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

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

Input data

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

Input data

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:

lTPl too large: discussion with Sebastien Lampert on the lTPl 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 quation 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
DGFI	7 mm	/
MAO	25 mm	/
OPA	6 mm	7 mm
TUW	7 mm	12 mm

scale [mm]	2008	2011
DGFI	6 mm	/
MAO	25 mm	/
OPA	4 mm	2 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)

DORIS contribution GRGS

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	/	/	/	/

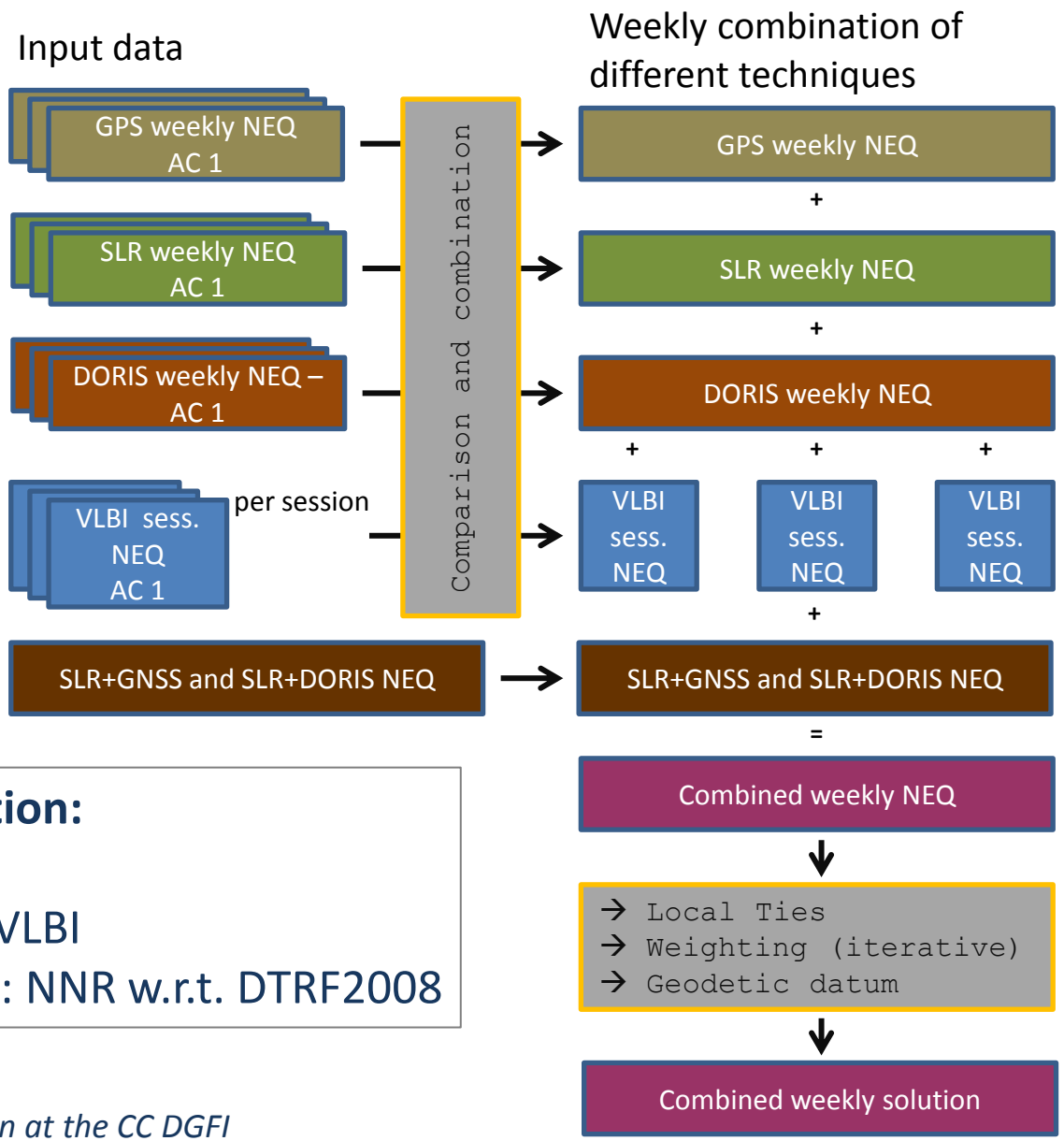
Input data used

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

Seitz: Combination at the CC DGFI

Combination

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

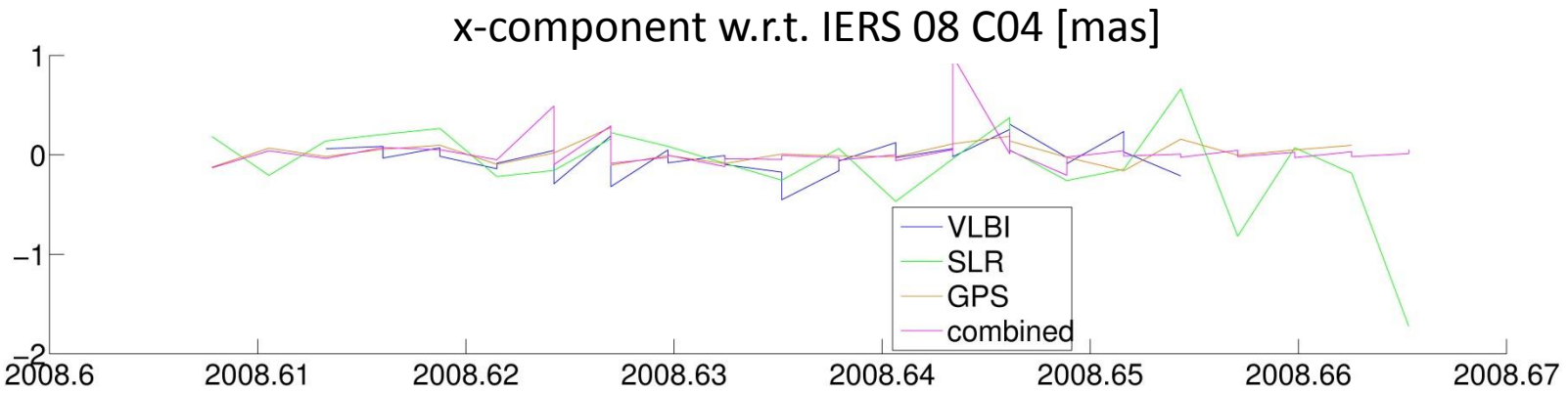
	translation	scale	RMS
GPS			2 mm
DORIS			10 mm
SLR	0-7 mm	0-1.5 mm	6 mm
VLBI		0-1.0 mm	7 mm

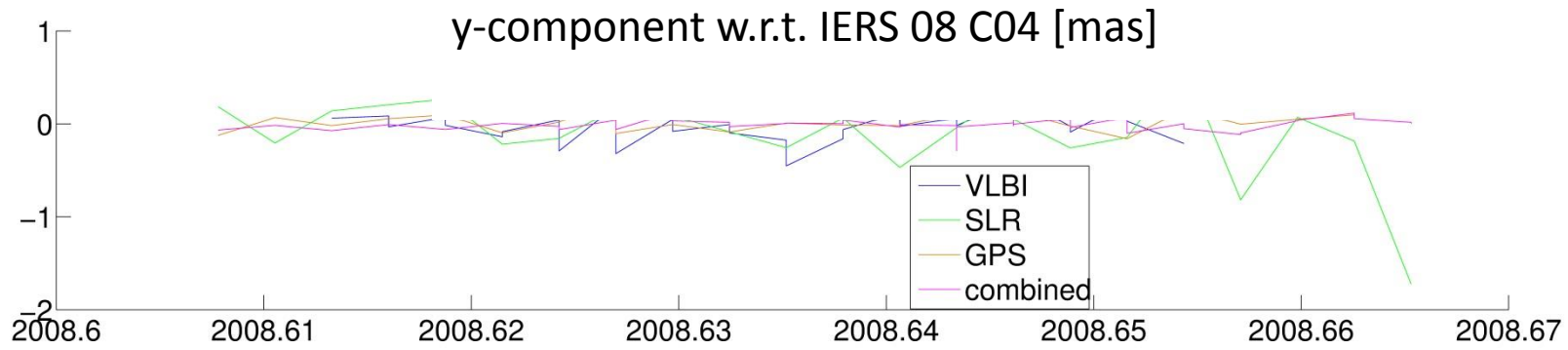
Transformation w.r.t. DTRF2008

	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

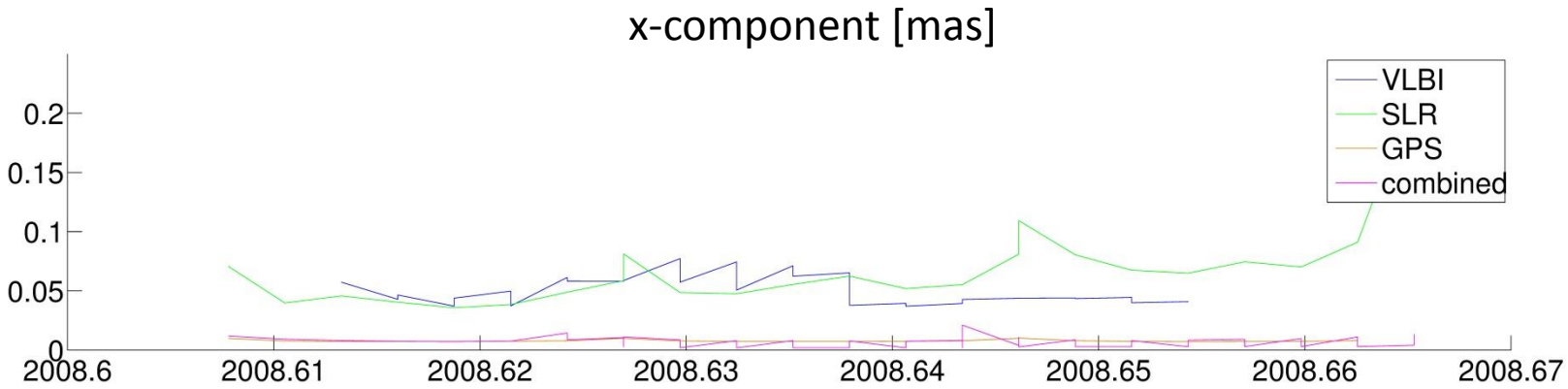
Terrestrial pole

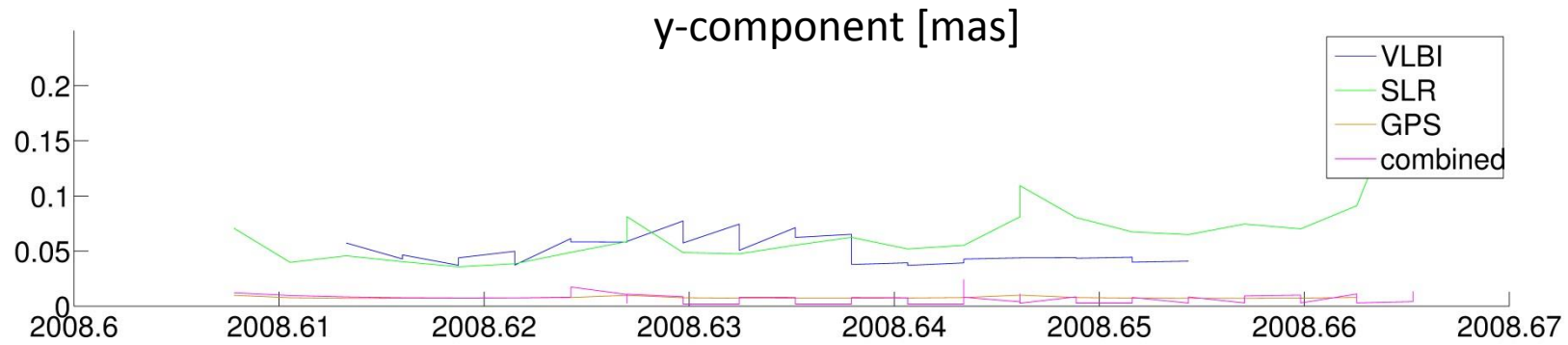




Combination: EOP standard deviations

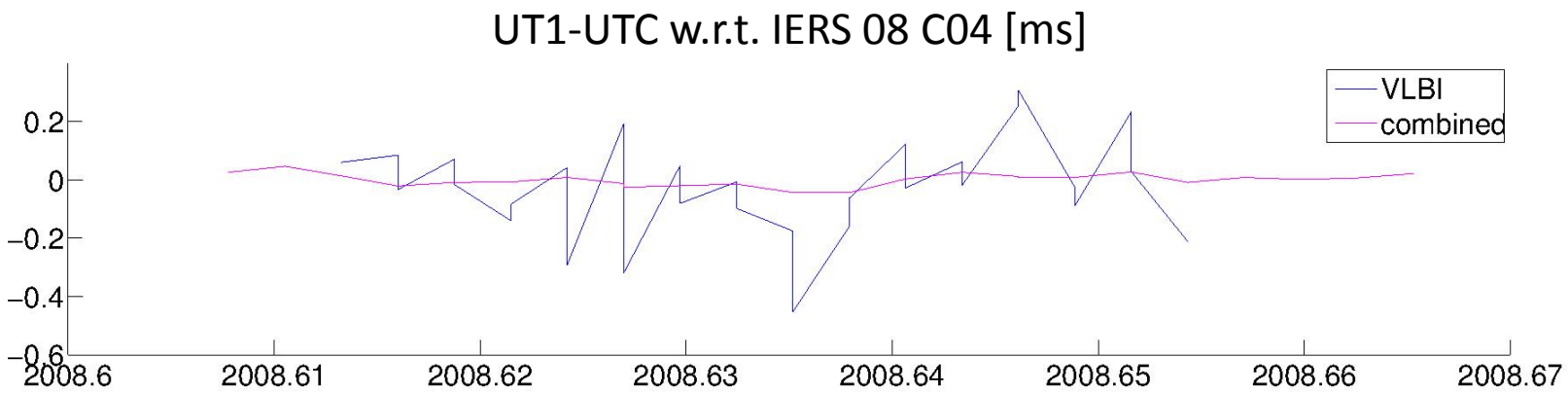
Terrestrial pole

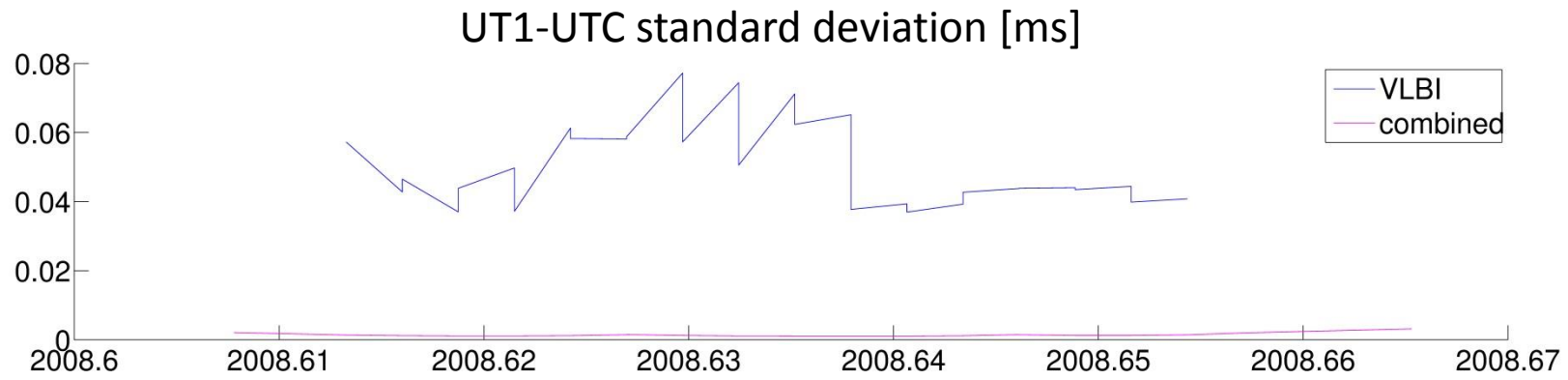




Combination: EOP

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: ~ dry part → *GPT model, GMF mapping function*
- estimated value: ~ wet part *(GMF mapping function)*

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

Corresponding gradients:

TGNTOT
TGETOT

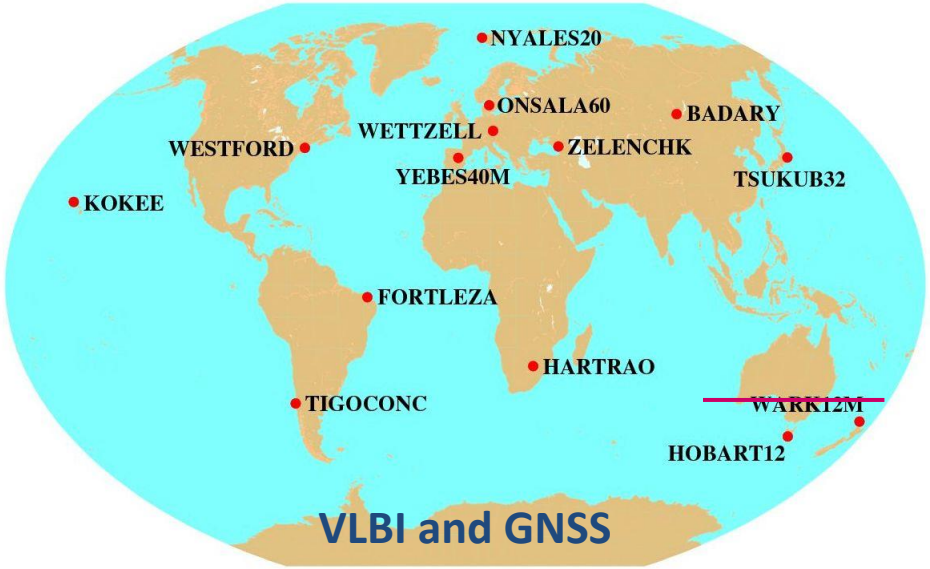
} a priori values = 0 (or standardized values for COL)

Tropospheric parameters in SINEX

Stations CONT08

DORIS
NyAlesund
Hartebeesthoek
Kokee Park

Stations CONT11



DORIS
NyAlesund
Hartebeesthoek
Kokee Park

Seitz: Combination at the

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

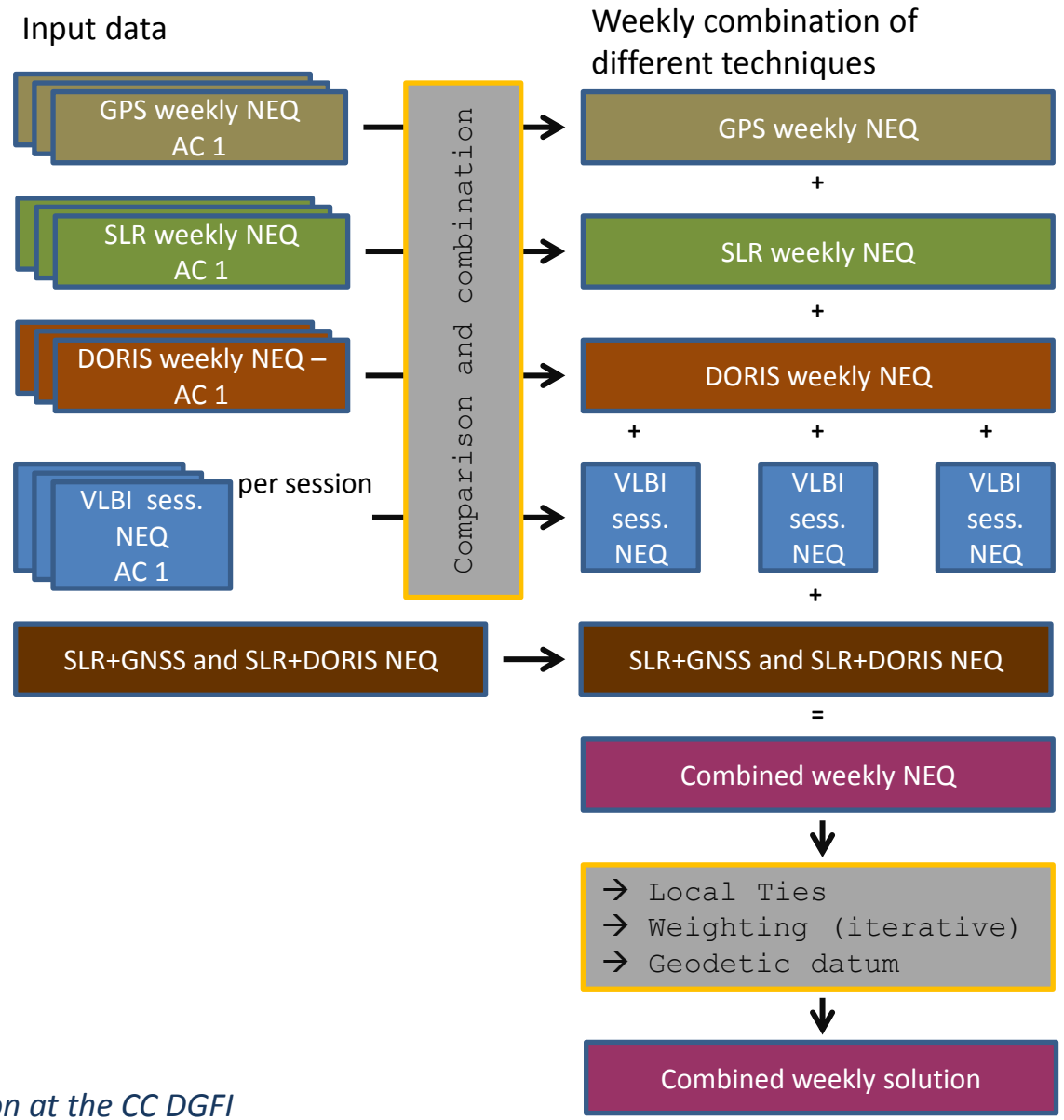
Tran: 0-5 mm

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



Seitz: Combination at the CC 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*10^15 vs. 1*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]

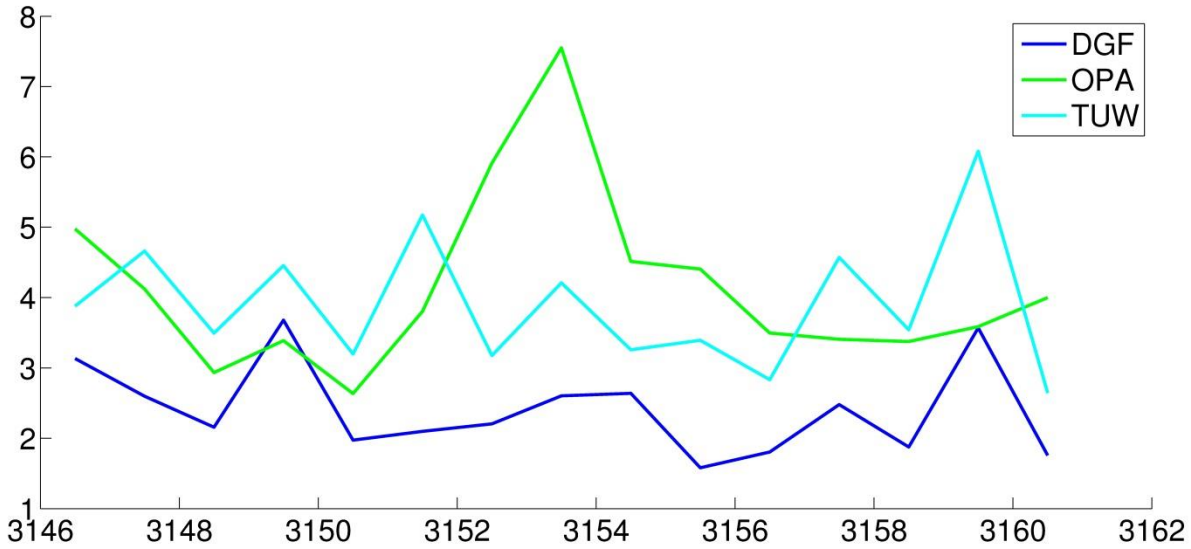
  - OPA: a priori values are not 0.0 (model values?)

  -> **nutation is not combined**

→ Parameterization of VLBI contributions must be further homogenized.

Combination results

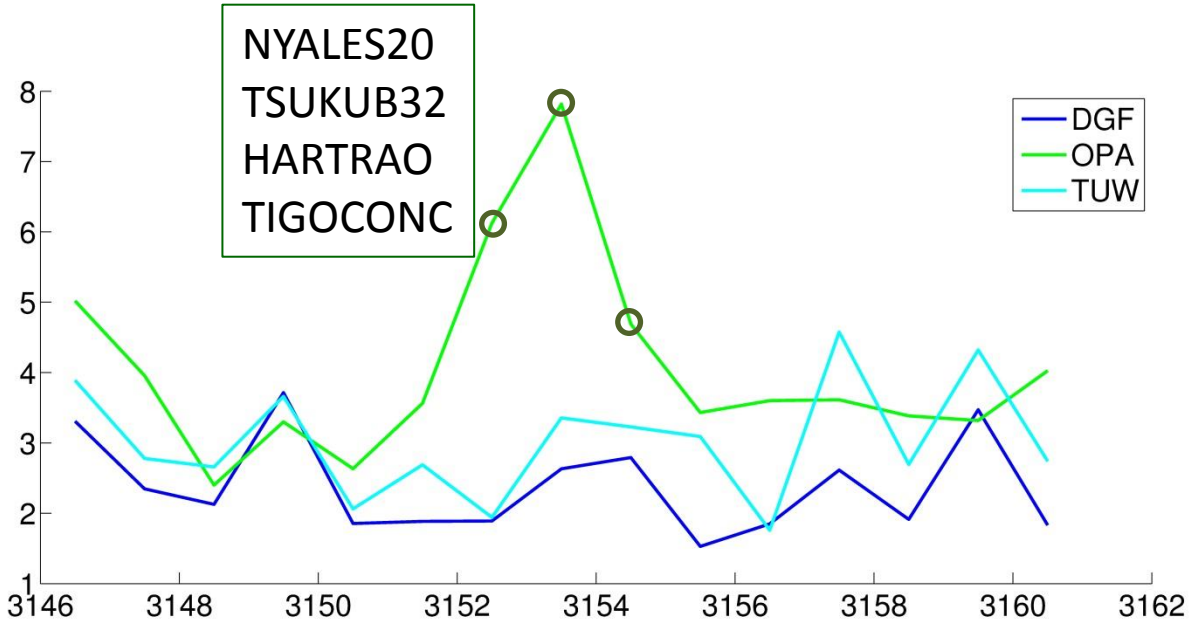
RMS of similarity transformation between combined and single AC solutions



→ Offsets between the AC contributions

Combination results

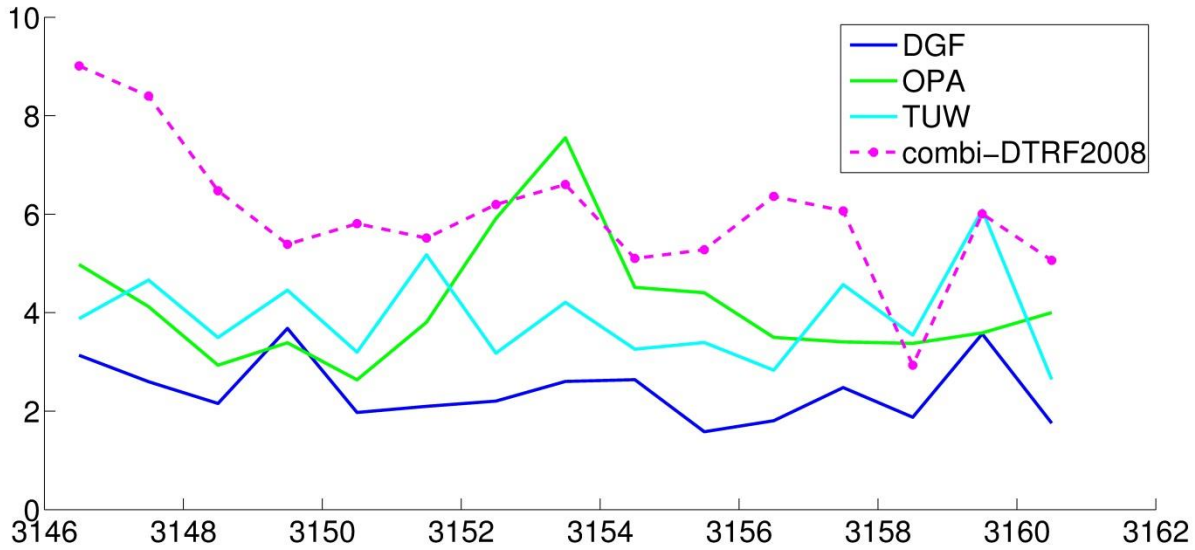
RMS of similarity transformation between combined and single AC solutions



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

Combination results

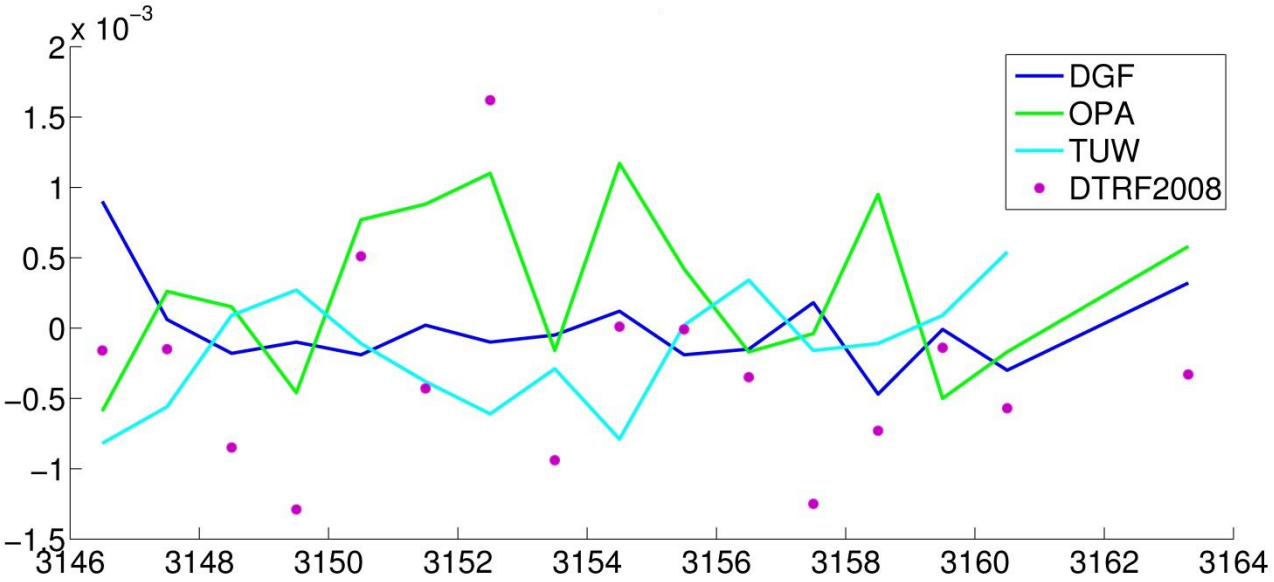
RMS of similarity transformation between combined and single AC solutions



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

Combination results

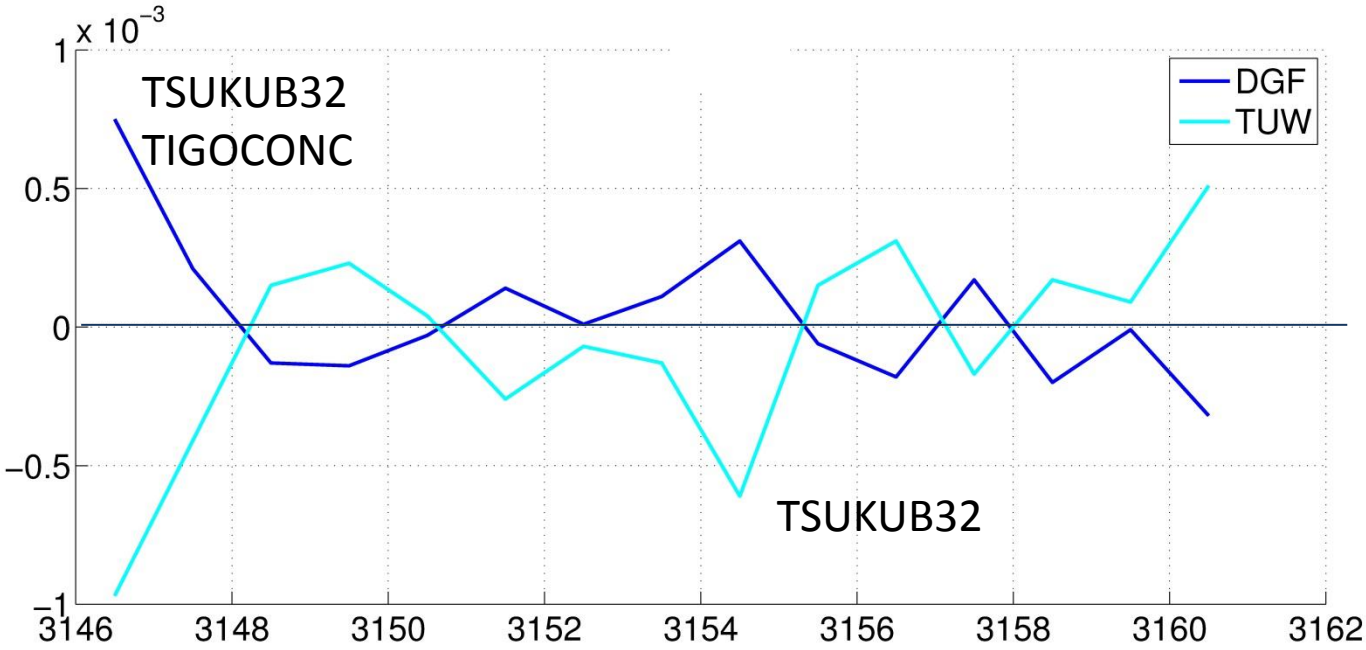
Scale differences [ppm] derived from transformation between combined and single AC solutions (and DTRF2008)



- 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)

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)

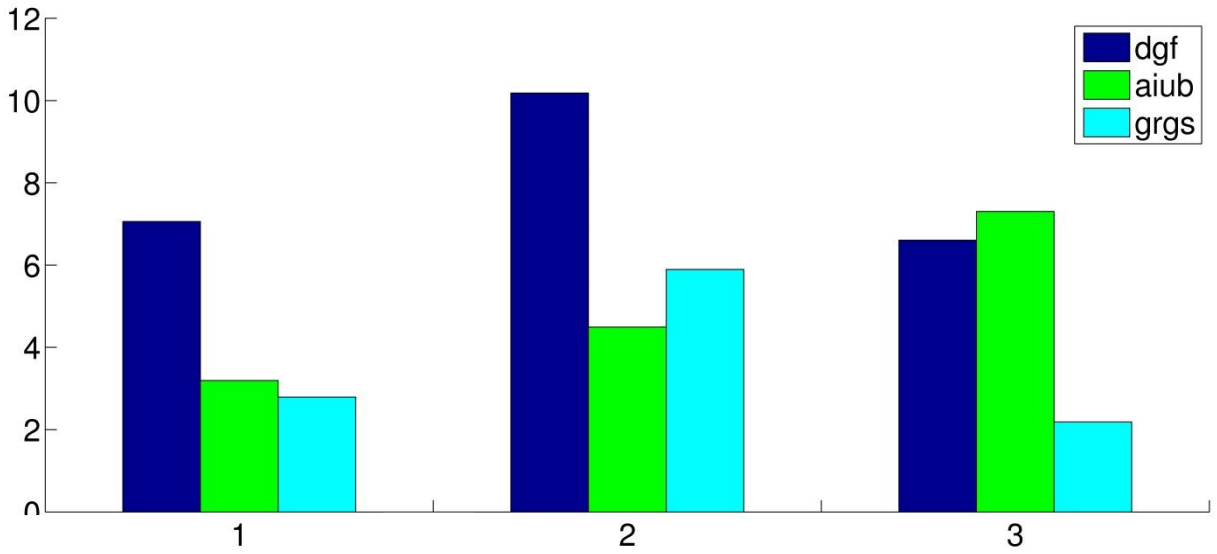
  -> only the EOP of AIUB and DGFI are combined
  - week 3 cannot be solved if EOP are combined (ITPI) !!

    What is the reason?

Analysis and combination of SLR data

Combination results

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

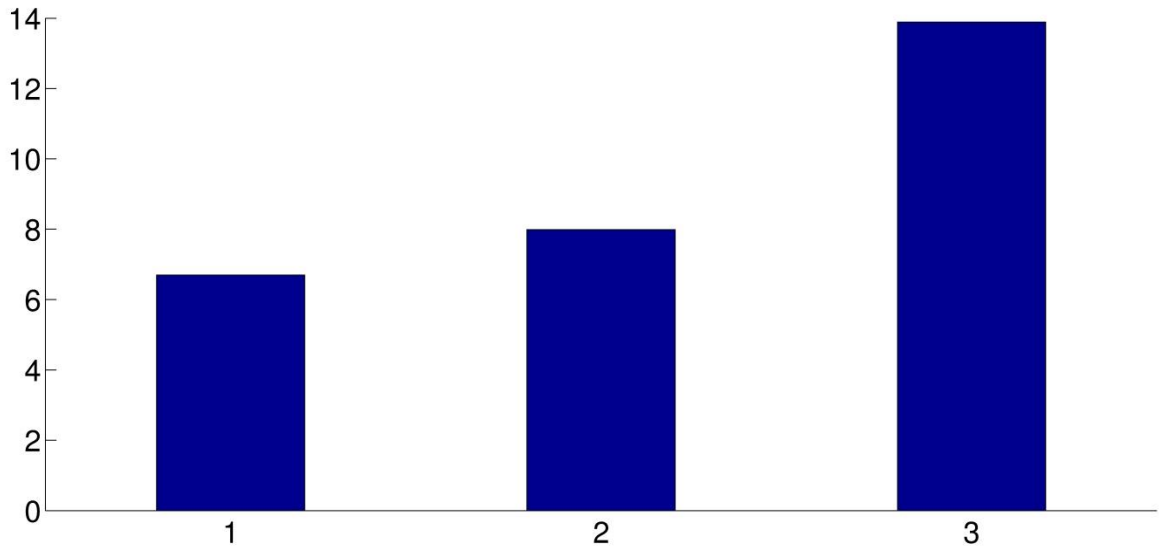


→ Comparable RMS values, DGFI values (weeks 1 and 2) slightly larger (improved compared to first DGFI solution)

Analysis and combination of SLR data

Combination results

RMS of similarity transformation between combined solution and DTRF2008

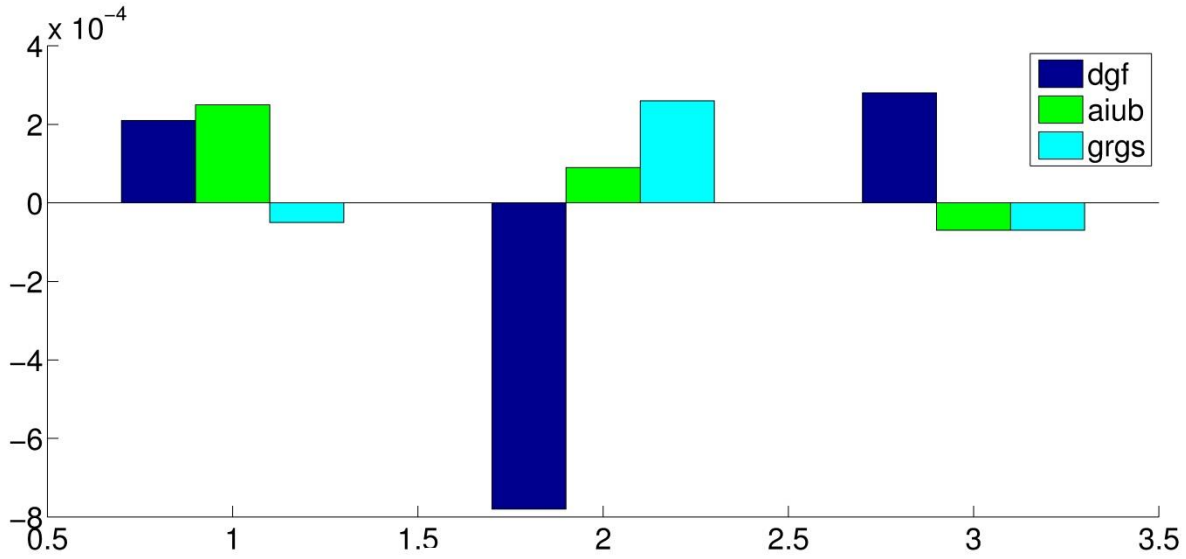


→ Comparable to RMS for single AC w.r.t. DTRF2008 (15 mm); week 1 and 2 benefit from combination

Analysis and combination of SLR data

Combination results

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

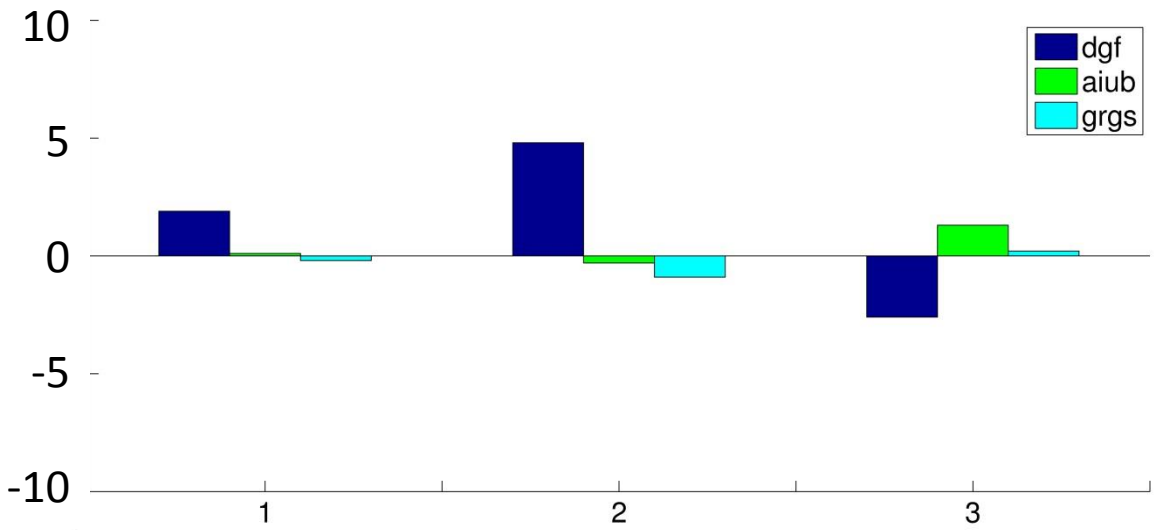


→ Agreement: 0.2 ppb (~ 1.5 mm) ; except of week 2 / DGFI

Analysis and combination of SLR data

Combination results

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

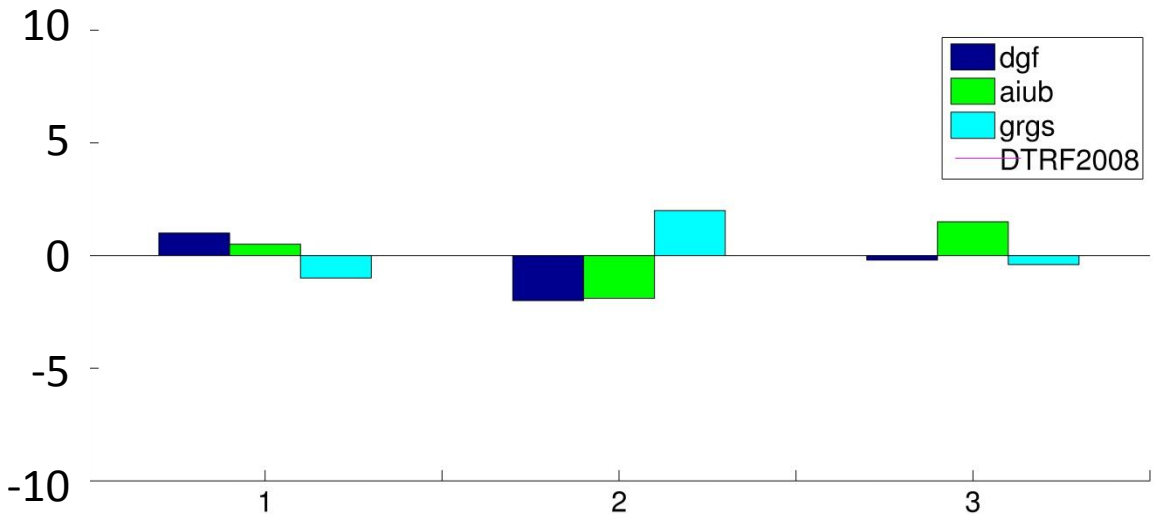


→ Agreement within 5.0 mm

Analysis and combination of SLR data

Combination results

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

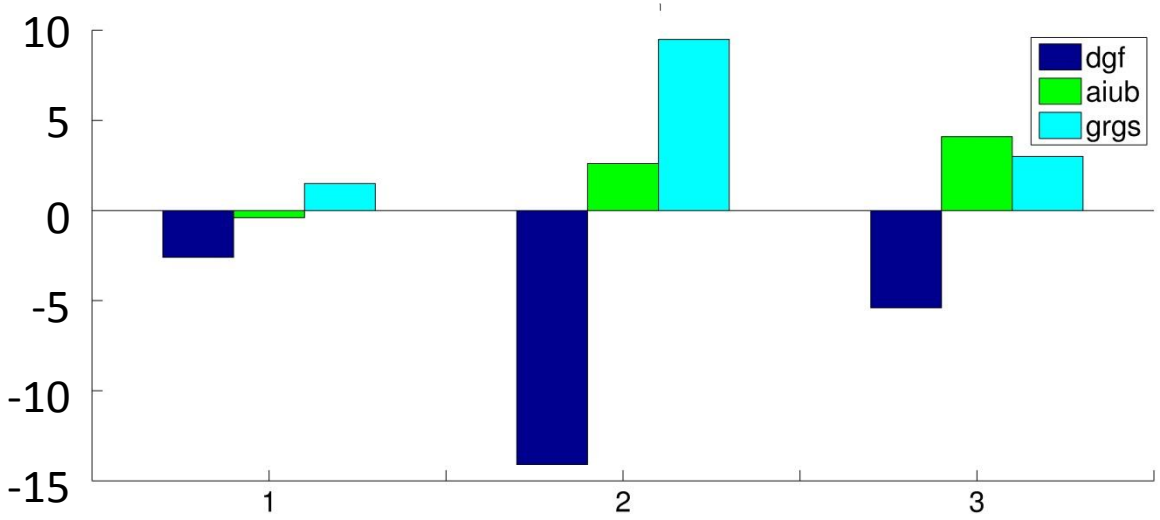


→ Agreement within 2.0 mm

Analysis and combination of SLR data

Combination results

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



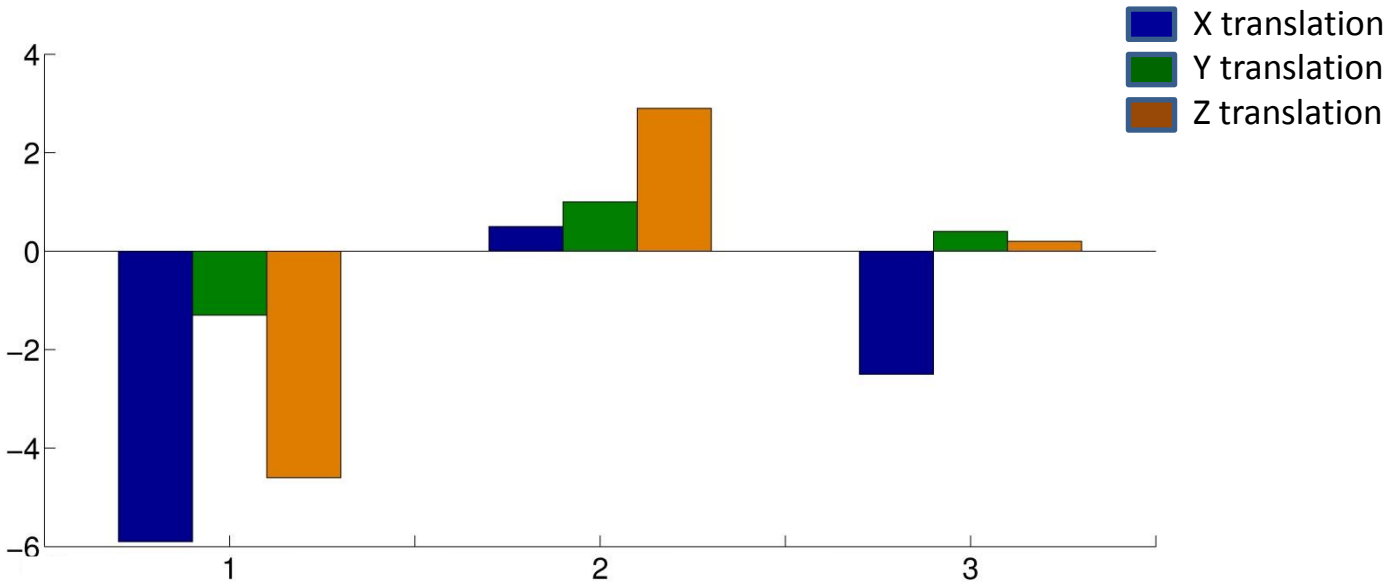
→ Agreement within 5.0 mm for week 1 and 3

→ Summarizing: homogeneous SLR input data

Analysis and combination of SLR data

Combination results

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

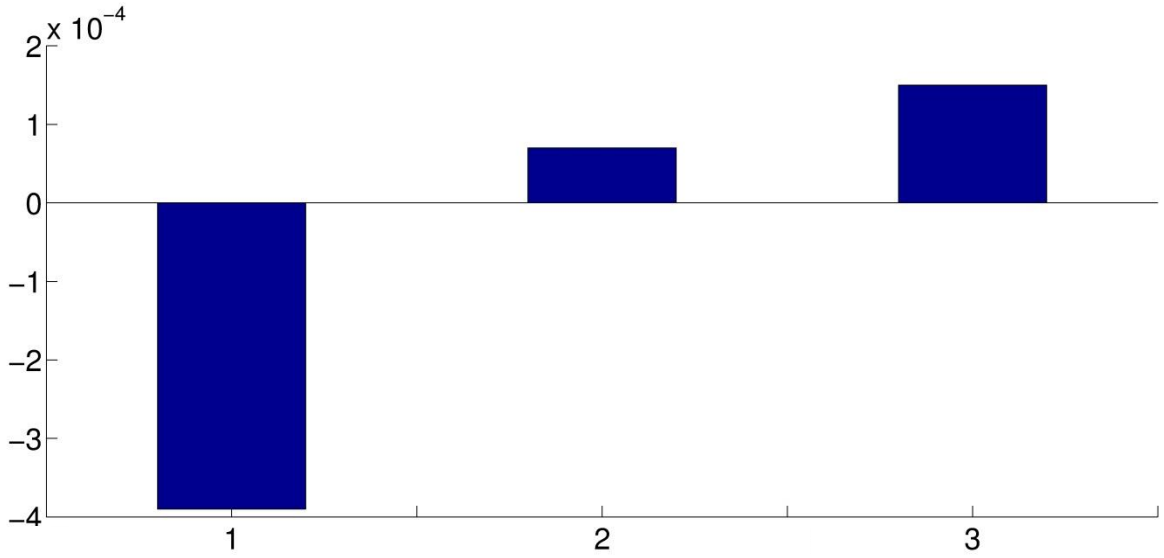


→ Agreement within 6 mm.

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:

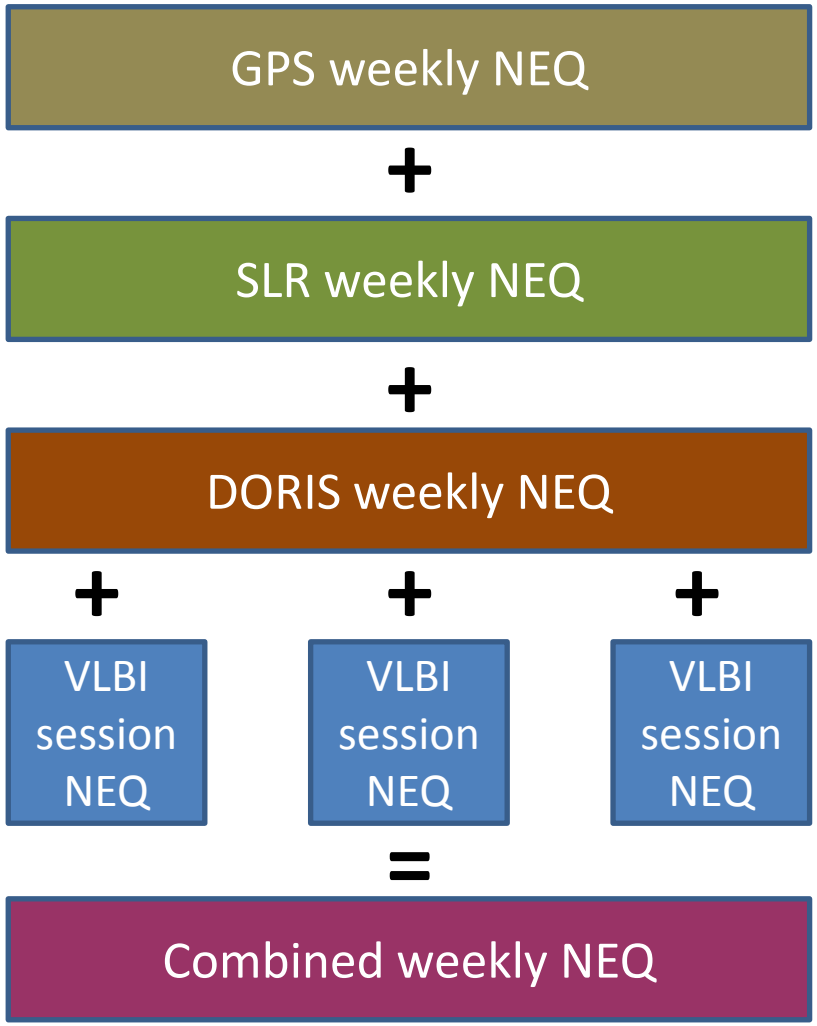
	A posteriori Sigma	Transformation DTRF2008	RMS of transformation
GRGS	1.0	datum parameters set up	10-20 mm

Combination:

→ No intra-technique combination for DORIS

Inter-technique combination

Flowchart of weekly combination

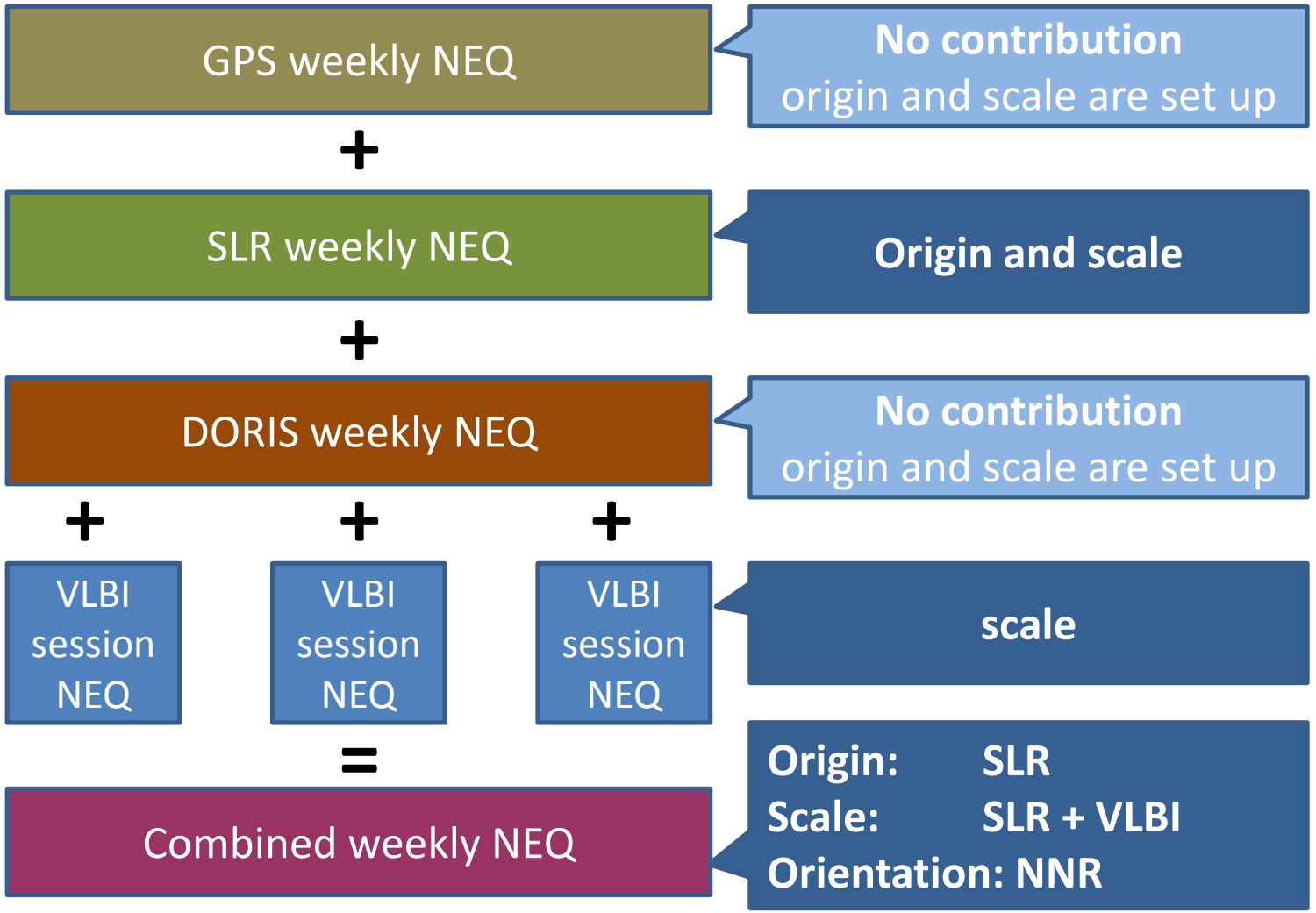


Selection of local ties
Max. local tie misfit : 25 mm

σ local ties
1.0 mm / component

Seitz: Combination at the CC DGFI

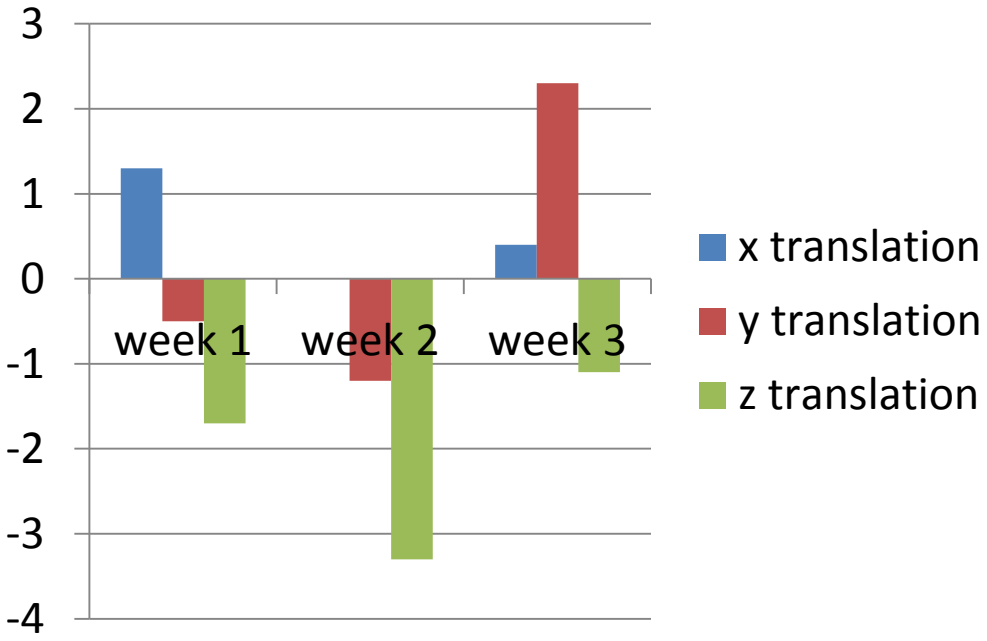
Combination: Datum realization



Combination: Datum realization

Conservation of the origin

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

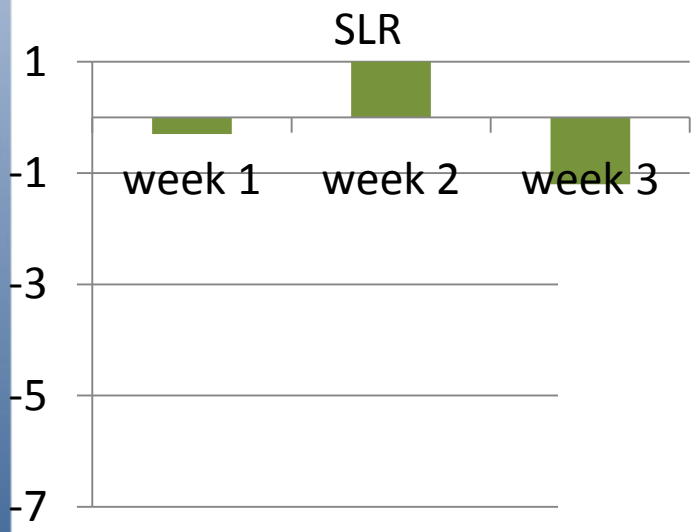


→ Good agreement between SLR only and combined solution

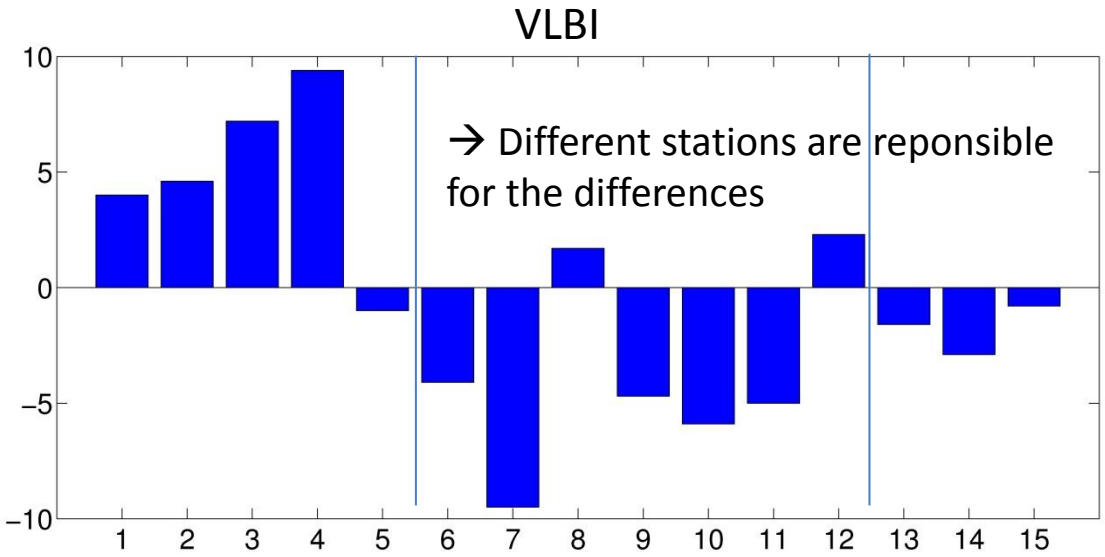
Combination: Datum realization

Conservation of the scale

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

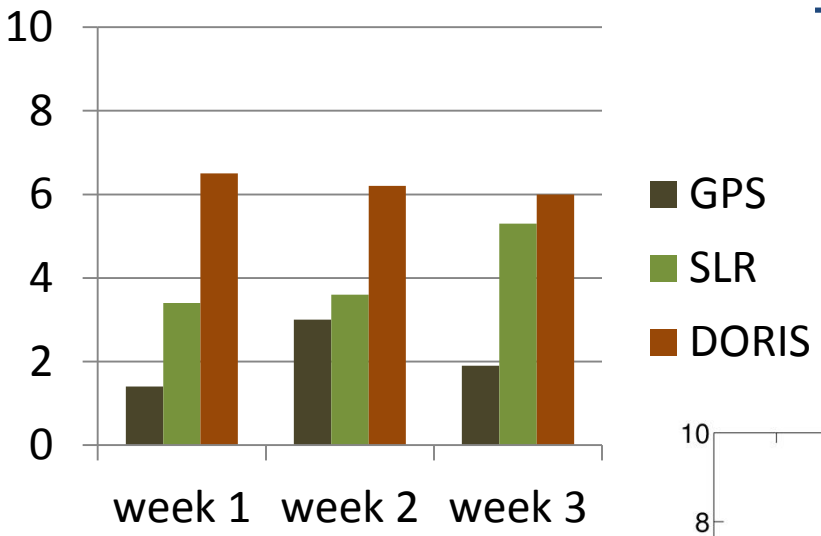


→ Variation of VLBI larger, but no mean offset between VLBI and SLR scale



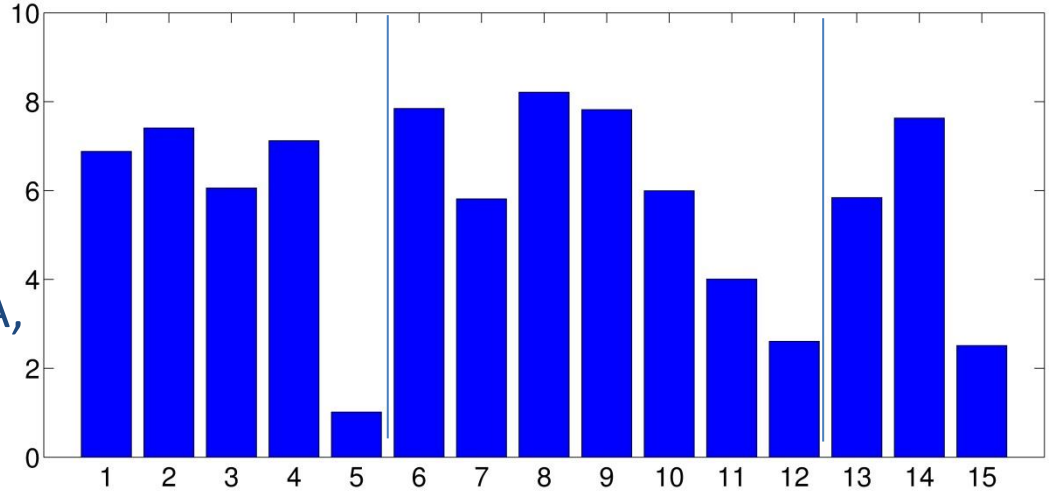
Combination: deformation of networks

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

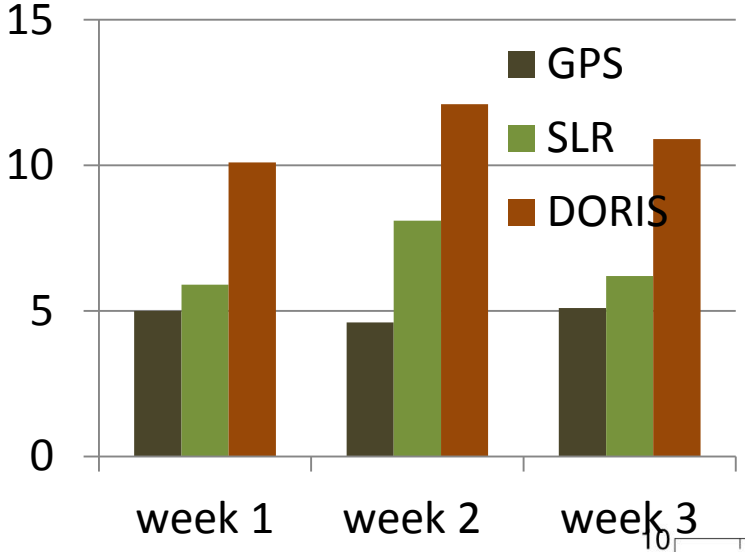
VLBI:	**-4.0 – 5.0 mm**
SLR:	**-2.3 – 1.4 mm**
GPS:	-1.6 – -2.5 mm
DORIS:	-3.7 – -5.3 mm

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

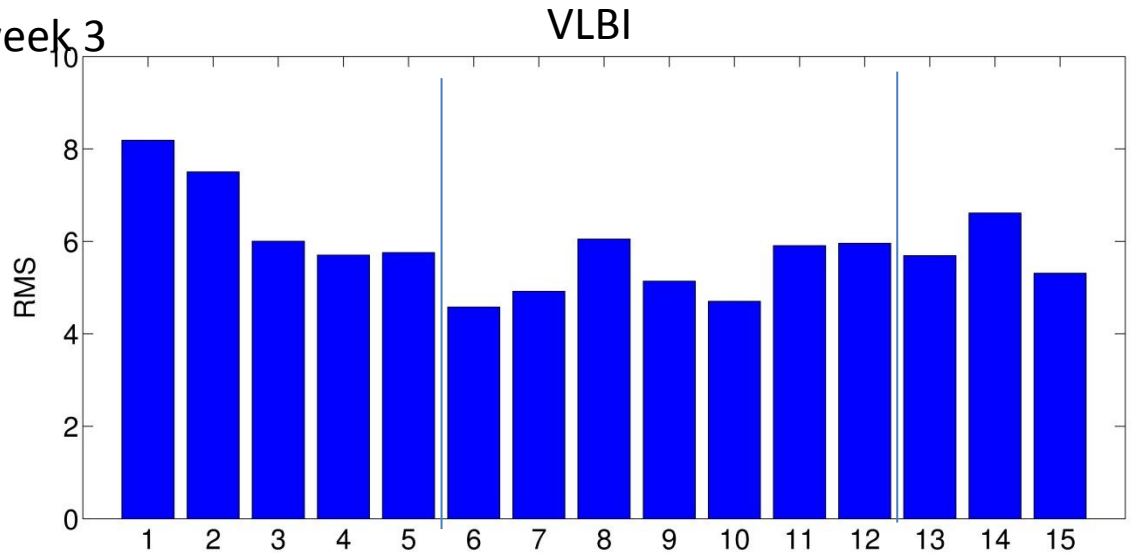
Combination: Comparison with DTRF2008

RMS values



Model differences between COL and DTRF2008 for VLBI and DORIS?

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



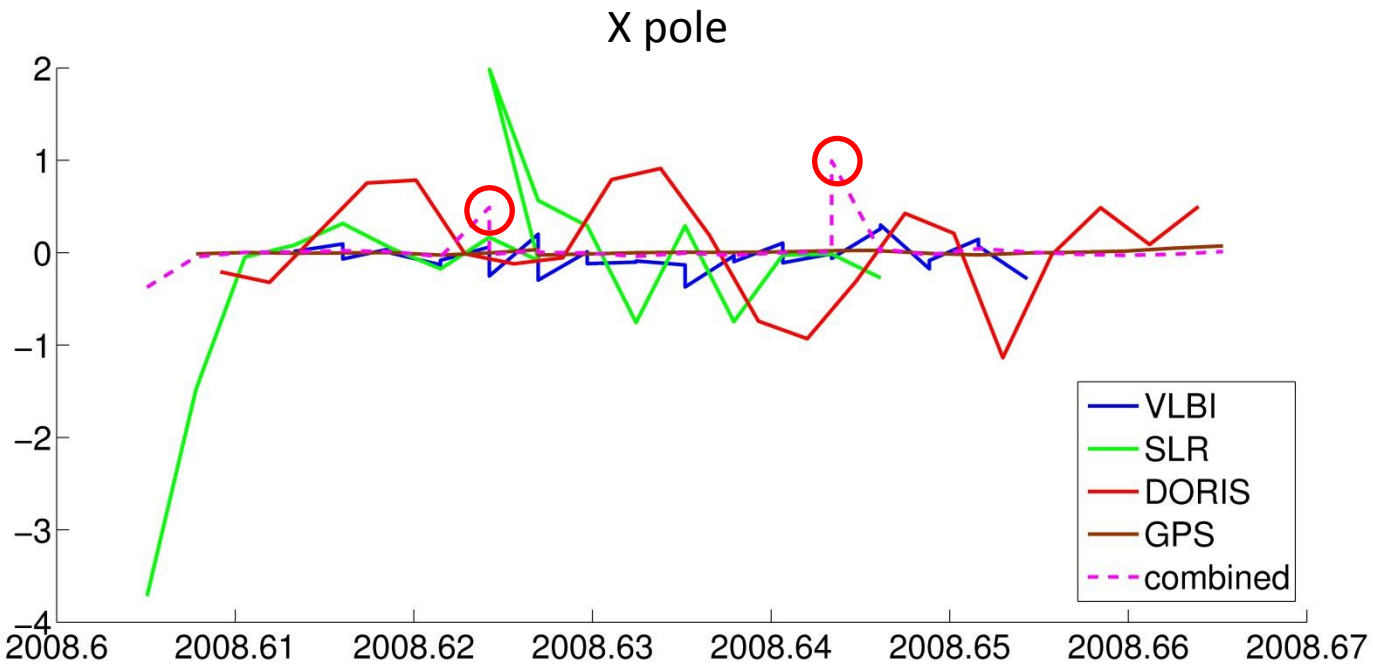
Combination: EOP

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

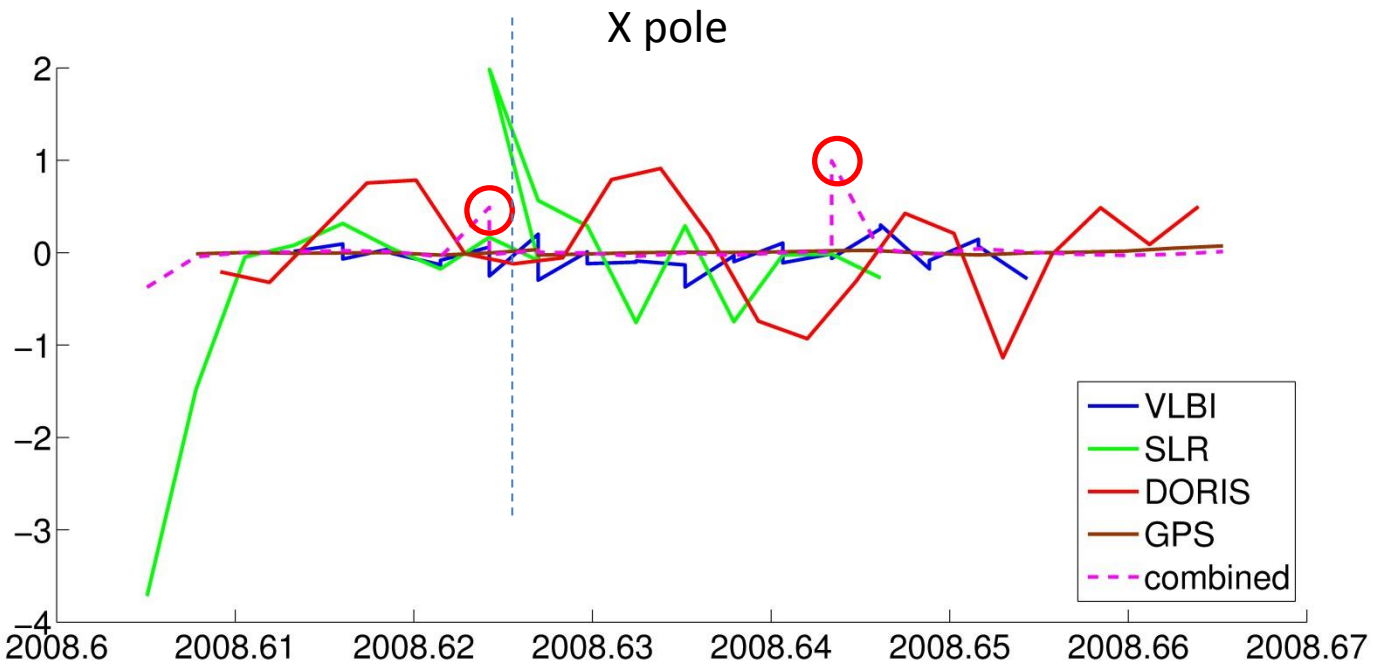
Pole coordinates (w.r.t. IERS 08 C04)



SLR week 3 cannot be solved

Combination: EOP results

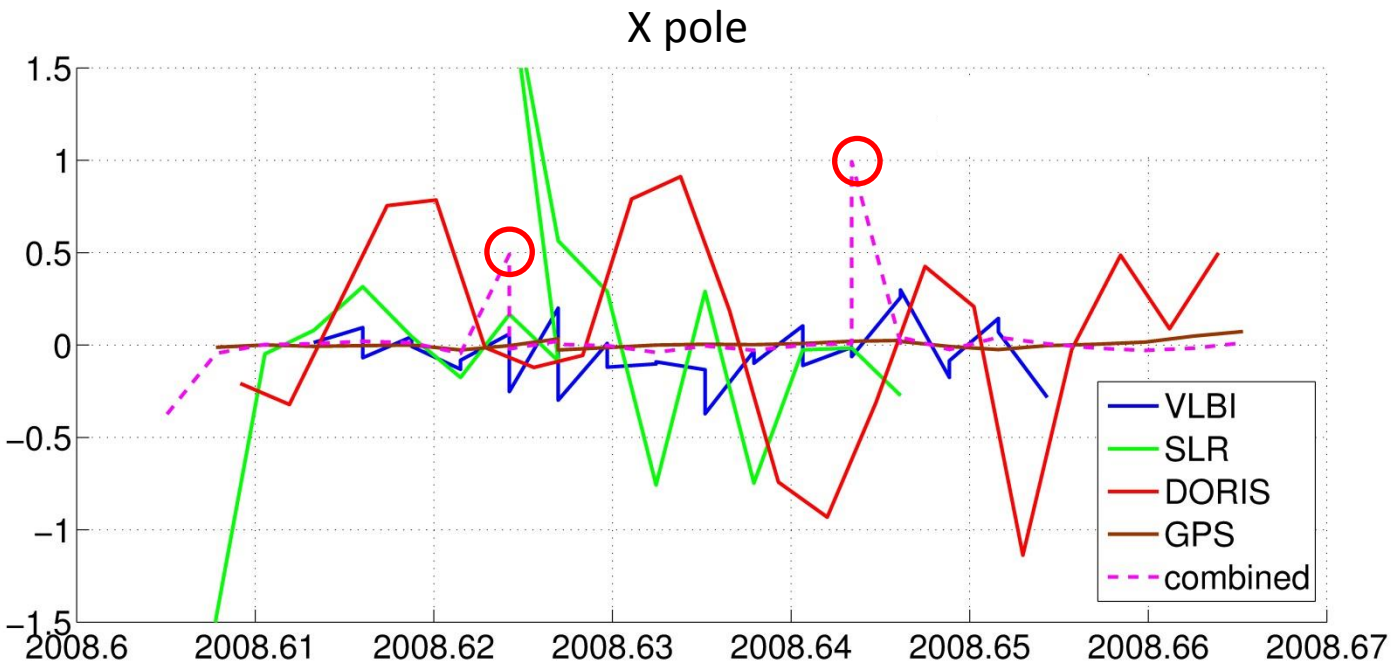
Pole coordinates (w.r.t. IERS 08 C04)



SLR week 3 cannot be solved

Combination: EOP results

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



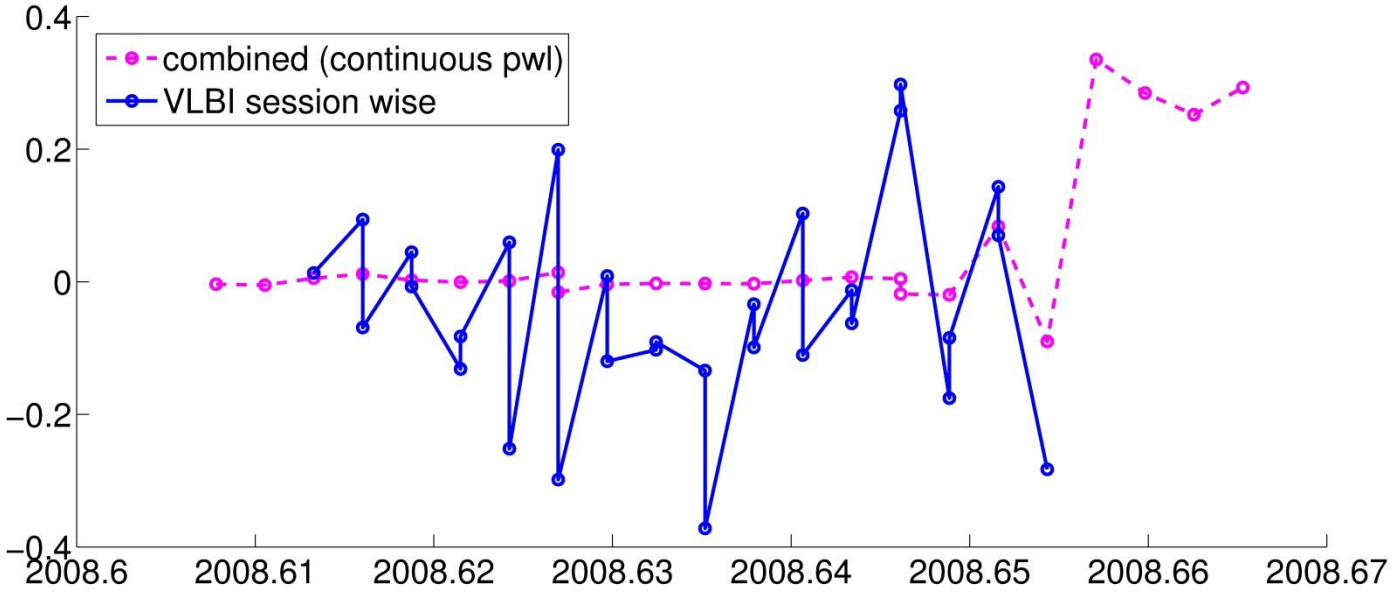
→ Outliers due to SLR contribution
(AIUB values: transformation from O+D -> pwl ?)

→ 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)