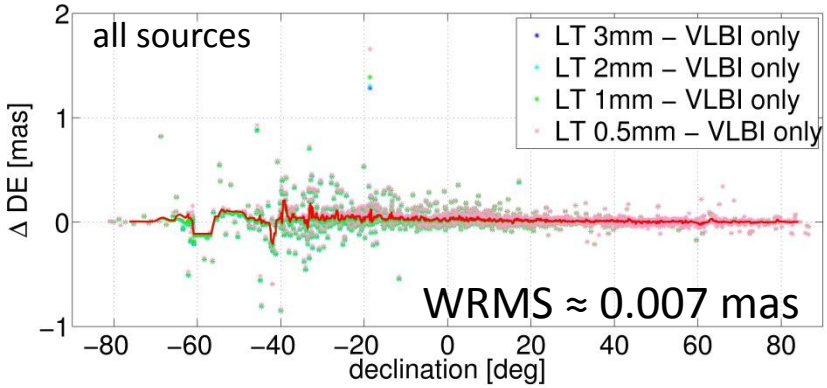
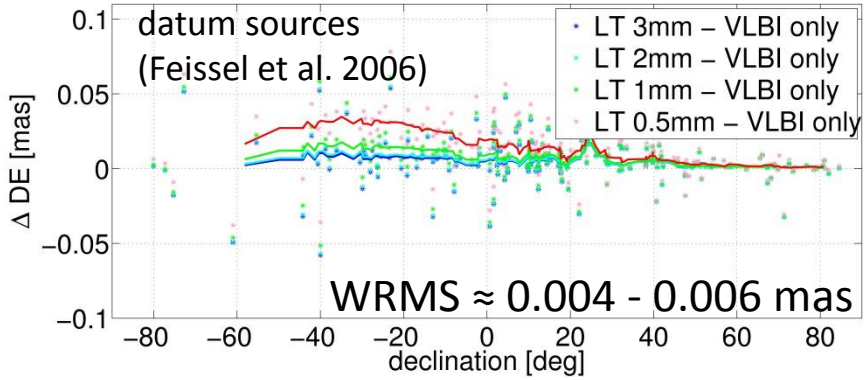
Effect of combination on source positions

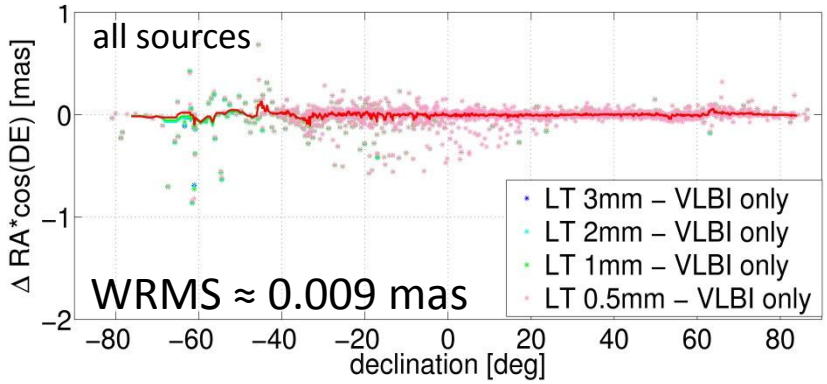
Comparison with VLBI-only solution

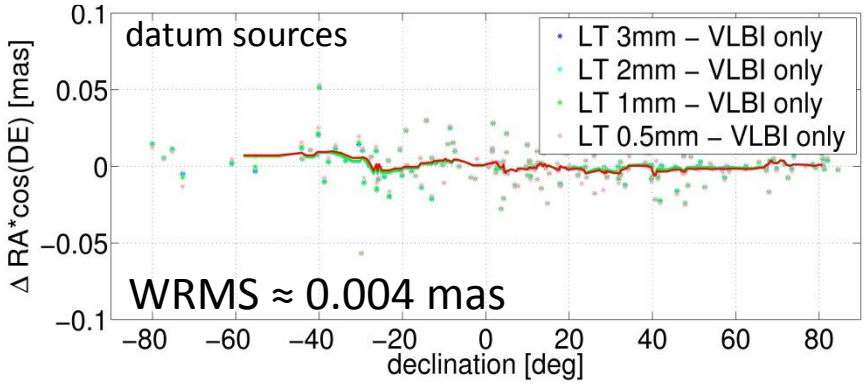
Declination





Right ascension





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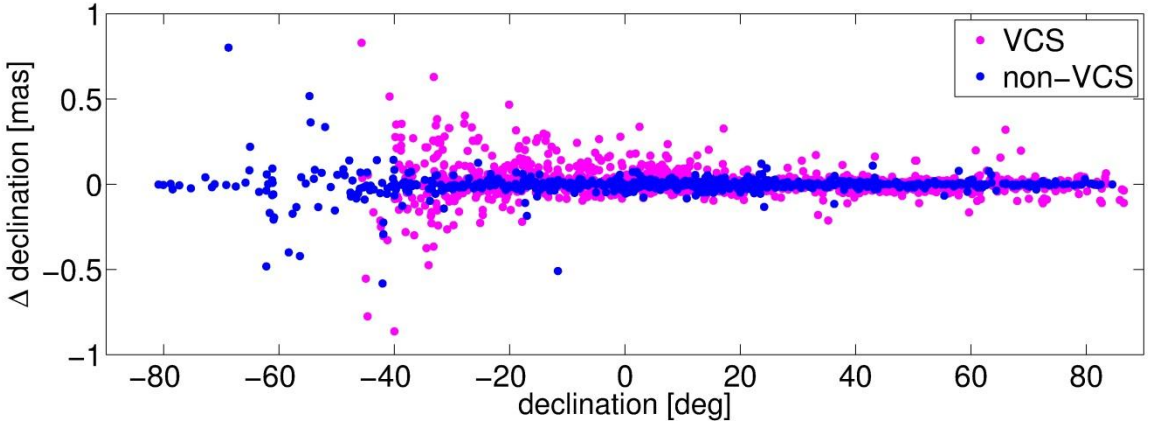
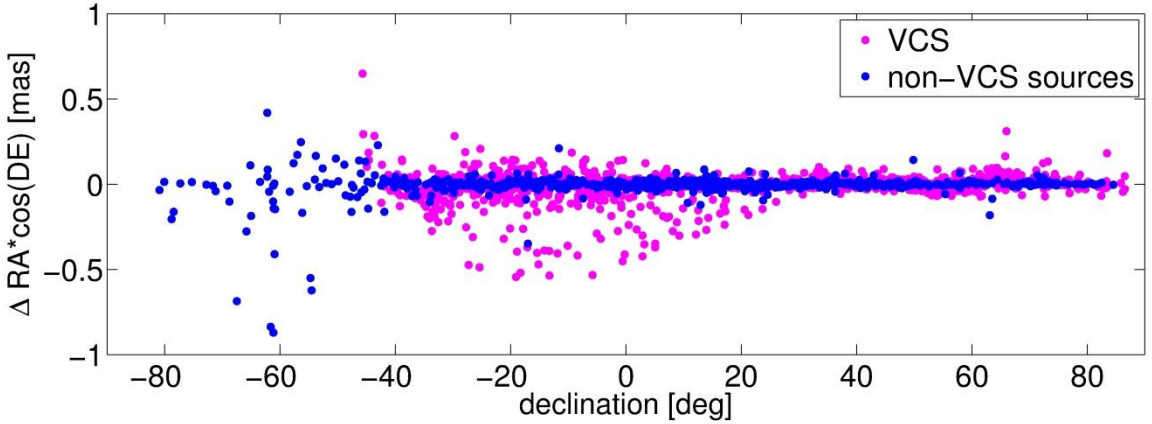
Effect of EOP combination on CRF (II)

Declination w.r.t. VLBI-only [mas]



non-VCS
VCS sources

Right ascension w.r.t. VLBI-only [mas]



Systematics of up to 0.5 mas for some of the sources with a declination between -40° and 30°

→ VCS sources are stronger affected by the combination.

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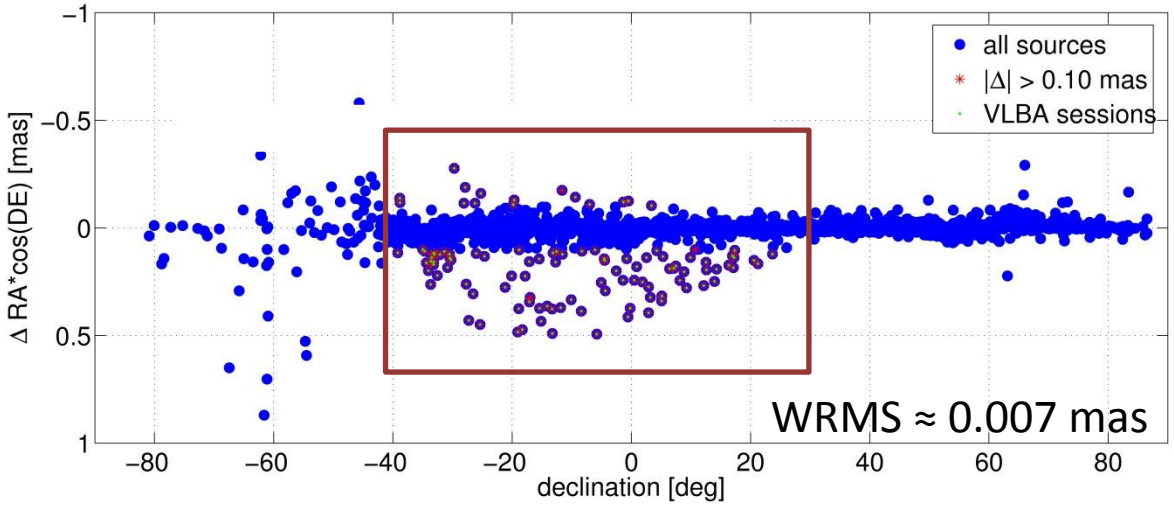
Effect of EOP combination on CRF (III)

Right ascension



Marked sources

- $-40° < DE < 30°$
- $|\Delta RA \cdot \cos(DE)| \geq 0.1$ mas
- 108 sources observed in 21 sessions / 18 VLBA sessions (105 sources)

→ EOP derived from regional VLBI and global GPS networks seem to show systematic differences

Mean effect on CRF is very small.

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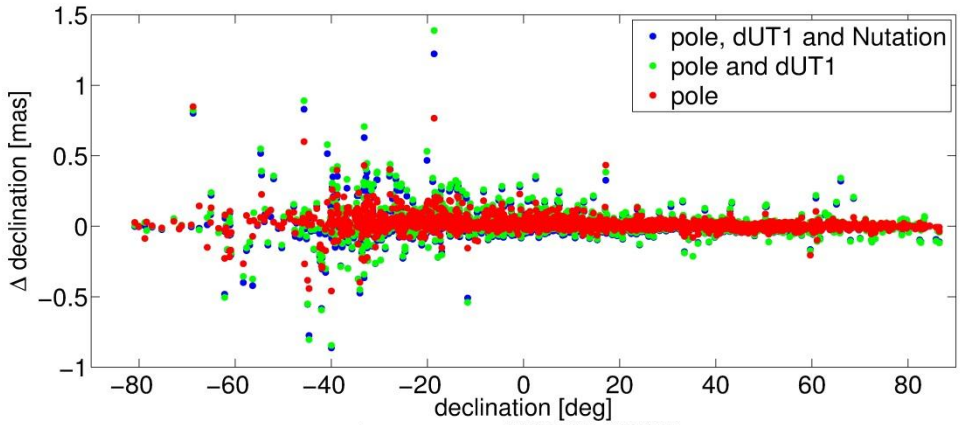
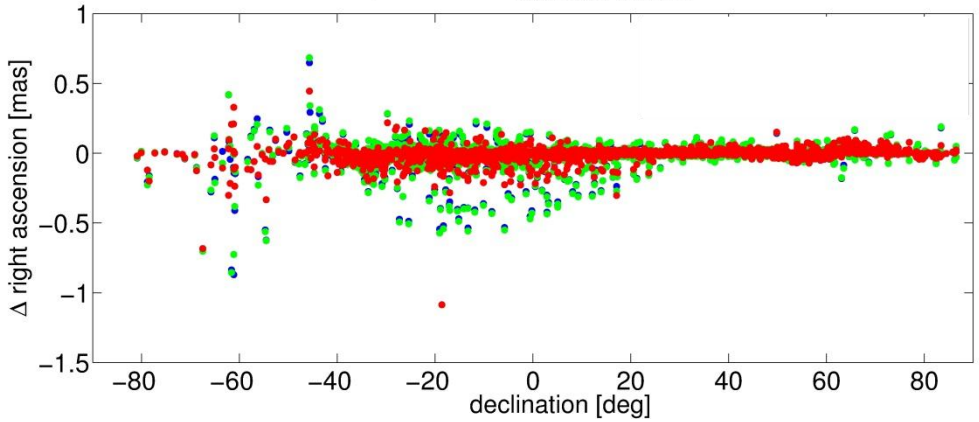
Effect of EOP combination on CRF (IV)

Combination of different EOP

Declination w.r.t. VLBI-only [mas]



Right ascension w.r.t. VLBI-only [mas]



WRMS

- 6.7 µas
- 6.1 µas
- 9.0 µas
- 5.5 µas

→ Combination of LOD has a larger impact on source positions than combination of pole and nutation rates.

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Conclusions (I)

Common adjustment of TRF, CRF and EOP is possible

Effect on the CRF:

- Datum sources: WRMS 0.004 mas (range ± 0.05)
- All sources: WRMS 0.007 mas (range -1.0/1.5)
- Standard deviations are improved in general (combination of the pole)
- Systematic effects on some of the sources observed by VCS sessions only (combination of LOD)

→ What do we reach?

- Consistent solution for all parameters (TRF, CRF and EOP) with full variance-covariance information for all parameters
- Continuous EOP series (for satellite era) - also for UT1-UTC and nutation
- Improvement of formal errors of EOP and source positions due to the combination
- Deformation of the solution is minimized as only minimum conditions are used

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Conclusions (II)

Issues of research

EOP combination

- effect on sources observed by regional (VCS) sessions only:

  different effects on sources observed before satellite era, in SLR-only and in SLR+GNSS era
- impact of different EOP on the CRF, e.g. impact of possible offsets in LOD derived from satellite techniques

TRF combination

- effects of co-location sites on the southern hemisphere on the CRF

Thank you for your attention