

New DGFI input data and Combination of techniques at CC DGFI

Manuela Seitz

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New DGFI input data

		VLBI	SLR
general	Pole tide	linear mean pole	linear mean pole
	A priori EOP	IERS 08 C04	IERS 08 C04
	A priori EOP interpolation	linear	linear
	Ocean loading	FES2004	FES2004
technique-specific	Relativistic model	improved	
	Satellites		L1/2
	Gravity field		EIGEN-GRG.RL02
	Ocean tides		FES2004

Outline

- Input data
- New SINEX files
- Intra-technique combination
- Inter-technique combination

Input data

Changes since November 2010

	AIUB	DGFI	ESOC	GFZ	GRGS	MAO	OPA	TUW
GPS	n2				n6			
SLR	n3	w2	w1		n2			
VLBI		n2			n4	n1	n1	n1
DORIS					n5			
L-P			n1	n1				
L-D			n1/n2					

New SINEX files

SINEX files Nov. 2010

Input data

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	AIUB	DGFI	ESOC	GFZ	GRGS	MAO	OPA	TUW
GPS	n2				n6			
SLR	n3	w2	w1		n2			
VLBI		n2			n4	n1	n1	n1
DORIS					n5			
L-P			n1	n1				
L-D			n1/n2					

New SINEX files

SINEX files Nov. 2010

Remarks to the new SINEX files

GPS

GRGS: orientation constrained (n6/n7)

AIUB: many DOMES numbers are used twice

SLR

AIUB, DGFI, GRGS: okay

VLBI

DGFI, MAO, OPA, TUW: okay

GRGS: station names are not given for all of the troposphere parameters

DORIS

„D“ in SINEX file is shifted by one column (SATA_*)

→ Except of [GPS/GRGS] all NEQ provide the expected number of degrees of freedom

Analysis and combination procedure at DGFI

Step by step

Per technique:

- daily to weekly [GPS/AIUB]
- comparison and combination of input files

Inter-technique1:

- comparison and combination of VLBI-, SLR-, and GPS-only contributions

Inter-technique2:

- comparison and combination of inter-technique 1 and pre-combined SLR-DORIS, SLR-GPS data

Analysis and combination of VLBI data

Contributions: DGFI, MAO, OPA, TUW (GRGS could not be read from SINEX)

Analysis:

	A posteriori Sigma	Transformation DTRF2008 (scale)	RMS of transformation
DGFI	1.0	≤ 9 mm	5 – 7 mm
MAO	20.0	20-30 mm	20-30 mm
OPA	800000.0	≤ 10 mm	5 – 7 mm
TUW	1.0	≤ 10 mm	5 – 7 mm

- DGFI, OPA and TUW are combined.
- standard deviations of OPA very large (ltpl of $1 \cdot 10^{15}$ vs. $1 \cdot 10^4$ for DGFI and TUW) → contribution to combined solution is very small

Analysis and combination of VLBI data

Combination aspects

- Consideration of variance components is necessary
- DGFI, OPA: EOP transformed from O+D -> pwl
- Troposphere parameters (TUW): have to be stabilized
- Sources (TUW): fixed to ICRF2

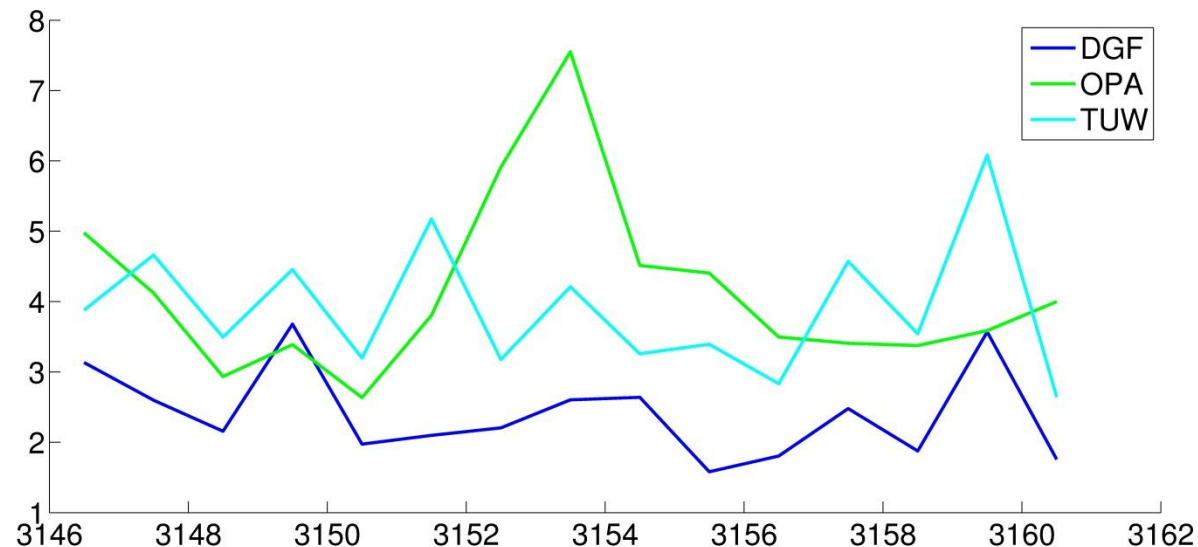
- dUT1: DGFI and TUW (UT1-UTC); OPA (UT1-TAI)
 - > **dUT1 combined for DGFI and TUW only**
- Nutation: TUW[X,Y]; DGFI and OPA [PSI, EPS]
 - OPA: a priori values are not 0.0 (model values?)
 - > **nutation is not combined**

→ Parameterization of VLBI contributions must be further homogenized.

Analysis and combination of VLBI data

Combination results

RMS of similarity transformation between combined and single AC solutions

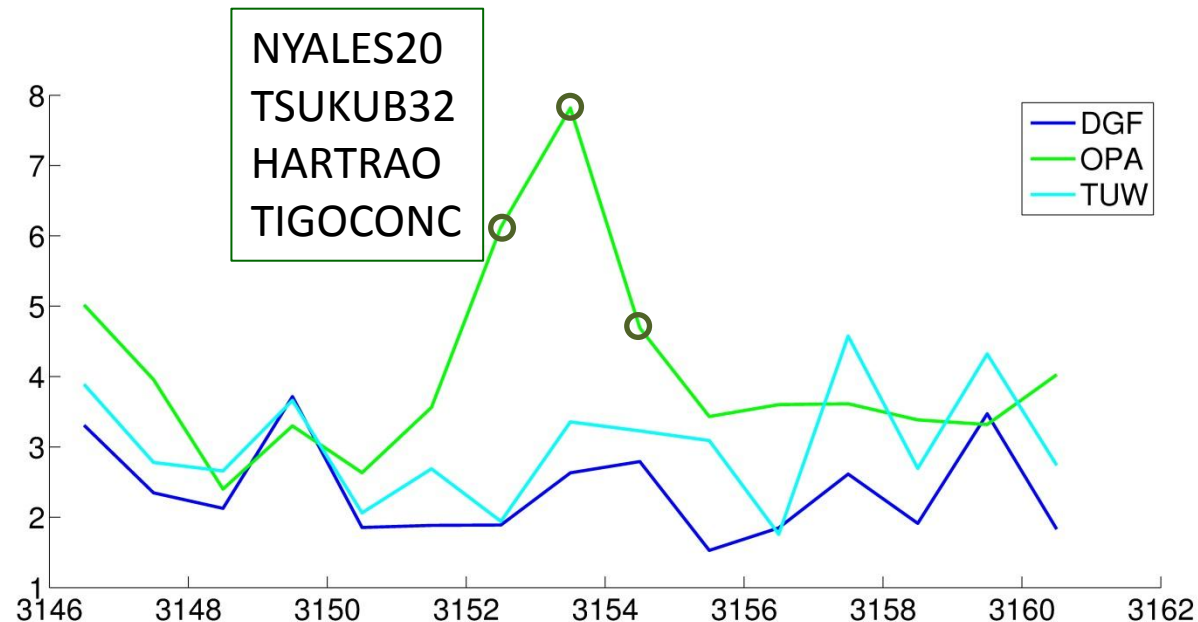


→ Offsets between the AC contributions

Analysis and combination of VLBI data

Combination results

RMS of similarity transformation between combined and single AC solutions

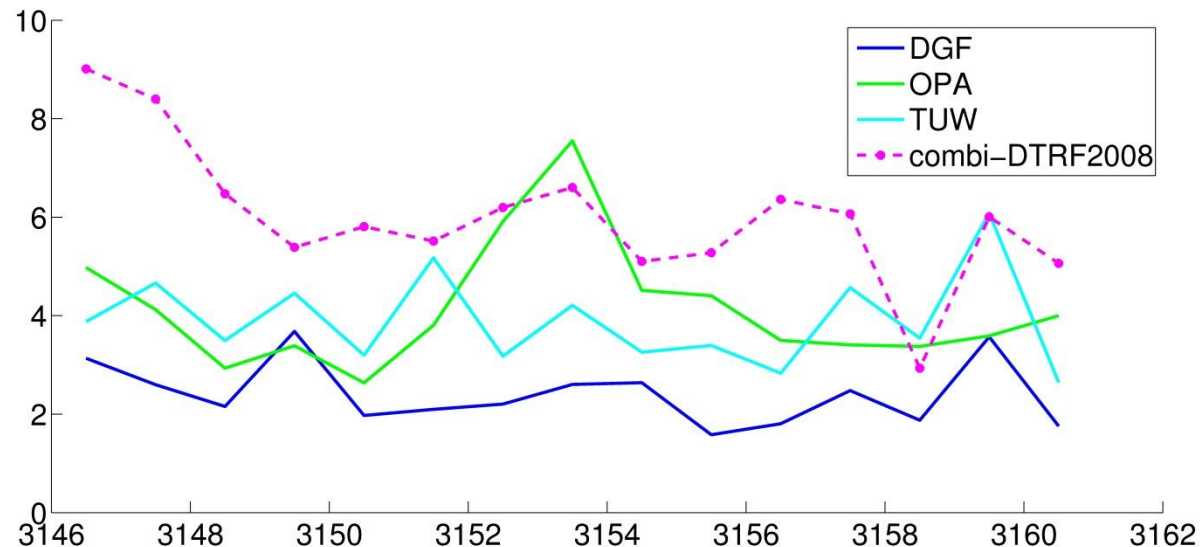


→ NYALES20 not used in transformation: offset between DGF and TUW removed. What are the reasons? Modell differences? (→ height component)

Analysis and combination of VLBI data

Combination results

RMS of similarity transformation between combined and single AC solutions

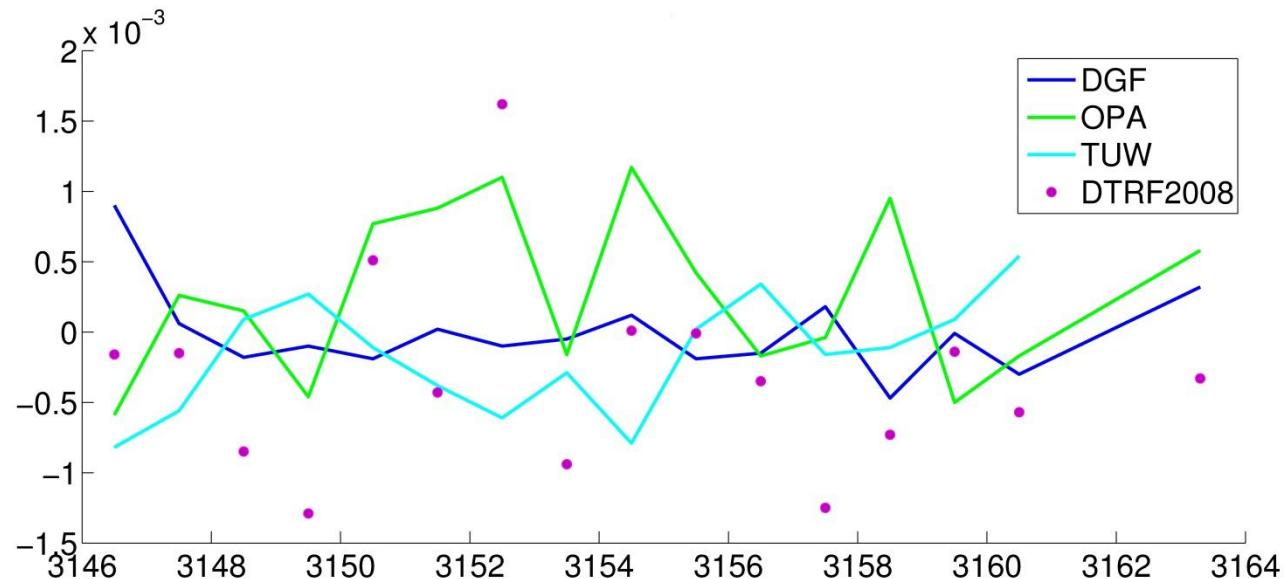


→ Agreement of AC better than agreement to DTRF2008 (model differences; epoch vs. multi-year solution)

Analysis and combination of VLBI data

Combination results

Scale differences [ppm] derived from transformation between combined and single AC solutions (and DTRF2008)

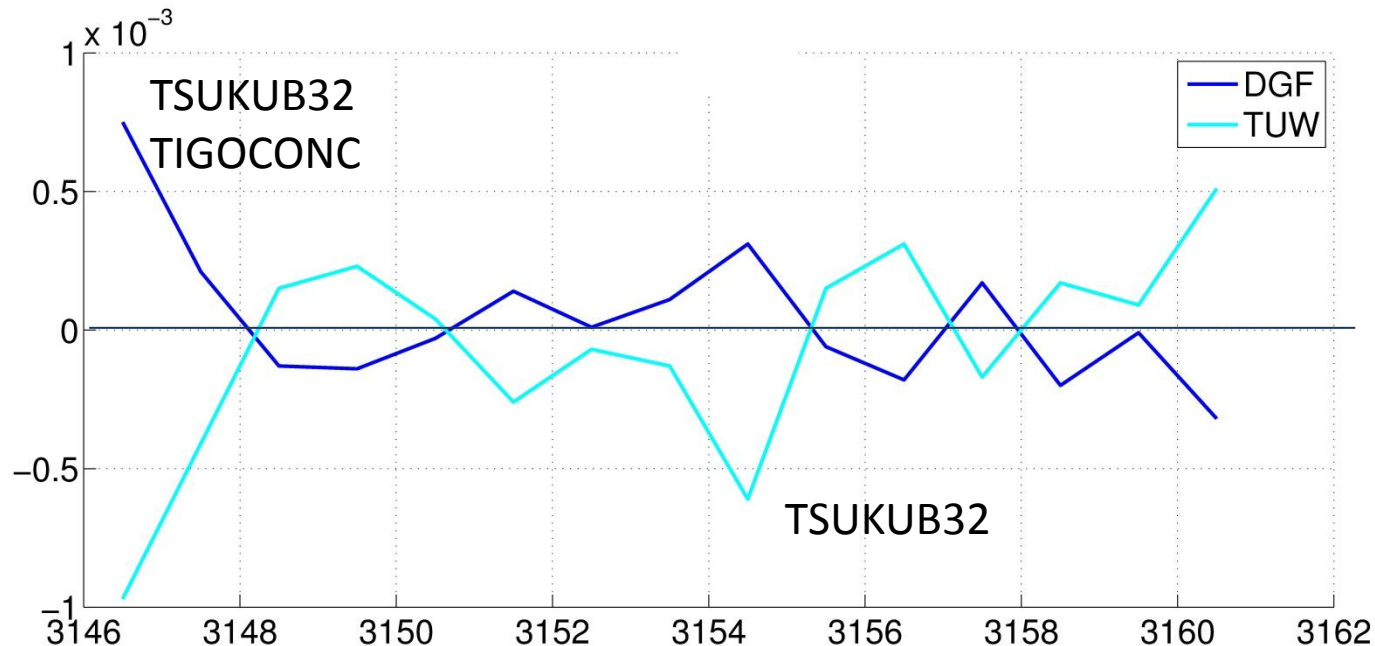


- Contribution of OPA very small (due to large STD).
- RMS of scale differences between AC comparable to comparison of combined solution and DTRF2008 (Offset: -0.5 ppb)

Analysis and combination of VLBI data

Combination results

Scale differences [ppm] derived from transformation between combined and single AC solutions



→ Scale is weighted mean of DGF and TUW.

Analysis and combination of VLBI data

Summary:

- Good agreement (MAO should be analyzed in detail)
- EOP parameterization must be homogenized (Nutation, dUT1)
 - DGF, MAO and OPA -> [X,Y]
 - Nutation parameters: correction to nutation model
a priori values = 0.0
 - OPA -> UT1-UTC
 - Same a priori values, interpolation
- SINEX completed (GRGS)
- Standard deviations of OPA must be investigated
- What are the reasons for the disagreements between the ACs?

Analysis and combination of SLR data

Contributions: AIUB, DGFI, GRGS

Analysis:

	A posteriori Sigma	Transformation DTRF2008 (tra, sc)	RMS of transformation
AIUB	0.01	≤ 5 mm	15 mm
DGFI	1.3	≤ 10 mm	15 mm
GRGS	0.5	≤ 10 mm	15 mm

- Homogeneous SLR input data
- Second week slightly worse than weeks 1 and 3

Analysis and combination of SLR data

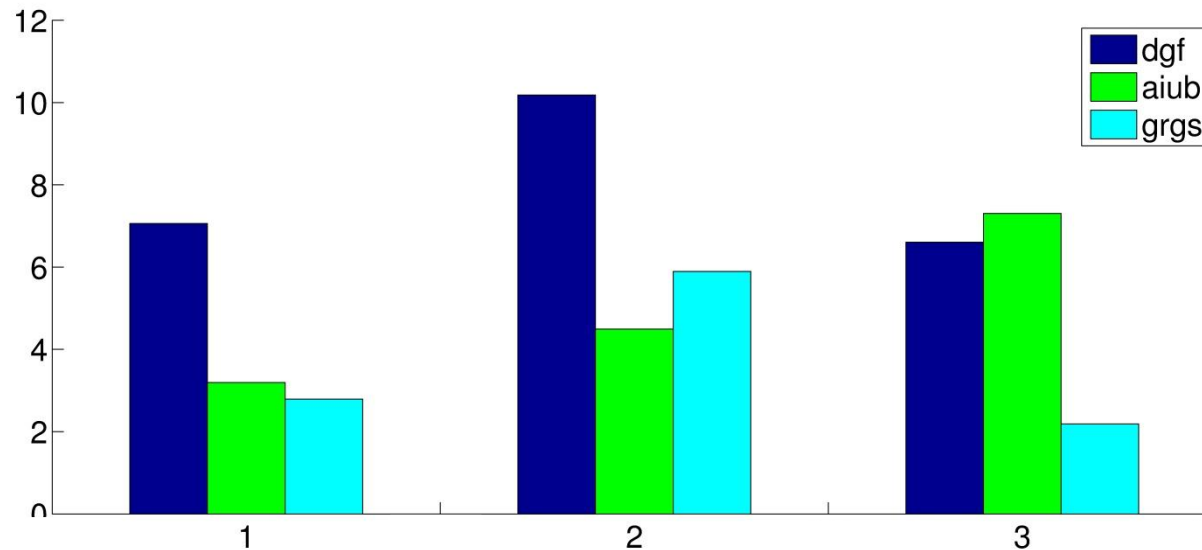
Combination aspects

- Consideration of variance components is necessary
- Geocentre coordinates (AIUB) fixed to 0.0
- EOP:
 - CODE: O+D -> pwl
 - GRGS provides pwl values at noon (cannot be transformed)
 - > only the EOP of AIUB and DGFI are combined
 - week 3 cannot be solved if EOP are combined (ITPI) !!
What is the reason?

Analysis and combination of SLR data

Combination results

RMS [mm] of similarity transformation between combined and single AC solutions

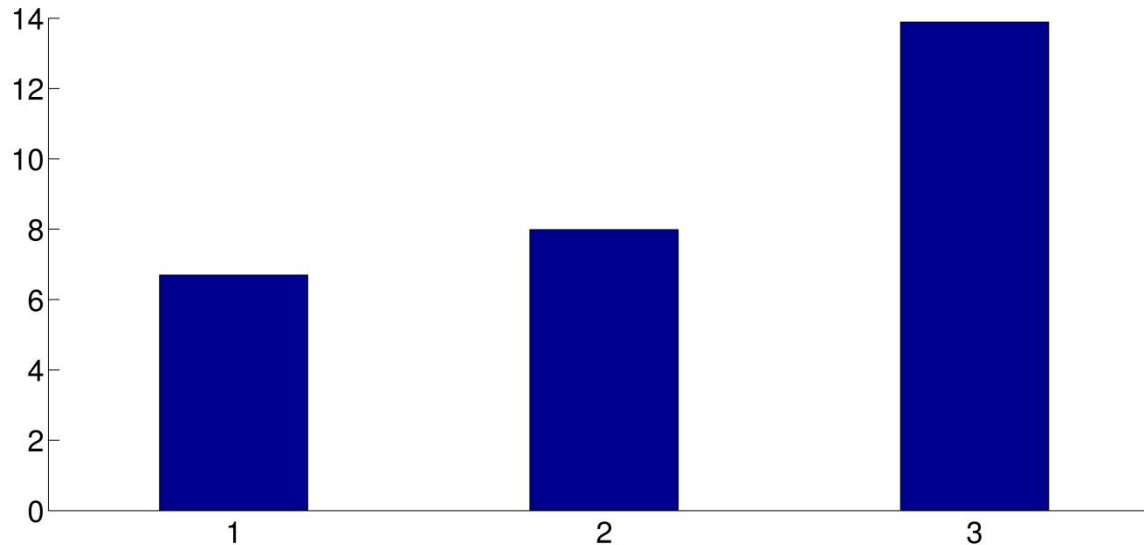


→ Comparable RMS values, DGFI values (weeks 1 and 2) slightly larger (improved compared to first DGFI solution)

Analysis and combination of SLR data

Combination results

RMS of similarity transformation between combined solution and DTRF2008

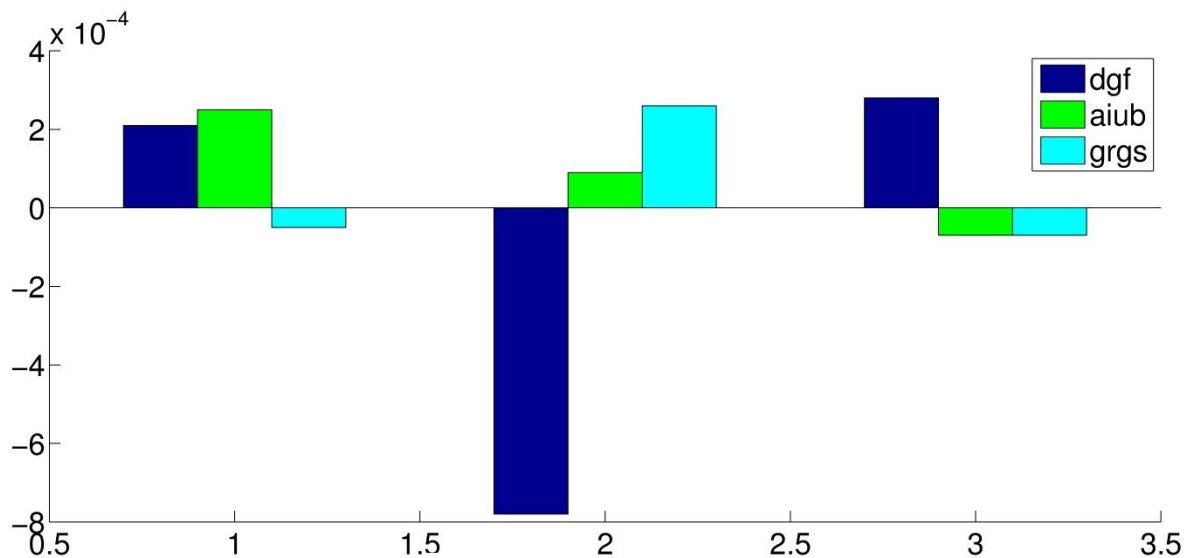


→ Comparable to RMS for single AC w.r.t. DTRF2008 (15 mm); week 1 and 2 benefit from combination

Analysis and combination of SLR data

Combination results

Scale differences [ppm] between combined solution and single AC solutions

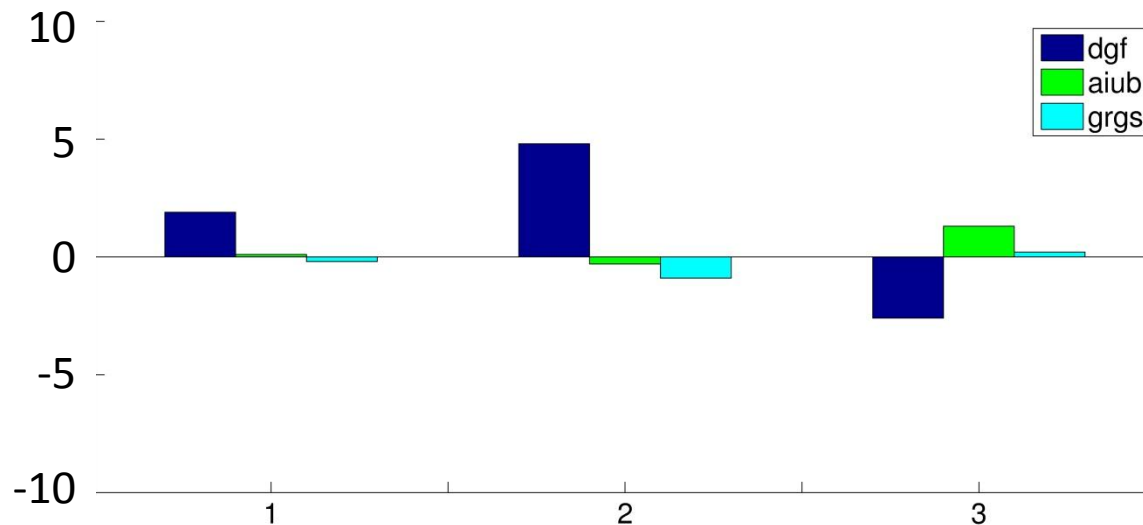


→ Agreement: 0.2 ppb (~ 1.5 mm) ; except of week 2 / DGFI

Analysis and combination of SLR data

Combination results

X-Translations [mm] between combined solution and single AC solutions

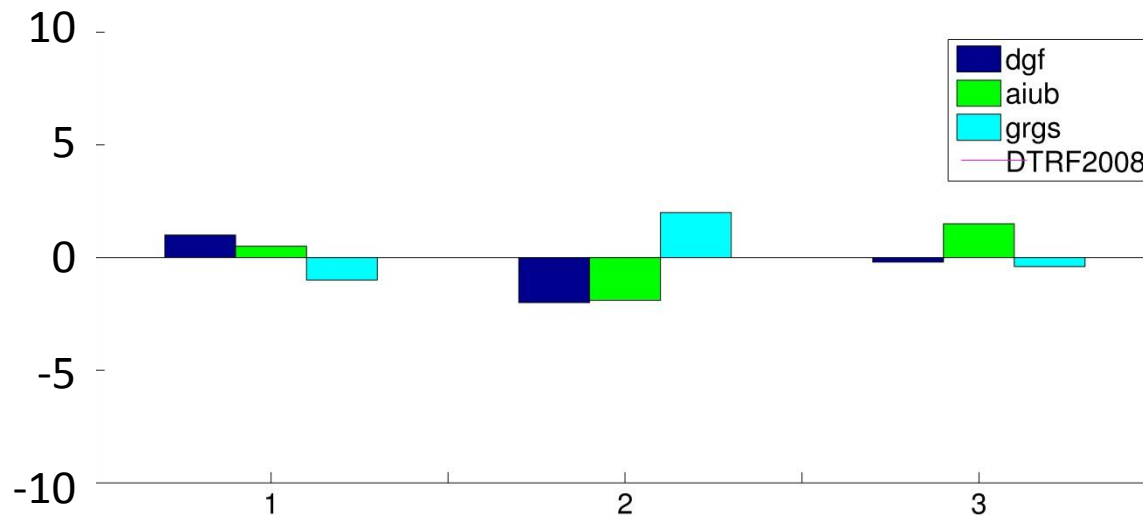


→ Agreement within 5.0 mm

Analysis and combination of SLR data

Combination results

Y-Translations [mm] between combined solution and single AC solutions

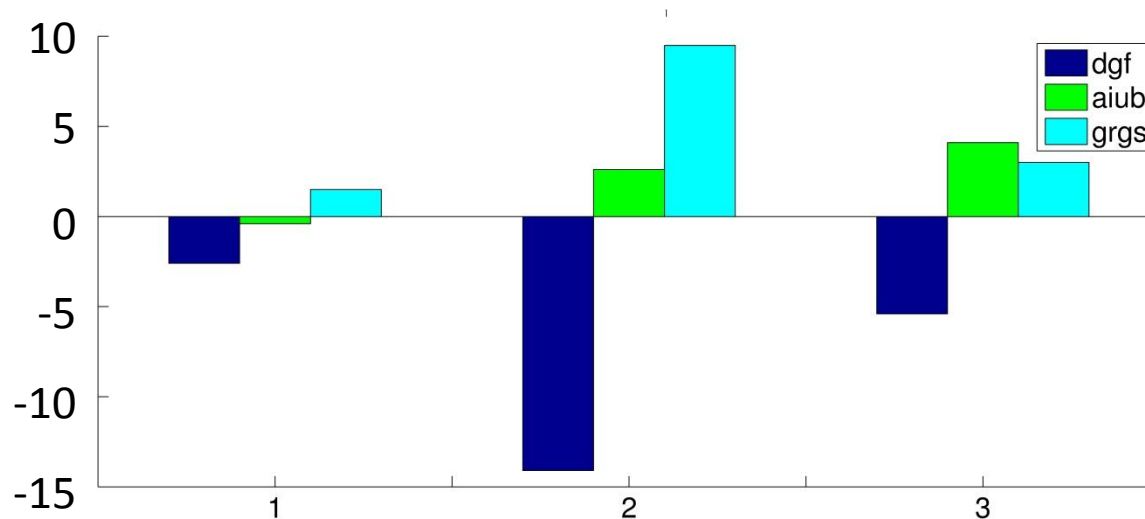


→ Agreement within 2.0 mm

Analysis and combination of SLR data

Combination results

Z-Translations [mm] between combined solution and single AC solutions

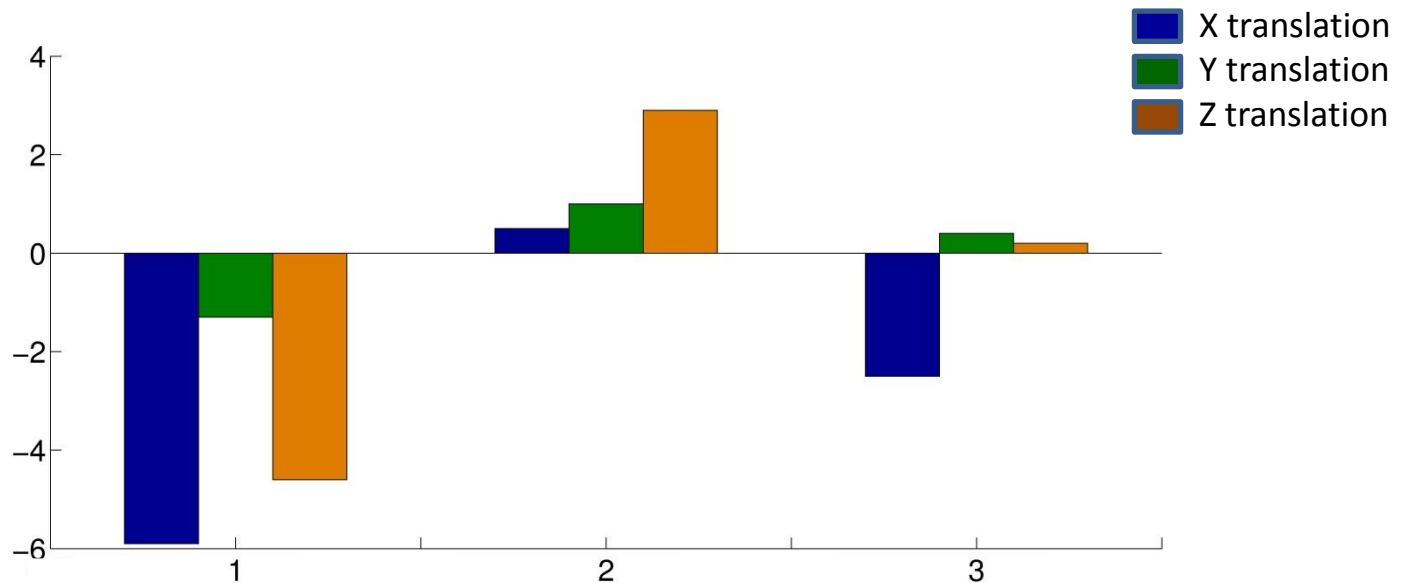


- Agreement within 5.0 mm for week 1 and 3
- Summarizing: homogeneous SLR input data

Analysis and combination of SLR data

Combination results

Translations of combined solution w.r.t. DTRF2008 [mm]

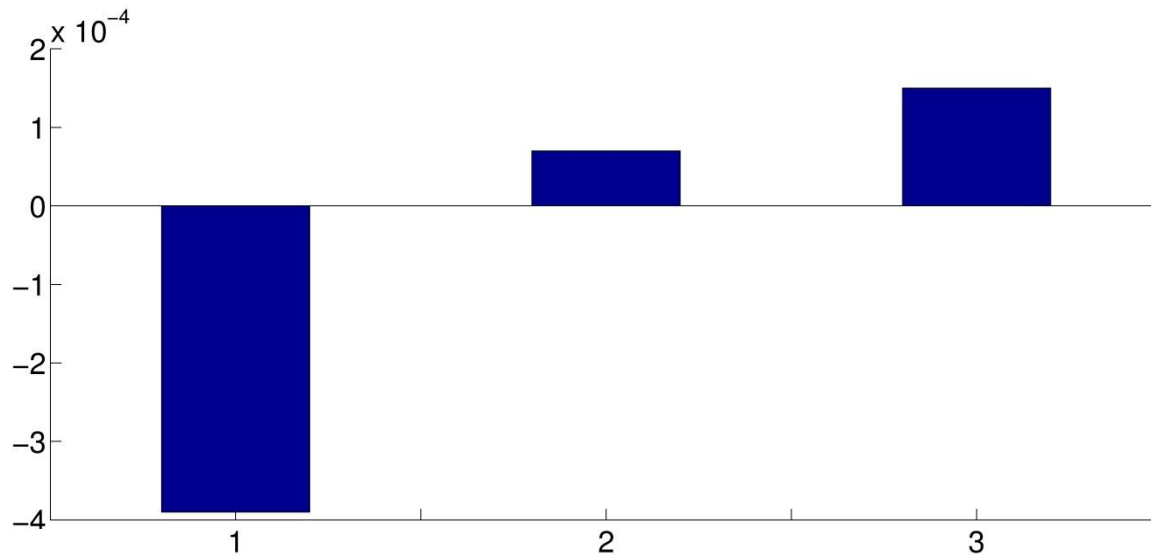


→ Agreement within 6 mm.

Analysis and combination of SLR data

Combination results

Scale of combined solution w.r.t. DTRF2008 [ppm]



→ Agreement: 0.4 ppb (~ 2.5 mm)

Analysis and combination of GPS data

Contributions: AIUB, GRGS

Analysis:

	A posteriori Sigma	Transformation DTRF2008	RMS of transformation
AIUB	0.01	datum parameters set up	7.0 mm
GRGS	2.0	datum parameters set up	6.0 mm

Combination:

RMS values (combined / single AC): 2-5 mm

RMS w.r.t. DTRF2008: 4-5 mm (Improvement compared to single AC)

→ Good agreement

Analysis and combination of DORIS data

Contributions: GRGS

Analysis:

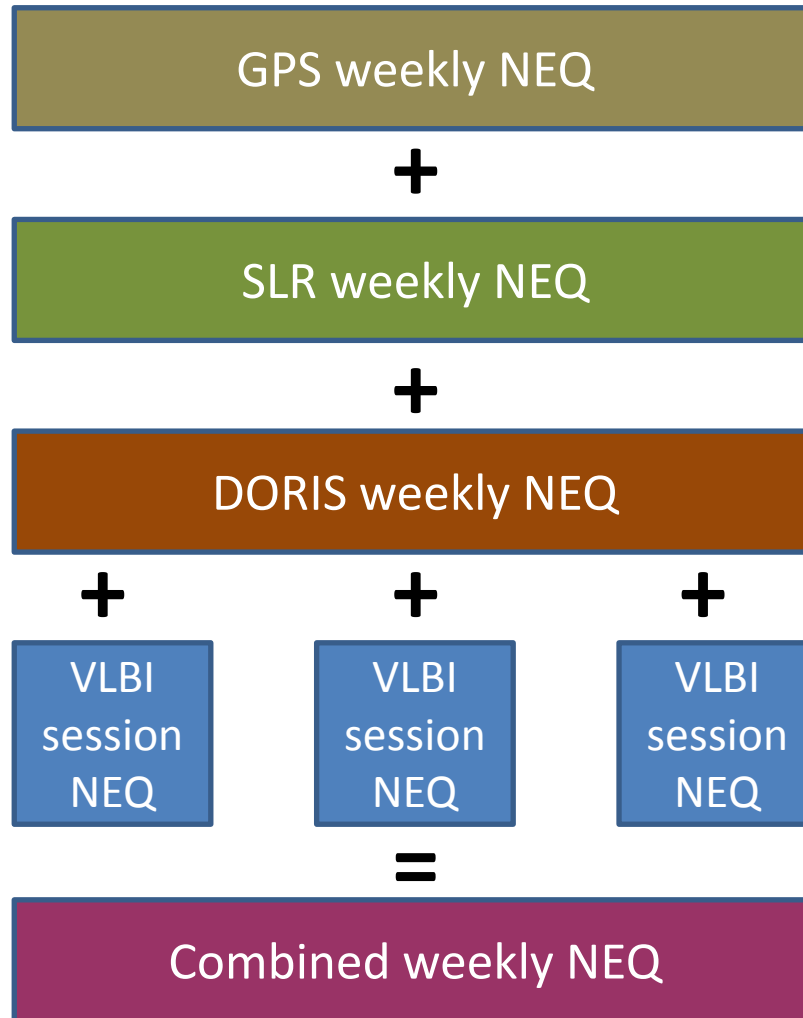
	A posteriori Sigma	Transformation DTRF2008	RMS of transformation
GRGS	1.0	datum parameters set up	10-20 mm

Combination:

→ No intra-technique combination for DORIS

Inter-technique combination

Flowchart of weekly combination



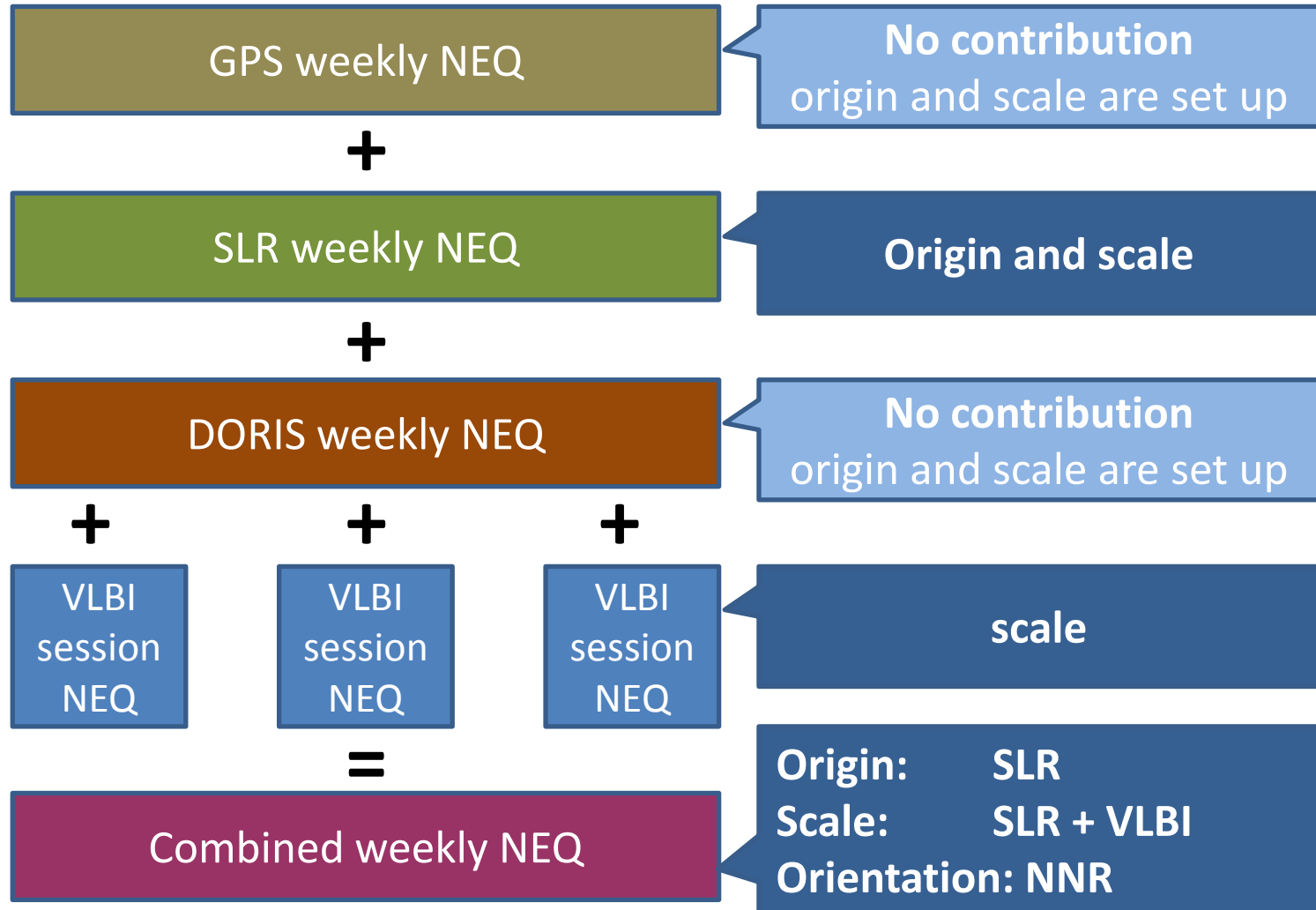
Selection of local ties

Max. local tie misfit : 25 mm

σ local ties

1.0 mm / component

Combination: Datum realization



Combination: Datum realization

Conservation of the origin

Translation between combined (P+R+L+D) and SLR only [mm]

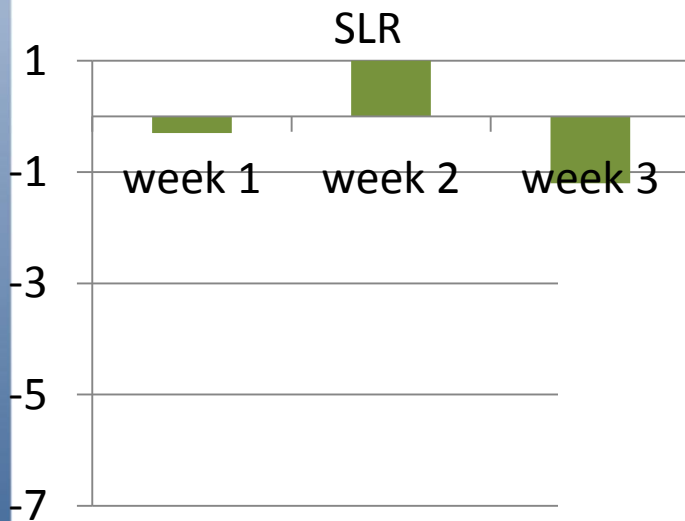


→ Good agreement between SLR only and combined solution

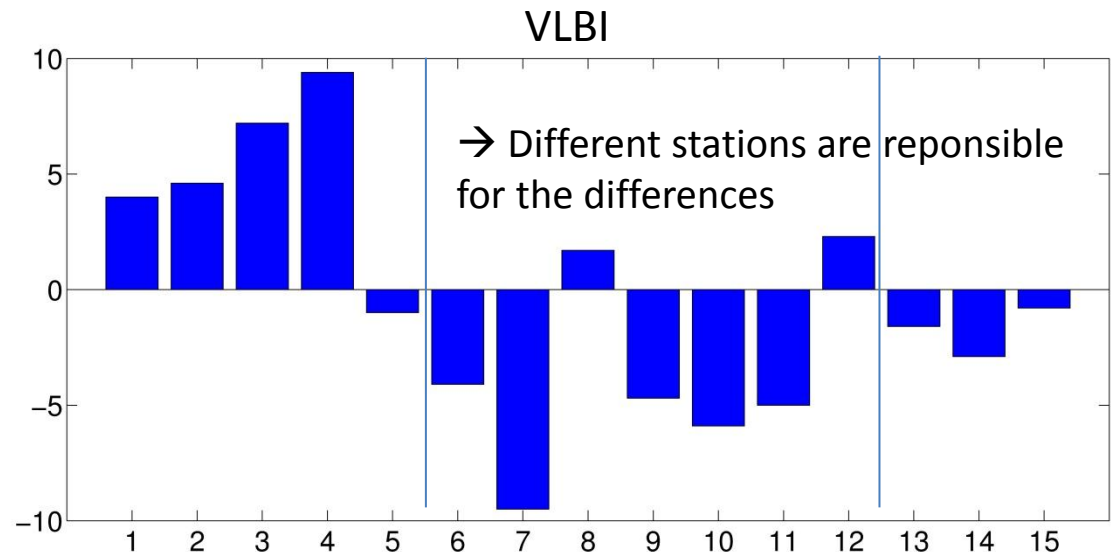
Combination: Datum realization

Conservation of the scale

Scale parameters between combined and VLBI/SLR only [mm]

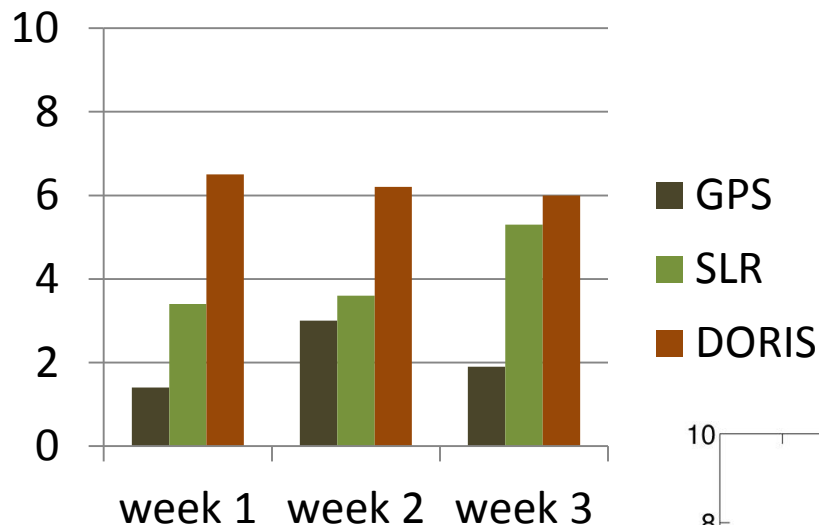


→ Variation of VLBI larger, but no mean offset between VLBI and SLR scale



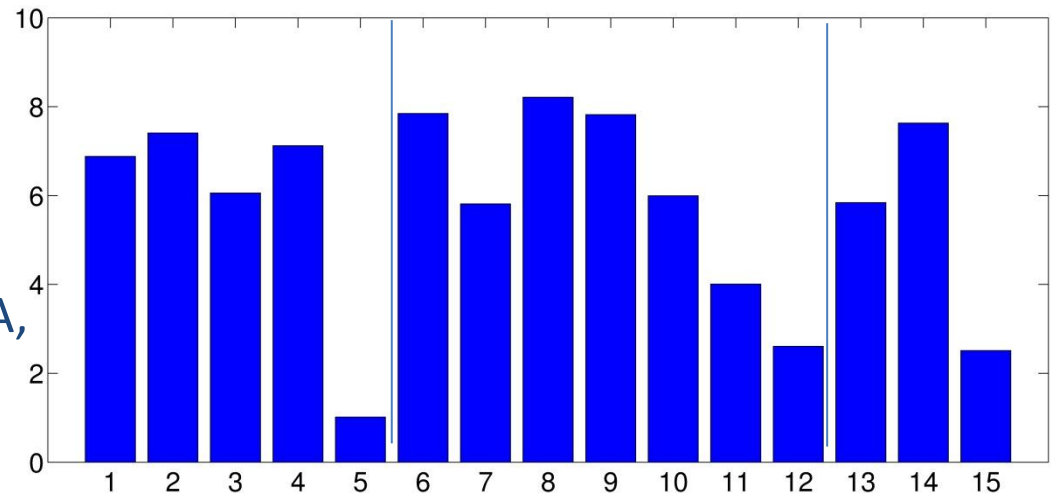
Combination: deformation of networks

RMS values of transformation between combined and single technique solution



→ Mean deformation can reach more than 5mm
SLR: Asian stations responsible for large RMS

VLBI stations with frequent residuals of 10-20 mm:
NYALES20, SVETLOE, TSUKUBA,
KOKEE, WESTFORD



Combination: Comparison with DTRF2008

Translations

SLR, GPS:	-6.0 – 3.5 mm
VLBI, DORIS:	-10.0 – 6.0 mm, 5.0 – 10.0 mm

Rotations

GPS:	-0.4 – 1.5 mm
SLR:	-6.0 – 1.8 mm
VLBI:	-9.0 – 7.0 mm
DORIS:	-11.0 – 11.0 mm

Scale

VLBI:	-4.0 – 5.0 mm
SLR:	-2.3 – 1.4 mm
GPS:	-1.6 – -2.5 mm
DORIS:	-3.7 – -5.3 mm

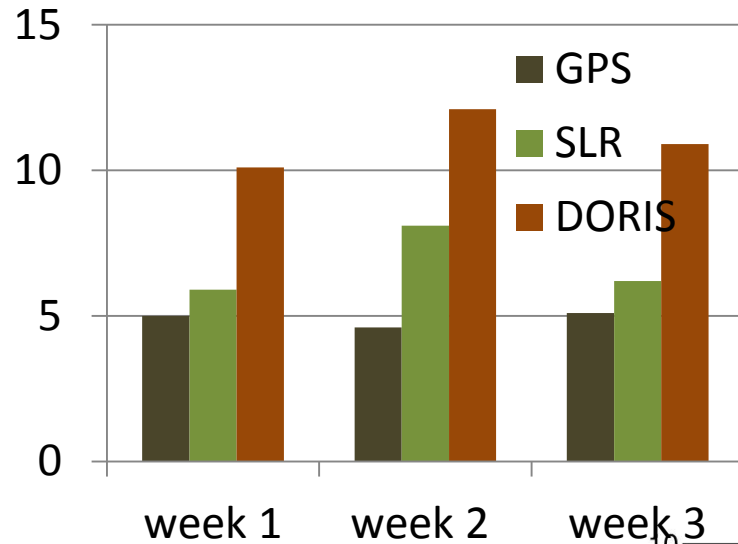
Datum realization w.r.t. DTRF2008
~ 5mm per component
(GPS orientation better)

Transfer into network parts

- translation/rotation : up to 11 mm
- Scale: up to ~ 5 mm

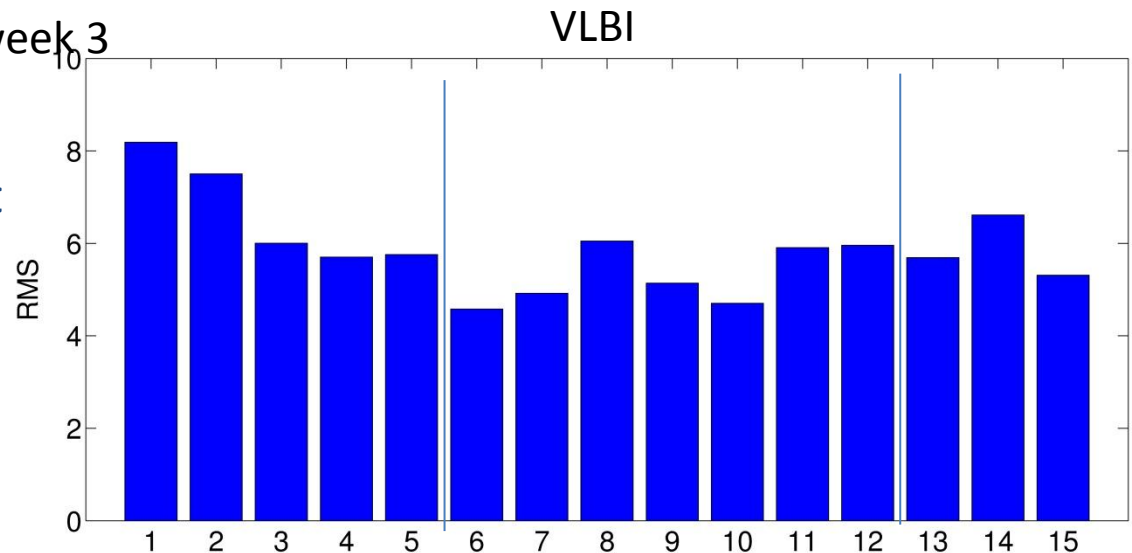
Combination: Comparison with DTRF2008

RMS values



Model differences between COL and DTRF2008 for VLBI and DORIS?

VLBI stations with frequent residuals of 10-20 mm: MEDICINA, NYALES20, TSUKU32



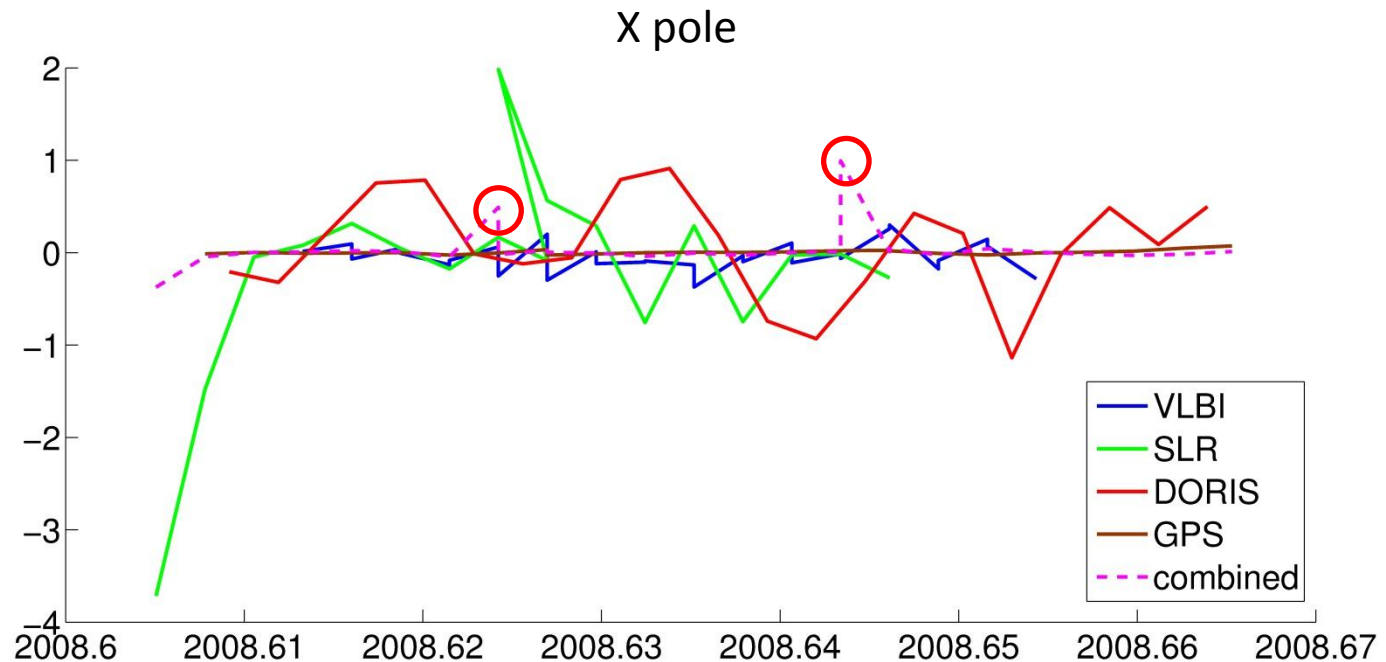
Combination: EOP

Combination of EOP (piece-wise linear at 0 h)

	pole	UT1-UTC	Nutation
GPS	AIUB+GRGS	AIUB (GRGS: UT1-TAI)	AIUB (GRGS: AV≠0)
SLR	AIUB (GRGS: pwl 12 h)	AIUB (GRGS: UT1-TAI; pwl 12 h)	/
VLBI	DGFI+GRGS+ TUW	DGFI+TUW (GRGS: UT1-TAI)	DGFI: mean epoch, no rates GRGS: AV≠0, mean epoch, no rates TUW: X,Y
DORIS	GRGS	/ (GRGS: UT1-TAI)	/ (GRGS: AV≠0)
Combined ?	yes	yes	no

Combination: EOP results

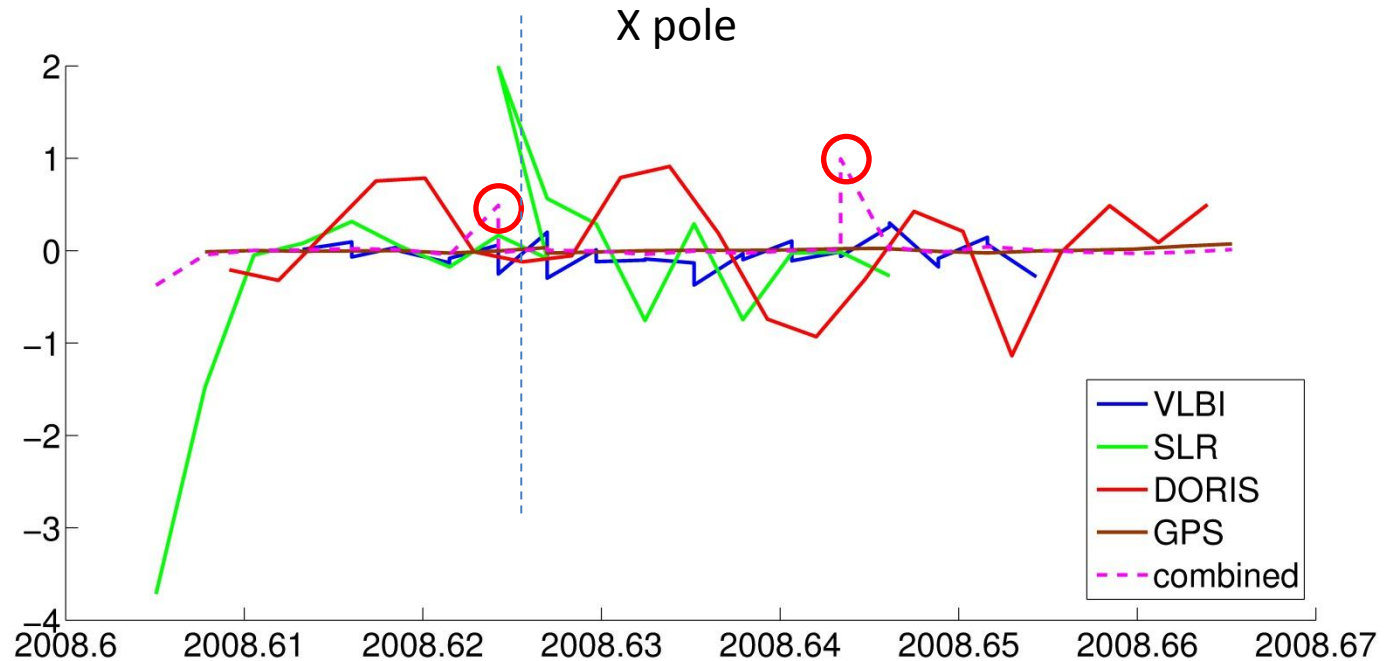
Pole coordinates (w.r.t. IERS 08 C04)



SLR week 3 cannot be solved

Combination: EOP results

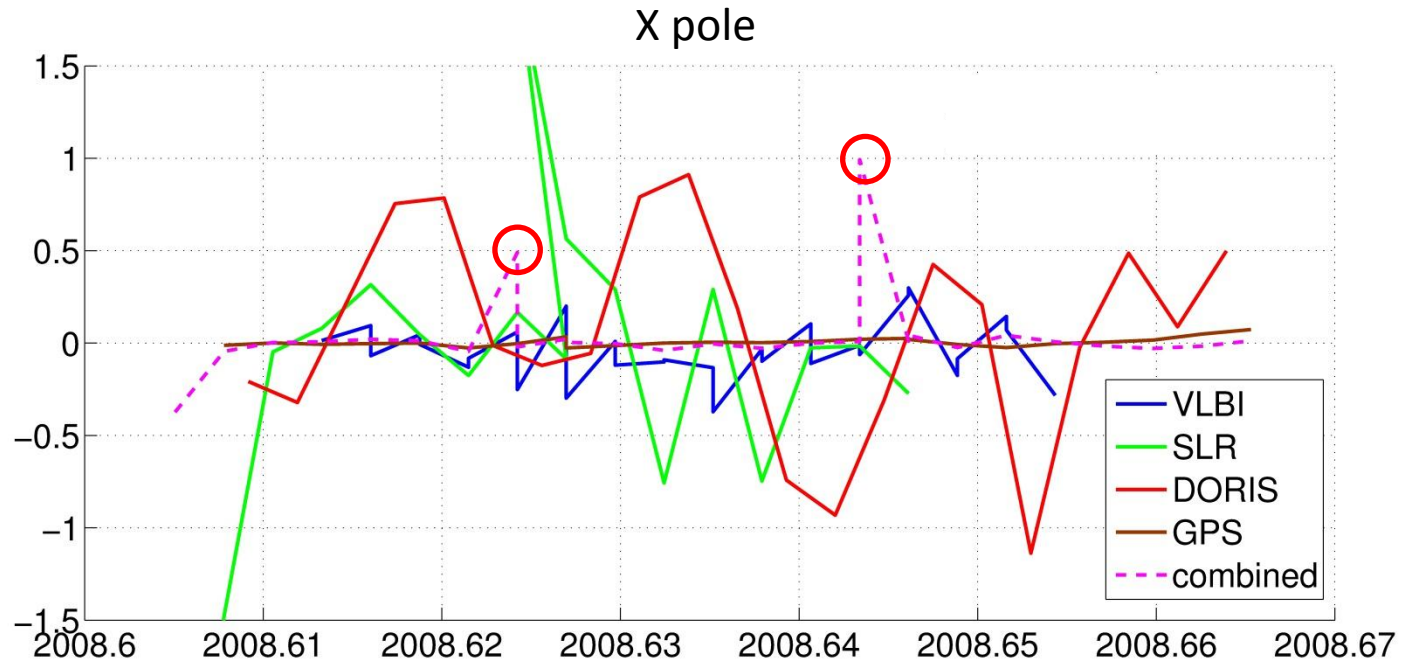
Pole coordinates (w.r.t. IERS 08 C04)



SLR week 3 cannot be solved

Combination: EOP results

Pole coordinates (w.r.t. IERS 08 C04)

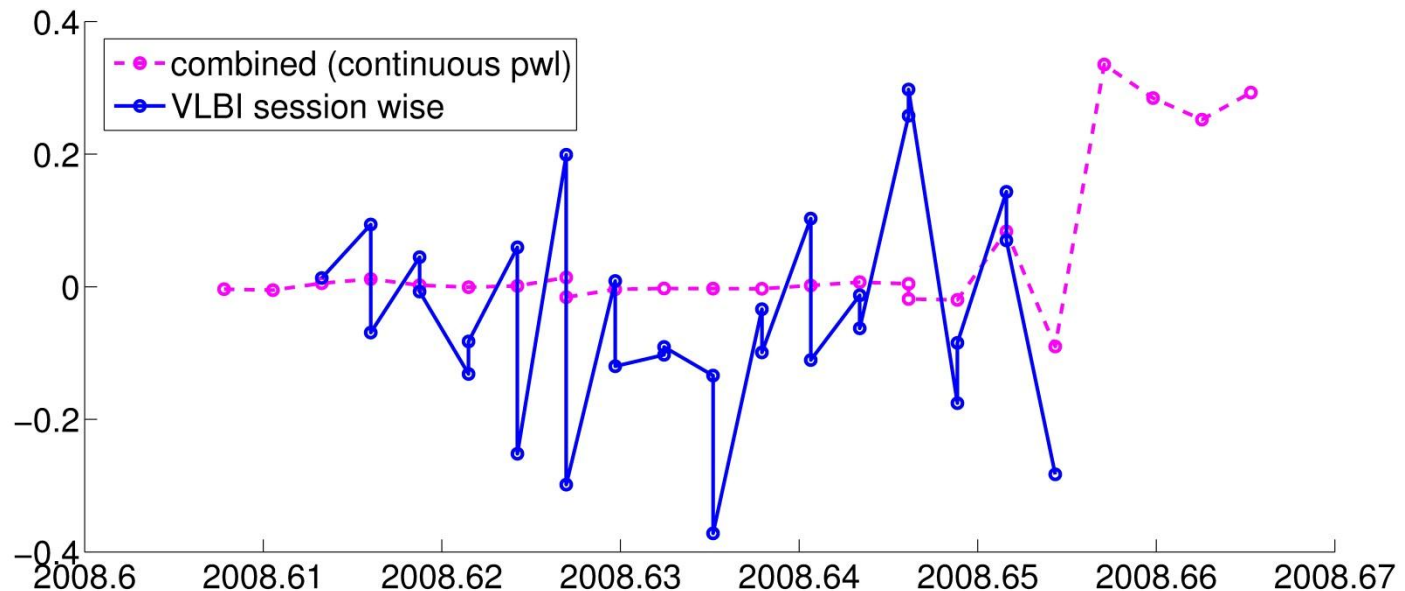


- Outliers due to SLR contribution
(AIUB values: transformation from O+D -> pwl ?)
- Y pole shows the same effects

	WRMS
X pole	39.4 uas
Y pole	32.8 uas

Combination: EOP results

UT1-UTC (w.r.t. IERS 08 C04)



	WRMS
UT1-UTC	20.1 us (w/o last four values)

Summary: to do

Input data

- Correct SINEX file:
constraints, statistical information, station names (tropospheric parameters), source names, satellite names
- Parameterization:
IERS2010 should be used (what about the new pole representation in the pole tide model?), Nutation -> [X,Y], UT1-UTC, same a priori values, for EOP: pwl at 0h or O+D

Combination

- Combination of all parameters
- Investigation of individual co-location sites
- VCE
- Pre-combined data should be included (more discussion is needed)