

Simultaneous adjustment of TRF and CRF

Manuela Seitz

Deutsches Geodätisches Forschungsinstitut

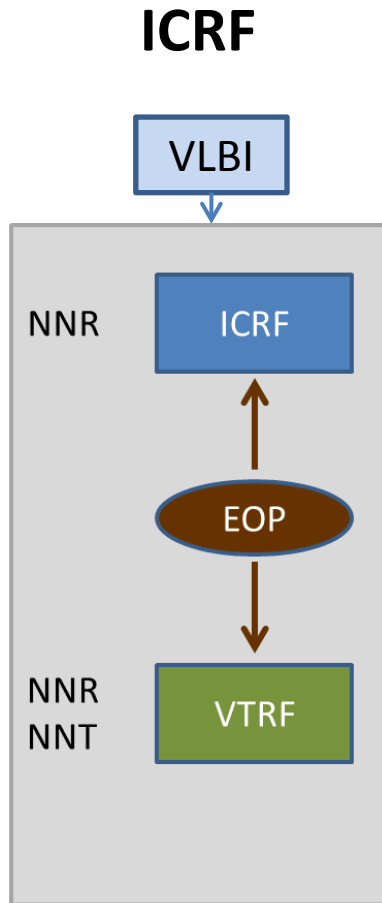
Unified Analysis Workshop 2011

Zurich, Switzerland

16./17. September 2011

Motivation (I)

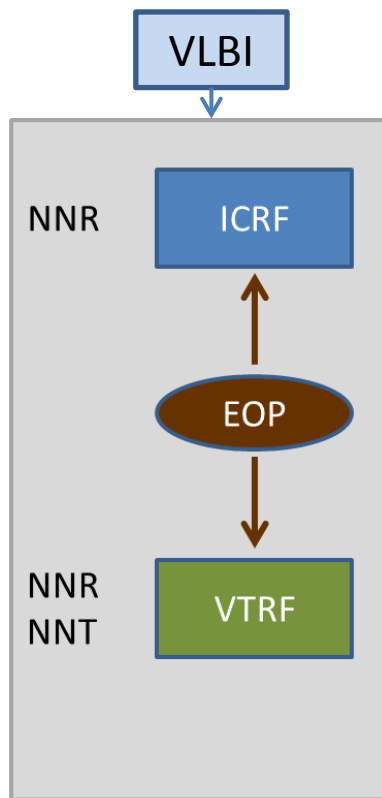
Current situation for ITRF / ICRF computation



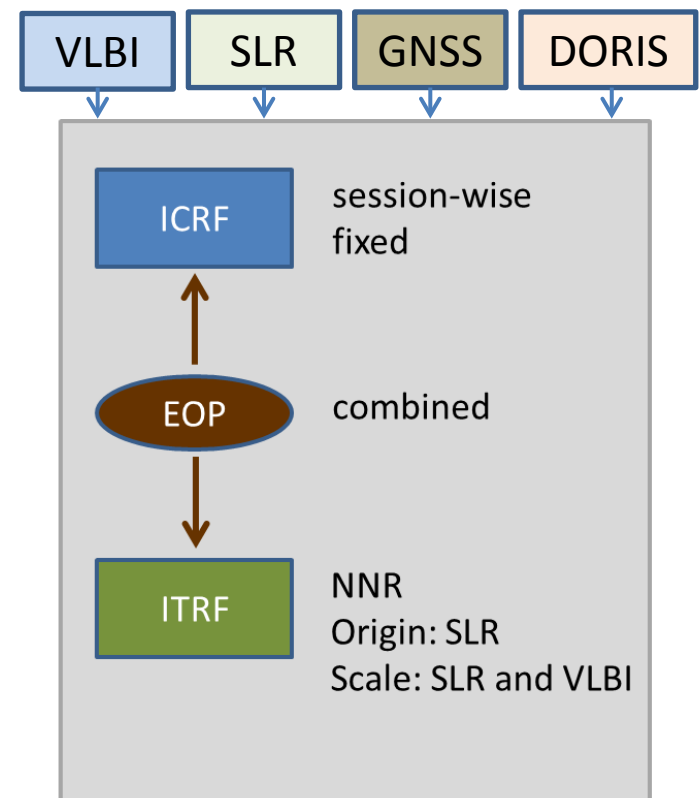
Motivation (I)

Current situation for ITRF / ICRF computation

ICRF

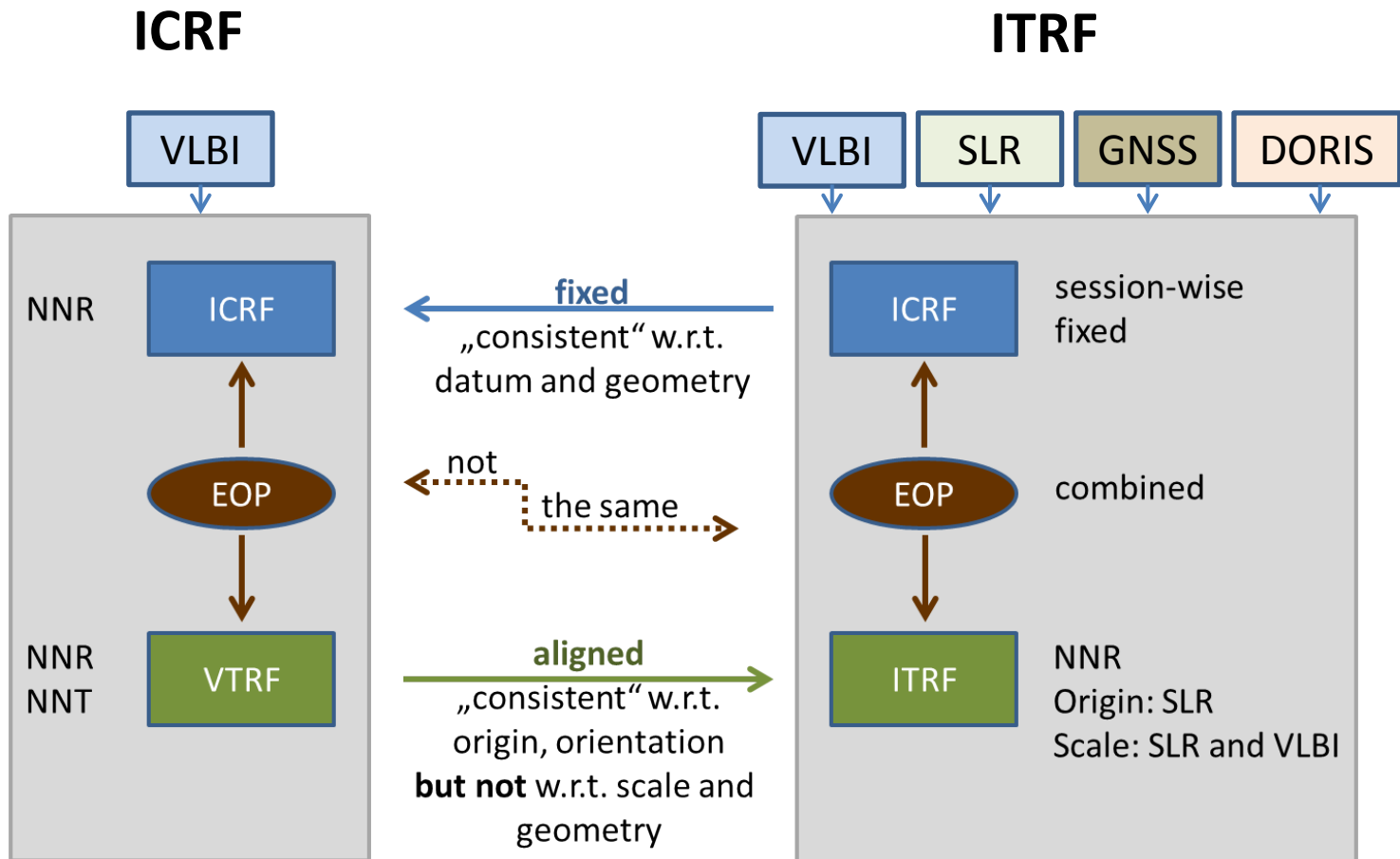


ITRF



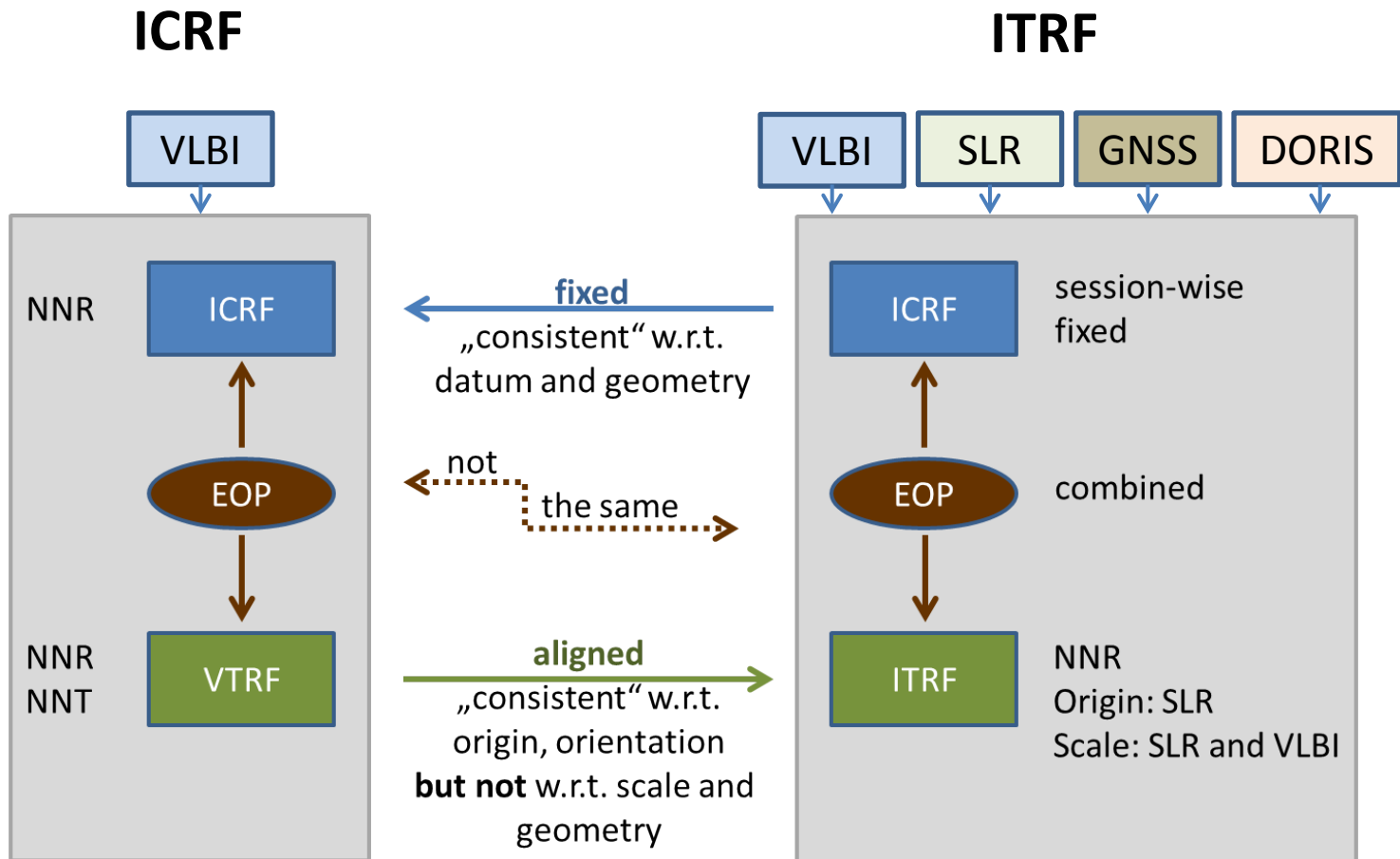
Motivation (I)

Current situation for ITRF / ICRF computation



Motivation (I)

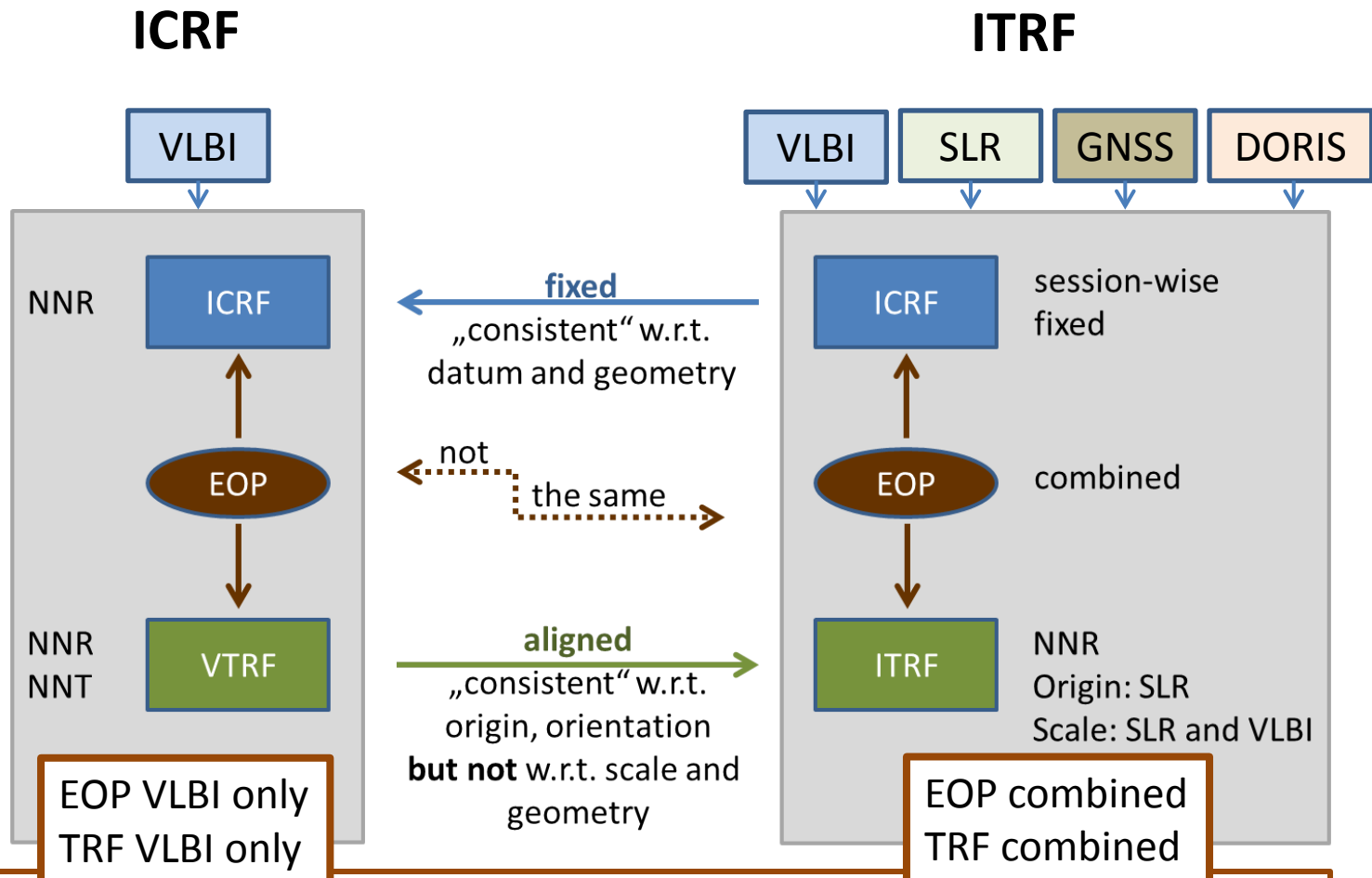
Current situation for ITRF / ICRF computation



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

Motivation (I)

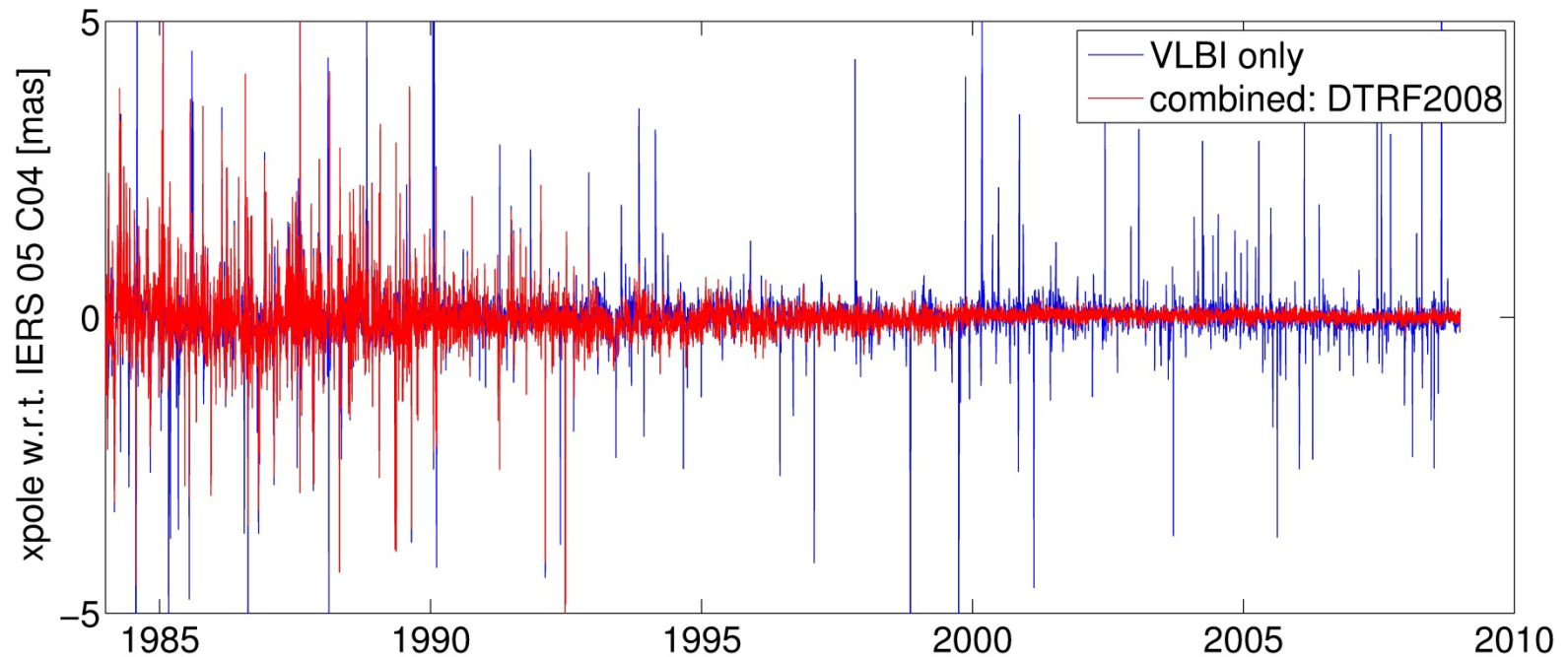
Current situation for ITRF / ICRF computation



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

Motivation (II)

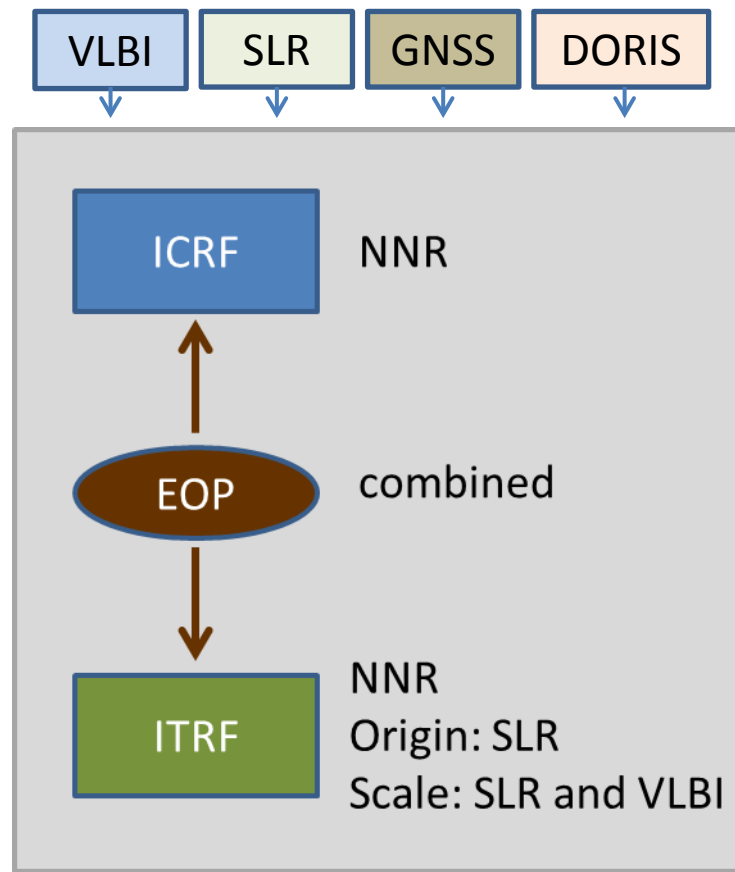
x component of terrestrial pole



	VLBI-only	DTRF2008
WRMS	163 μ as	123 μ as

Motivation (III)

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

Motivation (IV)

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
 - Effects on CRF 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

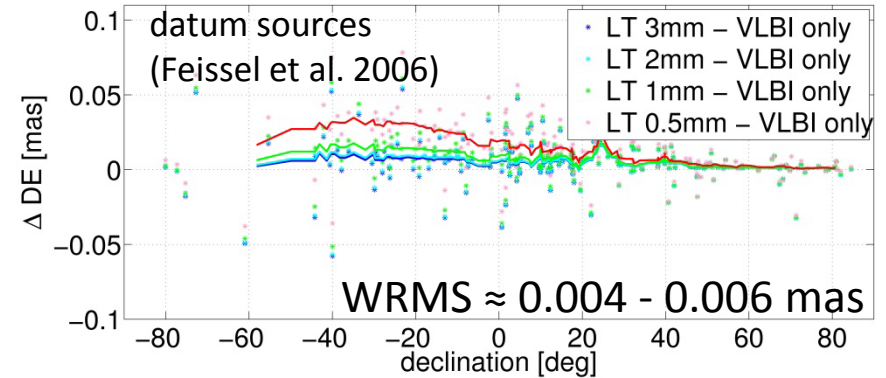
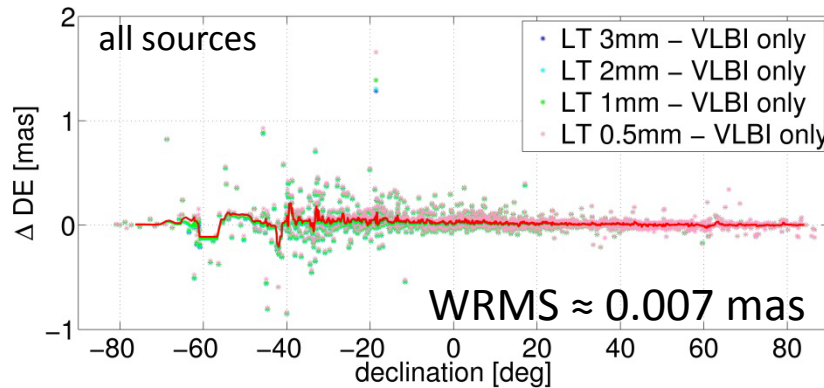
- Common parameters (sum $\approx$ 45,000)

	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

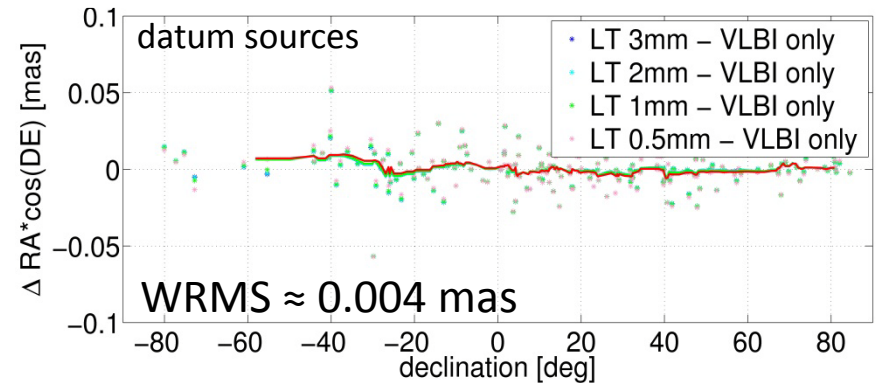
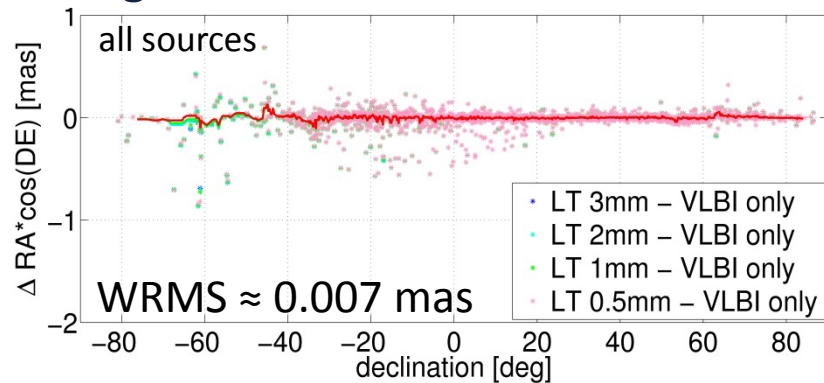
Effect of combination on source positions

Comparison with VLBI-only solution

Declination

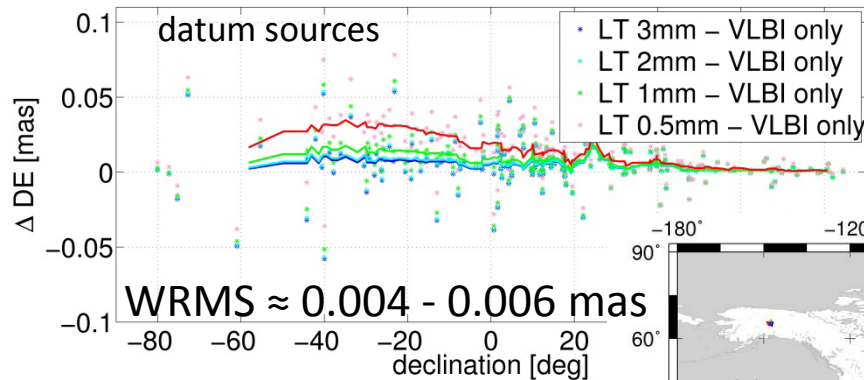


Right ascension

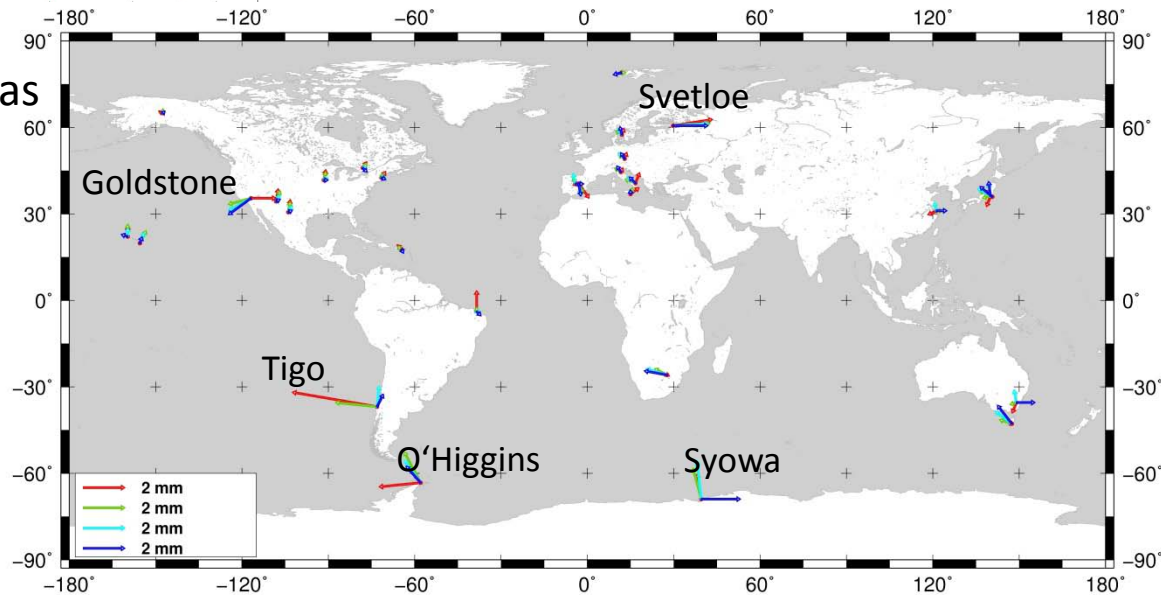


Effect of local ties on source positions

Declination w.r.t. VLBI-only



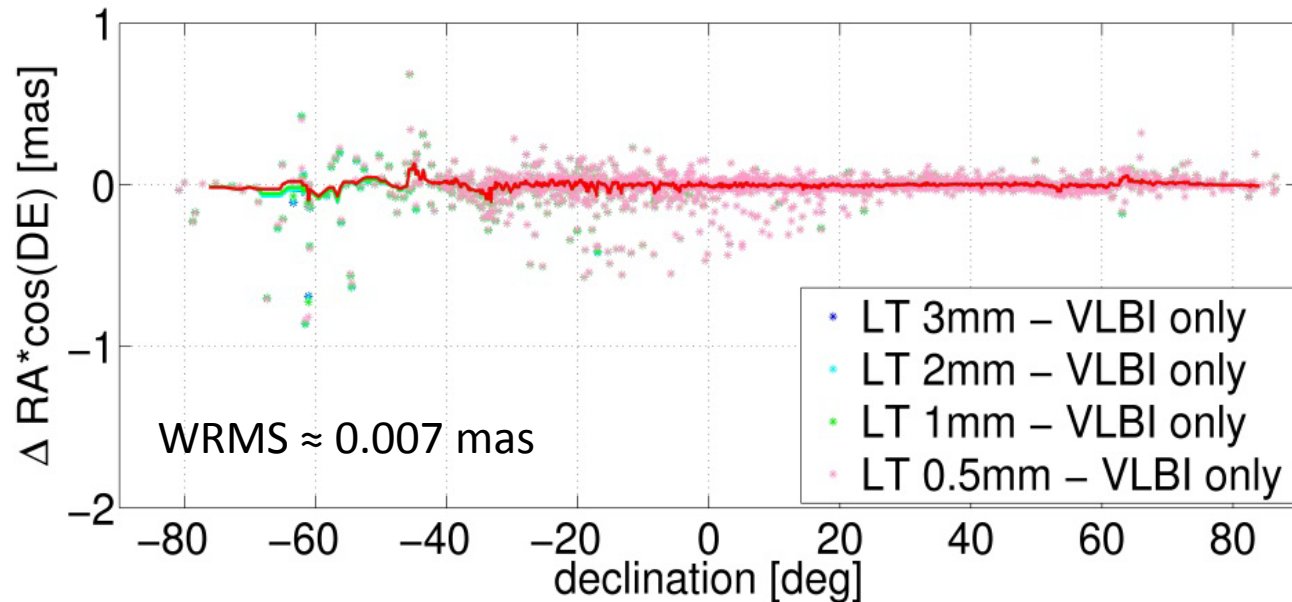
Residuals of VLBI
co-location sites:
combined – VLBI-only
(horizontal components)



Stations on the southern hemisphere show large residuals,
→ in particular sources in the southern hemisphere of CRF are affected.
But effect on CRF is very small.

Effect of EOP combination on CRF (I)

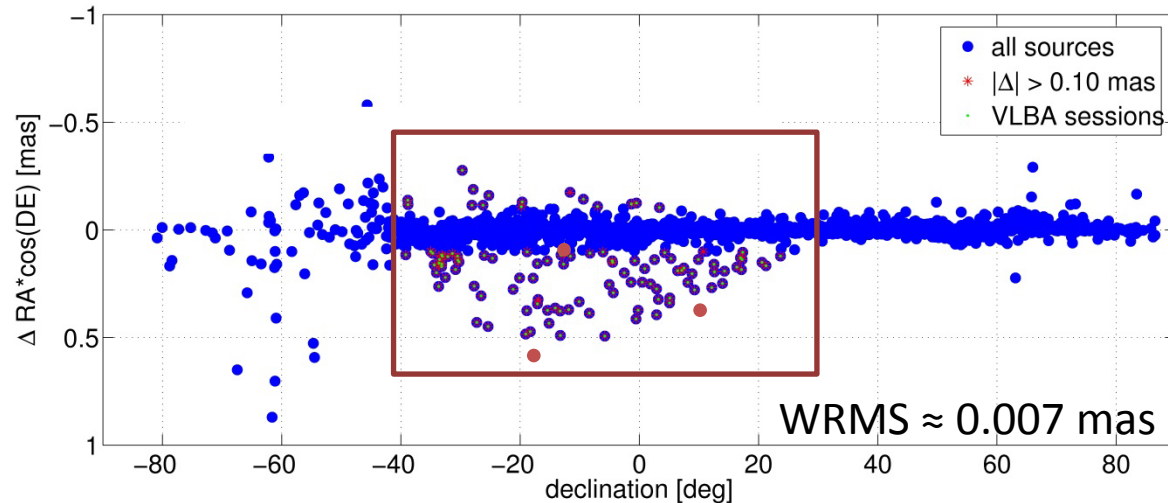
Right ascension



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

Effect of EOP combination on CRF (II)

Right ascension



Marked sources

- --- $40^\circ < DE < 30^\circ$
- $|\Delta RA \cdot \cos(DE)| \geq 0.1 \text{ mas}$
- 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.

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)

→ 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 accuracy due to the combination
- Deformation of the solution is minimized as only minimum conditions are used

Conclusions (II)

Issues of research

- sources observed by regional sessions only (EOP combination)
- effects of co-location sites on the southern hemisphere on the CRF (TRF combination)
- the stochastic model of the techniques must be studied well (the not justified dominance (not in that order of magnitude) of GPS is a critical issue), a variance component estimation cannot solve the problem.
- handling of the LOD offsets of the satellite techniques

Recommendations (I)

Recommendations

Technique observation analysis:

- VLBI/IVS should provide also source coordinates (full var-covar)
- All services should provide the full var-covar of constraints (datum-related) or normal equations without datum-related constraints
- Consistency in modeling and parametrization (EOP)
- All EOP parameter should be provided (including LOD and nutation rates from satellite techniques)

Recommendations (II)

Recommendations

Combination:

- The simultaneous adjustment of TRF and CRF should be focussed
- Validation procedures for all estimated parameters have to be developed
- All issues of ITRF are also relevant here, e.g.
 - Information on datum-related constraints is required for input data
 - Non-linear station motions
 - Monitoring of local ties
 - Rigorous combination

→ IAG Resolution on the improvement of the consistency of ICRF and ITRF

Thank you for your
attention