Common Realization of Terrestrial and Celestial Reference Systems

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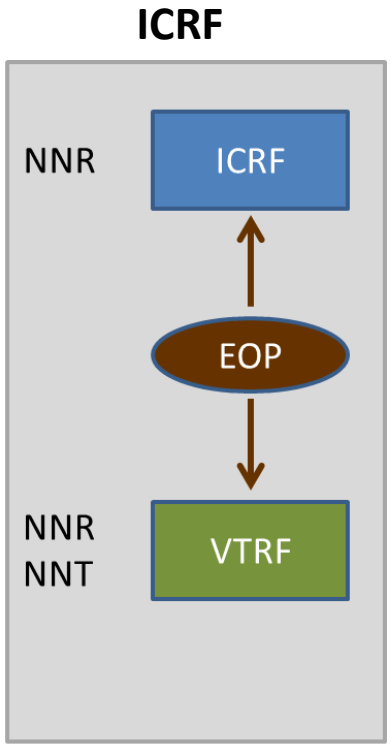
Outline

- Motivation
- Data
- Computation strategy
- Solution approaches
- Discussion of the results
- Conclusions

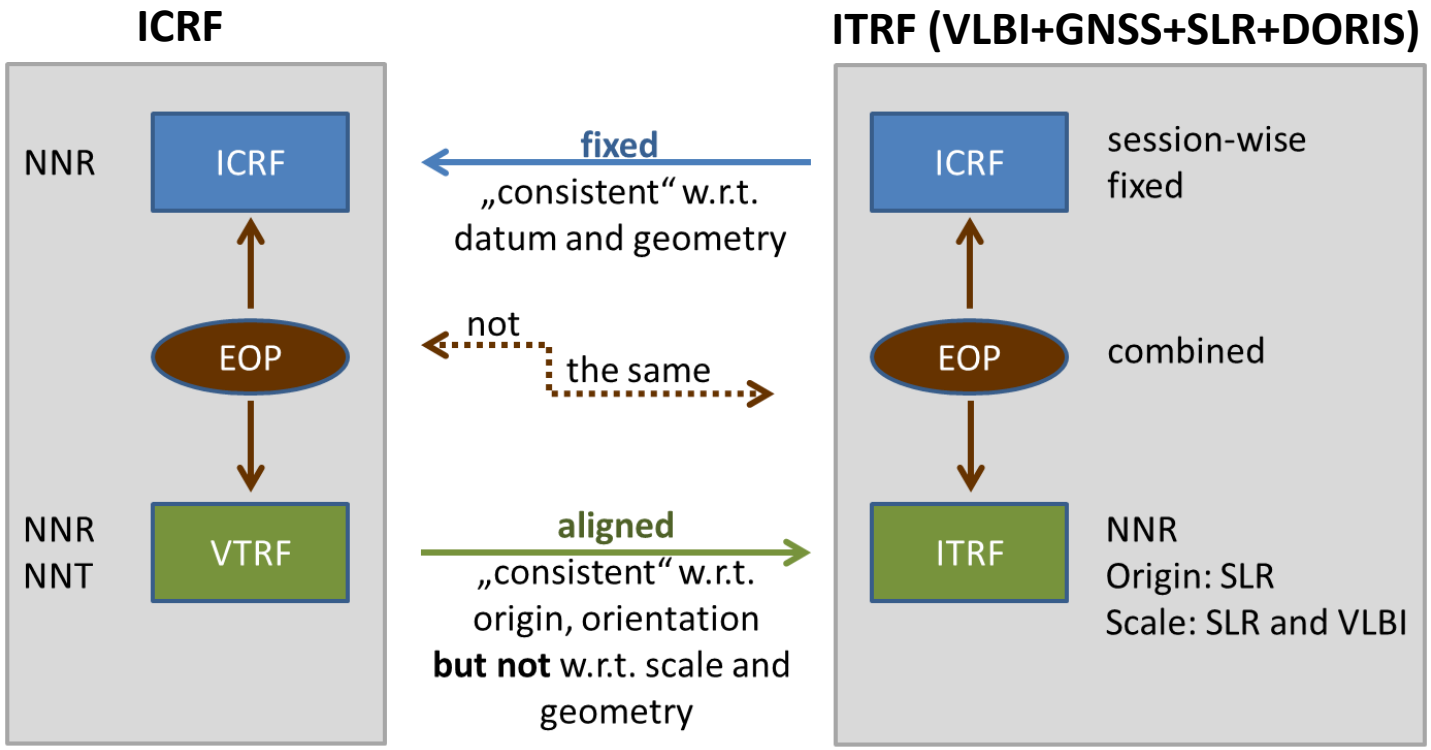
Motivation

Current situation for ICRF / ITRF computation



Motivation

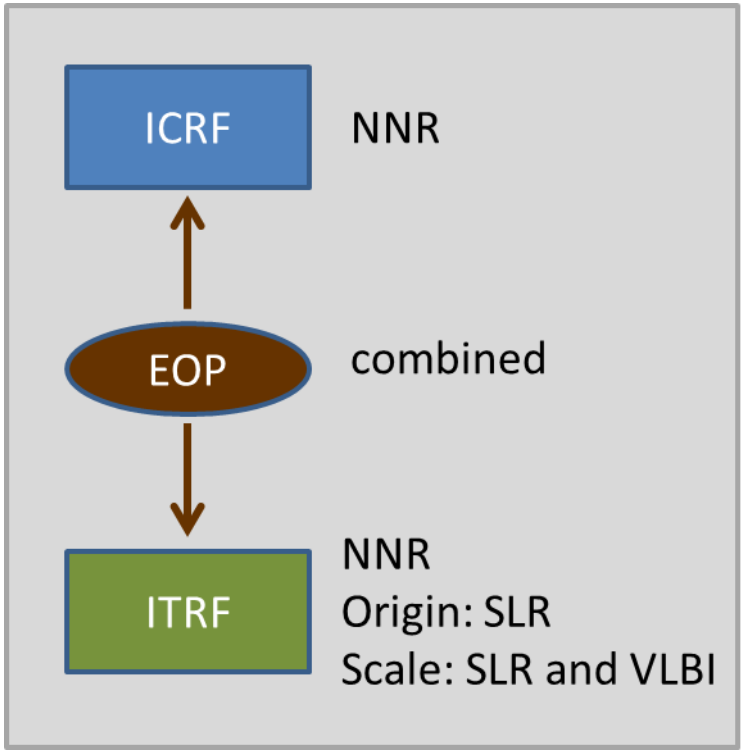
Current situation for ICRF / ITRF computation



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

Motivation

Consistent realization of ICRS and ITRS



- TRF (VLBI+SLR+GNSS+DORIS), CRF and EOP are simultaneously estimated in one adjustment
- only minimum conditions (no net rotation conditions) are used for datum realization

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Motivation

What is expected from a common adjustment?

- Consistency between all parameters
- Impovement of the accuracy of EOP time series w.r.t. technique-specific
- Effects on CRF due to
  - Combination of EOP (benefit)
  - Combination of station coordinates (+/-)

Data used

- Time series of normal equations of VLBI, GPS and SLR data
- Generated using consistent models and parameterizations (GGOS-D project)

	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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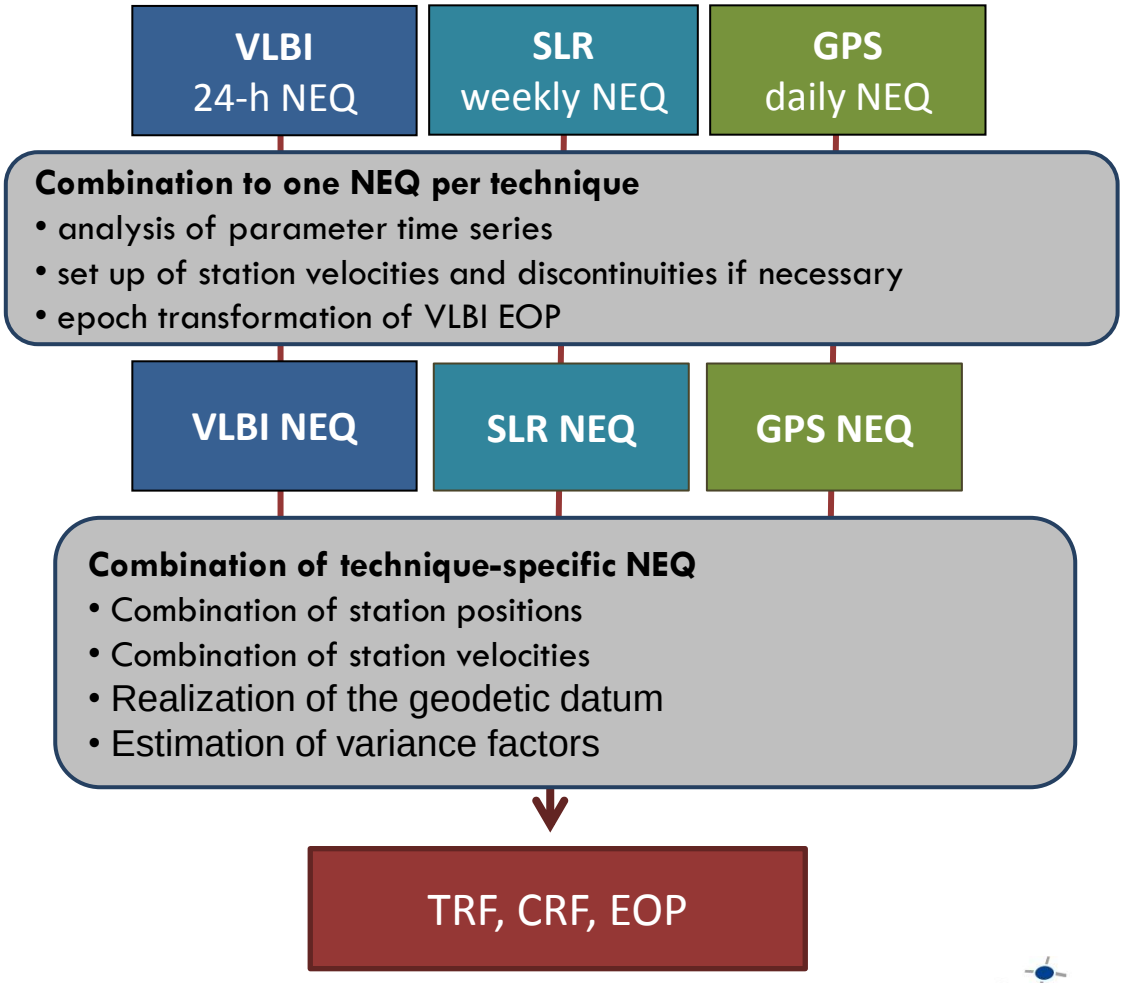
Computation strategy (I)

… based on normal equations (NEQ)



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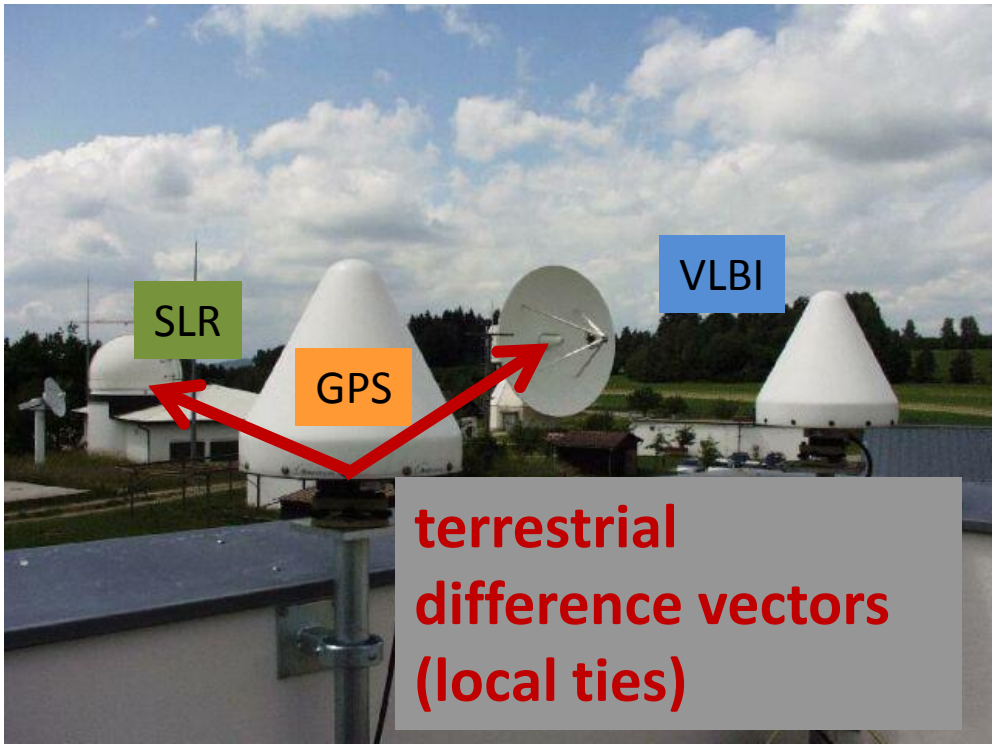
Computation strategy (II)

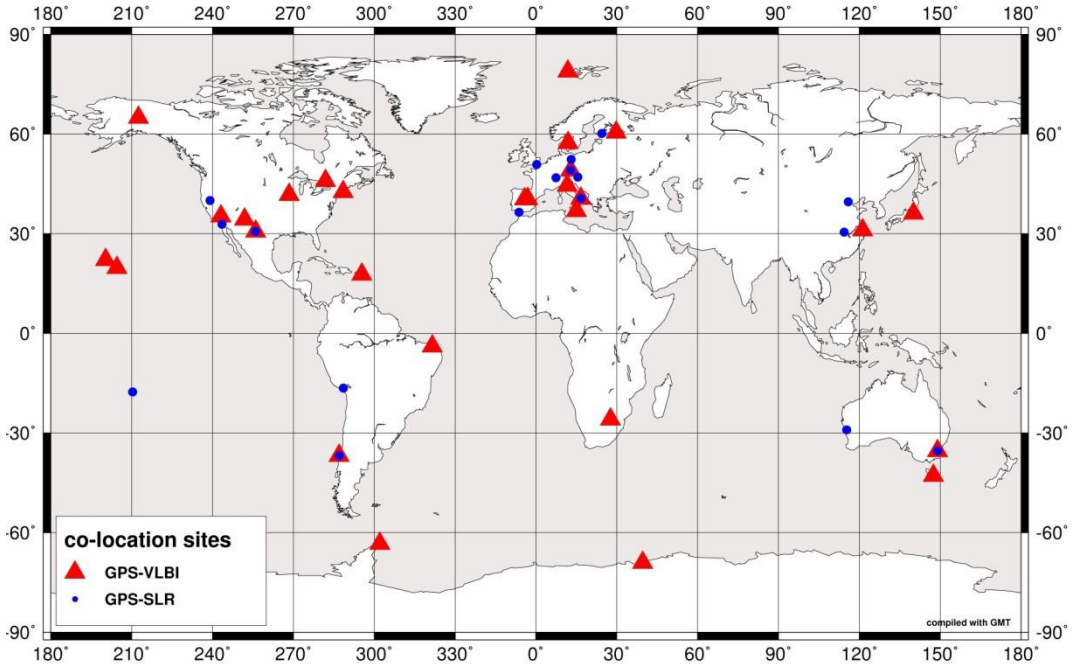
Combination of station positions for example at station Wettzell



http://www.fs.wettzell.de/

Solution approaches

Global distribution of co-location sites



- Critical aspects w.r.t. the combination:
  - Inhomogeneous distribution
  - Discrepancies between local ties and space geodetic techniques can reach a few centimetres

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Solution approaches

For comparisons

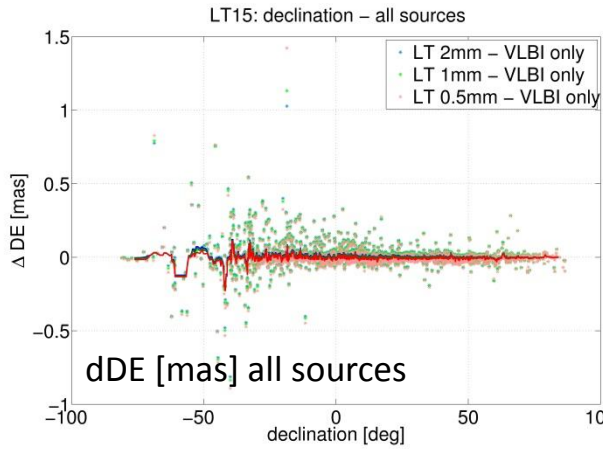
VLBI only solution (2378 sources)

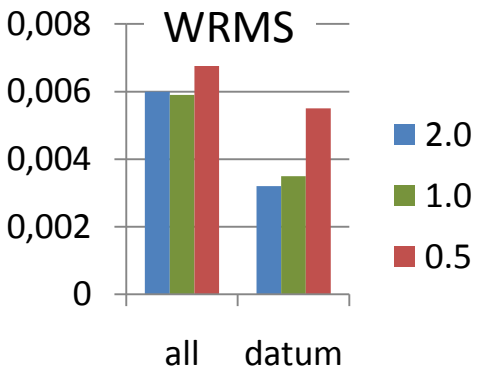
Three combined solutions

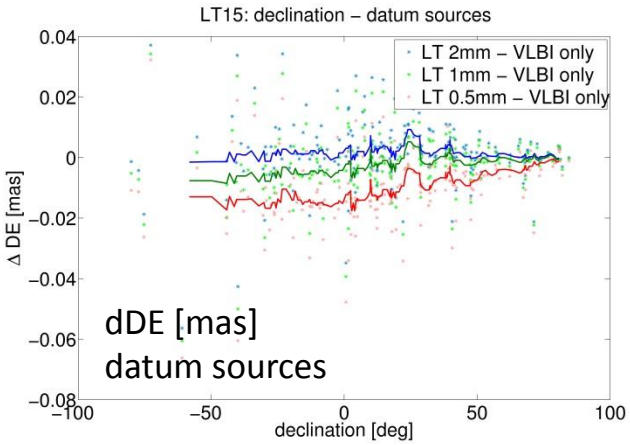
- Terrestrial difference vectors (local ties) introduced with variable standard deviations σ=2.0, 1.0 and 0.5 mm;
  Aspects to be considered:
  - Ensure consistency of the combined frame
  - Limit the deformation of the networks

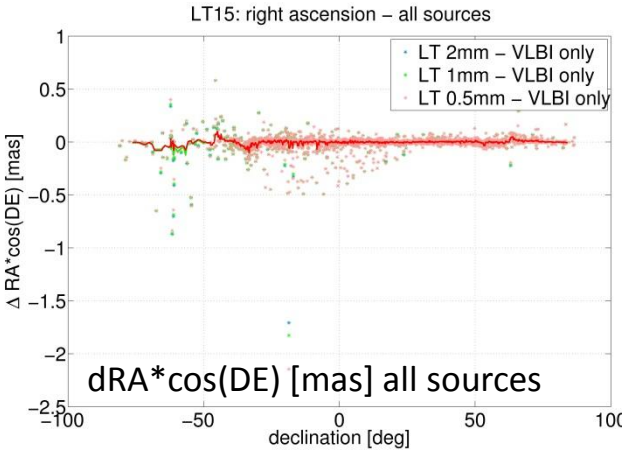
Combined solution (I)

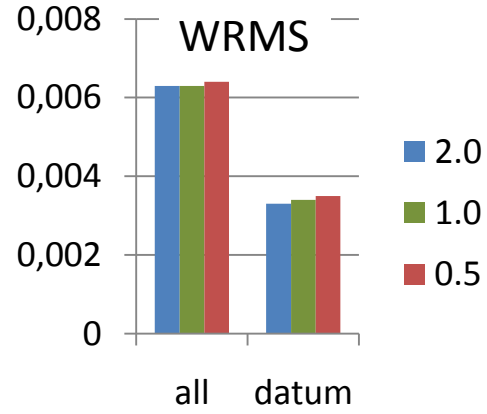
Effect of combination on source positions (w.r.t. VLBI only)

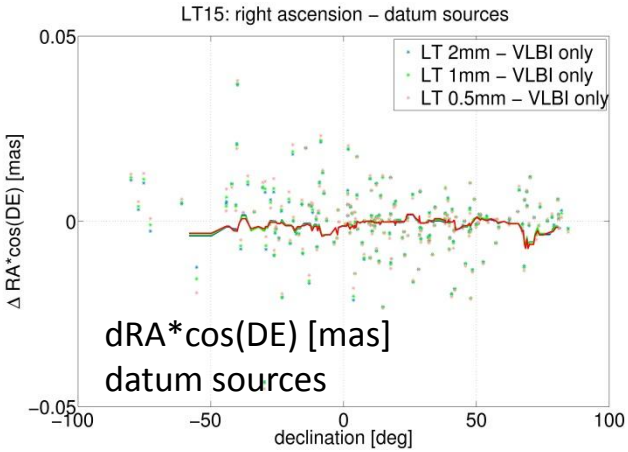












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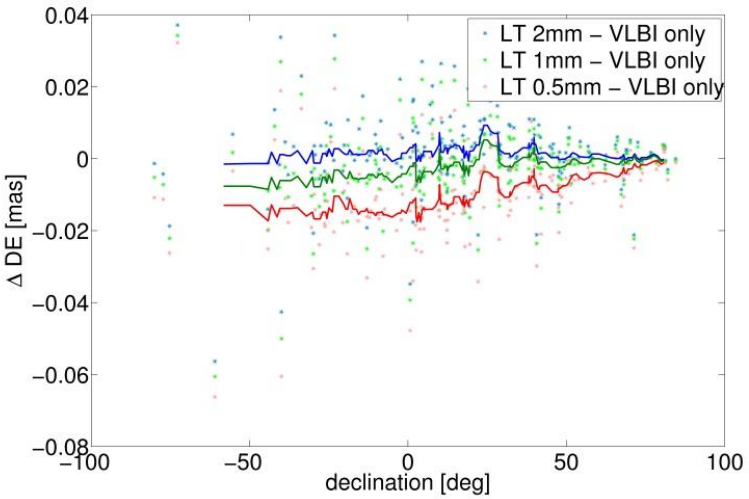
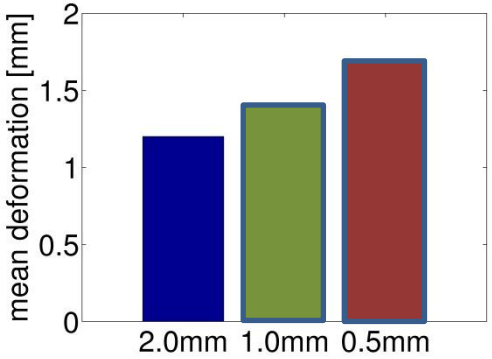
Combined solution (II)

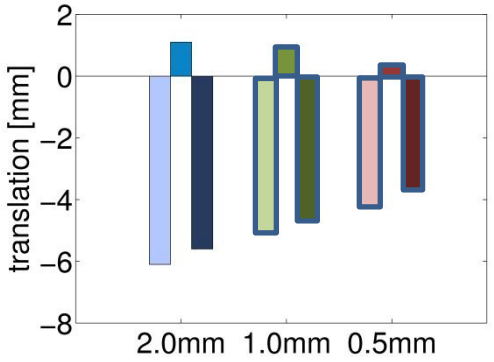
Effects of combination on CRF and TRF



Mean deformation of station network



Translation of VLBI network part w.r.t. DTRF2008



Deformation of the network and datum realization have to be balanced.

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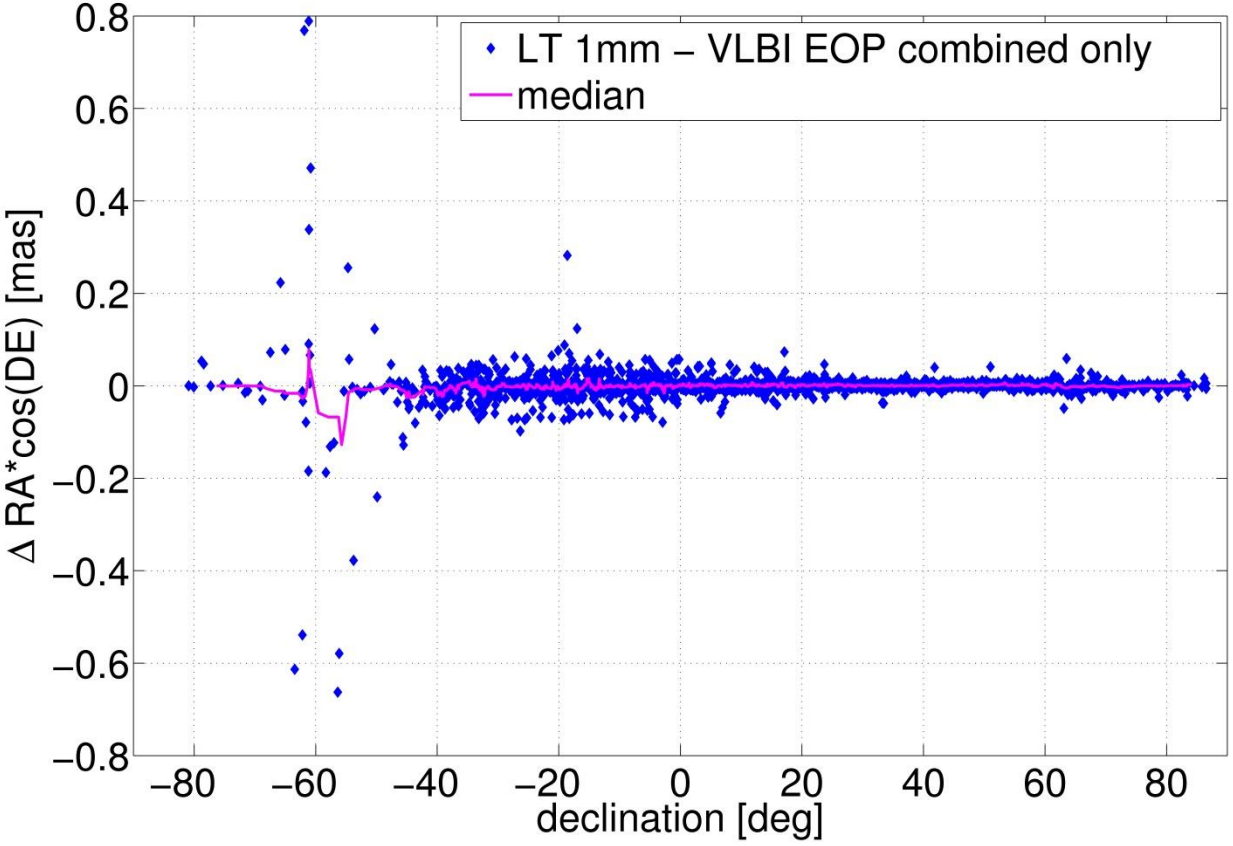
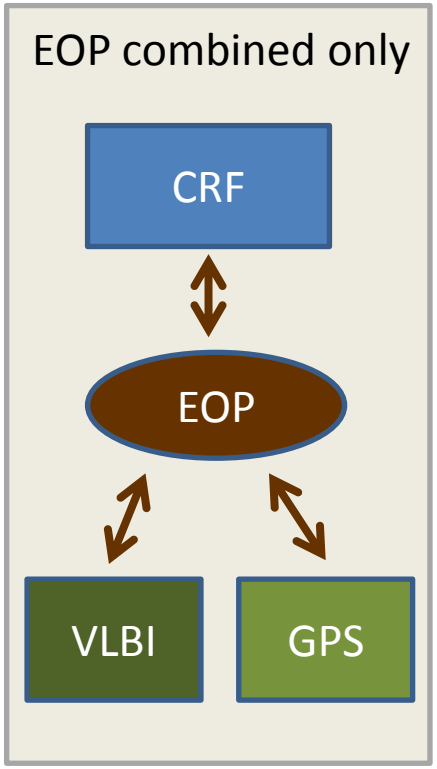
Combined solution (III)

Effect of local ties

CRF-TRF solution w.r.t. „EOP combined only“





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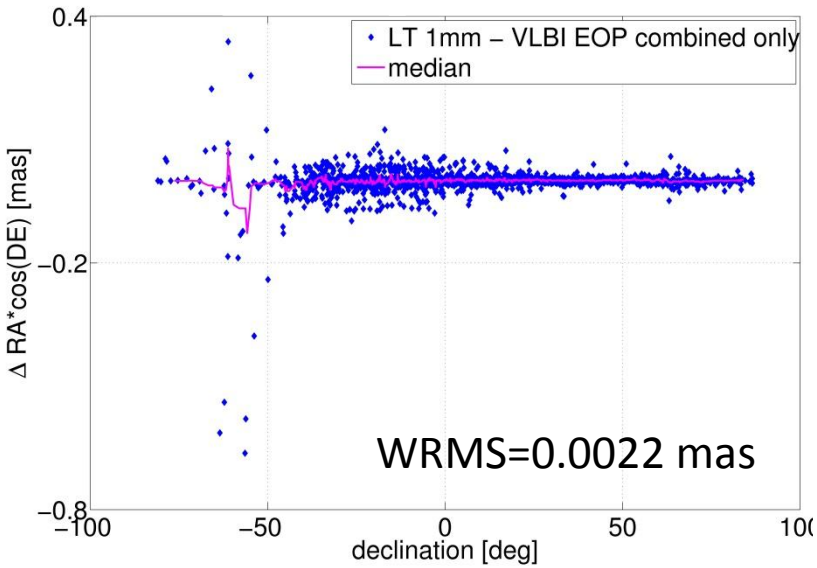
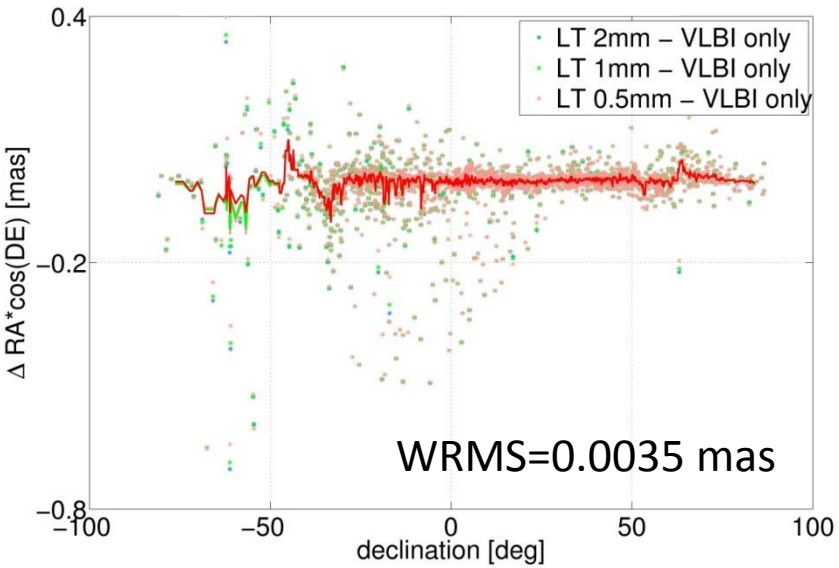
Combined solution (III)

Effect of combined EOP

CRF-TRF solution w.r.t. „EOP combined only“





- Effect at -40°<DE < 40° results from EOP combination
- Large standard deviations of sources are not the reason for the signature
- Sources observed by one session type only?
- Sources in the South are affected by combination of station coordinates

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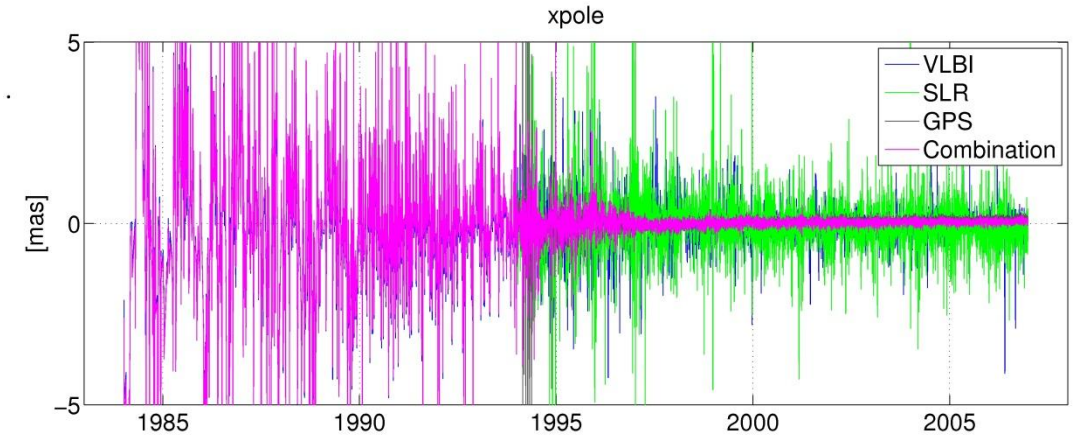
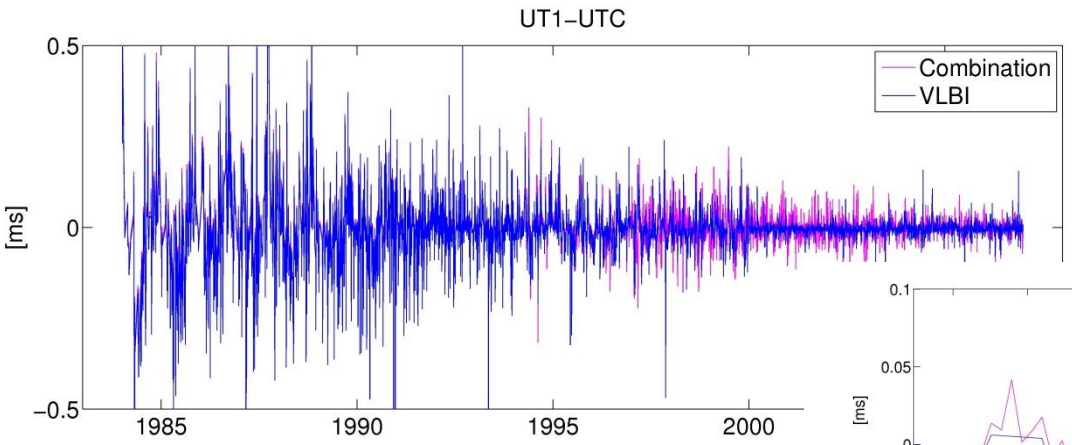
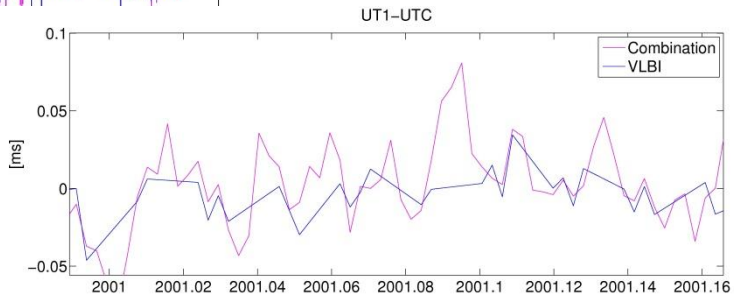
Combined solution (IV)

EOP results (w.r.t. IERS 08 C04)







- Scatter of EOP series is removed by the combination
- UT1-UTC and Nutation: starting in 1997 series are continuous because of SLR and GPS contribution

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Combined solution (V)

EOP results: RMS values w.r.t. IERS 08 C04

	Xpole [µas]	Ypole [µas]	UT1-UTC [µs]	Nutation X [µas]	Nutation Y [µas]
VLBI	450.0	453.0	32.3	217.5	212.4
GPS	85.6	83.8			
SLR	732.2	745.6			
Combi	**92.4**	**89.2**	**34.2**	**289.9**	**298.6**
Combi VLBI only epochs			**24.3**	**197.2**	**204.2**

Conclusions

- Common adjustment of TRF, CRF and EOP is possible
  → Consistency of TRF, CRF and EOP is achieved

- Effect of combination on the CRF is very small e.g. compared to handling of gradient constraints (systematic, 0.1 mas and more in dDE)
  - Datum sources : WRMS 0.004 mas (range +- 0.05)
  - All sources: WRMS 0.007 mas (range -2.5/1.5)

- Sum of the effects of combination of EOP and combination of frames
  - “bow”-signature at -40° < DE < 40° results from EOP combination
  - Sources close to the celestial South pole are affected by the combination of the station coordinates (local ties)

Next steps

- Investigation of the effects of individual co-location sites
- Effect of VLBI session types on source coordinate differences
- Development of validation procedures

- Improvement of the relative weighting of the techniques
  → further reduction of EOP series noise

- Extension of the input series

Acknowledgement

We thank all the members of the GGOS-D group for providing the input data and for discussions.