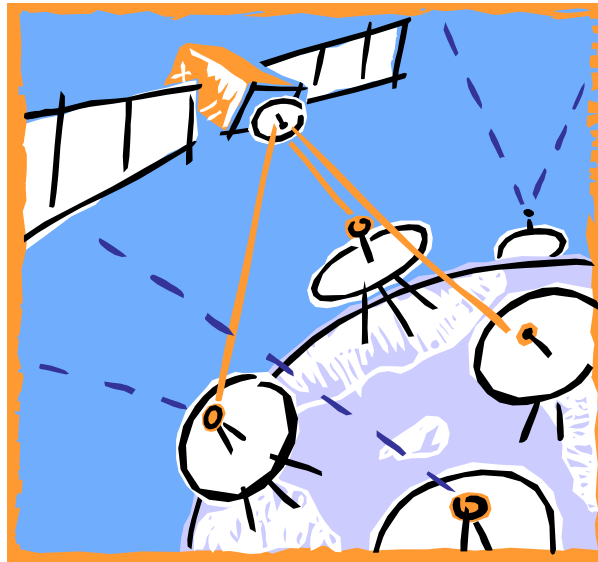


Generation of GNSS Orbits Based on Microwave and SLR Observations



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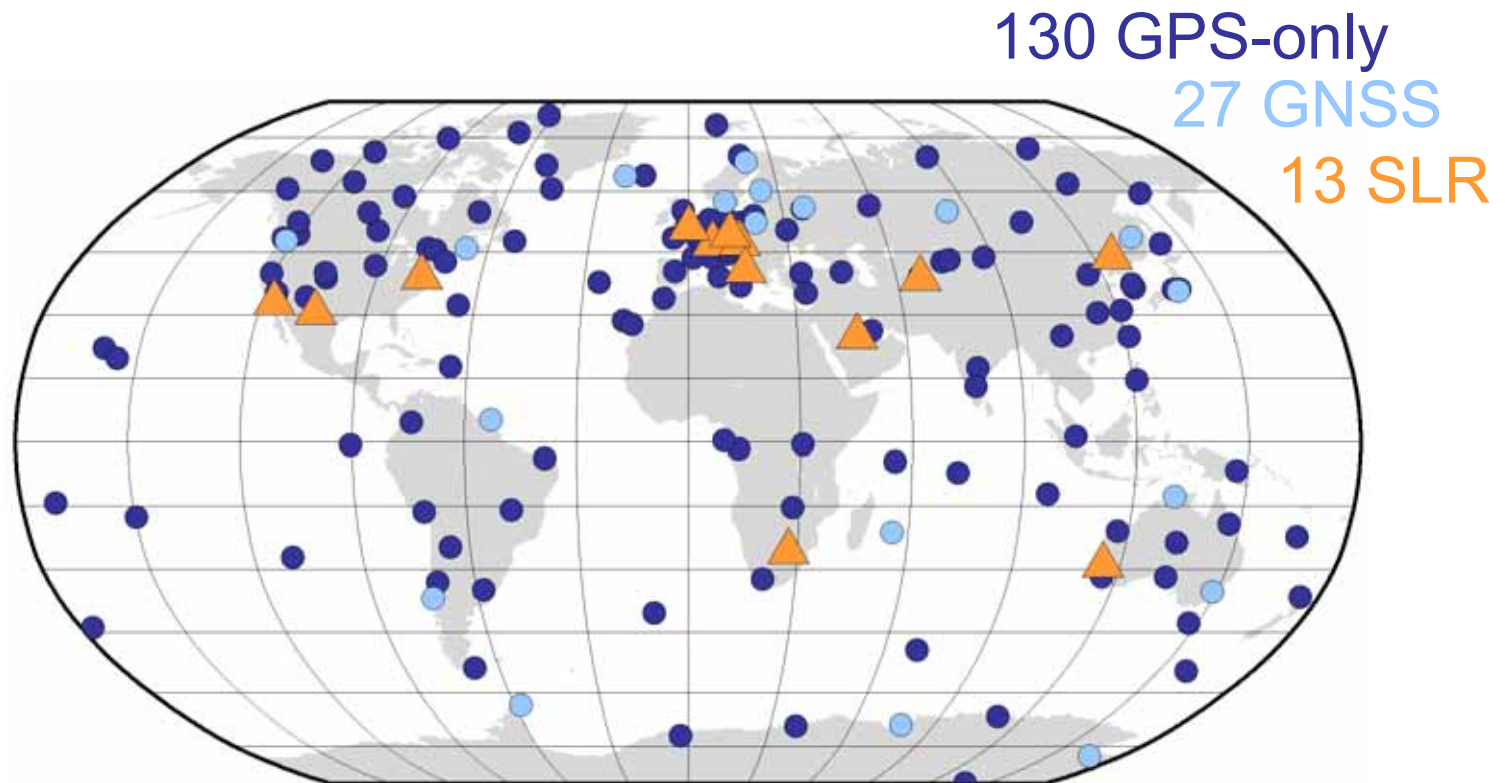
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- GNSS tracking data is regularly collected by both the microwave (IGS/IGLOS) and the SLR observation technique.
- Does it make sense to perform GNSS POD on the basis of the two observation techniques?

GNSS tracking network



1 GPS:	20,000 MW	10 SLR (NP)
1 GLONASS:	3,000 MW	15 SLR (NP)

Combination strategy (1)

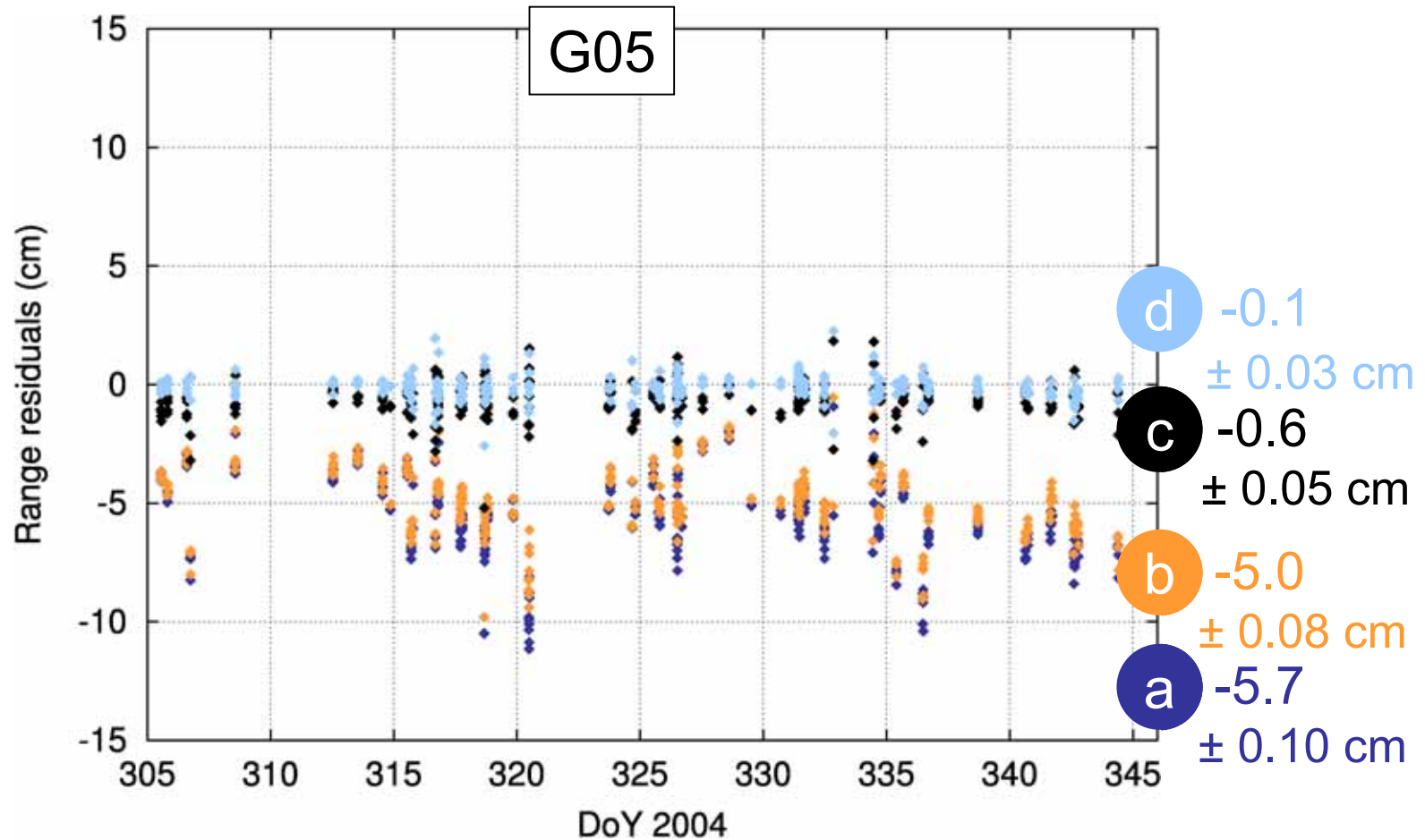
- Combination at level of observations
(specifically at level of NEQ information)
→ MW phase + SLR range
- Computation of common GNSS
(GPS + GLONASS) orbit parameters
→ 41 x 1-day arcs
- Bernese GPS Software (development
version)

Combination strategy (2)

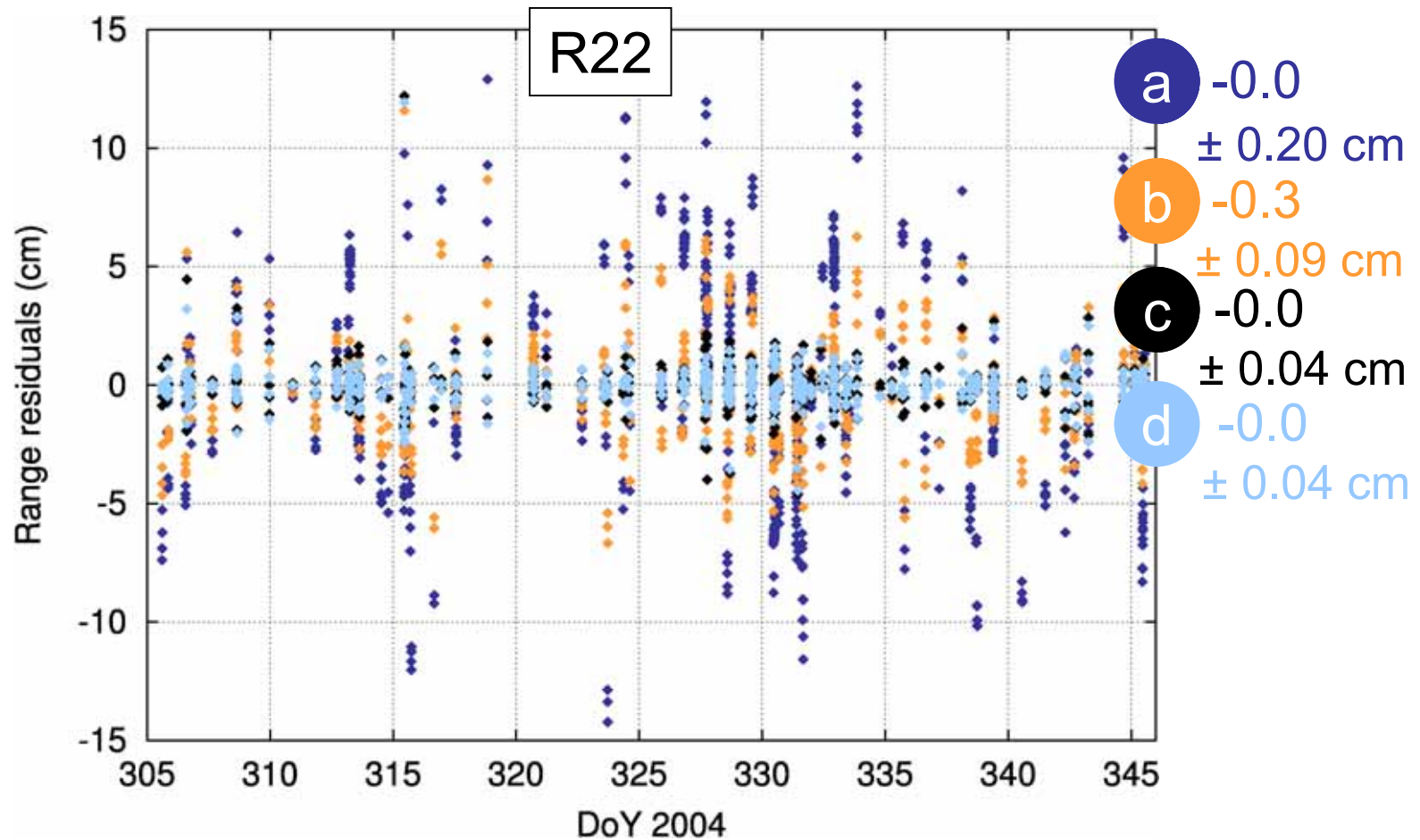
Weighting of SLR observations:

- a $\sigma = \infty$
- b $\sigma = 1 \text{ cm}$
- c $\sigma = 1 \text{ mm}$
- d $\sigma = 0.1 \text{ mm}$

Range residuals (1)



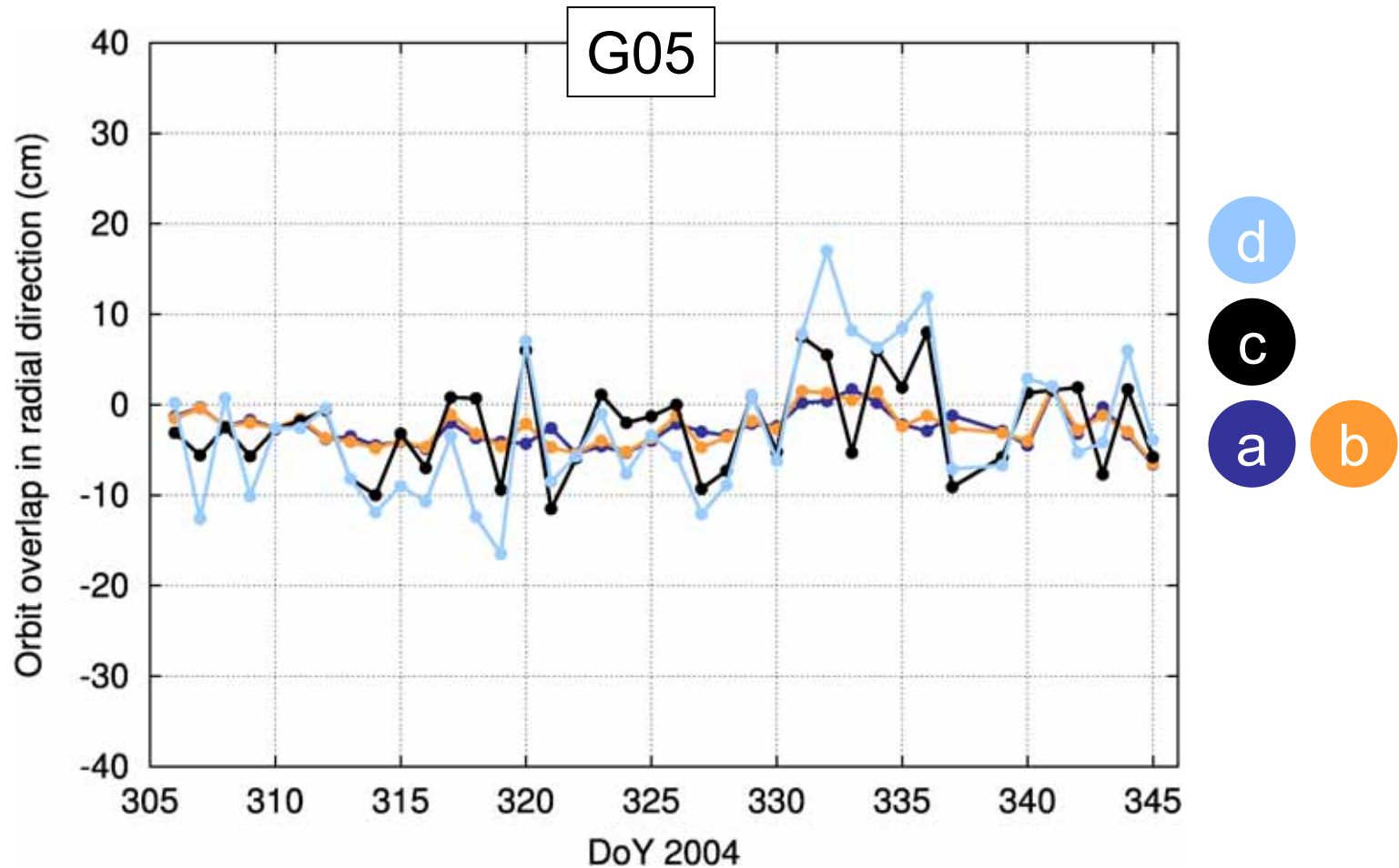
Range residuals (2)



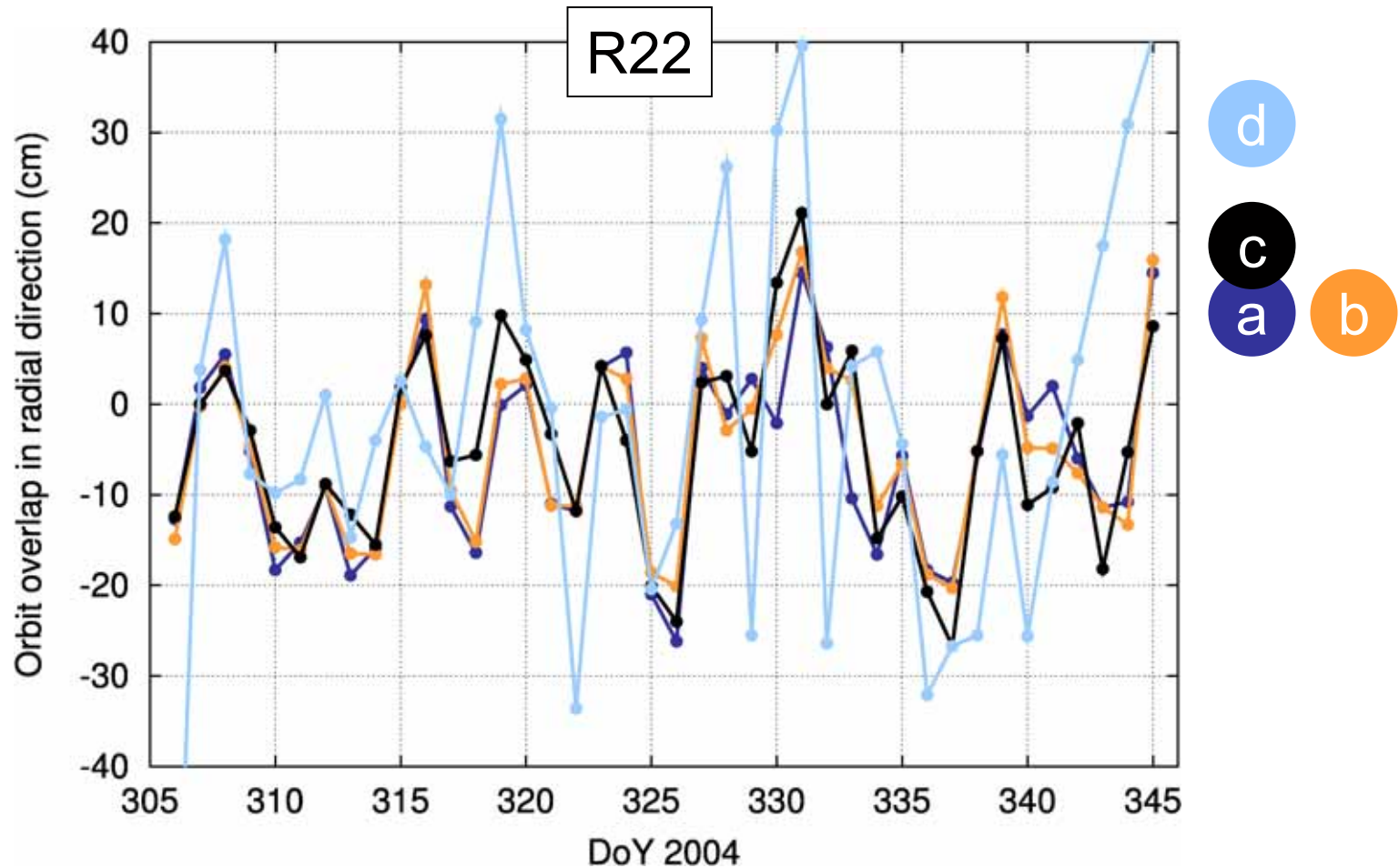
Observed range biases

Satellite	a	Bias (cm)	STD (cm)
GPS G05		-5.7 ± 0.1	1.7
GPS G06		-5.8 ± 0.2	3.5
GLONASS R03		-3.1 ± 0.5	5.6
GLONASS R22		0.0 ± 0.2	5.0
GLONASS R24		1.1 ± 0.3	6.3

1-day orbit difference at day boundary (1)



1-day orbit difference at day boundary (2)



Conclusions

- From the technical point of view, combined POD analysis of MW and SLR tracking data is no problem.
- Significant biases between the two observation techniques obviously do not allow a rigorous combination for GNSS POD.
- The impact of SLR data on POD is more pronounced for the GLONASS than for the GPS satellite constellation.

Possible explanations for the observed biases

- Mismodelling of GNSS satellite (and receiver) MW antenna phase center offsets and patterns

at present → **relative model** with **unmodelled** satellite patterns

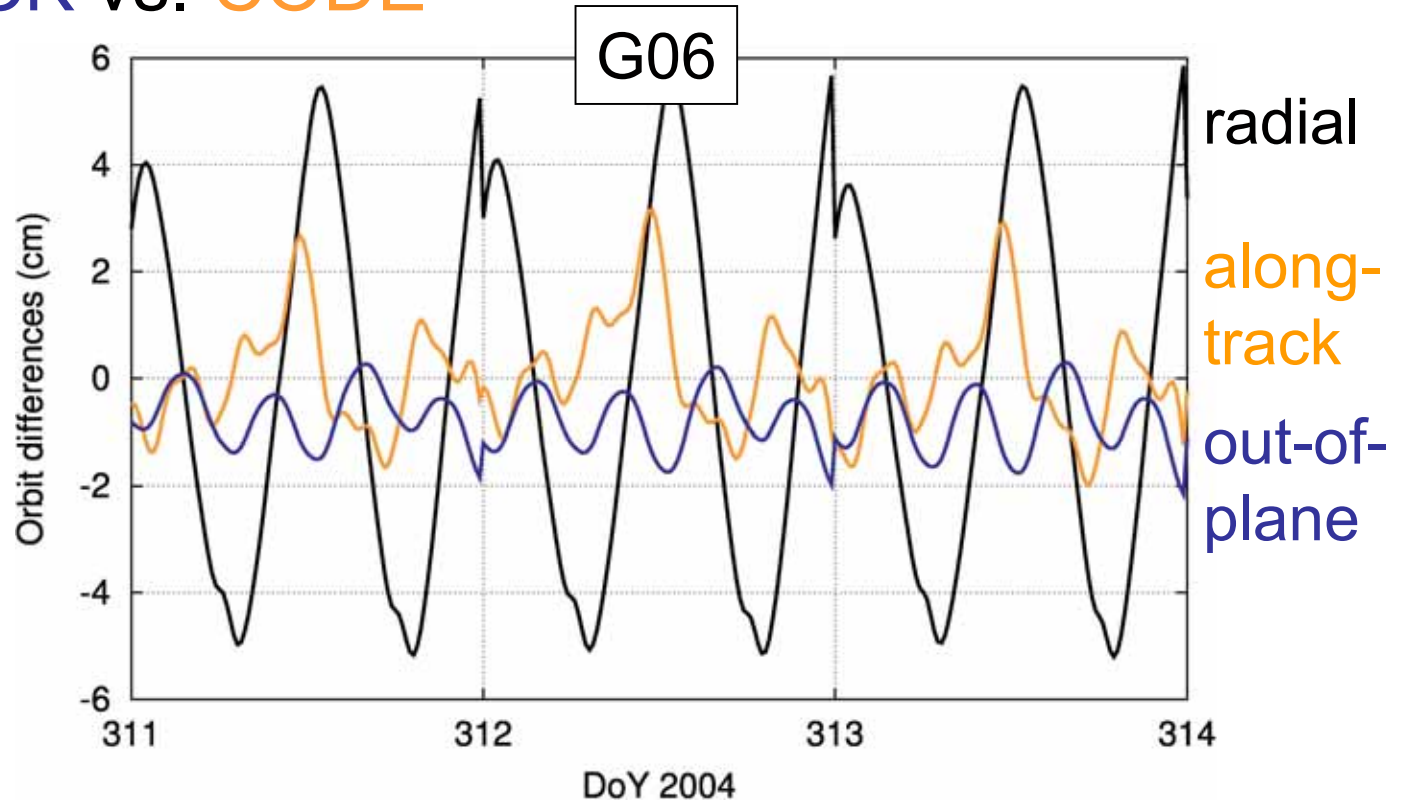
new → **absolute models**, specific to satellite groups or even to each individual satellite (currently under investigation within the IGS!)

Possible explanations for the observed biases

- Mismodelling of GNSS satellite (and receiver) MW antenna phase center offsets and patterns
- Possibly incorrect SLR retro-reflector offsets
- Orbit modeling issues, e.g., solar radiation pressure

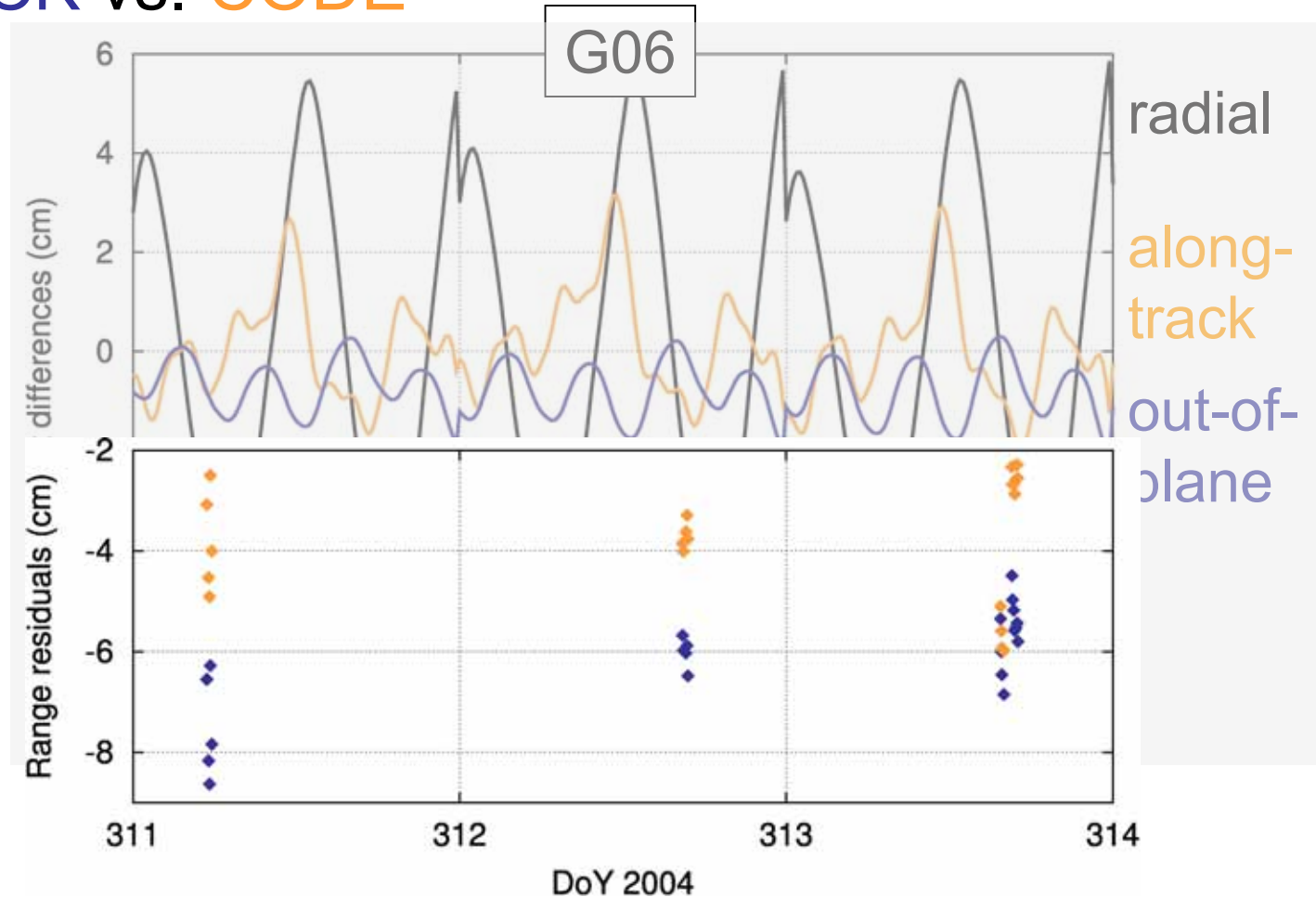
Solar radiation pressure modeling

ROCK vs. CODE



Solar radiation pressure modeling

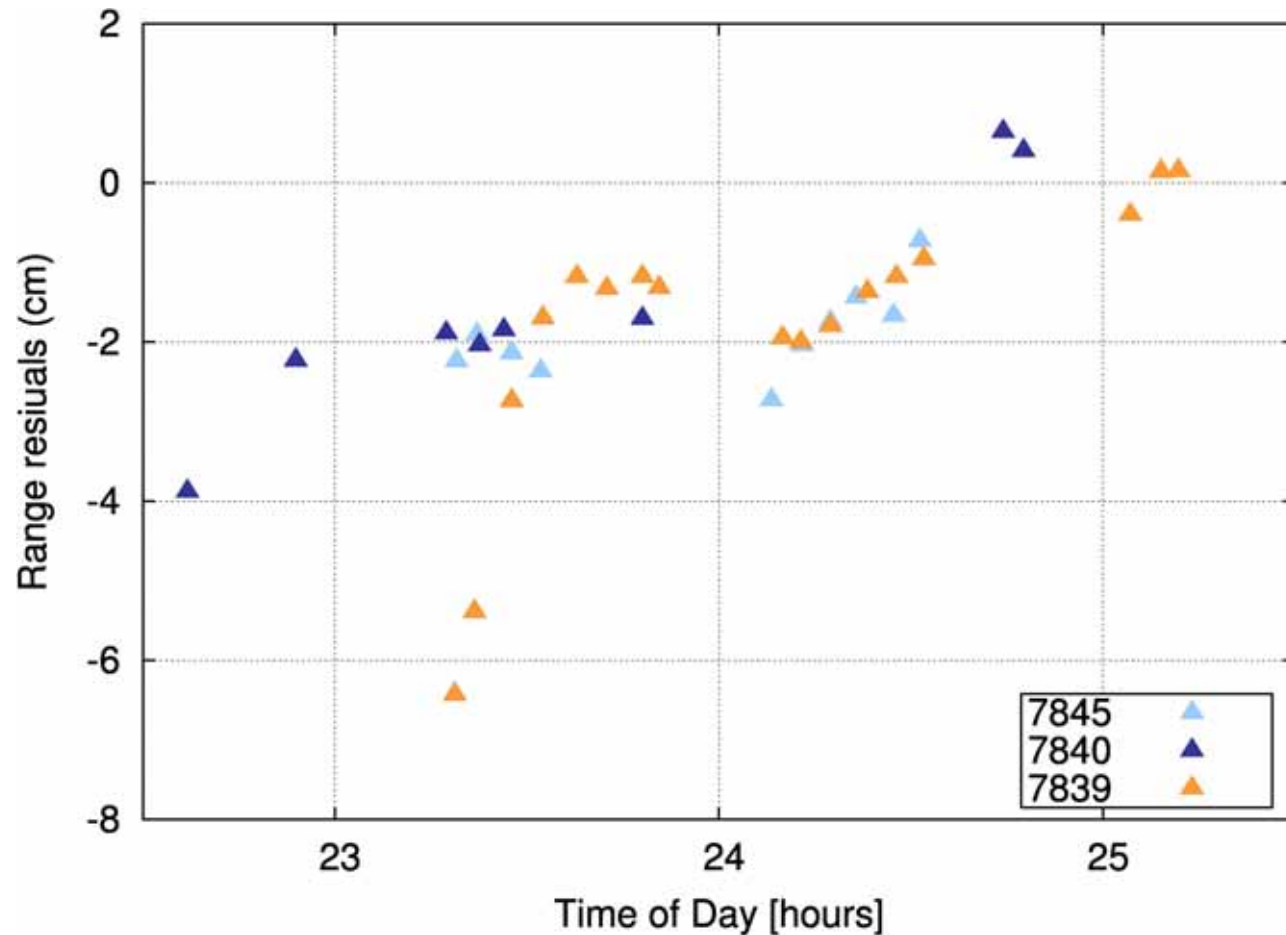
ROCK vs. CODE



Possible explanations for the observed biases

- Mismodelling of GNSS satellite (and receiver) MW antenna phase center offsets and patterns
- Possibly incorrect SLR retro-reflector offsets
- Orbit modeling issues, e.g., solar radiation pressure
- Issues related to SLR calibration

Issues related to SLR calibration



Possible explanations for the observed biases

- Mismodelling of GNSS satellite (and receiver) MW antenna phase center offsets and patterns
- Possibly incorrect SLR retro-reflector offsets
- Orbit modeling issues, e.g., solar radiation pressure
- Issues related to SLR calibration
- Unmodelled effects (?)

