

Validation of components of local ties

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Outline

1 Introduction

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- 2 Single-technique solutions
 - Input data
 - Preliminary analysis
 - Results

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Reference frame as the realization of a reference system

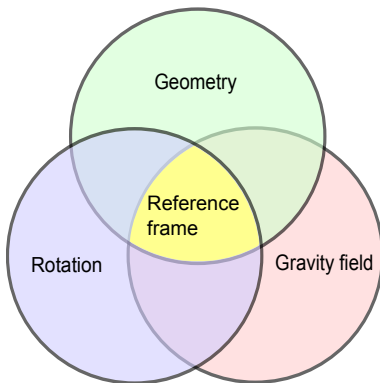
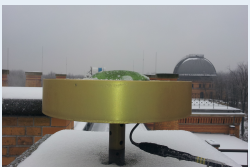


Figure: Reference frame as the connections of the three pillars of geodesy, according to IAG (2014)

Combination of different geodetic space techniques

GPS



DORIS



SLR



VLBI



Combination strategy

Combination of the different techniques

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- Local ties at co-located sites

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- Local ties at co-located sites
 - Inhomogeneous data base
 - IERS Working Group on Site Survey and Co-location

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- Pole coordinates as global ties (Seitz et al., 2012)

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- Local ties at co-located sites
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 - IERS Working Group on Site Survey and Co-location
- Pole coordinates as global ties (Seitz et al., 2012)
- Our approach: combination of the pole coordinates and the degree-1 surface load coefficients (Blewitt, 2003), common origin of GNSS and SLR

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Data

Data

GNSS



- daily normal equation systems 1994 - 2010
- GPS and GLONASS
- 334 stations

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GNSS



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SLR



- weekly normal equation systems 1994 - 2010
- LAGEOS-1/-2
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GPS, GLONASS and SLR

from a homogeneous reprocessing (Fritsche et al., 2014)

Station network

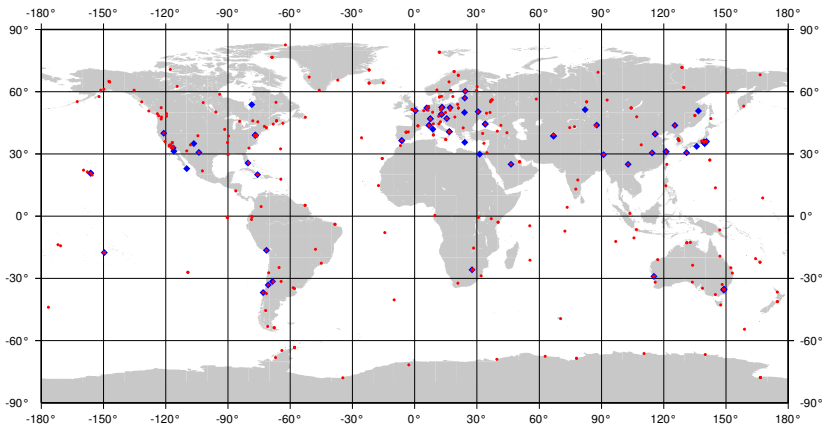


Figure: Globally distributed GNSS (red) and SLR (blue) stations

Preliminary analysis at station positions time series of all stations

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- Elimination of position outliers
- Station events (jumps)
- Core stations for the definition of the geodetic datum

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- Elimination of position outliers
- Station events (jumps)
- Core stations for the definition of the geodetic datum
 - Selection according to the length and accuracy of the station position time series and the global distribution
 - Similar to IGS and ILRS solutions

Pole coordinates

Pole coordinates

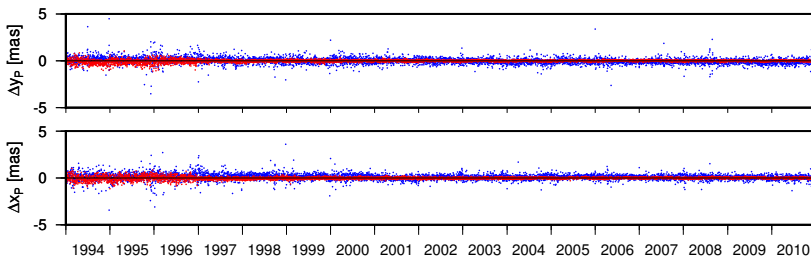


Figure: Differences Δx_P , Δy_P of estimated and “IERS 08 C04” pole coordinates

Offset, Trend	GNSS-only		SLR-only	
Δx_P	-0.04 mas	0.00 mas/a	0.14 mas	0.00 mas/a
Δy_P	-0.06 mas	0.00 mas/a	0.11 mas	0.00 mas/a

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$$w_{GNSS} = 1$$
$$w_{SLR} = \frac{s_{GNSS}^2}{s_{SLR}^2}$$

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based on Thaller (2008)

Definition of the geodetic datum

Combination strategy

- Combination of the pole coordinates of GNSS and SLR
- Combination of the degree-1 surface load coefficients
- Station velocities at co-located sites were set to be equal

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- Origin: GNSS and SLR observations
- Network scale: GNSS and SLR observations

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- Origin: GNSS and SLR observations
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- Orientation:
 - NNR around the X , Y , Z axis for GNSS
 - NNR around the Z axis for SLR

temporal change: NNR around the X , Y , Z axis for GNSS

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→ minimum constraint solution

Estimation of components of the local ties

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Strategy

- a priori positions and velocities
 - $\Delta \mathbf{x}^{LT} = \mathbf{x}_{SLR}^{LT} - \mathbf{x}_{GNSS}^{LT}$
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Strategy

- a priori positions and velocities
 - $\Delta \mathbf{X}^{LT} = \mathbf{X}_{SLR}^{LT} - \mathbf{X}_{GNSS}^{LT}$
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Result

$$\delta \mathbf{X} = (\mathbf{X}_{SLR}^{est} - \mathbf{X}_{GNSS}^{est}) - \Delta \mathbf{X}^{LT}$$

Local Ties

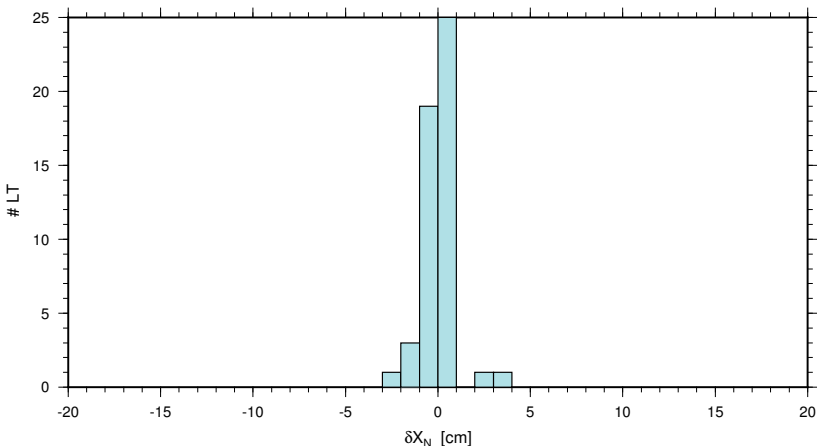


Figure: Histogram of differences δX_N [cm] in the north component of estimated and measured local ties.

Local Ties

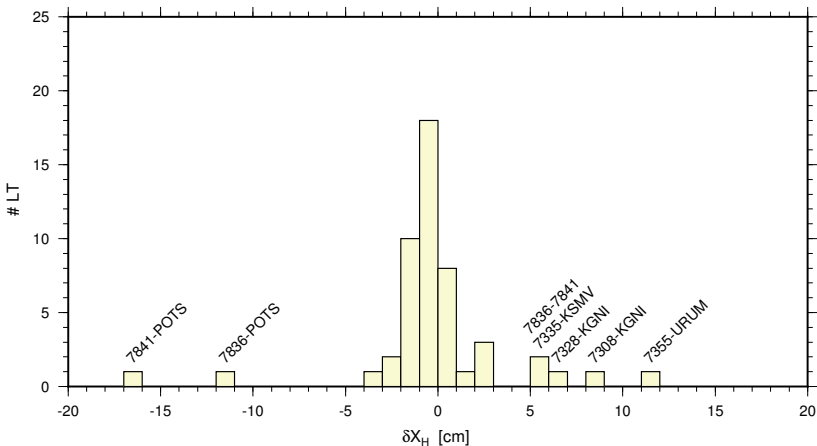


Figure: Histogram of differences δX_H [cm] in the height component of estimated and measured local ties.

Effect of the measured local ties

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Using a 14-parameter Helmert transformation

- between the single-technique solutions
 - GNSS: \mathbf{X}_{GNSS}^{est}
 - SLR + LT: $\mathbf{X}_{SLR}^{est} + \Delta\mathbf{X}^{LT}$

Transformation parameters of a 14-parameter Helmert transformation

GNSS		SLR + LT	
T_X [mm]	\dot{T}_X [mm/a]	1,76	-0,38
T_Y [mm]	\dot{T}_Y [mm/a]	-16,51	0,39
T_Z [mm]	\dot{T}_Z [mm/a]	3,20	-0,14
R_X [masec]	\dot{R}_X [masec/a]	0,031	-0,012
R_Y [masec]	\dot{R}_Y [masec/a]	0,382	-0,007
R_Z [masec]	\dot{R}_Z [masec/a]	-0,147	0,005
m [mm/km]	\dot{m} [mm/km/a]	-0,00064	-0,00025

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- **Translation** in direction of Y and **rotation** of the network around Y by using all measured local ties.

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- **Combination** of GNSS and SLR with **minimum constraint** conditions.
- **Estimation** of components of the **local ties** at co-located sites **using** the pole coordinates as **global ties**.
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→ Combination of different geodetic space techniques to realize a global terrestrial reference system in the framework of GGOS.

Thank you very much for your attention.

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Definition of core stations

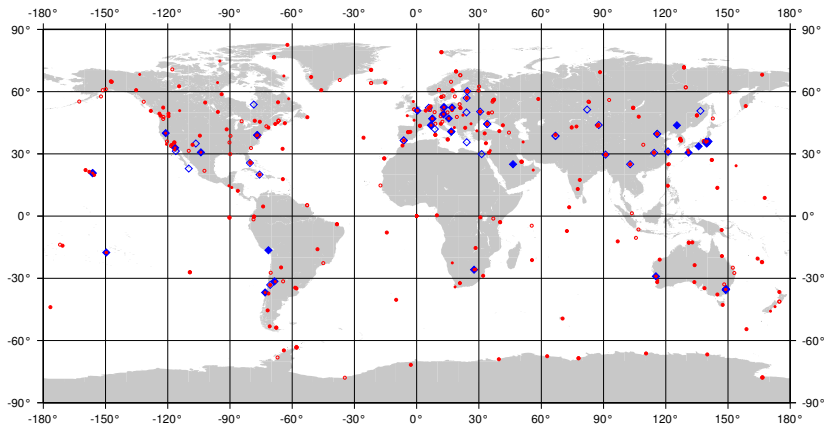


Figure: Definition of core stations (filled symbol) of the GNSS (red) the SLR (blue) network

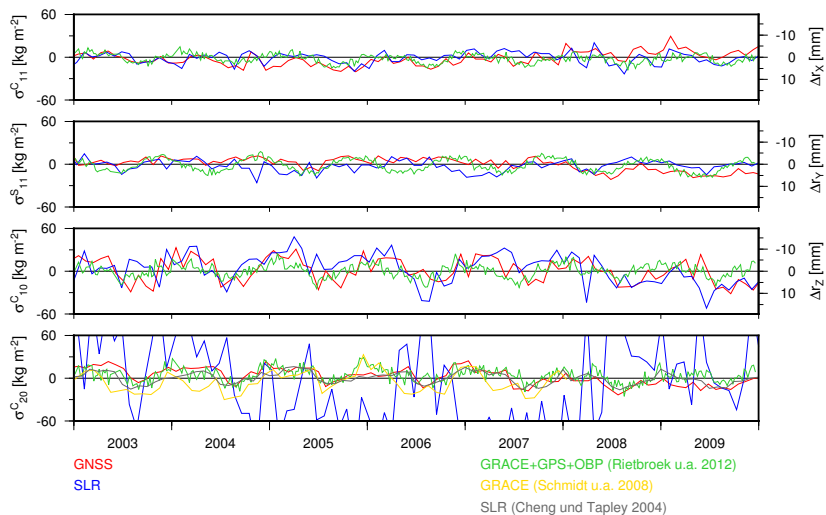


Figure: Surface load coefficients and difference of CF w. r. t. CM

Modeling of surface loads (Blewitt, 2003)

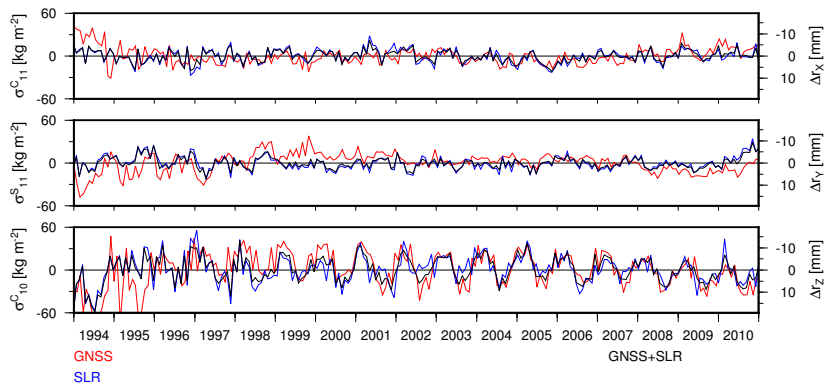


Figure: Degree-1 surface load coefficients ($\sigma_{10}^C, \sigma_{11}^C, \sigma_{11}^S$) (left) and differences $[\Delta \mathbf{r}_{CF}]_{CM}$ (right)

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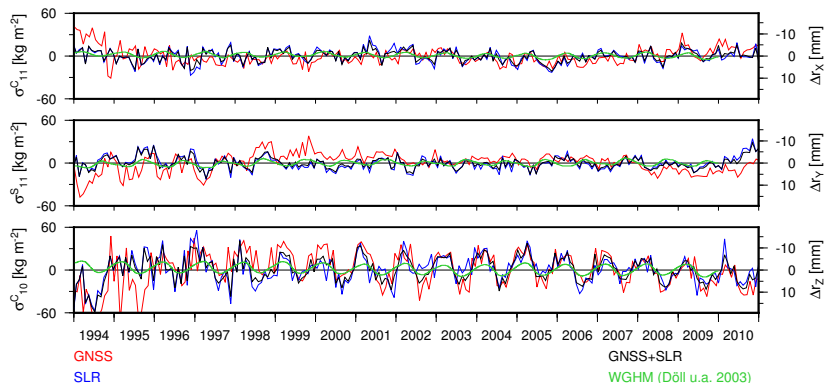


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