

Combination of techniques at CC DGFI

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Outline

- Input data
- New SINEX files
- Intra-technique combination
 - Comparison of SLR files
- Inter-technique combination

New models used

Coordinates:

- ocean loading model FES2004 (Forum)

Gravity:

- gravity fields provided by GRGS for CONT08 and CONT11 (Forum)
- Atmospheric tides: Ray and Ponte 2003 (Forum)

EOP:

- A priori IERS 08 C04 (Pole and UT1-UTC), 3h pwl
- A priori Nutation: IAU2000A model, [XY] daily pwl
- Linear interpolation

Tropospheric parameters:

- GPT (Saastamoinen dry)/GMF
- Zenith delay: 2h pwl, Gradients: daily pwl
- Mendes-Pavlis for SLR (Forum)

Input data

Status and changes since May 2012

	AIUB	ASI	DGFI	ESOC	GFZ	GRGS	MAO	OPA	TUW
GPS	n3/08				n1	n9			
SLR	n3	n1	n3	n1/08		n4			
VLBI			n2			n6	n1	n2	n3
DORIS						n7			
L-P				n1/08	n1/08				
L-D				n2/08					
L-P-D				n1/08					

New SINEX files
SINEX files May 2012

Seitz: Combination at the CC DGFI

Information about new models and
 parametrizations often missed!



Parameters - GPS

	AIUB	GFZ	GRGS
Stat. pos	daily	daily	weekly
Pole	daily, pwl		3h, pwl
UT1	daily, pwl		3h, pwl
Nut.	daily, pwl (Psi/Eps)		daily, noon, pwl?
Trop. ZD Grad.	2h, pwl daily, pwl		2h[1,3,5,..], pwl daily [3h,21h]
Geoc.	daily		
SAO	daily		

Parameters - GPS: parameters used

	AIUB	GFZ	GRGS	Comb. GPS
Stat. pos	daily	daily	weekly	weekly
Pole	daily, pwl		3h, pwl	daily, pwl
UT1	daily, pwl		3h, pwl	daily, pwl
Nut.	daily, pwl (Psi/Eps)		daily, noon, pwl?	/
Trop. ZD Grad.	2h, pwl daily, pwl		2h[1,3,5,..], pwl daily [3h,21h]	/
Geoc.	daily			
SAO	daily			

Parameters - SLR

	AIUB	ASI	DGFI	ESOC	GRGS
Stat. pos	weekly	weekly	weekly	weekly	weekly
Pole	daily, O+R	3h, pwl	daily, pwl	daily O+R, noon	daily, pwl
UT1	daily, O+R	3h, pwl	daily, pwl	daily LOD, noon	daily, pwl
Nut.					12h, pwl (Psi, Eps)
Geoc.	weekly				
R-Biases	x	x red.	x red.	x	x

Parameters - SLR: parameters used

	AIUB	ASI	DGFI	ESOC	GRGS	Comb. SLR
Stat. pos	weekly	weekly	weekly	weekly	weekly	weekly
Pole	daily, O+R	3h, pwl	daily, pwl	daily O+R, noon	daily, pwl	daily, pwl
UT1	daily, O+R	3h, pwl	daily, pwl	daily LOD, noon	daily, pwl	daily, pwl
Nut.					12h, pwl (Psi, Eps)	/
Geoc.	weekly					
R-Biases	x	x red.	x red.	x	x	

Parameters - VLBI

	DGFI	GRGS	MAO	OPA	TUW
Stat. pos	daily	daily	daily	daily	daily
Pole	O+R, noon	3h, pwl	Offset, daily, ~noon	Daily O+R, noon	3h, pwl
UT1	O+R, noon	3h, pwl	Offset, daily, ~noon	daily LOD, noon	3h, pwl
Nut.	daily offset ~noon, (Psi,Eps)	12h, pwl	daily offset, ~noon	daily offset, ~noon	daily, pwl
Src coord.		x		x	x
Trop. ZD Grad.		1h, pwl /			2h, pwl daily, pwl

Parameters – VLBI: parameters used

	DGFI	GRGS	MAO	OPA	TUW	Combi
Stat. pos	daily	daily	daily	daily	daily	daily
Pole	O+R, noon	3h, pwl	Offset, daily, ~noon	Daily O+R, noon	3h, pwl	daily, pwl
UT1	O+R, noon	3h, pwl	Offset, daily, ~noon	daily LOD, noon	3h, pwl	daily, pwl
Nut.	daily offset ~noon, (Psi,Eps)	12h, pwl	daily offset, ~noon	daily offset, ~noon	daily, pwl	daily, pwl
Src coord.		x		x	x	x
Trop. ZD Grad.		1h, pwl /			2h, pwl daily, pwl	2h pwl, daily pwl

Parameters – DORIS: available and used ones

	GRGS	Combination
Stat. pos	weekly	weekly
Pole	3h, pwl	
UT1	3h, pwl	
Nut.	12h, pwl	
Trop. ZD Grad.	1h, pwl / (weak geometry?)	

Parameters – pre-combined NEQ

	ESOC P-L	ESOC L-D	GFZ P-L
Stat. pos	Weekly (11 L, 197 P)	Weekly (23 L, 48 D)	Daily (3 L, 65 P)
Pole	Daily O+R, noon	Daily O+R, noon	Daily, pwl
UT1	Daily LOD, noon	Daily LOD, noon	Daily, pwl
Biases	x		
SAO	x		

Parameters – pre-combined NEQ: used

Parameters, which can be used in the combination

	ESOC P-L	ESOC L-D	GFZ P-L
Stat. pos	Weekly (11 L, 197 P)	Weekly (23 L, 48 D)	Daily (3 L, 65 P)
Pole	Daily O+R, noon	Daily O+R, noon	Daily, pwl
UT1	Daily LOD, noon	Daily LOD, noon	Daily, pwl
Biases	x		
SAO	x		

Homogenization of parameterization

- Differences in parameterization in particular for **EOP and tropospheric parameters**: 3h pwl and daily pwl. The two parameterizations cannot be homogenized. → less than 50% of the contributed parameters are used!
 - Subdaily pwl parameterization:
 - does not allow for parameter transformations except of a transformation to daily offsets
 - Is critical w.r.t. correlations between pole and nutation (nutation should be one offset per day at maximum)
- We should use a more flexible parameterization: **subdaily offset+rate**
- would allow any kind of EOP transformation.
 - a very stable EOP estimation as well as the study of subdaily EOP would be possible.
- homogenization of epochs!

Remarks on the new SINEX files

GPS AIUB n3:

- 2008 only
- geo-centre and satellite antenna offsets are set up
- solution okay

GPS GFZ n1:

- contains only station positions,
- NEQ stored in an old SINEX format (type INFO)
- solution okay

Remarks on the new SINEX files

GPS **GRGS n9:**

orientation constrained w.r.t. individual components for some NEQs, discussion with Sylvain in Nov.2011: SINEX file for test purposes: okay

SLR see presentation by Mathis Bloßfeld

Remarks on the new SINEX files

VLBI **TUW n4:**

orientation at least partly fixed in three NEQ,
08238 and 11261 (z-rot.), 08233 (all components)

GRGS:

station names related to troposphere parameters
do not correspond to the station names in block
SITE/ID → SINEX cannot be read

OPA:

ITPI too large: discussion with Sebastien Lampert on
the ITPI values given in SINEX which seem to be not
reduced → Dan MacMillan will look at this problem in
Calc/Solve

Remarks on the new SINEX files

precombined **ESOC: SLR+GPS, SLR+DORIS, SLR+GPS+DORIS**
new SINEX version (> 2.00), but constraints (given in SINEX) are included in the NEQ
we have to change the DGFI program to be able to remove the constraints

Reduction of $l^T P l$

$$l_1^T P_{11} l_1 = l^T P l - y_2^T N_{22}^{-1} y_2$$

1... remaining
2... reduced parameters

if N_{22} is the part of the normal equation matrix related to the parameters, which should be reduced. y_2 is the corresponding right hand side of NEQ.
(see also App. II of the new SINEX format description, which will be provided very soon by Daniela Thaller/SINEX WG)

$l^T P l$ is needed for the computation of the a posteriori variance factor

$$v^T P v = l^T P l - y^T \hat{x}$$

$$\sigma = \sqrt{\frac{v^T P v}{n - u}}$$

→ A large $l^T P l$ leads to large standard deviations.

Comparison of GNSS contributions

Contributions:

	#stat	std
AIUB (08)	250	0.2 mm
GRGS	120	0.3 mm
GFZ	50	0.7 mm

RMS of transformation w.r.t. DTRF2008

AIUB 7 mm

GFZ 10 mm

GRGS 3.5 (08) -6 mm (11)

RMS of transformation between ACs

	AIUB (250)	GRGS (120)	GFZ (50)
AIUB		5 mm (08)	10-15 mm
GRGS			10-15 mm

Combination of GNSS contributions

Solutions: 2008 (AIUB+GRGS+GFZ), 2011 (GRGS+GFZ)

- Very different variance factors (must be considered)
- EOP and Trop. parameters: different parameterization, cannot be homogenized and combined (AIUB EOP used)
- GFZ: stations with very large differences to AIUB and/or GRGS

week	BAKO (Indon.) 23101M002	MBAR (Uganda) 33901M001	SEY1 (Seychelles) 39801M001	STR1 (Austr.) 50119M002
08/237	160 cm			
11/254	160 cm		80cm	170cm
11/261	160 cm	20cm	80cm	170cm
11/268	160 cm	20cm	80cm	170cm

→ Stations have to be reduced from GFZ NEQ before combination

Combined GNSS solutions

- Datum: NNT, NNR, NNS w.r.t. DTRF2008 (scale und translation are set up for GNSS)
- RMS of Transformation w.r.t. DTRF2008

Year/week	RMS with GFZ	RMS w/o GFZ
2008/1	5 mm	4 mm
2008/2	5 mm	3 mm
2008/3	5 mm	4 mm
2011/1	7 mm	4 mm (GRGS only)
2011/2	6 mm	5 mm (GRGS only)
2011/3	7 mm	4 mm (GRGS only)

→ model discrepancies between GFZ and AIUB/GRGS ?

Comparison of VLBI contributions

- DGFI (08), MAO, OPA, TUW, (GRGS: SINEX problem)
- Standard deviations:
 - DGFI and TUW: same level, different a post. variance factors → considered in the combination
 - OPA shows very large std → used only for comparisons

Transformation w.r.t. DTRF2008 (mean RMS and scale)

RMS [mm]	2008	2011	scale [mm]	2008	2011
DGFI	7 mm	/	DGFI	6 mm	/
MAO	25 mm	/	MAO	25 mm	/
OPA	6 mm	7 mm	OPA	4 mm	2 mm
TUW	7 mm	12 mm	TUW	5 mm	5 mm

→ MAO shows large differences. Model differences? MAO not used in combination.

Combination of VLBI contributions

- DGFI (08), TUW, (OPA for comparisons)
- Parameters:
 - station coordinates: combined
 - EOP: different parameterization, not combined (DGFI used)
 - Source positions: TUW only

Transformation: AC w.r.t. combined

	RMS [mm]	Scale [mm]
DGFI	1-2 mm	0-1 mm
TUW	1-3 mm	0-1.4 mm
OPA (does not contribute to combined solution)	4 (08) – 13 (11) mm	0-7 mm

→ Good agreement.

Combination of VLBI contributions

Transformation: combined w.r.t. DTRF2008

RMS

	RMS [mm]
2008	5-9 mm
2011	9-20 mm
2011 w/o Zelenchukskaya	6-12 mm

scale

	scale [mm]
2008	1-10 mm
2011	0-9 mm

→ Good agreement with DTRF2008.

SLR contributions and combination

- Presentation by Mathis Bloßfeld
- Combination:
 - 2008 and 2011: AIUB + DGFI + ASI (w/o EOP)

Transformation w.r.t. DTRF2008

(Translation and scale are set up as new parameters)

RMS:

2008: 10-12 mm

2011: 15 mm

→ Good agreement.

Combination: GPS+VLBI+SLR+DORIS

Parameters in the combination

	GPS	VLBI	SLR	DORIS
Station coordinates	weekly	daily	weekly	weekly
EOP	Daily, pwl	Daily, pwl	Daily, pwl	/
Source coordinates	/	TUW only	/	/
Troposphere parameters	/	/	/	/

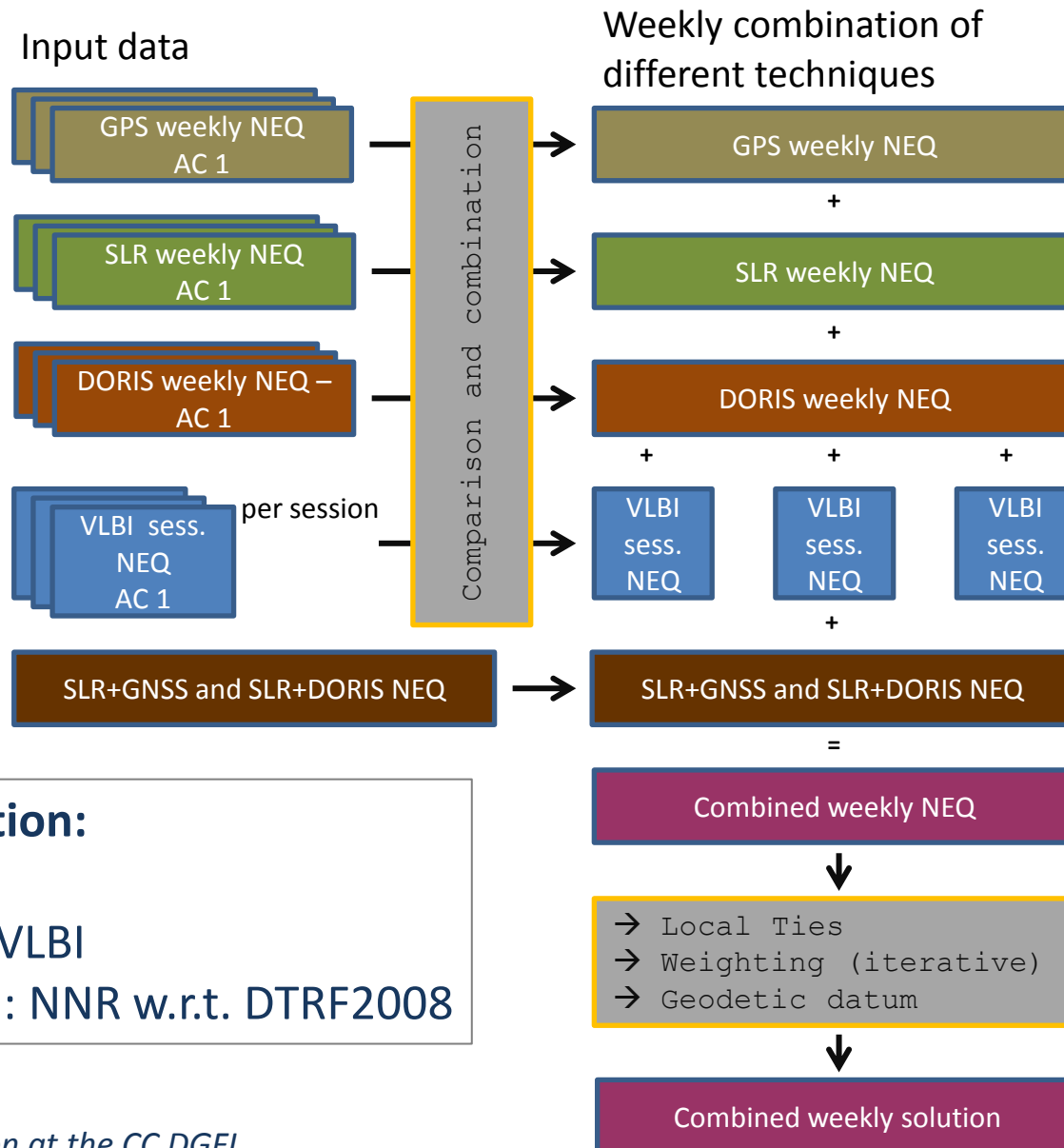
Input data used

Only 9 of 18 contributions could be used
(not considering parameterization differences)

	AIUB	ASI	DGFI	ESOC	GFZ	GRGS	MAO	OPA	TUW
GPS	n3/08				n1	n9			
SLR	n3	n1	n3	n1/08		n4			
VLBI			n2			n6	n1	n2	n3
DORIS						n7			
L-P				n1/08	n1/08				
L-D				n2/08					
L-P-D				n1/08					

→ A better situation for the input data should be reached !

Combination procedure at DGFI



Datum realization:

- Origin: SLR
- Scale: SLR+VLBI
- Orientation: NNR w.r.t. DTRF2008

Combination

Internal transformation: Combination w.r.t. single technique

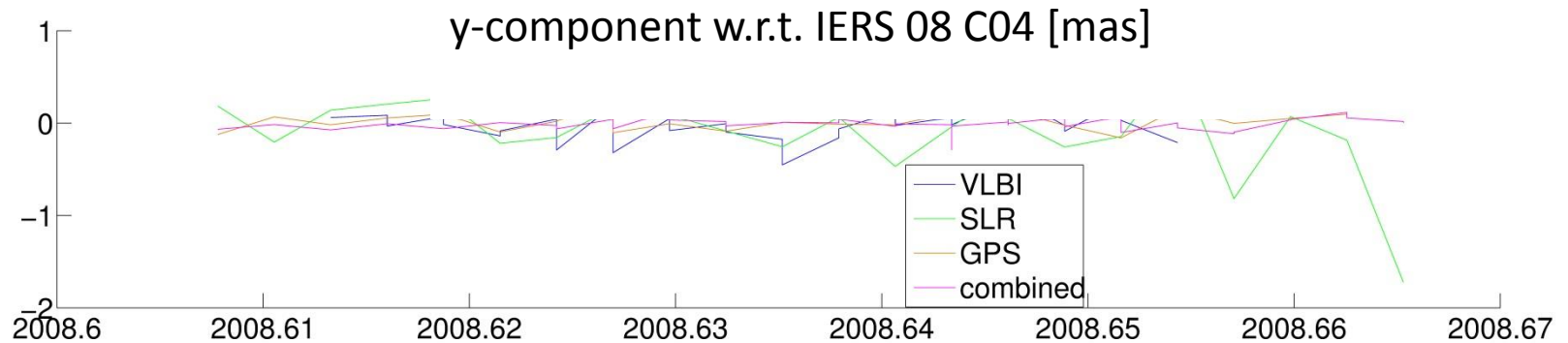
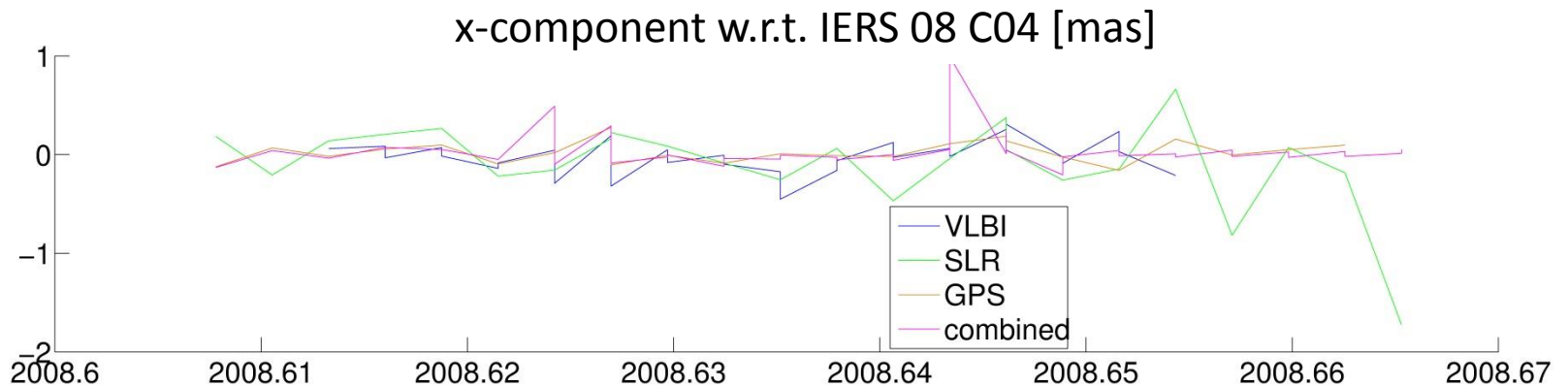
	translation	scale	RMS
GPS			2 mm
DORIS			10 mm
SLR	0-7 mm	0-1.5 mm	6 mm
VLBI		0-1.0 mm	7 mm

Transformation w.r.t. DTRF2008

	translation	scale	RMS
GPS	0-6 mm	0-3 mm	4 mm
DORIS	0-10 mm	5-11 mm	10-20 mm
SLR	0-10 mm	3 mm	8-17 mm
VLBI	0-10 mm	0-6 mm	3-9 mm

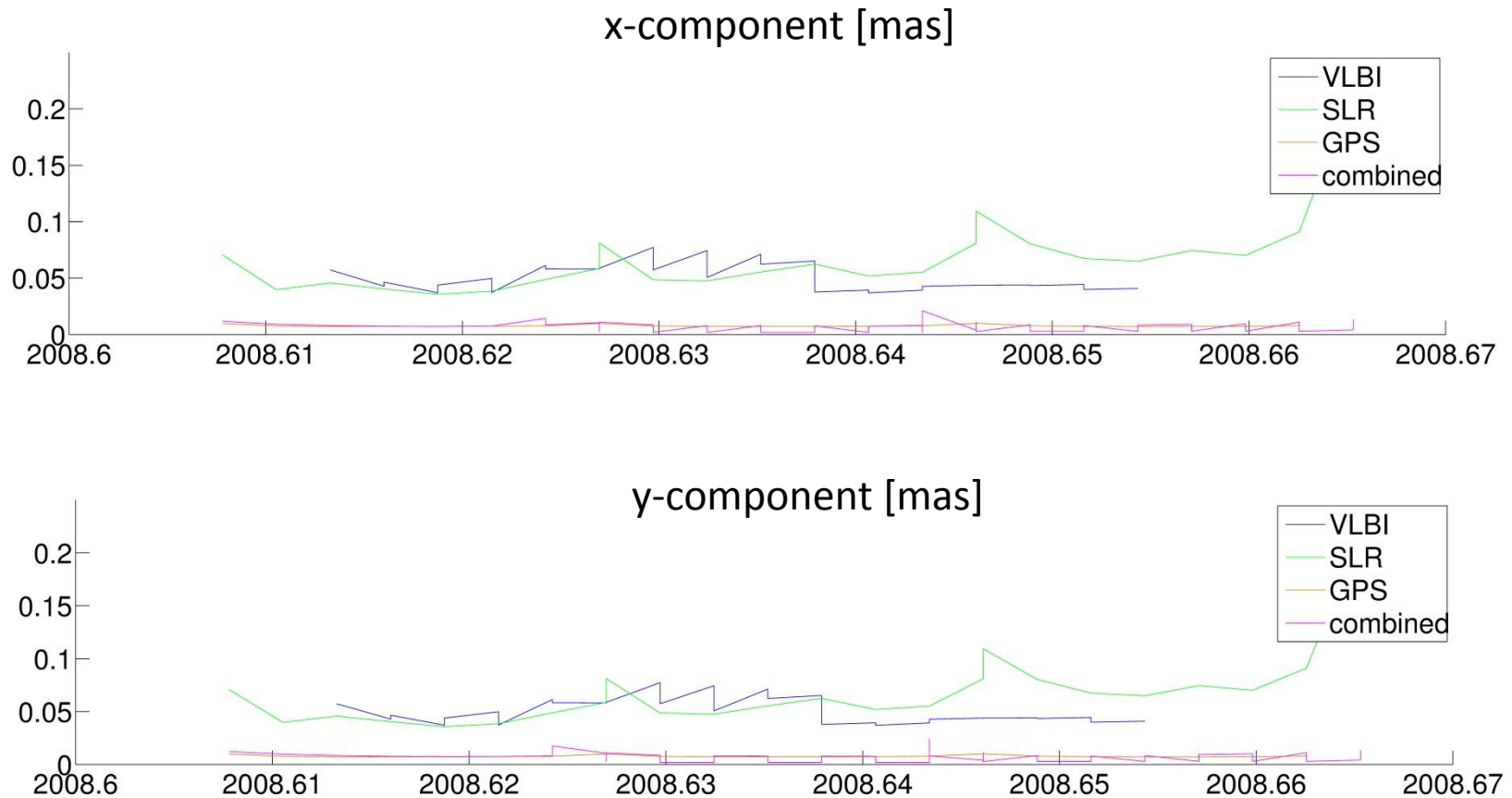
Combination: EOP

Terrestrial pole



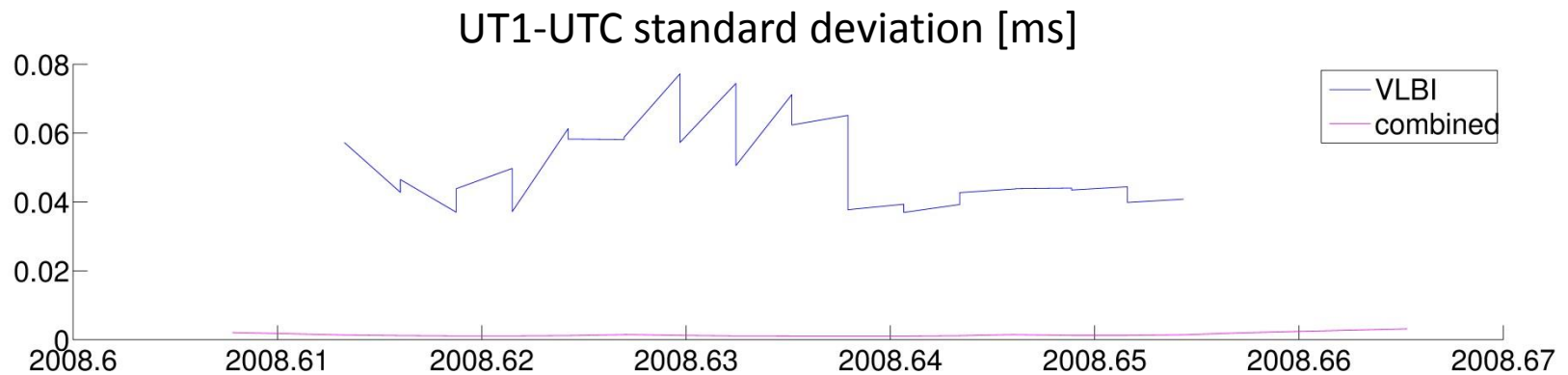
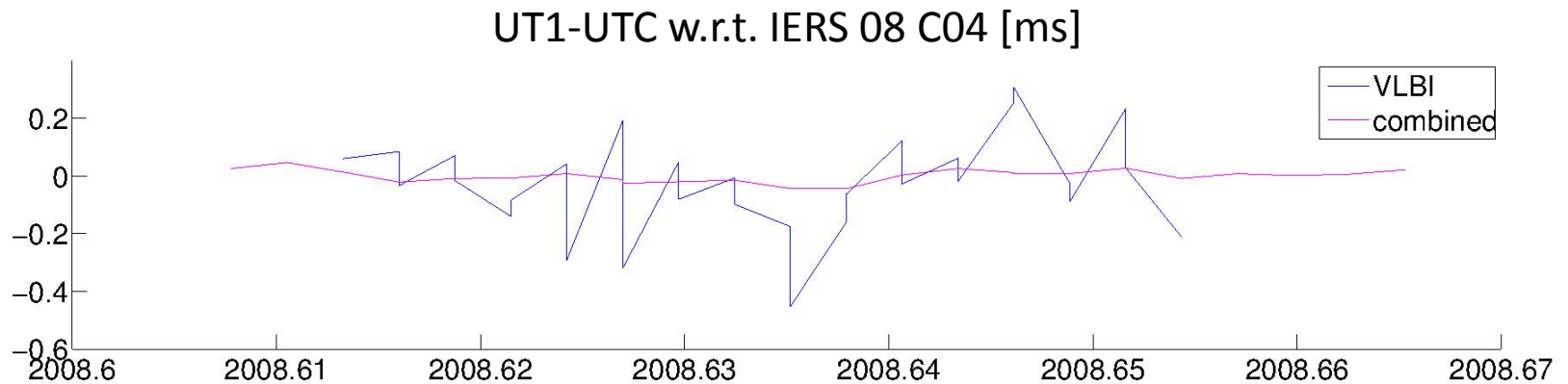
Combination: EOP standard deviations

Terrestrial pole



Combination: EOP

UT1-UTC w.r.t. IERS 08 C04 [ms]



Summary

- Combination works well, but
- many contributions (parameters) not yet included
- Except of SINEX problems homogenization of parameterizations is the most important task for the future (EOP and troposphere)

END

Tropospheric parameters in SINEX

ZBIAS: tropospheric bias at zenith
What does it exactly mean?

COL specs

TROTOT: total tropospheric delay

- a priori value: $\sim$ dry part $\rightarrow$ *GPT model, GMF mapping function*
- estimated value: $\sim$ wet part (*GMF mapping function*)

$\rightarrow$ the use of TROTOT with: a priori values = dry ZD (*GPT/GMF*)
would be necessary for comparisons

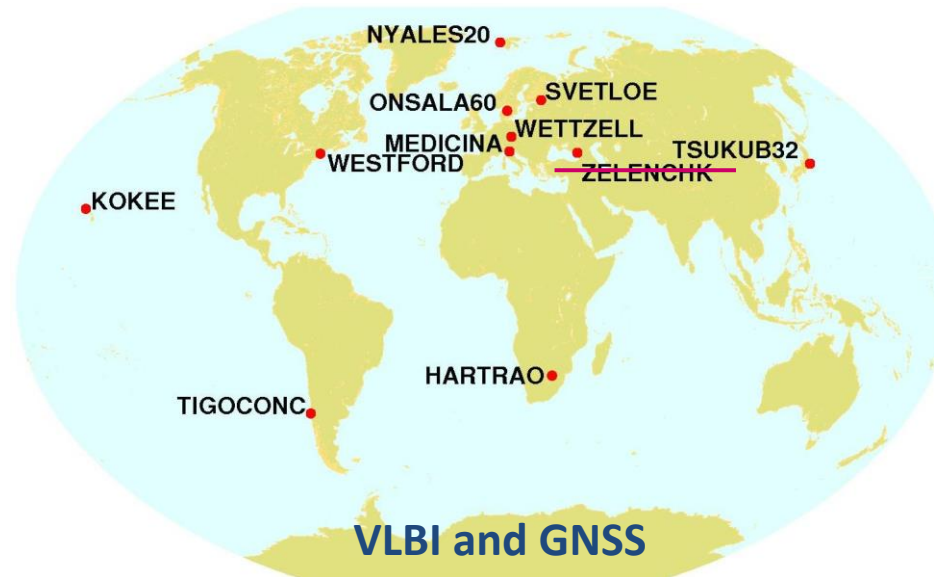
Corresponding gradients:

TGNTOT
TGETOT

} a priori values = 0 (or standardized values for COL)

Tropospheric parameters in SINEX

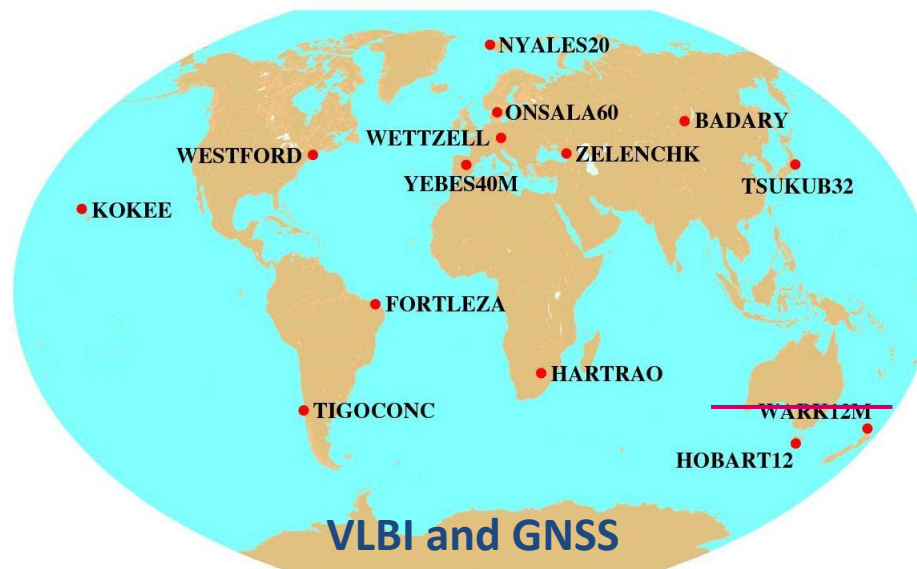
Stations CONT08



DORIS

NyAlesund
Hartebeesthoek
Kokee Park

Stations CONT11



DORIS

NyAlesund
Hartebeesthoek
Kokee Park

Comparison of SLR input series

- AIUB: CONT08, CONT11
- DGFI: CONT08, (CONT11)
- GRGS: CONT08

Comparison CONT08

	RMS	Tran. [mm]	Scale [mm]
AIUB-GRGS	7 - 12	4 - 6	1 - 4
DGFI-GRGS	5 - 10	3 - 10	0 - 5
AIUB-DGFI	10	3 - 20	1 - 7

Stations with large residuals are excluded from the transformation

- Station lists are not identical
- Number of common stations 14-19

Comparison of SLR input series

Comparison CONT08: Stations with large residuals [mm]

station	code	AIUB-GRGS	DGFI-GRGS	AIUB-DGFI
Borowiec	7811	70	50	70
Riyadh	7832	30		44
Shanghai		/	/	35
Changchun	7237			40
Koganai	7308	/	/	60
Fort Davis	7406	1600	1600	
Maui	7119			50
Washington	7105	1700	1700	
Mon. Peak	7110	200	200	100
San Juan	7406	70	70	30
Arequipa	7403	3400	3400	30

→ A SLR internal comparison/homogenization is necessary

Comparison of SLR input series

Comparison CONT11

AIUB-DGFI (number of common stations: 20-22)

RMS: 10 mm

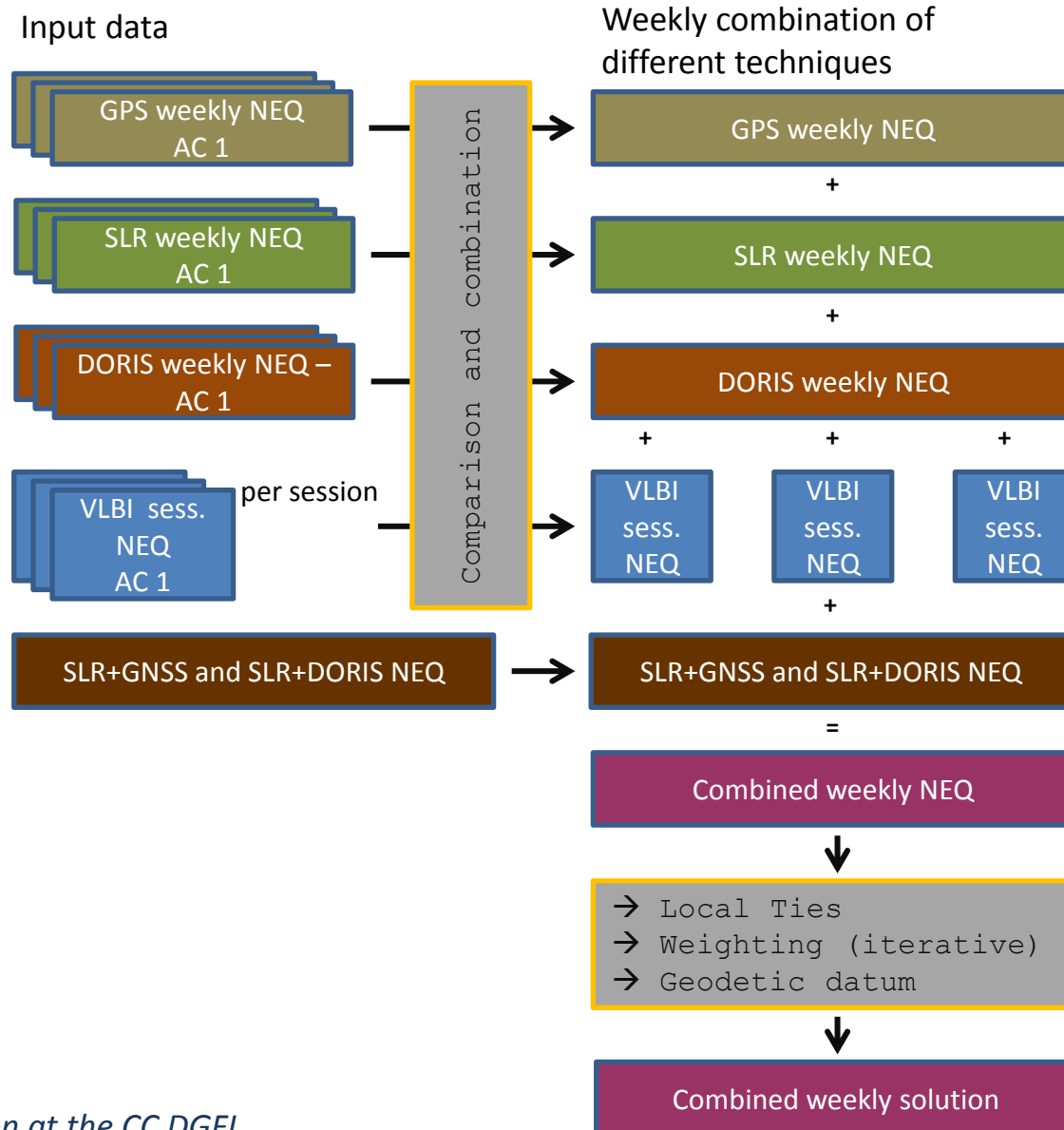
Tran: 0-5 mm

Scale: 4-7 mm

Stations with large residuals

Station	code	Max. residual [mm]
Kiev	1824	60
Potsdam	7841	30
Washington	7105	30
Arequipa	7403	30
Mt. Stromlo	7825	30

Combination procedure at DGFI



Local ties

CONT11 contains the co-location sites

- 12338 Badary GPS-VLBI
- 13420 Yebes GPS-VLBI
- 50116 Hobart GPS-VLBI (new antenna HOBART12)

for which no local ties were available so far (ITRF2008/DTRF2008).

Zuheir Altamimi provides us local vectors (without standard deviations) for Badary and Yebes.

→ will be provided in the forum

To do

Data Series

- CONT11 series

Models

- ✓ Jean Michel provided the gravity field model for CONT11 → COL forum
- ✓ Ocean loading (FES2004): tabeled values from Scherneck provided by Rolf König (→ forum)
- ✓ Atmospheric tides: Ray-Ponte model (→ COL forum or GGFC website)
- Models applied by all ACs

To do

Parameterization

EOP

- Homogenization of EOP parameterization
 - daily piece-wise-linear representation (0h) or offset and drift
 - Nutation [X,Y]
 - Nutation parameters: correction to nutation model
a priori values = 0.0
 - UT1-UTC (OPA: UT1-TAI)
 - Same a priori values and a priori interpolation

To do

Parameterization

Troposphere

- Homogenization of troposphere parameters (microwave techniques) (GPT/GMF -> TROTOT, TGNTOT, TGETOT)
- Tropospheric parameters should be provided for all CONT08 and CONT11 VLBI stations and the co-located GPS and DORIS stations

Solution related

- MAO: RMS w.r.t. DTRF2008 much larger than for the other VLBI contributions (20-30mm)
 - OPA: standard deviations (ITPI)
- Currently not used in the combination

To do

Combination

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

END

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

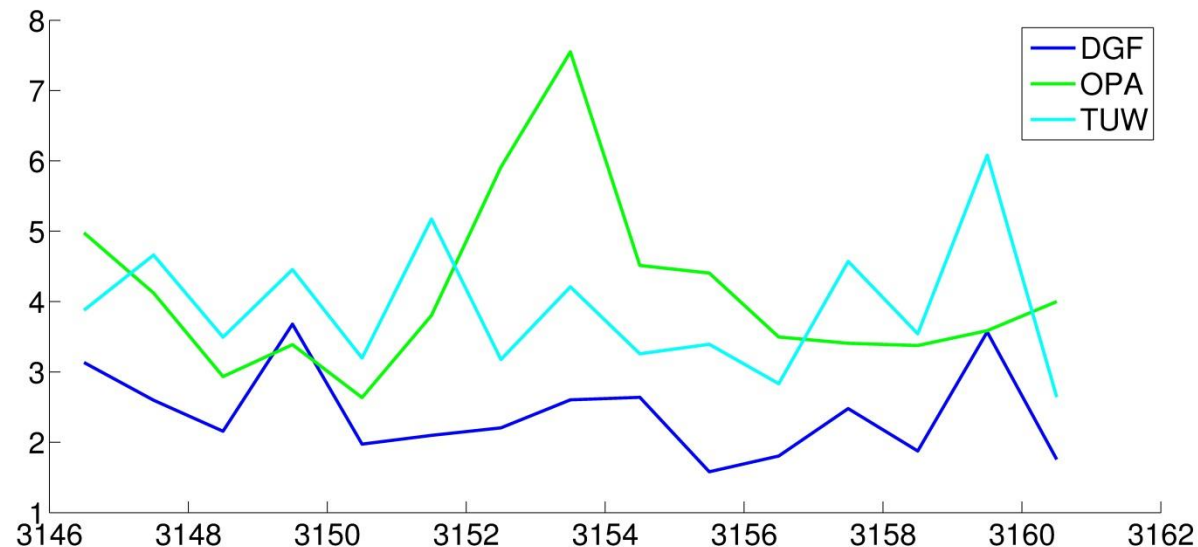
- Consideration of variance components is necessary
- DGFI, OPA: EOP transformed from O+D -> pwl
- Troposphere parameters (TUW): have to be stabilized
- Sources (TUW): fixed to ICRF2
- dUT1: DGFI and TUW (UT1-UTC); OPA (UT1-TAI)
 - > **dUT1 combined for DGFI and TUW only**
- Nutation: TUW[X,Y]; DGFI 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

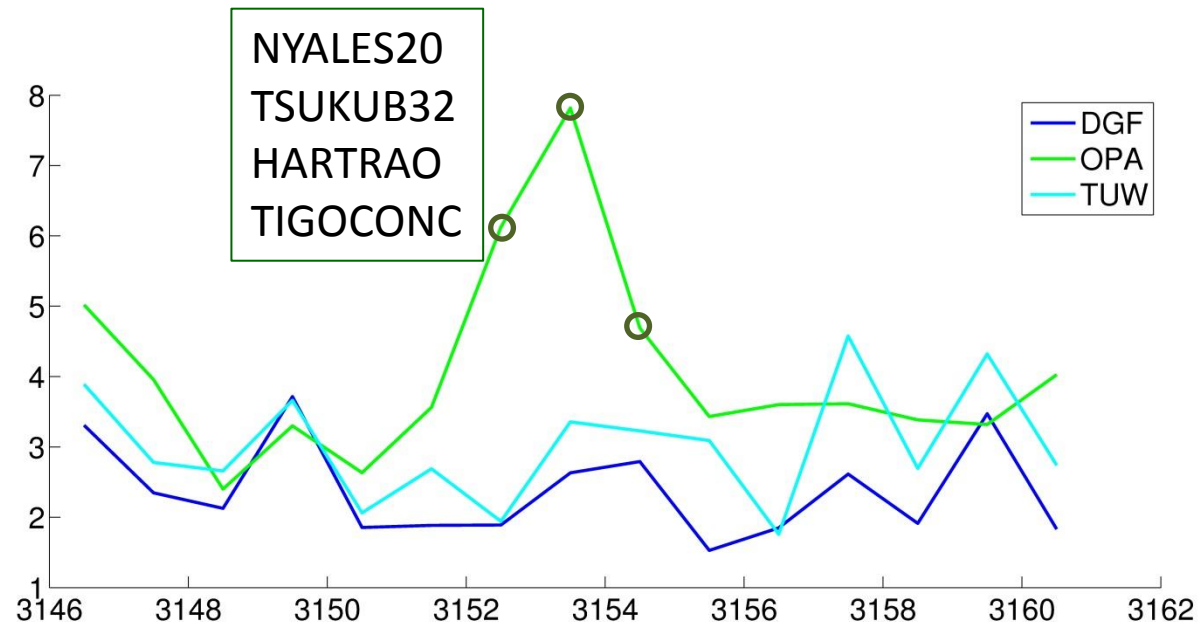


→ Offsets between the AC contributions

Analysis and combination of VLBI data

Combination results

RMS of similarity transformation between combined and single AC solutions

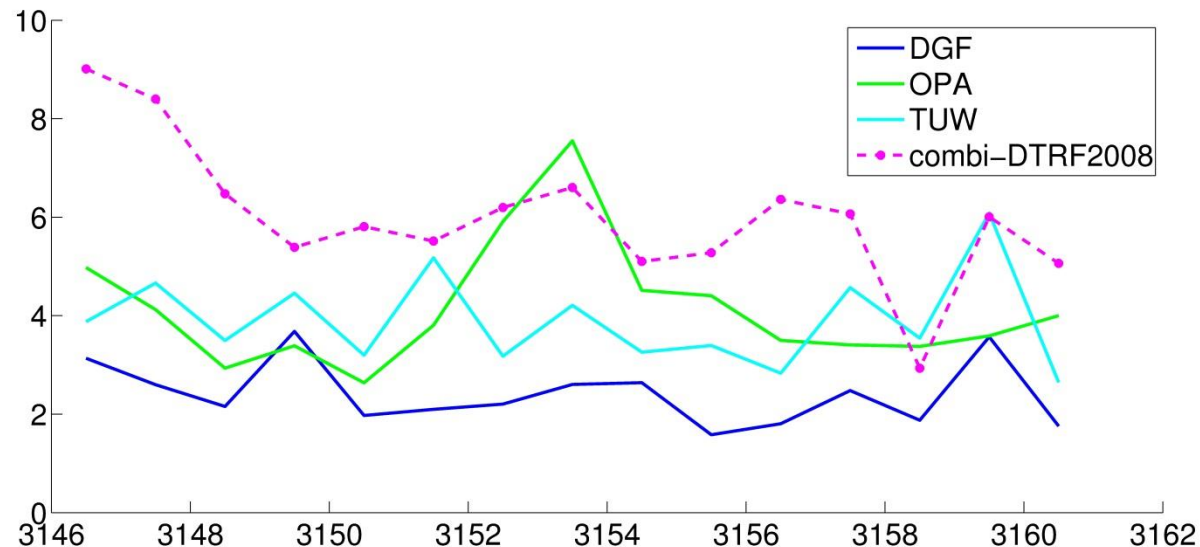


→ NYALES20 not used in transformation: offset between DGF and TUW removed. What are the reasons? Modell differences? (→ height component)

Analysis and combination of VLBI data

Combination results

RMS of similarity transformation between combined and single AC solutions

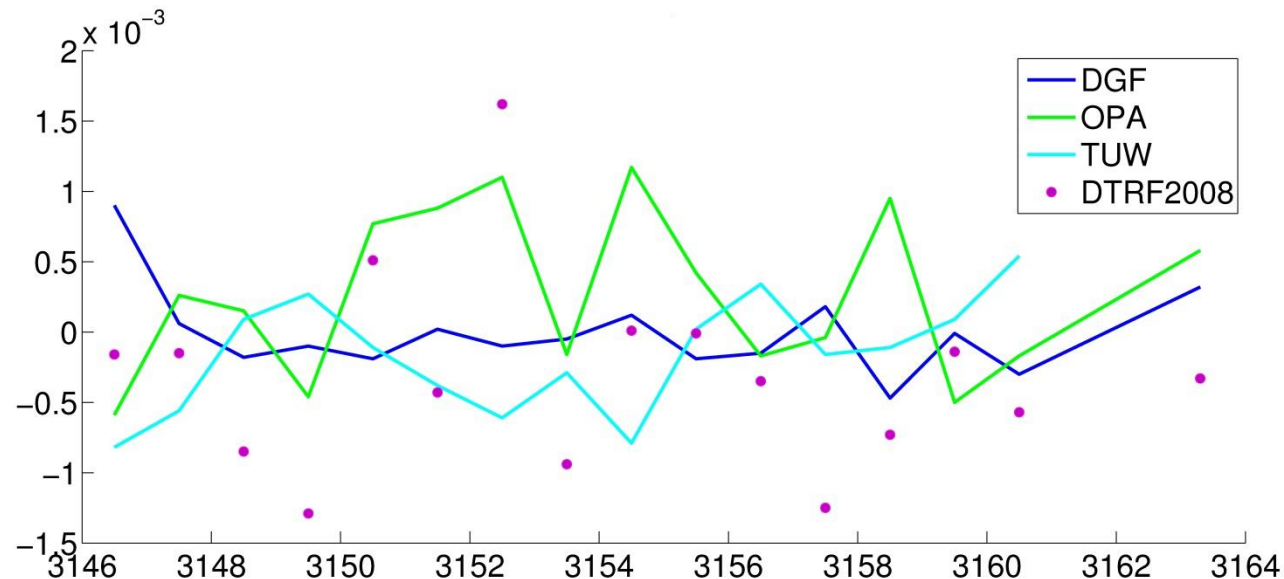


→ Agreement of AC better than agreement to DTRF2008 (model differences; epoch vs. multi-year solution)

Analysis and combination of VLBI data

Combination results

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

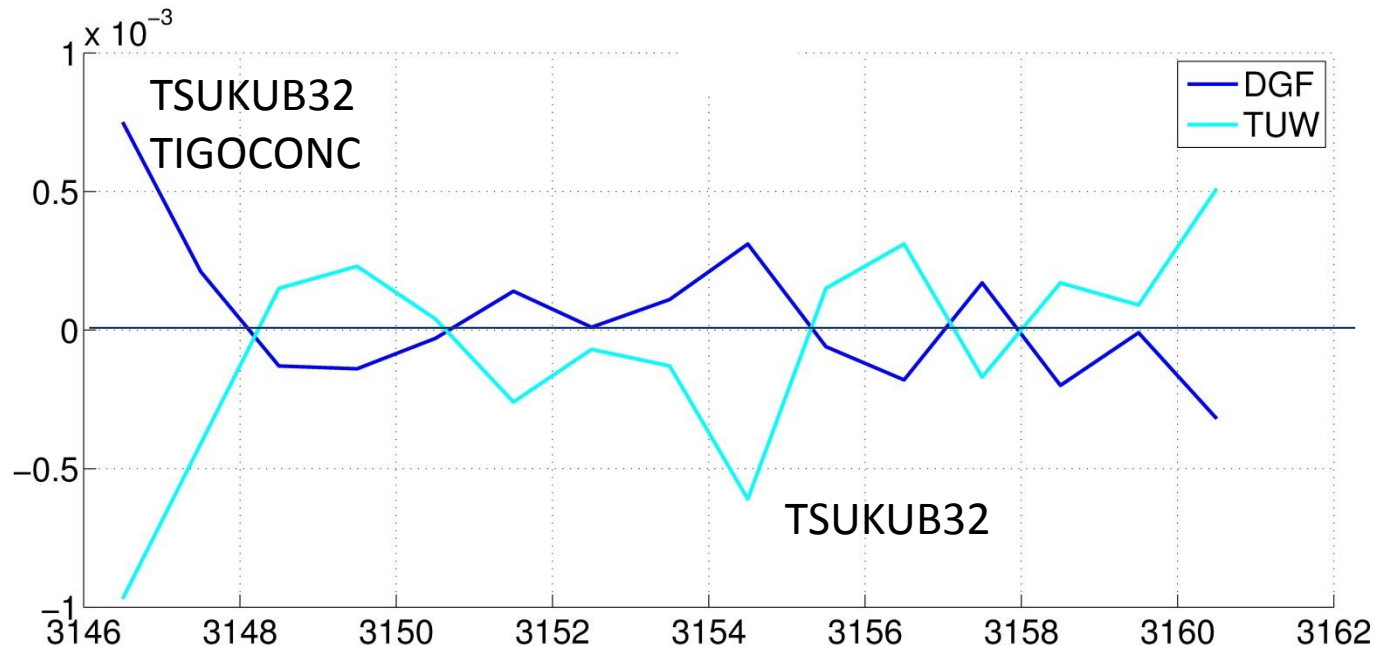


- Contribution of OPA very small (due to large STD).
- RMS of scale differences between AC comparable to comparison of combined solution and DTRF2008 (Offset: -0.5 ppb)

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

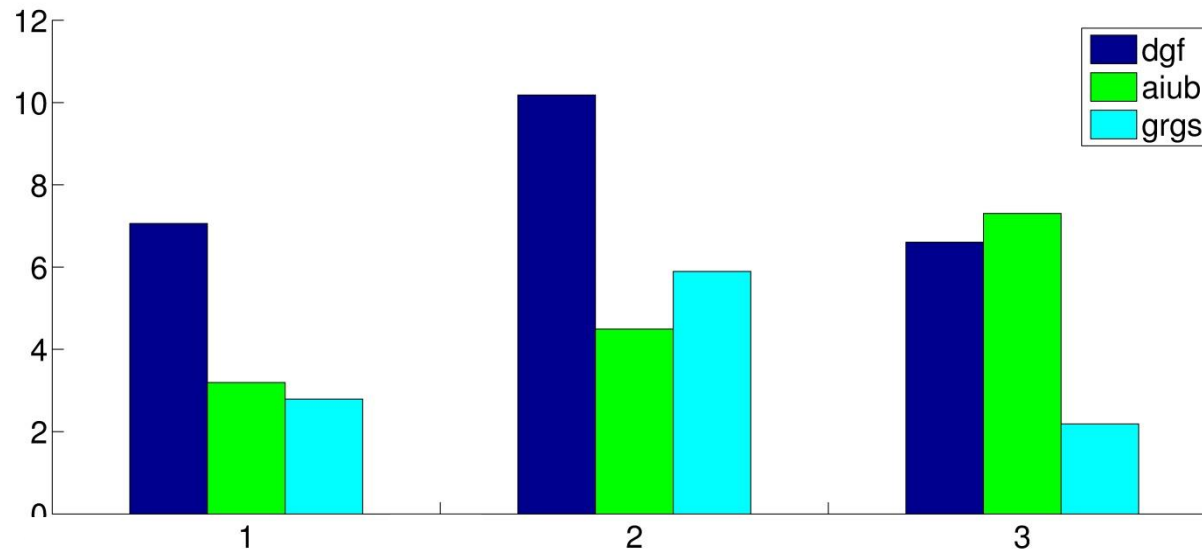
Combination aspects

- 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

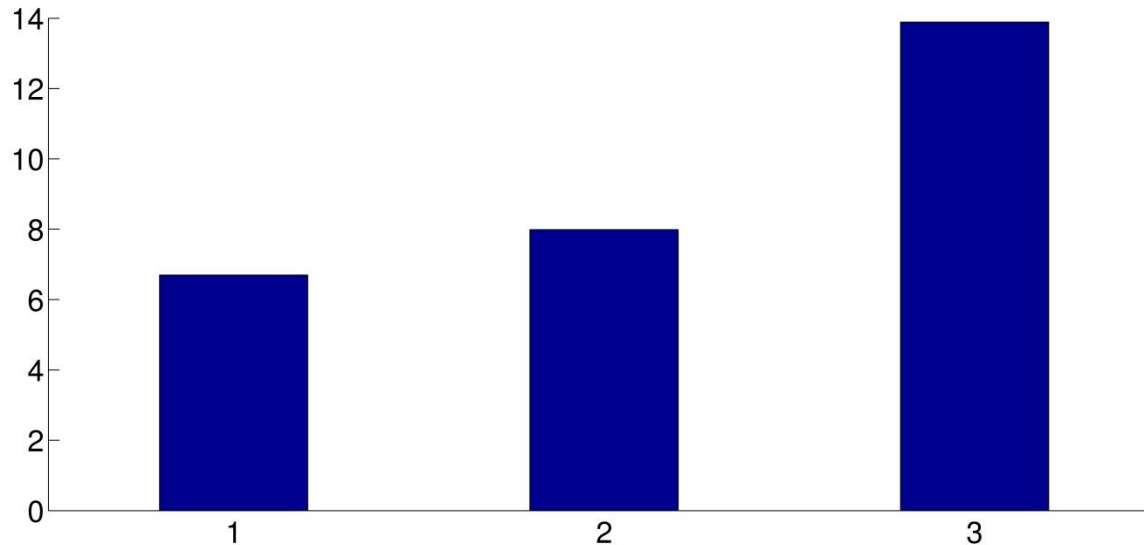


→ Comparable RMS values, DGFI values (weeks 1 and 2) slightly larger (improved compared to first DGFI solution)

Analysis and combination of SLR data

Combination results

RMS of similarity transformation between combined solution and DTRF2008

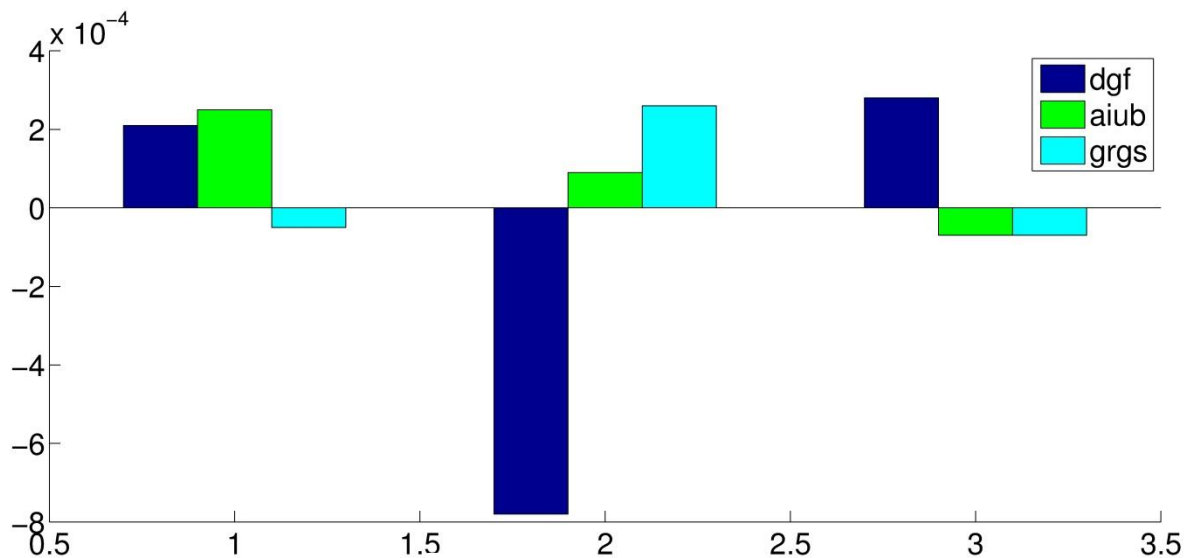


→ Comparable to RMS for single AC w.r.t. DTRF2008 (15 mm); week 1 and 2 benefit from combination

Analysis and combination of SLR data

Combination results

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

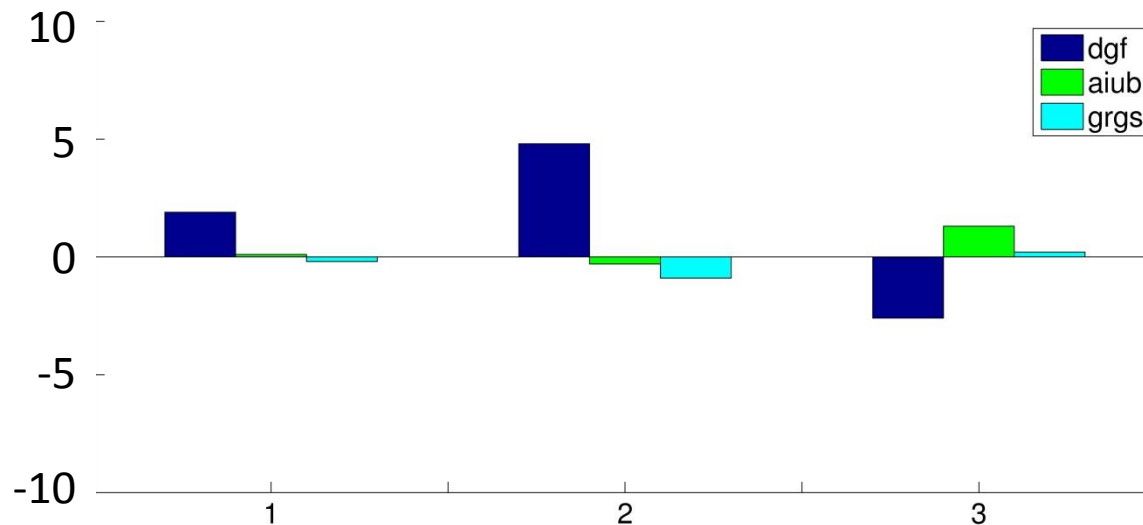


→ Agreement: 0.2 ppb (~ 1.5 mm) ; except of week 2 / DGFI

Analysis and combination of SLR data

Combination results

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

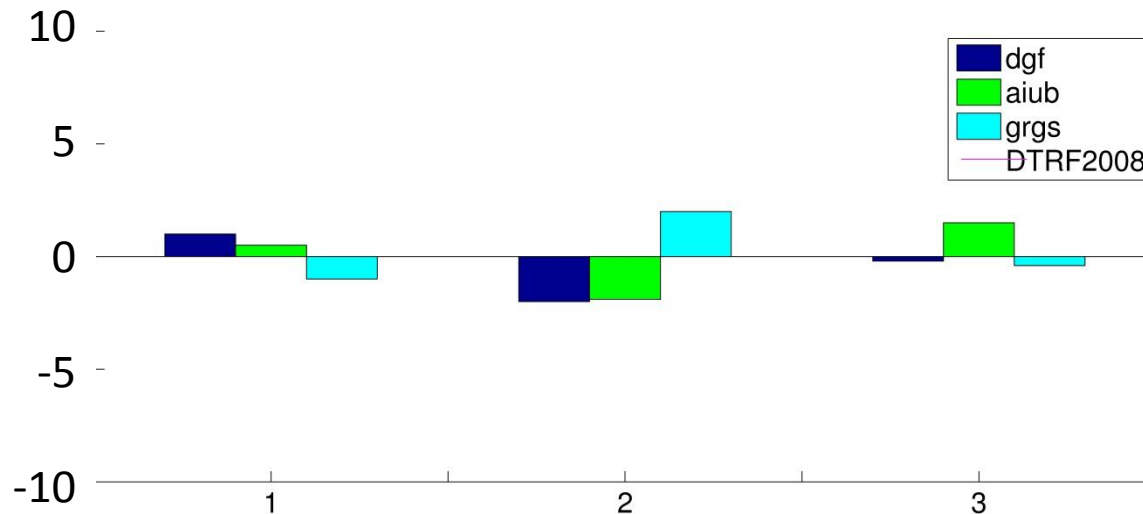


→ Agreement within 5.0 mm

Analysis and combination of SLR data

Combination results

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

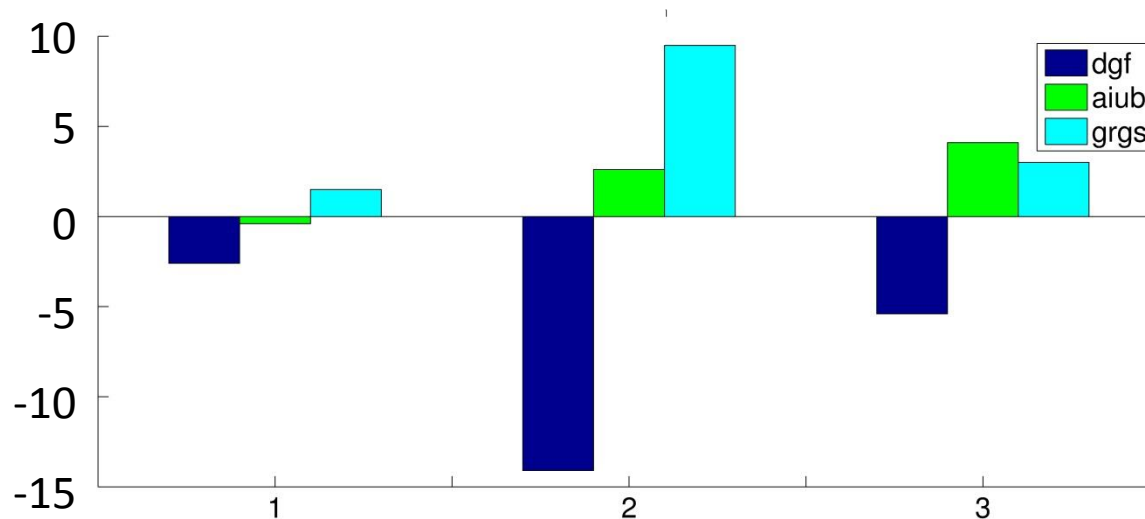


→ Agreement within 2.0 mm

Analysis and combination of SLR data

Combination results

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

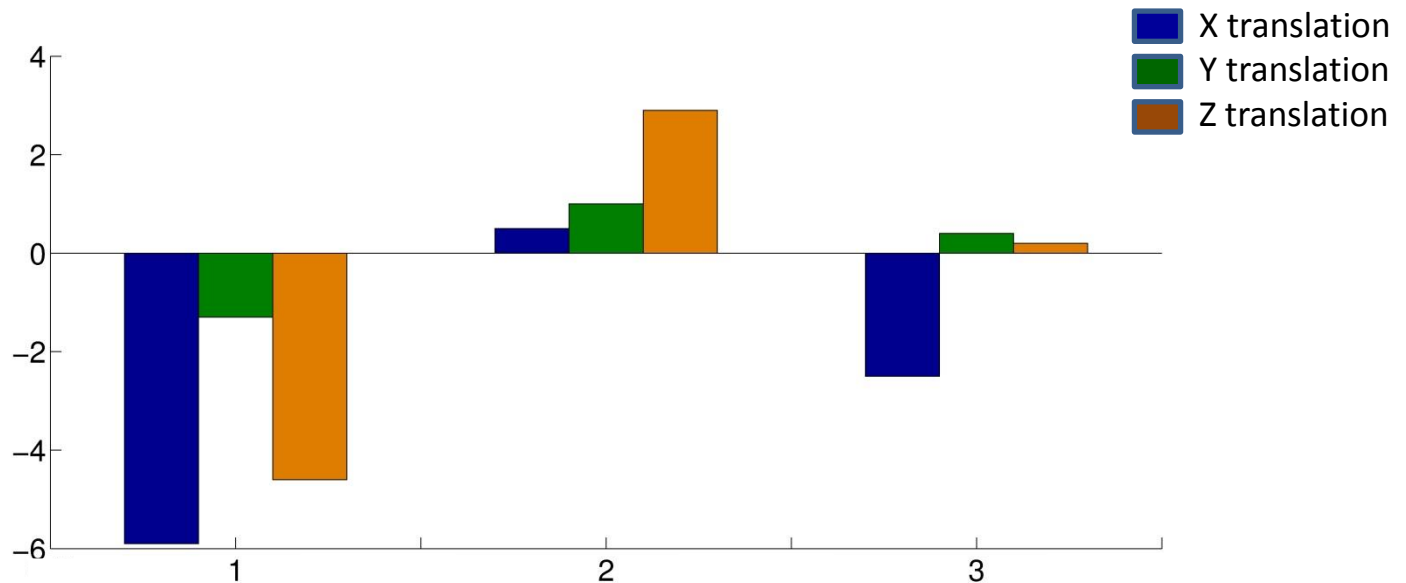


- Agreement within 5.0 mm for week 1 and 3
- Summarizing: homogeneous SLR input data

Analysis and combination of SLR data

Combination results

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

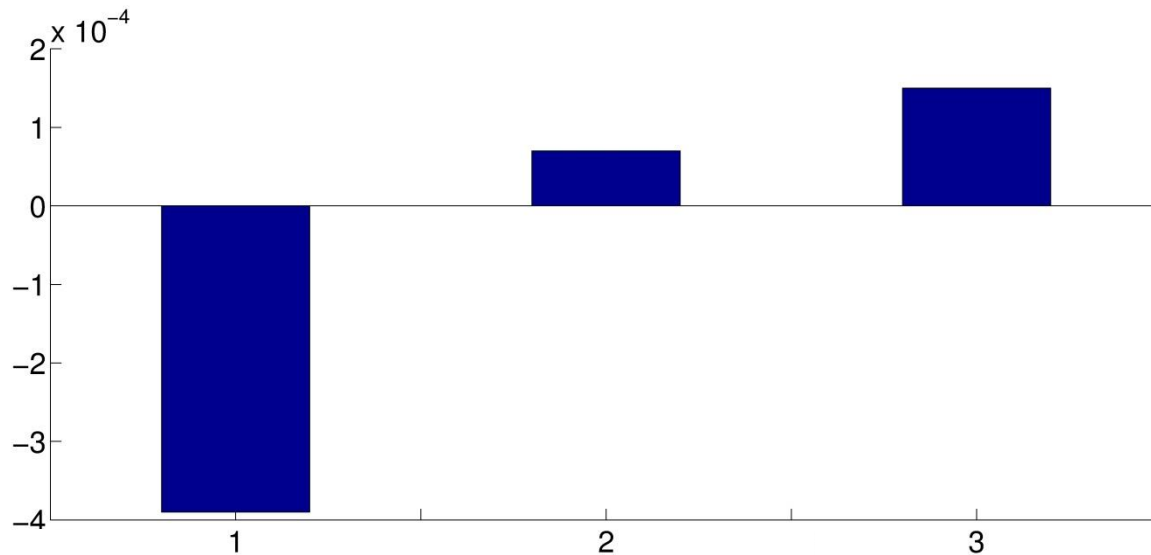


→ Agreement within 6 mm.

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:

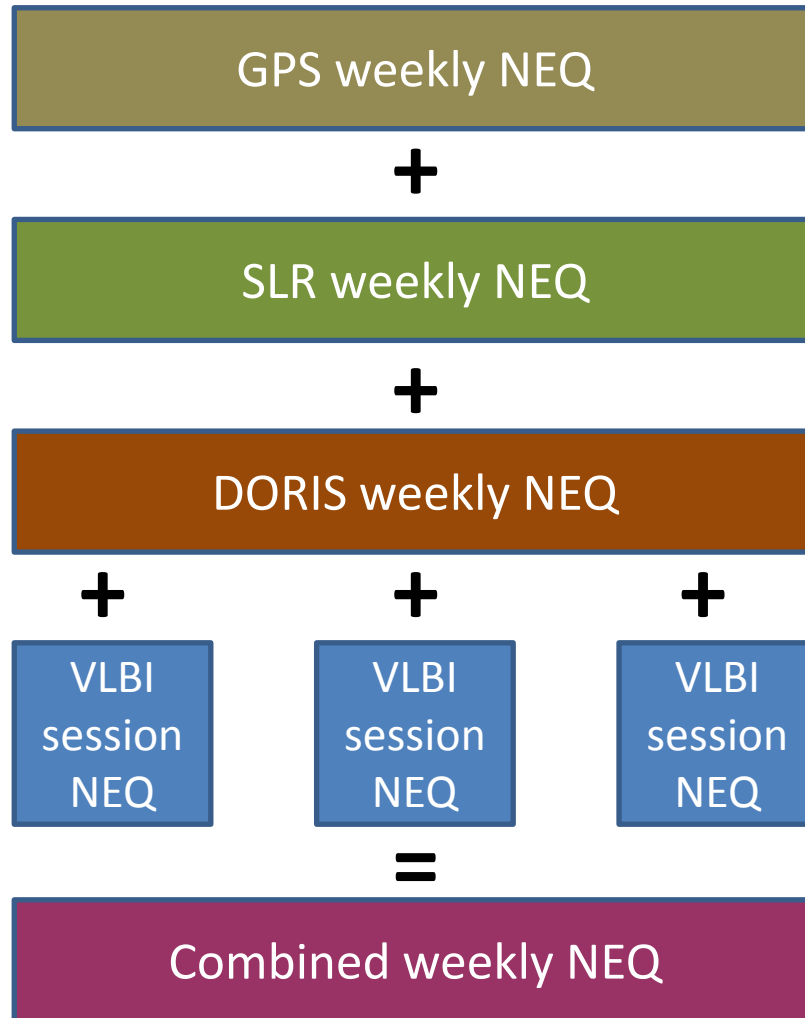
	A posteriori Sigma	Transformation DTRF2008	RMS of transformation
GRGS	1.0	datum parameters set up	10-20 mm

Combination:

→ No intra-technique combination for DORIS

Inter-technique combination

Flowchart of weekly combination



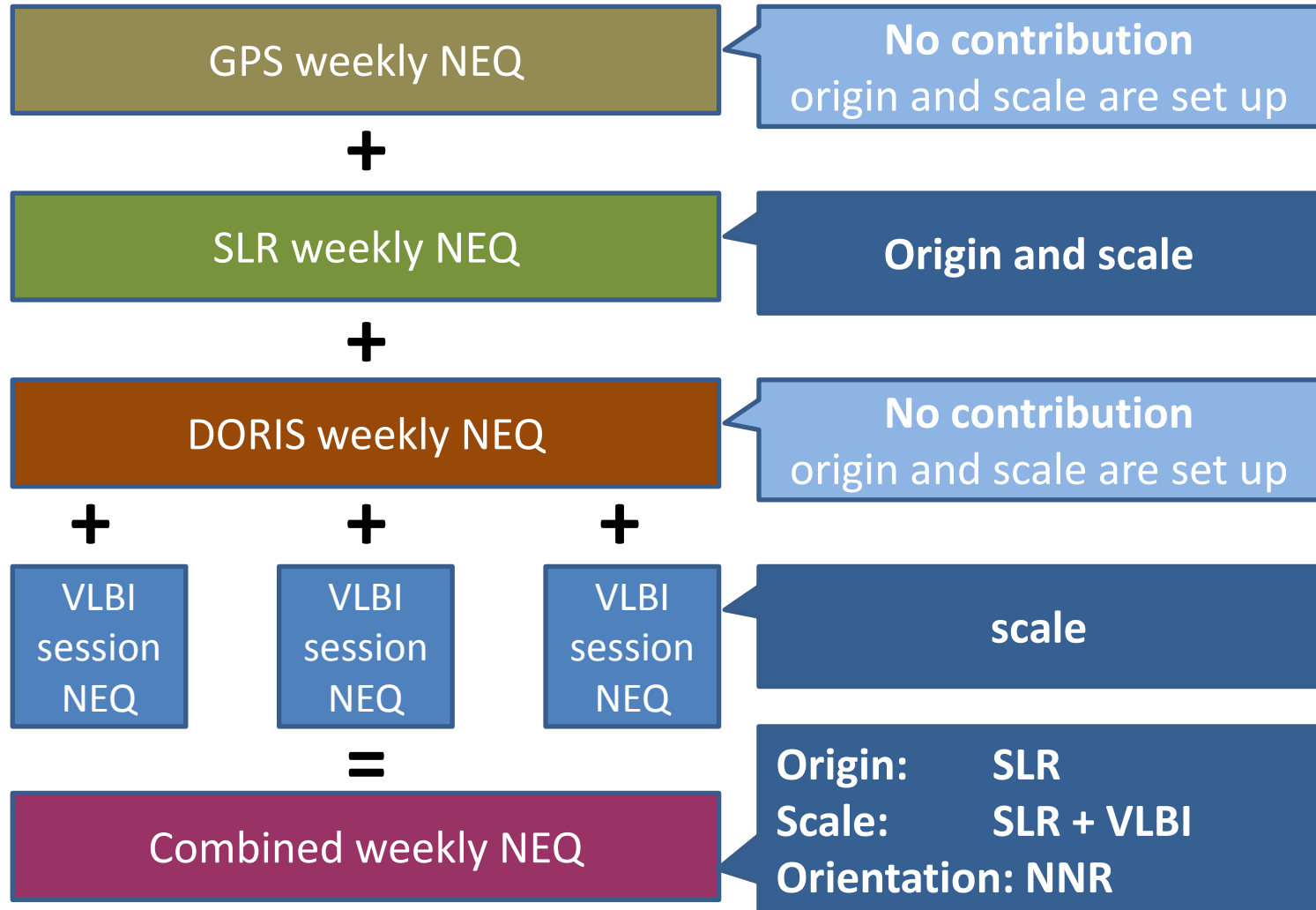
Selection of local ties

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]

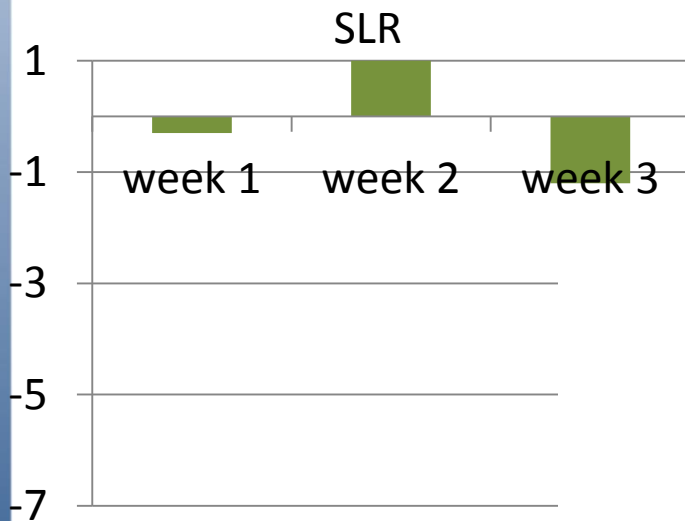


→ Good agreement between SLR only and combined solution

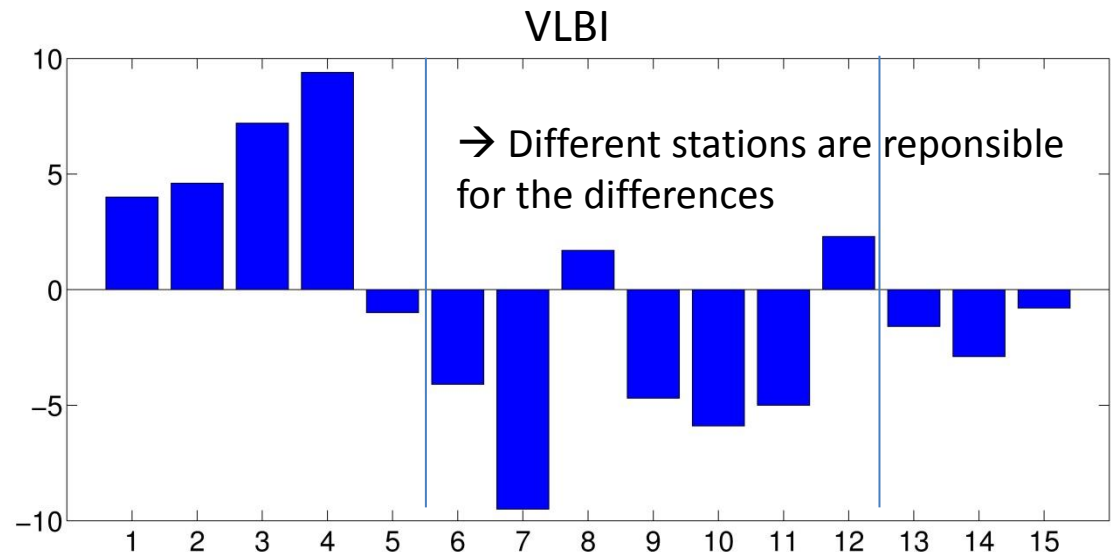
Combination: Datum realization

Conservation of the scale

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

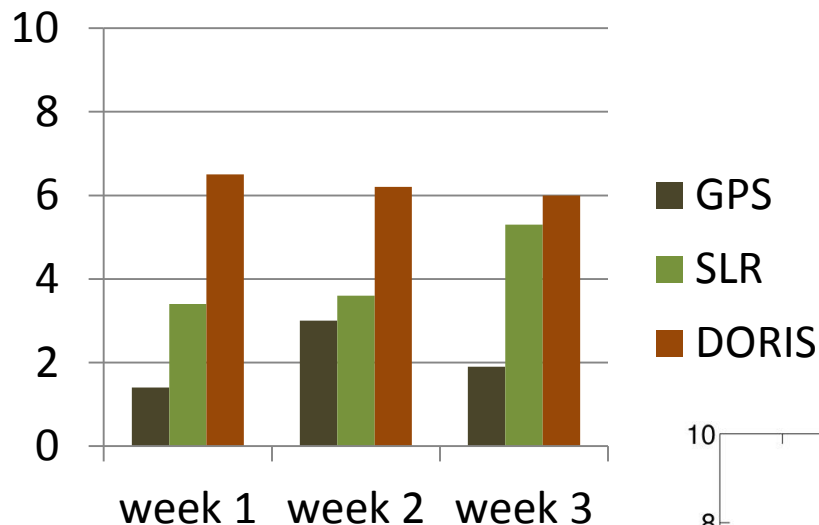


→ Variation of VLBI larger, but no mean offset between VLBI and SLR scale



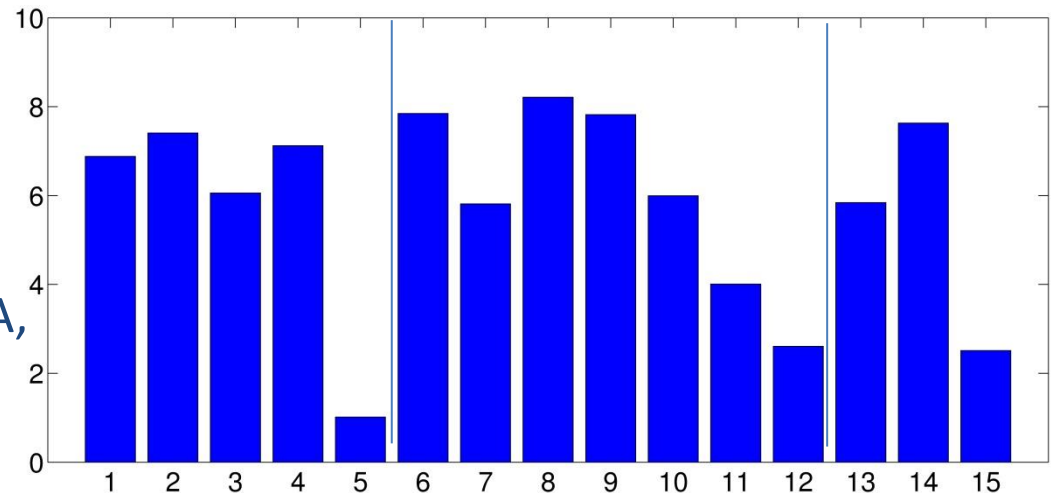
Combination: deformation of networks

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

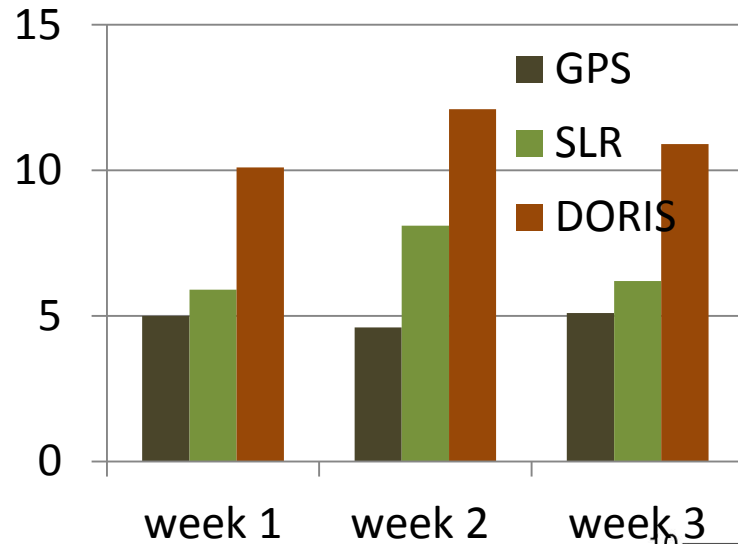
Datum realization w.r.t. DTRF2008
~ 5mm per component
(GPS orientation better)

Transfer into network parts

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

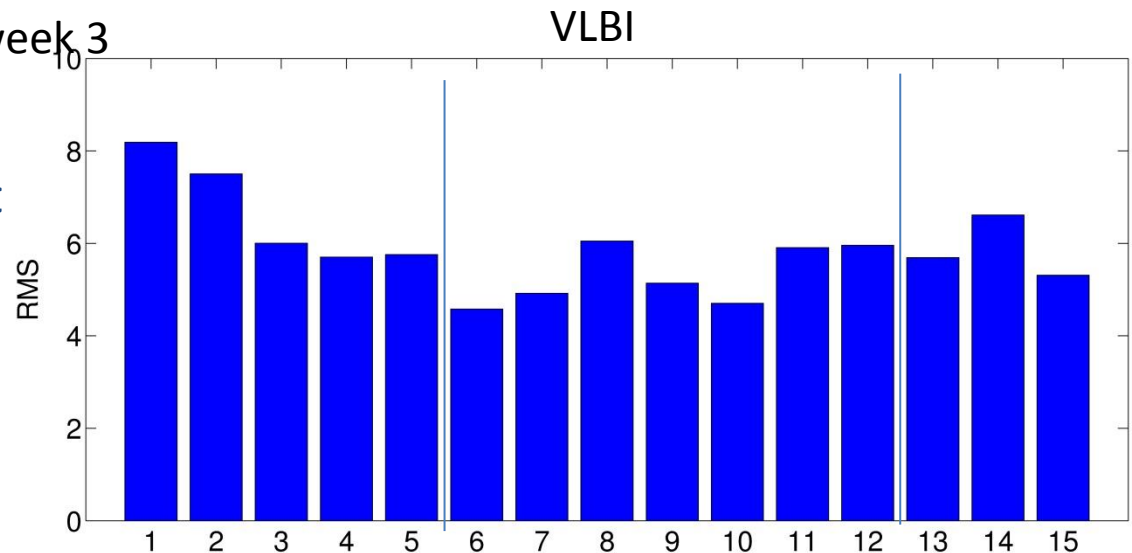
Combination: Comparison with DTRF2008

RMS values



Model differences between COL and DTRF2008 for VLBI and DORIS?

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



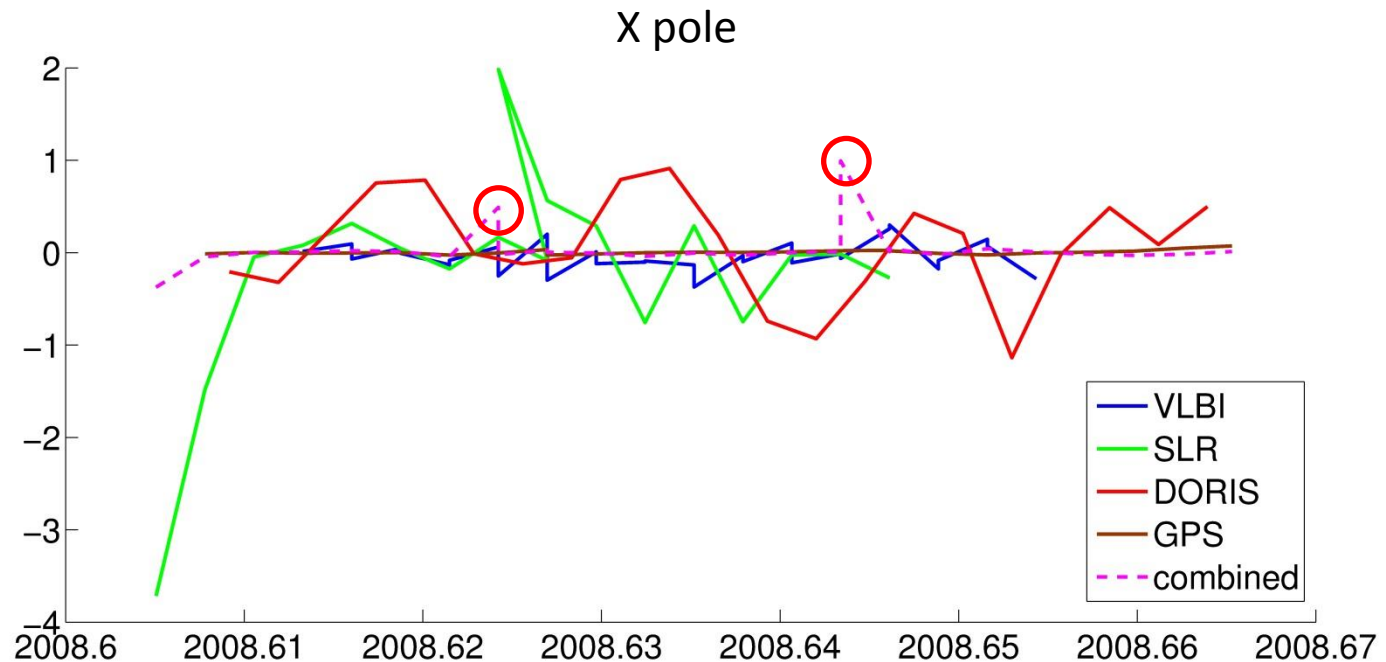
Combination: EOP

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

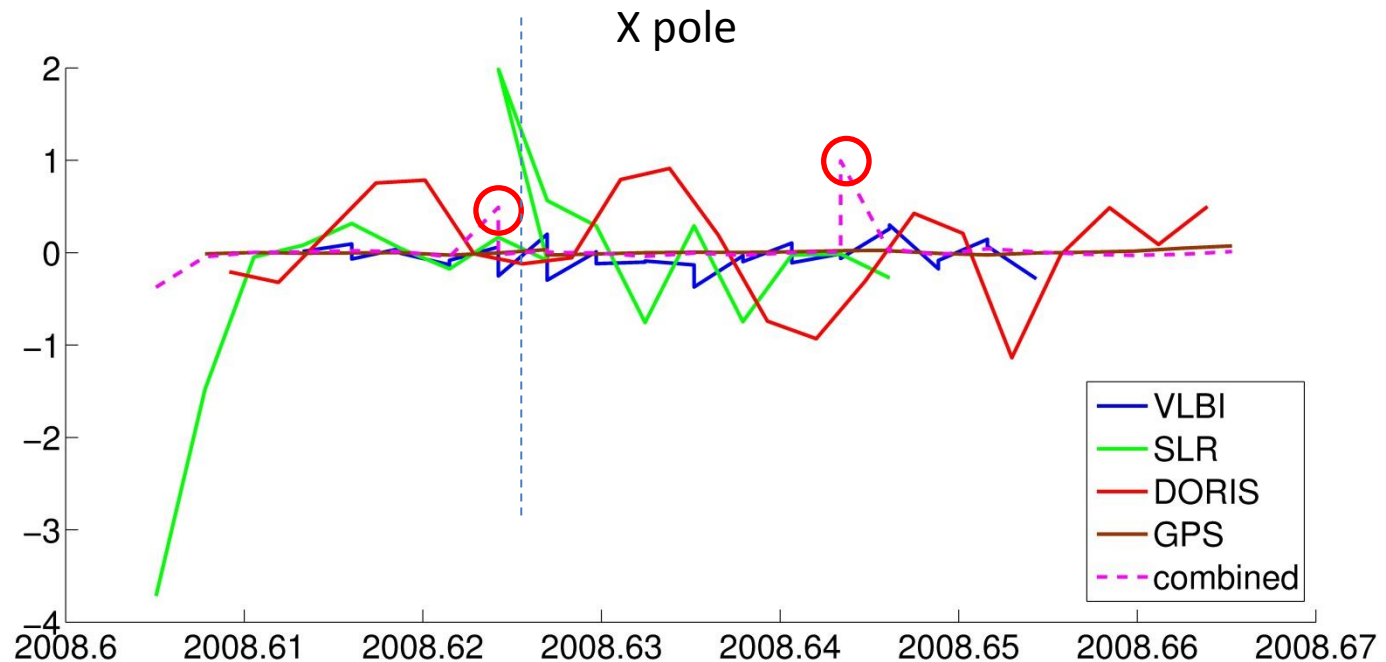
Pole coordinates (w.r.t. IERS 08 C04)



SLR week 3 cannot be solved

Combination: EOP results

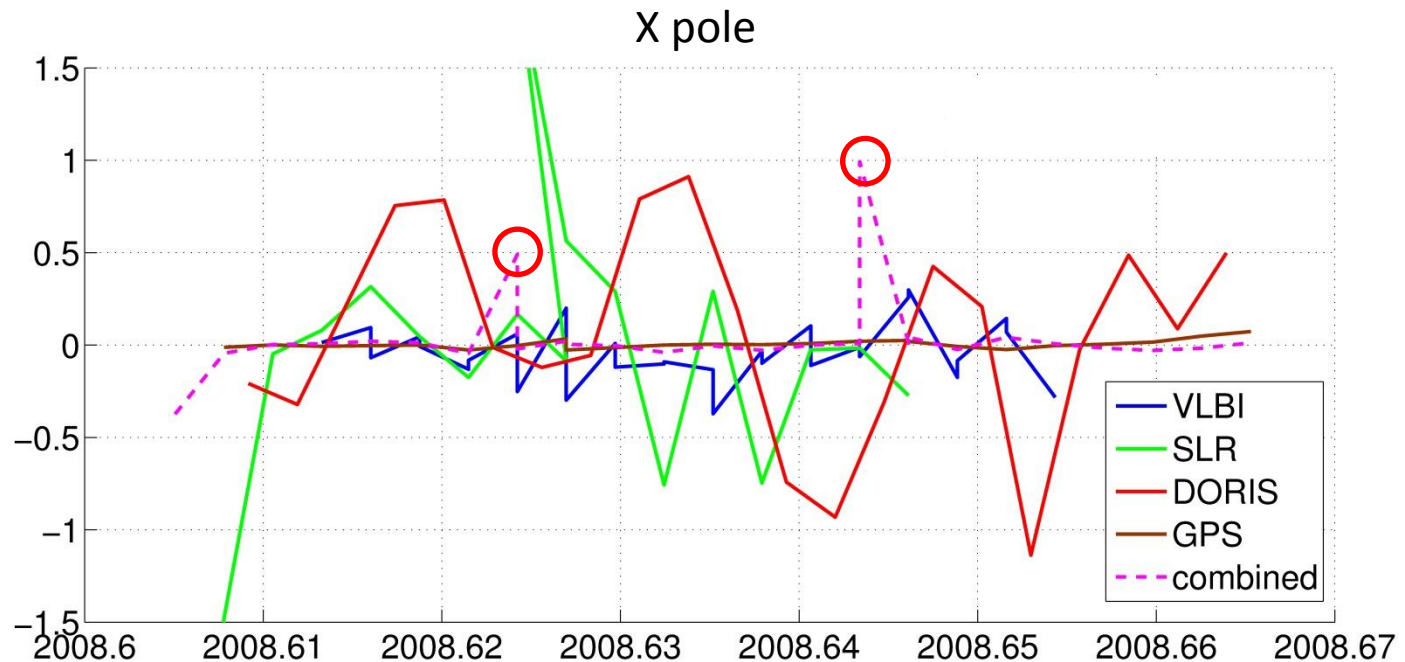
Pole coordinates (w.r.t. IERS 08 C04)



SLR week 3 cannot be solved

Combination: EOP results

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

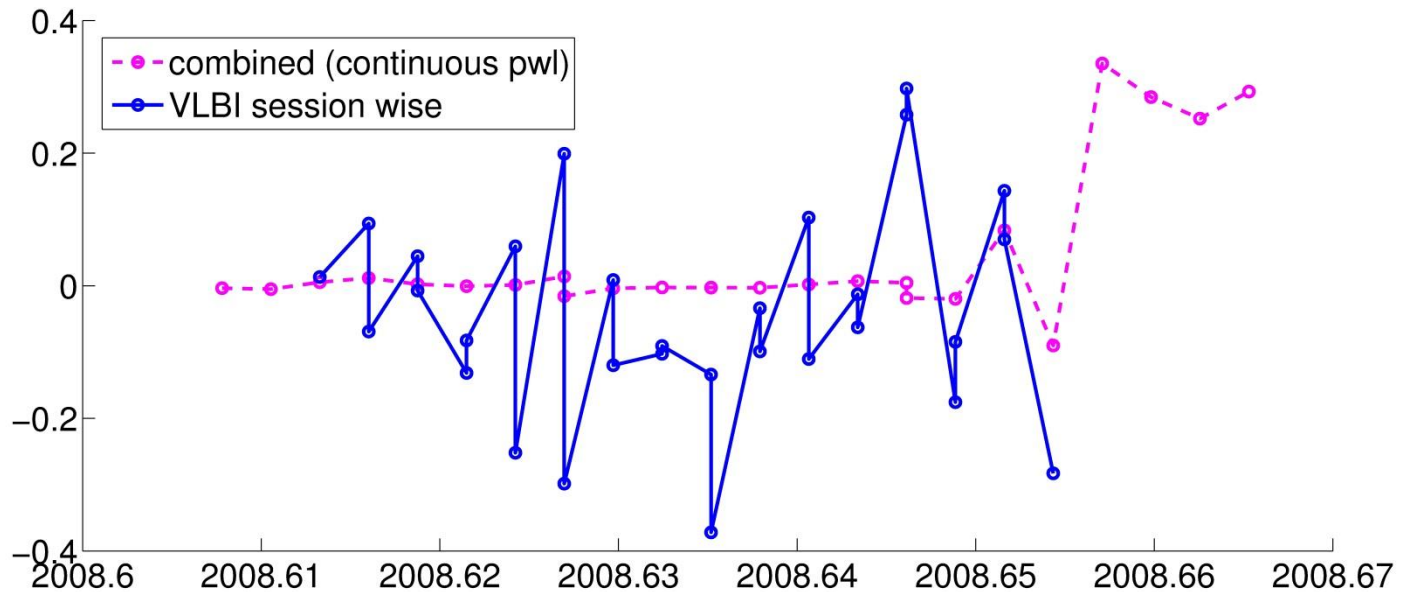


- Outliers due to SLR contribution
(AIUB values: transformation from O+D -> pwl ?)
- Y pole shows the same effects

	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)