Deutsches Geodätisches Forschungsinstitut
Technische Universität München
(DGFI-TUM)

EGU2017-14776

Common Adjustment of TRF, EOP and CRF for a Consistent Realization of Reference Systems

Younghee Kwak, Detlef Angermann, Mathis Bloßfeld, Michael Gerstl, Ralf Schmid, and Manuela Seitz
Deutsches Geodätisches Forschungsinstitut der Technischen Universität München
(younghee.kwak@tum.de)

Abstract

The International Celestial Reference System is realized today solely by VLBI which is the only space geodetic technique which allows the observation of the inertial space. In contrast, the International Terrestrial Reference System is currently realized through the combination of four space geodetic techniques: GNSS, VLBI, SLR and DORIS. To connect two systems, Earth orientation parameters (EOP) are estimated simultaneously with Terrestrial Reference Frame (TRF) fixing Celestial Reference Frame (CRF) at DGFI-TUM. This way of estimation/combination intrinsically contains inconsistency between TRF, EOP, and CRF because the data and geometry of the contributing networks are different. To overcome this inconsistency, a combined normal equation system where all parameters (TRF, EOP and CRF) are included would ensure a common network. In this presentation, we simultaneously estimate TRF, EOP, and CRF using most recent data (2005-2015) of GNSS, VLBI, and SLR. We show the latest results of the consistent realization and discuss the pros and cons of the simultaneous estimation.

Input Solutions

	GNSS	SLR	VLBI
Institution	CODE	DGFI-TUM	DGFI-TUM
Software	Bernese	DOGS-OC	OCCAM
Resolution	daily	weekly	session-wise
Time span	January 2005 - December 2015		
Coord. jumps	according to DTRF2014 processing		

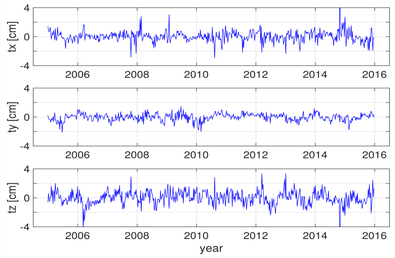
	GNSS	SLR	VLBI	combination
station coordinates & velocities (TRF)	X	X	X	X
source coordinates (CRF)			X	X
terrestrial x-/y-pole	X	X	X	X
UT1-UTC	(X)	(X)	X	X
celestial X-/Y-pole			X	X

- GNSS:
  - CODE contribution to repro2/ITRF2014 ("cf2"), complemented by operational solutions ("cof") for the latest months
- SLR:
  - DGFI-TUM solution based on LAGEOS-1/2
  - 7-day orbits
  - stations with less than 10 normal points excluded
- VLBI:
  - DGFI-TUM solution considering more than 1550 24-hour sessions (all types)
  - stations contained in less than 10 sessions excluded
  - NNR condition w.r.t. ICRF2 defining sources
  - special handling sources treated as arc parameters

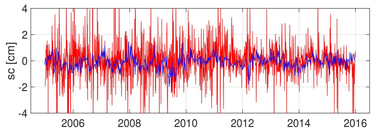
Validation of Single Techniques

Single-technique TRFs

- Estimated epoch-wise translation of SLR-only solutions w.r.t DTRF2014

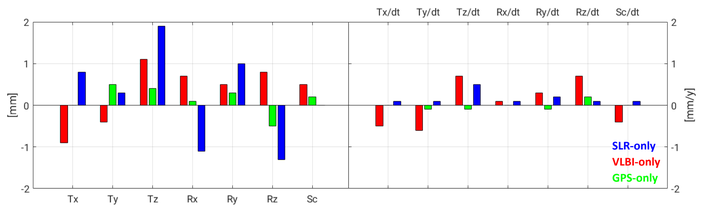


- Estimated epoch-wise scale differences of SLR-/VLBI-only solutions w.r.t DTRF2014

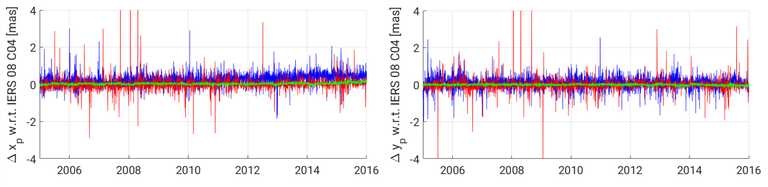


- High scatter of VLBI-only scale parameters due to different session types
- Very good agreement of both scale time series (scale consistency between VLBI and SLR)

- Estimated transformation parameters of multi-year solutions w.r.t DTRF2014

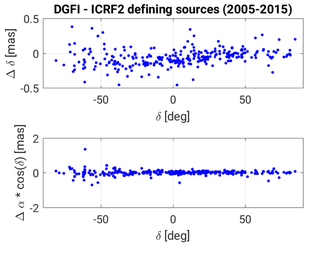


Single-technique EOPs



Single-technique CRF

- Transformation parameters between two CRFs



w.r.t. ICRF2 (2005.0 – 2016.0) [µas]	
A_1	-7.9 ± 6.0
A_2	34.3 ± 6.1
A_3	1.7 ± 5.5
D_α	11.6 ± 11.8
D_δ	72.9 ± 8.4
B_δ	-71.6 ± 5.8

3 rotations,
2 slopes and
1 bias
(ICRF2 defining sources)

$$\Delta\alpha = A_1 \tan\delta \cos\alpha + A_2 \tan\delta \sin\alpha - A_3 + D_\alpha(\delta - \delta_0)$$
$$\Delta\delta = -A_1 \sin\alpha + A_2 \cos\alpha + D_\delta(\delta - \delta_0) + B_\delta$$

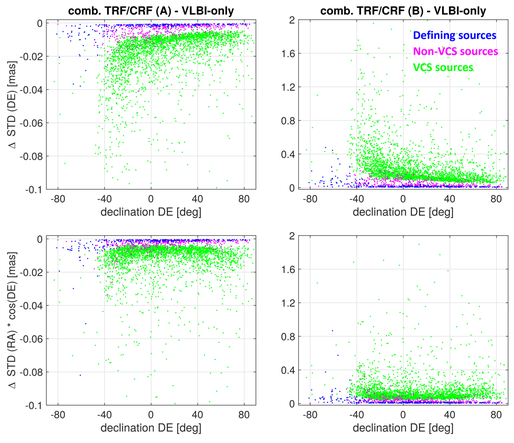
Combination

origin: *SLR,* ***scale:*** *SLR/VLBI*
orientation: *NNR for GNSS subnetwork*
EOP: *all combined*

- Local ties

	ΔLT < 3 cm	ΔLT < 5 cm **Solution A**	ΔLT < 10 cm	ΔLT < 100 cm **Solution B**
Intra-technique	35	41	48	50
GPS/VLBI	29	48	66	123
GPS/SLR	30	55	61	82
SLR/VLBI	4	6	7	14
Total	98	150	182	269

- Combination impact on standard deviations of CRFs



- Local tie selections impact on the CRFs, especially for VCS sources.
- **Solution A**: Sufficient number of local ties with good agreements (ΔLT) improves the standard deviations of declination and right ascension.
- **Solution B**: Including all the co-location sites degrades the standard deviations of declination and right ascension.

* Positive sign means improvement and negative sign means degradation of standard deviations.

- Estimated transformation parameters of **combined** solutions w.r.t DTRF2014

The transformation parameters of combined solutions w.r.t DTRF2014 shows slightly smaller offsets and trends than the single-technique TRFs.

- EOPs w.r.t IERS 08 C04

Since the GPS solution is dominant in the combination, the polar motion plots of the combined solution are similar to the single-technique EOPs of GPS.

Conclusion

- Simultaneous realization of TRS/EOP/CRS has been done using GPS, VLBI and SLR data for 11 years (2005.0-2016.0).
- Inter-technique combination results in reduced/increased standard deviations for the source positions depending on local tie selections.
- Combination has biggest impact on poorly observed sources.
- Further studies: impact of local tie selection/weighting; impact of not-combining EOPs; impact of seasonal station motions