

Session 1.2a Strength, Weakness, Modeling Standards and Processing Strategies of Space Geodetic Techniques

Impact of GLONASS in a rigorous combination with GPS

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Outline

Observation data, modeling, processing scheme

Results from a combined GNSS processing

- Station coordinates/velocities
- Orbit validation
- Satellite clocks

Conclusions

Observation data and modeling

- Reprocessing starting on observation level: 1994 - 2011
- 340 GNSS stations in total (140 with GLONASS observation), 70 SLR stations
- GLONASS included since 01. January 2002
- GPS-only, GLONASS-only and GPS+GLONASS-combined solutions
- SLR: range residuals w.r.t. to microwave-based GNSS satellite orbits
- Processing of 24-hour epoch for clock solutions
- Major modelling aspects

Terrestrial reference frame: ITRF2008/IGS08

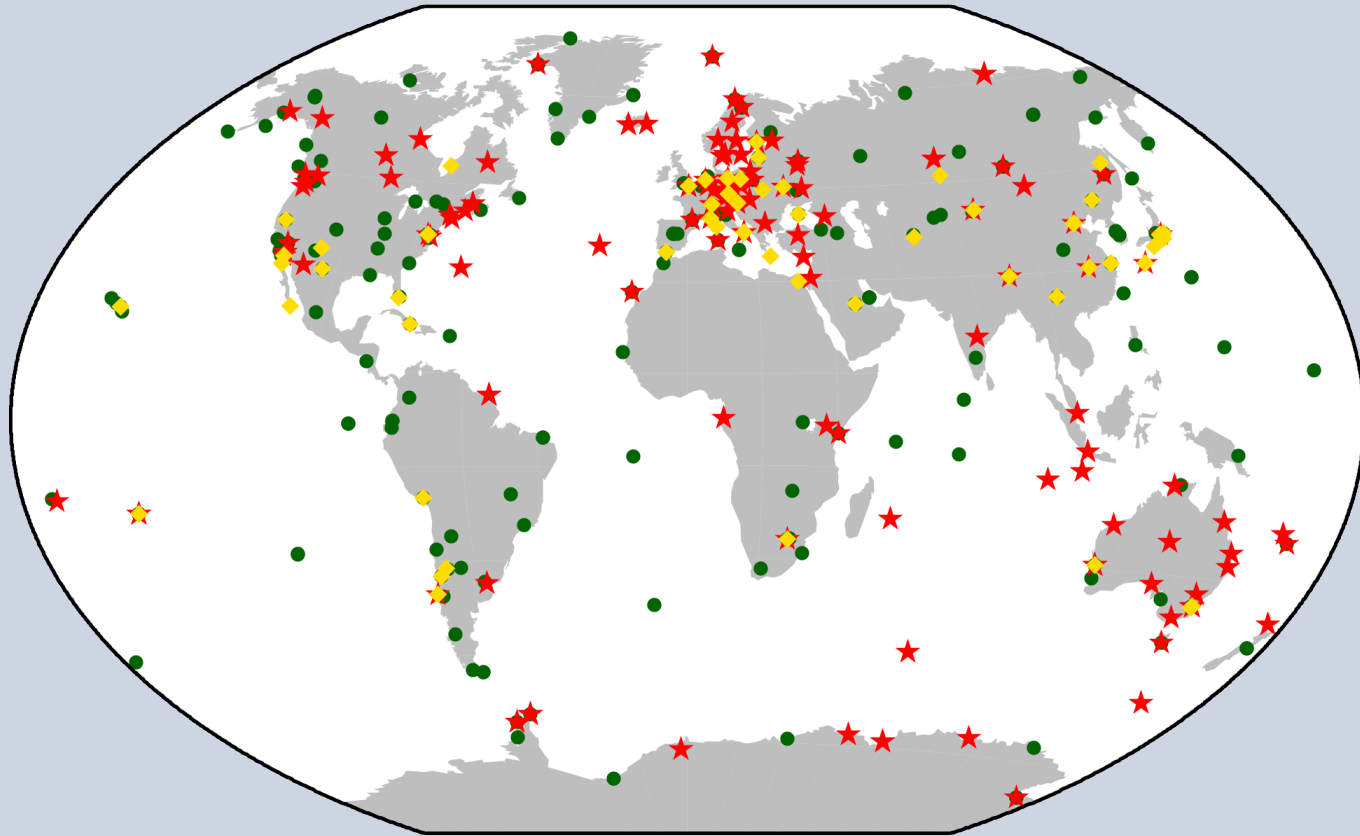
GNSS antenna phase center: IGS08.atx

Atmospheric tidal loading: $S_1 + S_2$ tides (Ray and Ponte, 2003)

Atmospheric+oceanic non-tidal loading: GRACE AOD1B (RL04)

Radiation pressure for GNSS satellites: Earth albedo included

Station network

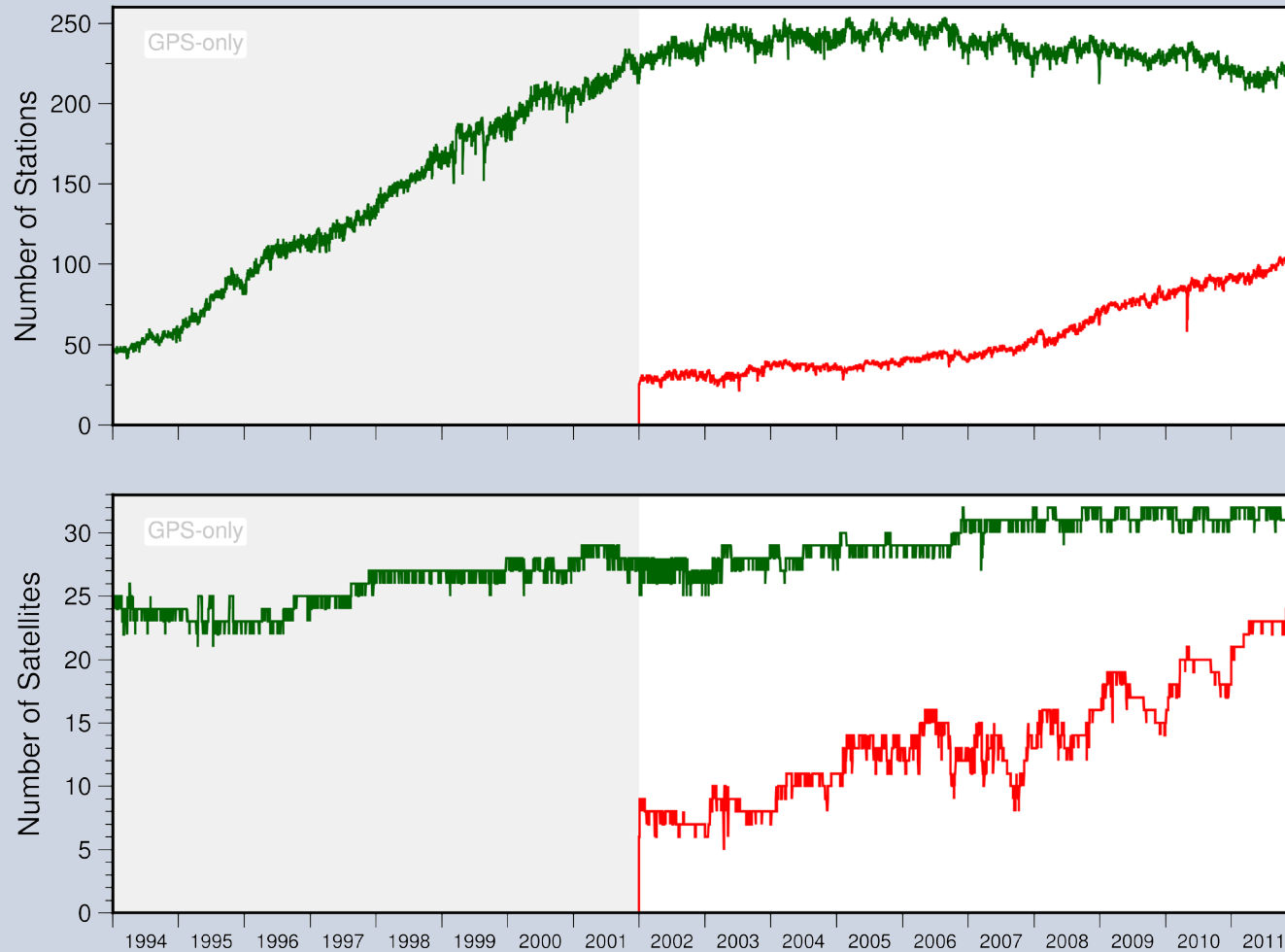


□ GPS+GLONASS

● GPS-only

◆ SLR

Number of processed stations and satellites



GPS

GPS+GLONASS

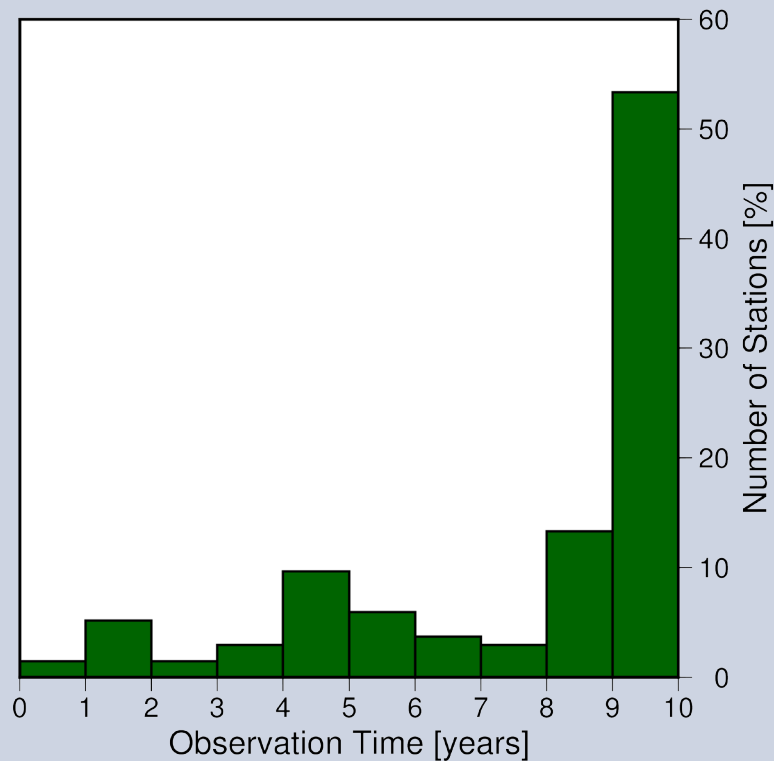
GPS

GLONASS

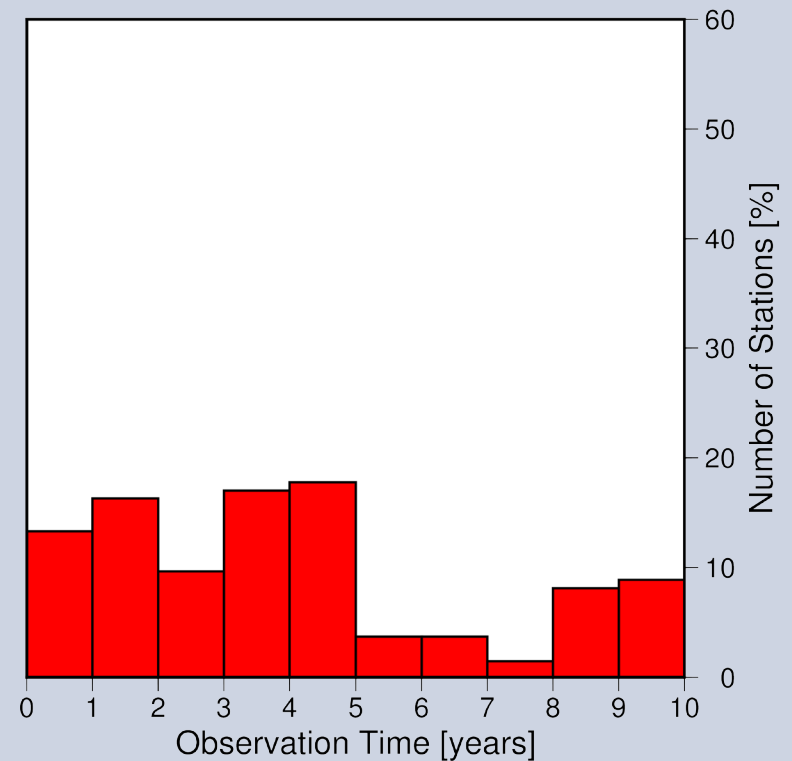
System-specific number of observation days

Relative contribution in terms of time series length

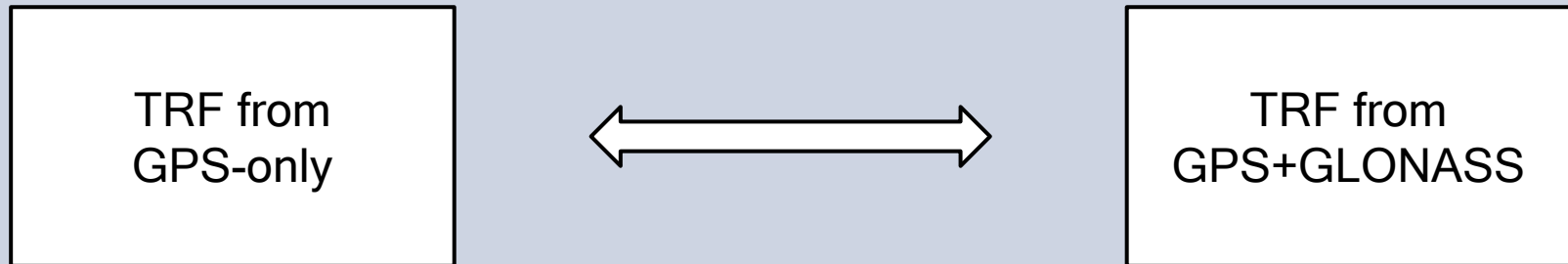
GPS



GLONASS



Terrestrial Reference Frame (TRF)



IGS08 w.r.t.	Translation [mm] / Translation rates [mm/y]			Scale [ppb]/ Scale rate [ppb/y]
	X	Y	Z	
GPS-only	-4.3	-7.0	-2.8	-0.41
	-1.1	+1.3	+0.7	-0.02
GPS+GLONASS	-4.1	-6.7	-2.6	-0.42
	-1.0	+1.2	+0.7	-0.02

TRF: Time series analysis

Input: daily position time series

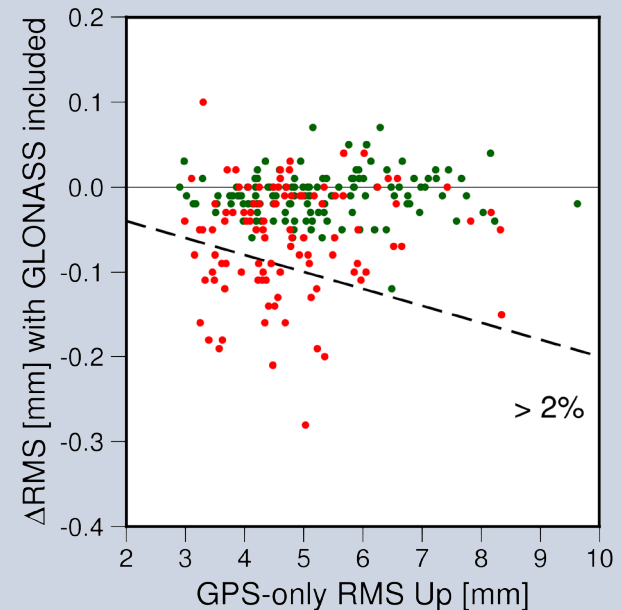
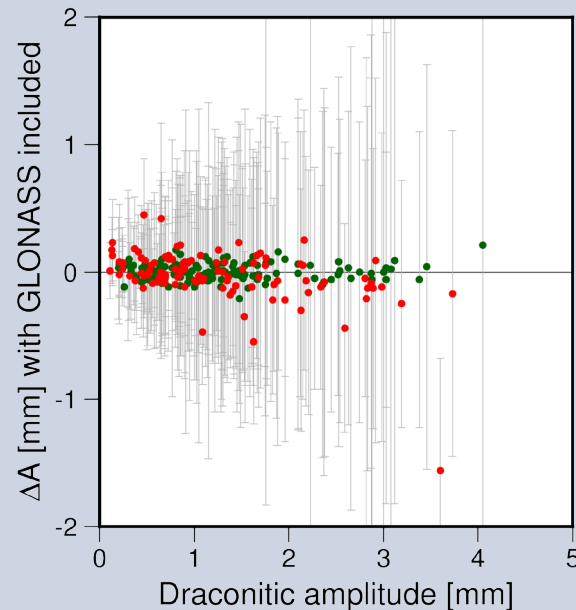
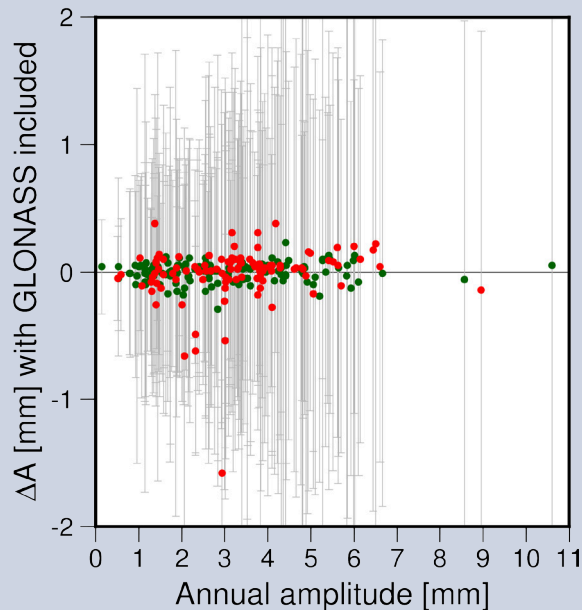
Functional model: annual, semi-annual, draconitic harmonics

Stochastic model: combined white + flicker noise model

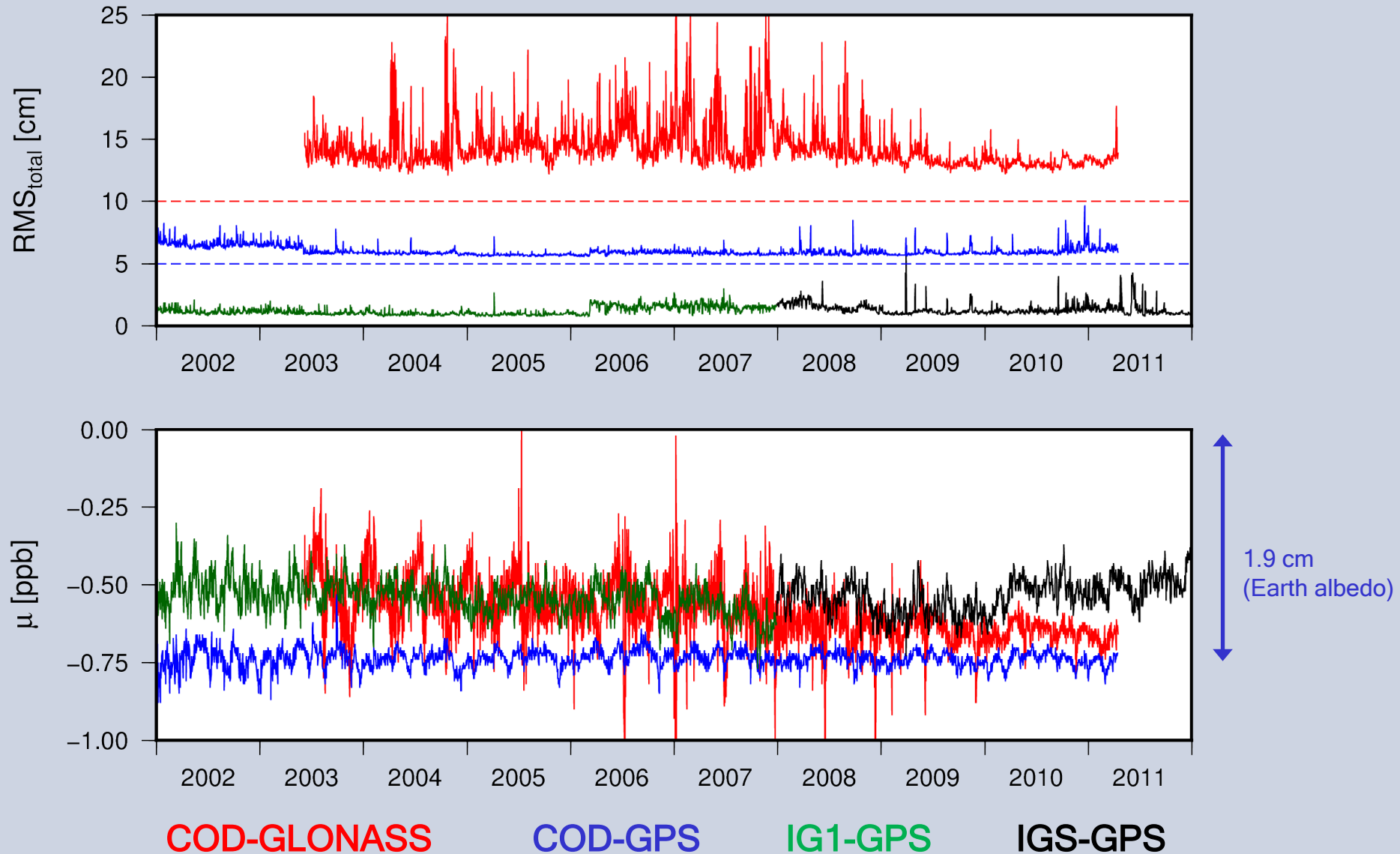
GPS+GLONASS

(vertical components)

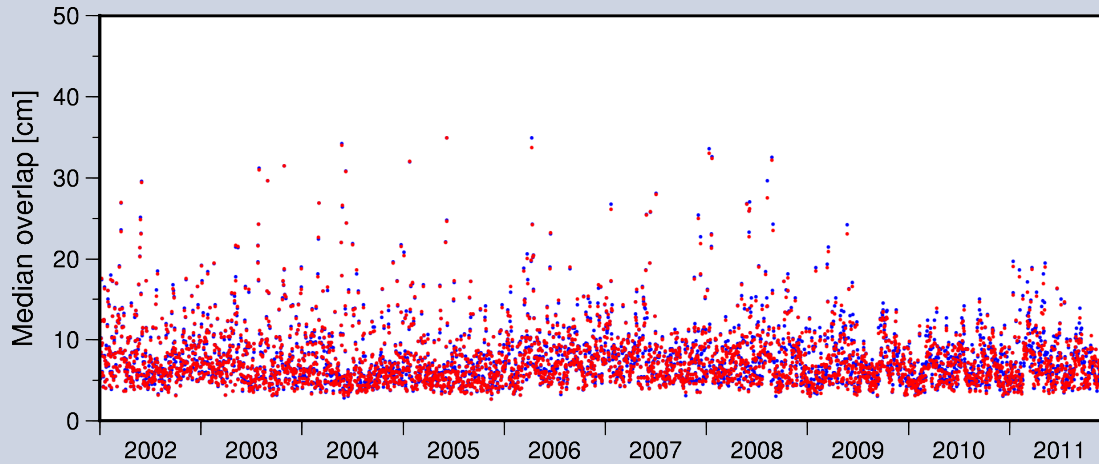
GPS-only



ORB: Transformation of satellite positions



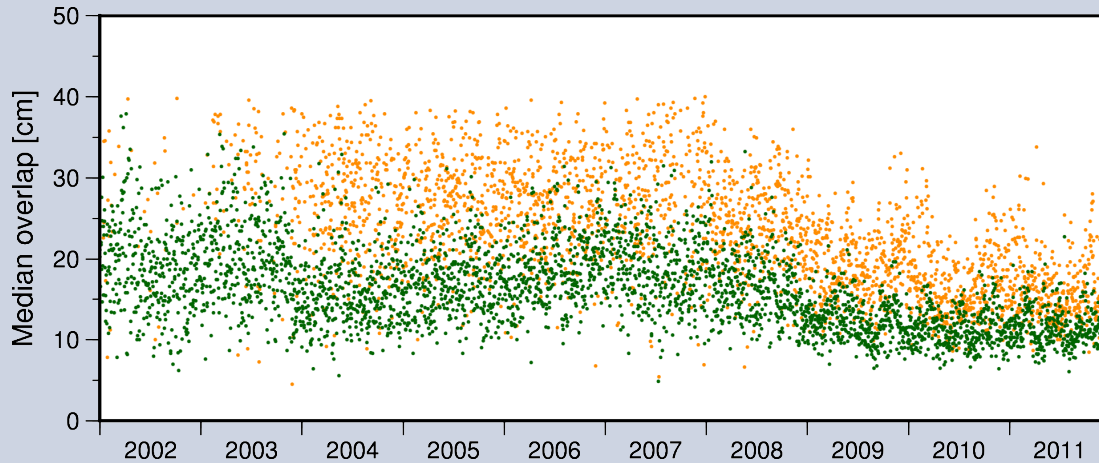
ORB: Overlaps from 1-day arcs



GPS:

GPS-only

GPS+GLONASS

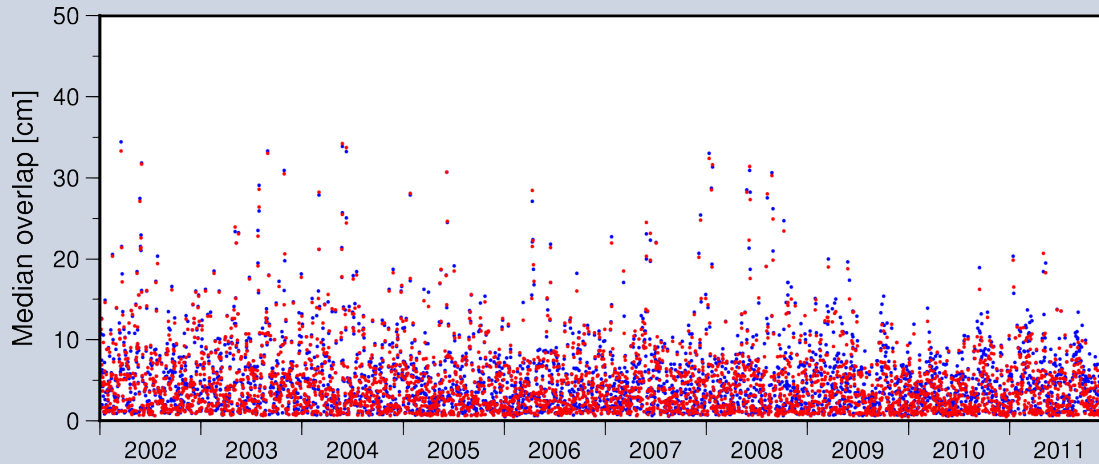


GLONASS:

GLONASS-only

GPS+GLONASS

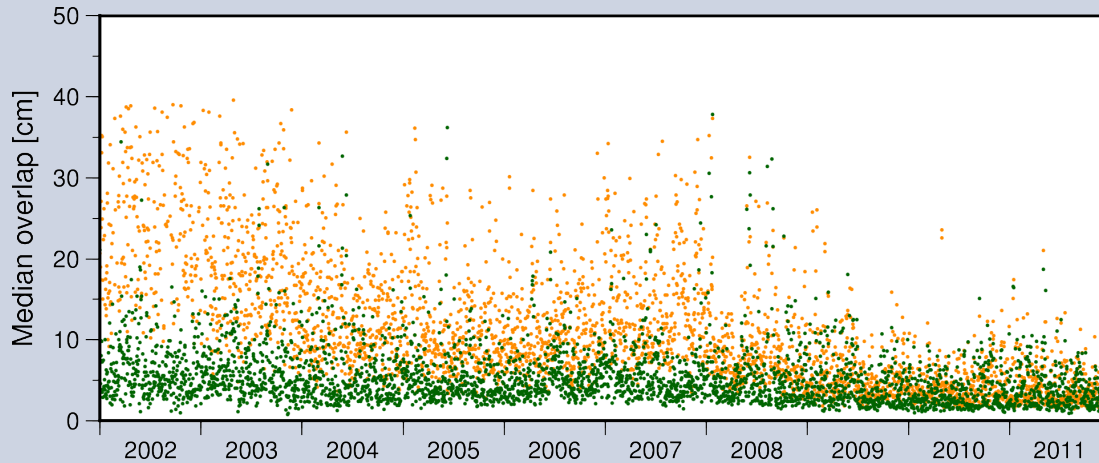
ORB: Overlaps from 3-day arcs



GPS:

GPS-only

GPS+GLONASS

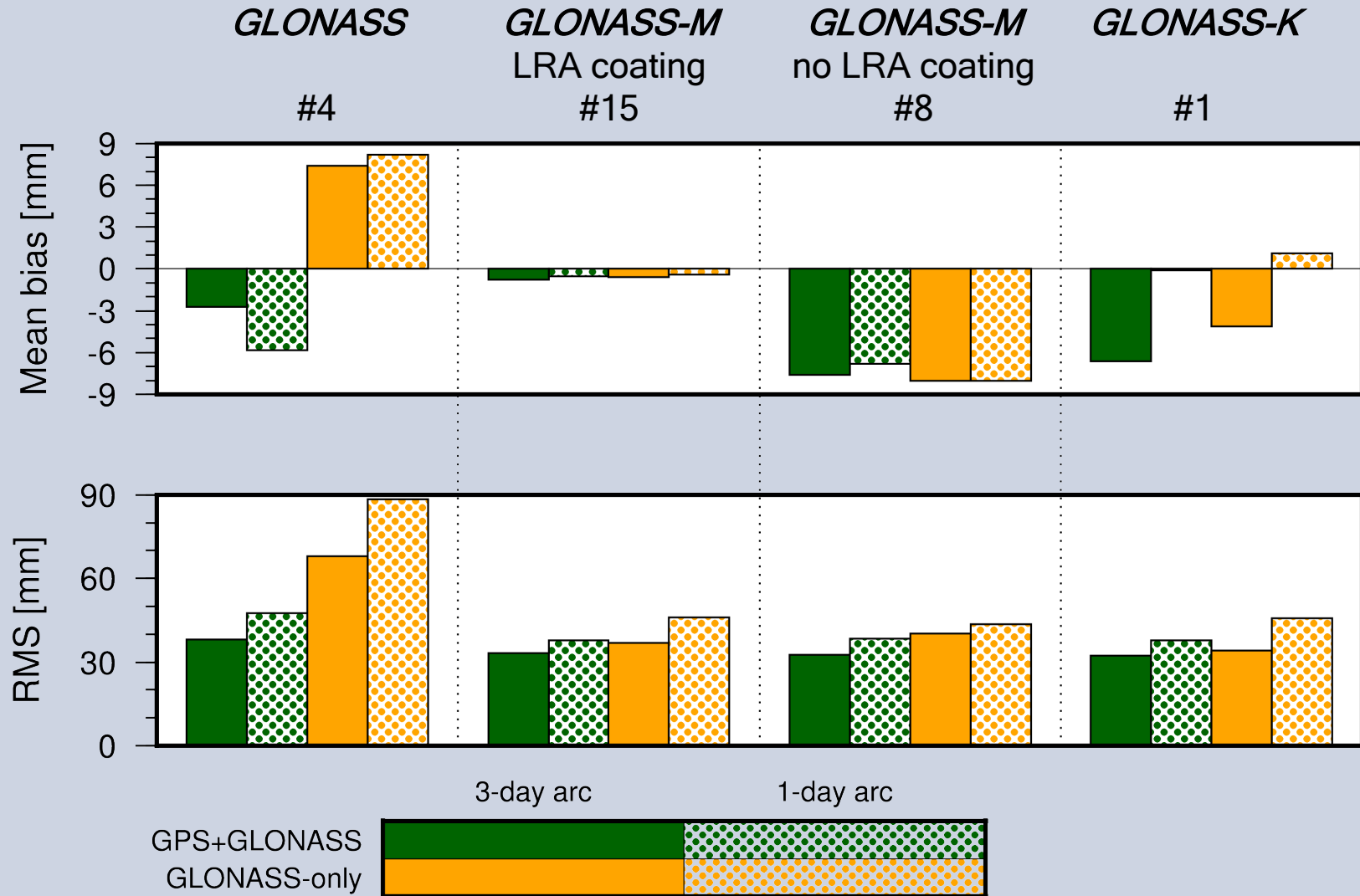


GLONASS:

GLONASS-only

GPS+GLONASS

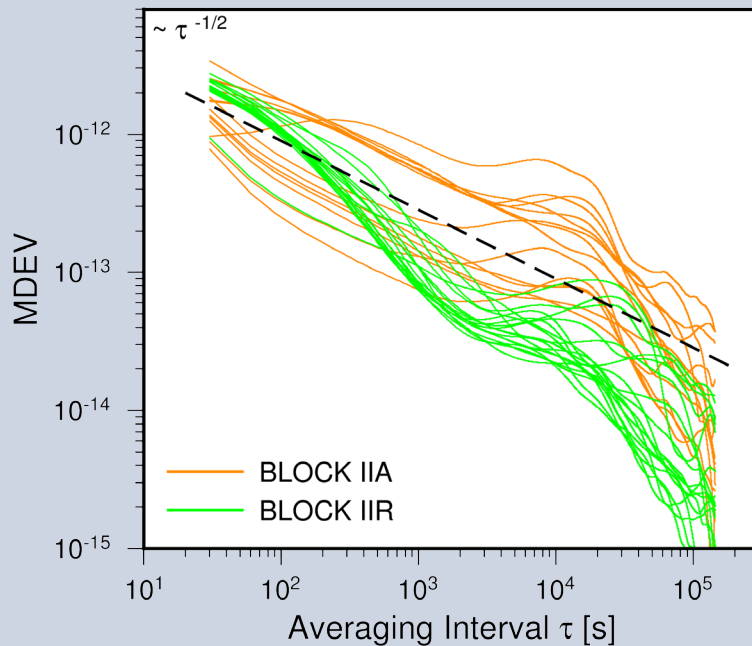
ORB: SLR range residuals



GNSS satellite clocks (30sec)

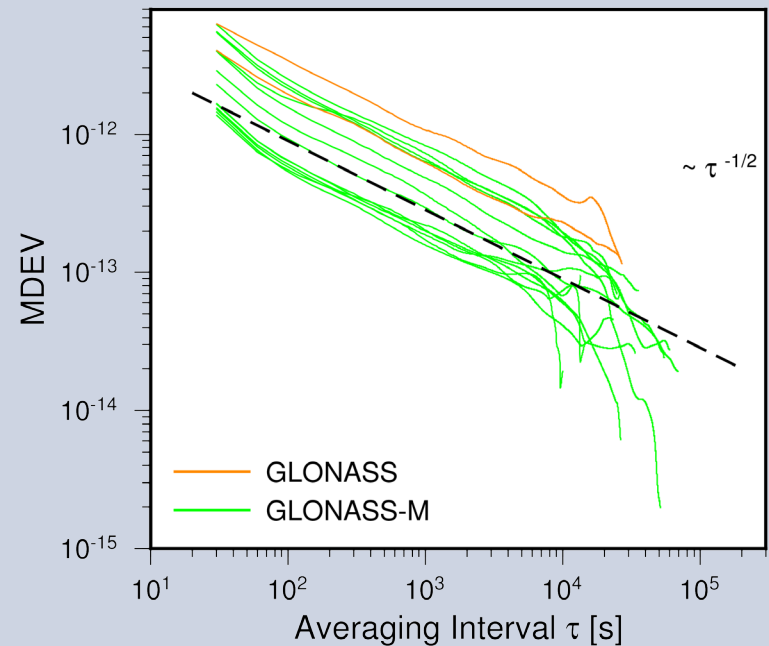
Modified Allan Deviation (MDEV) from a 5-day interval in 2008

GPS



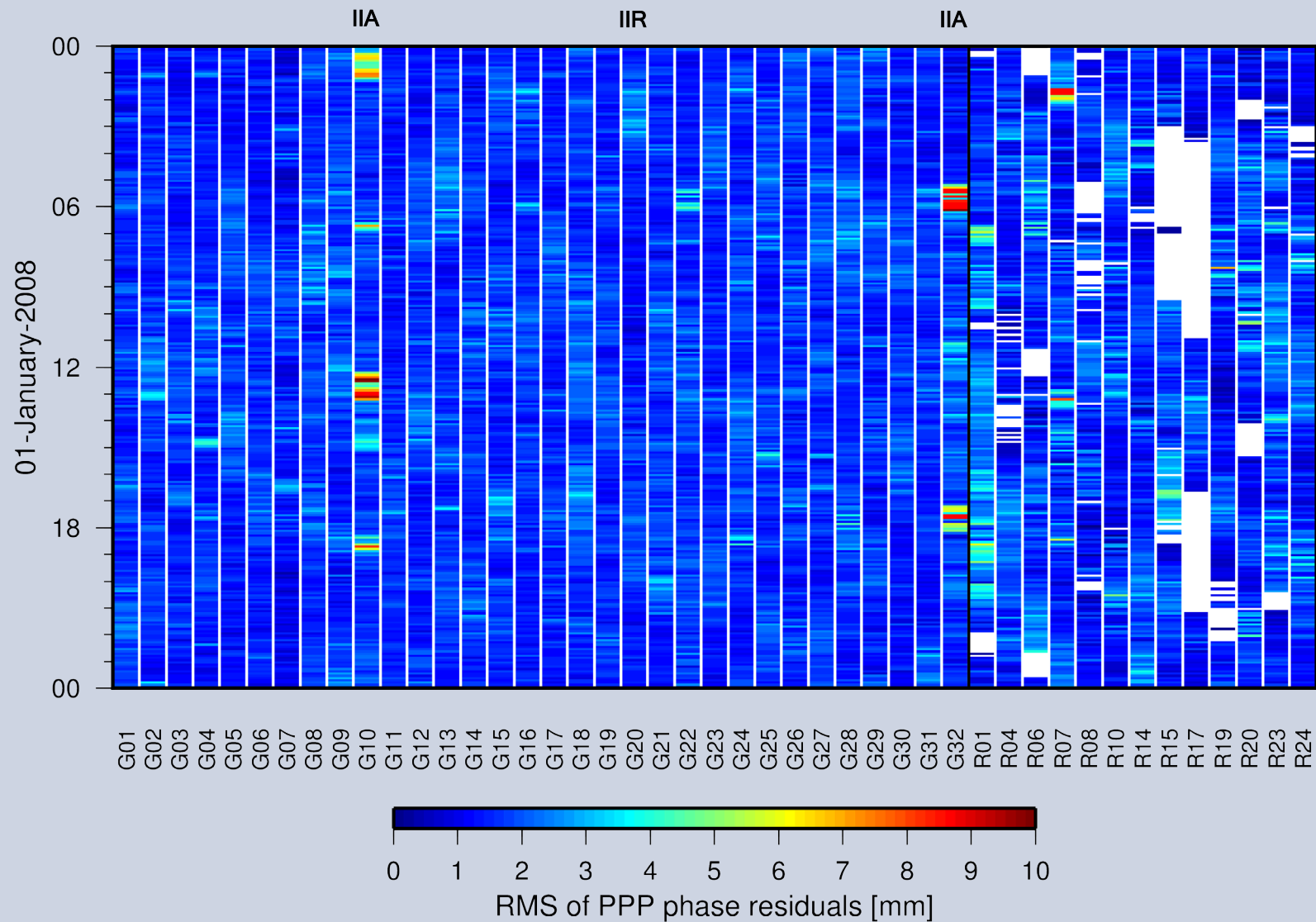
(missing epochs < 5%)

GLONASS



(missing epochs < 15%)

PPP Phase Residuals



Conclusions

- Impact of including GLONASS on TRF parameters
 - no systematic effect for linear TRF parameters
 - slight reduction of daily position repeatabilities
- Combination with GPS and 3-day arc length significantly improves GLONASS orbits
- Conventional consideration of albedo modeling required
- Study of remaining model errors based on precise clocks products (yaw maneuvers modeling for both GNSS)

Acknowledgement

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