

On space ties for some LEOs

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Content

- Motivation
- SLR residual statistics from GPS-based Low Earth Orbiter (LEO) Precise Orbit Determination (POD)
- SLR Center-of-Mass correction (CoM) estimation for GPS-based LEO orbits

Introduction

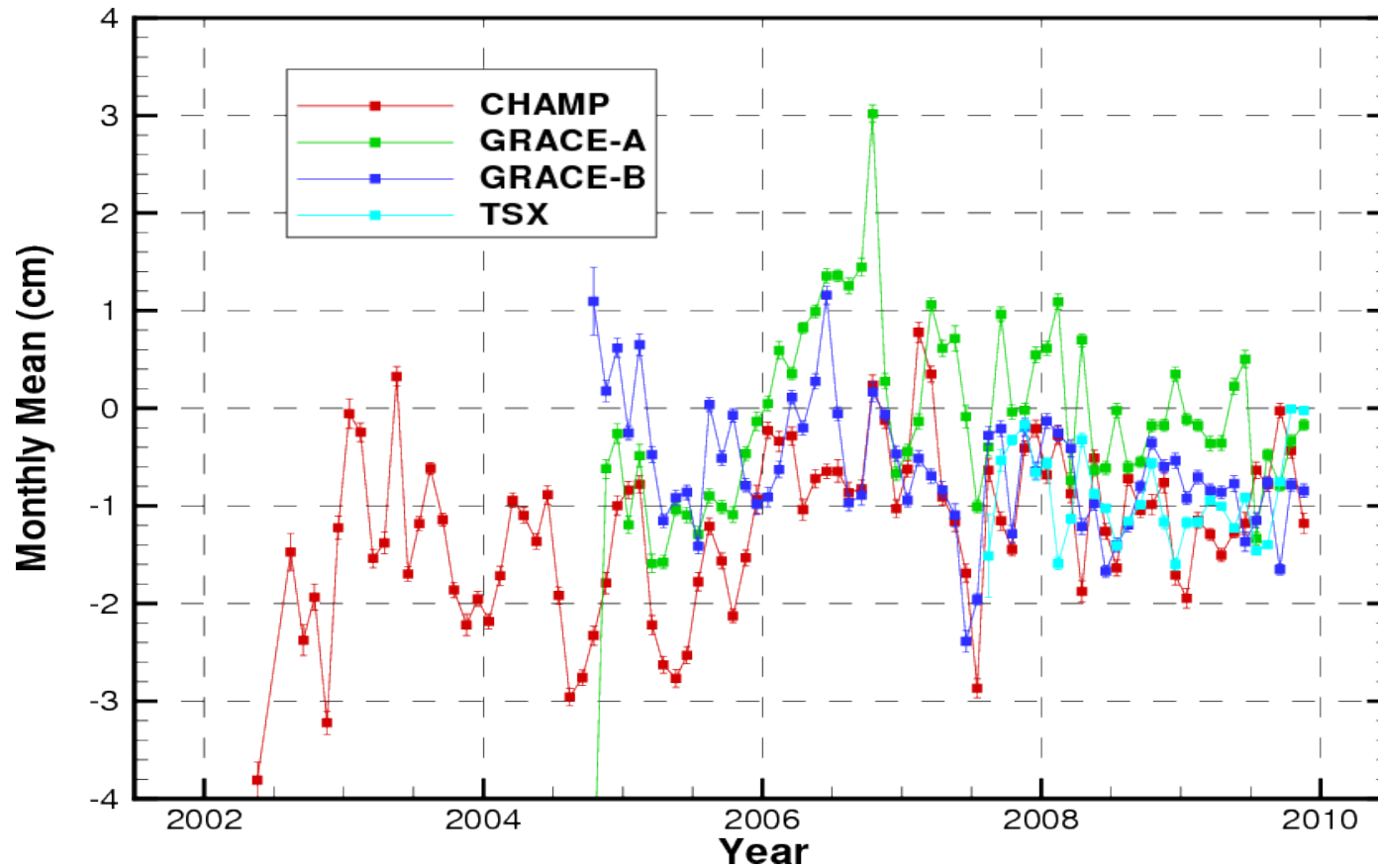
- GFZ generates operationally CHAMP, GRACE and TerraSAR-X Rapid Science Orbits (RSOs) based on on-board GPS tracking
- All satellites are complementarily tracked by SLR
- For RSO generation SLR is down-weighted to serve as QC
- Space ties:
 - Dynamic POD works on the CoM of the satellites
 - CoM offsets of the GPS antennae and the Laser Retro-Reflector (LRR) are given by the satellite builders
- We do have now a long-term RSO history available:
 - Check bias of RSO SLR residuals
 - Cross-check with independent CoM estimates from SLR data and fixed orbits

GFZ Rapid Science Orbits

- Two-step processing
 - Generate the GPS orbits and clocks from GPS ground data
 - A priori station coordinates ITRF2000(IGS00)
 - Minor changes in time (gross errors, velocities)
 - All solved for, a priori sigma 10 cm
 - Generate the LEO orbit from GPS on-board data
 - SLR down-weighted
 - Station coordinates ITRF2000, with minor changes in time
- Available next day
 - EOP issue

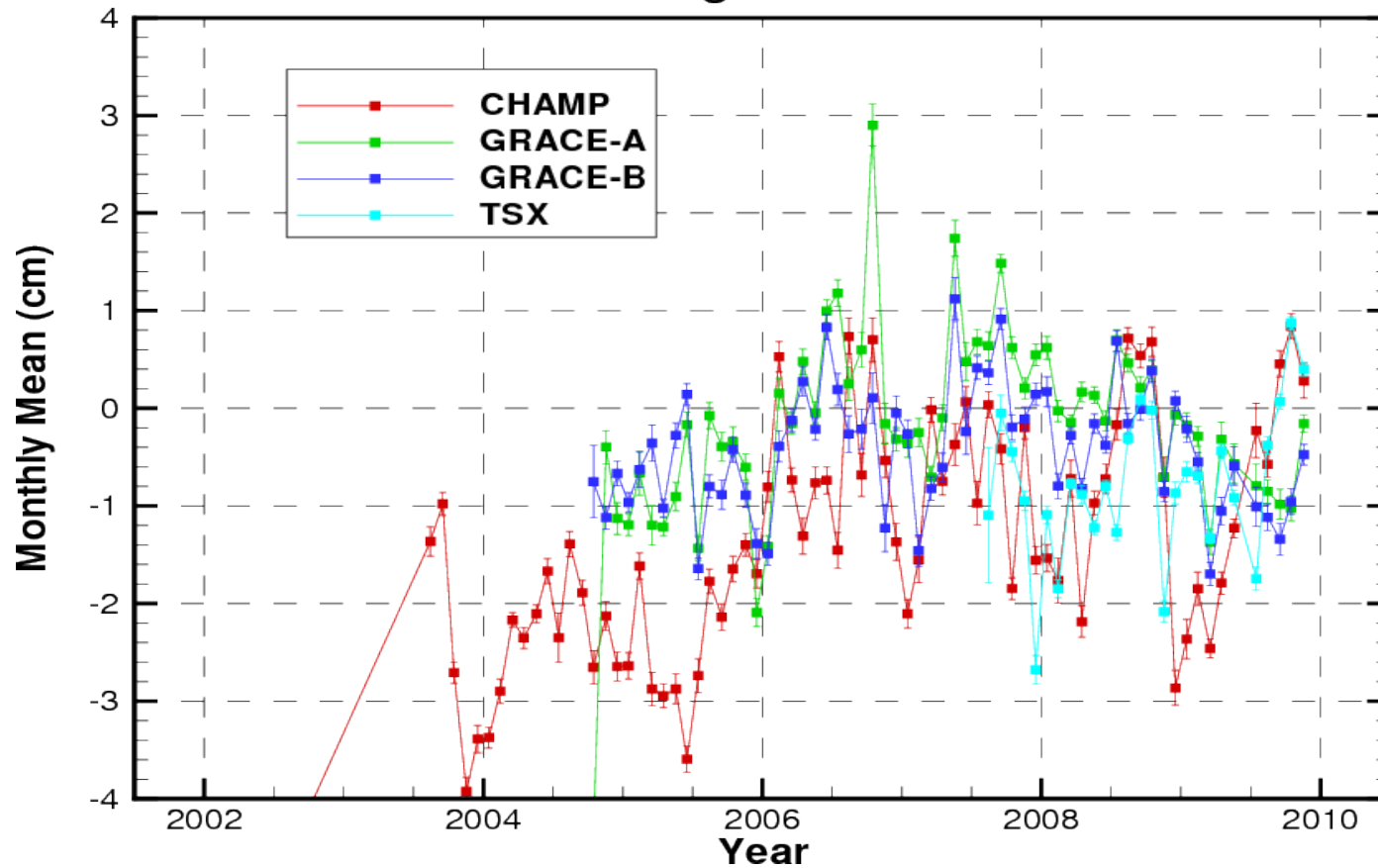
RSO SLR Residuals

All SLR stations



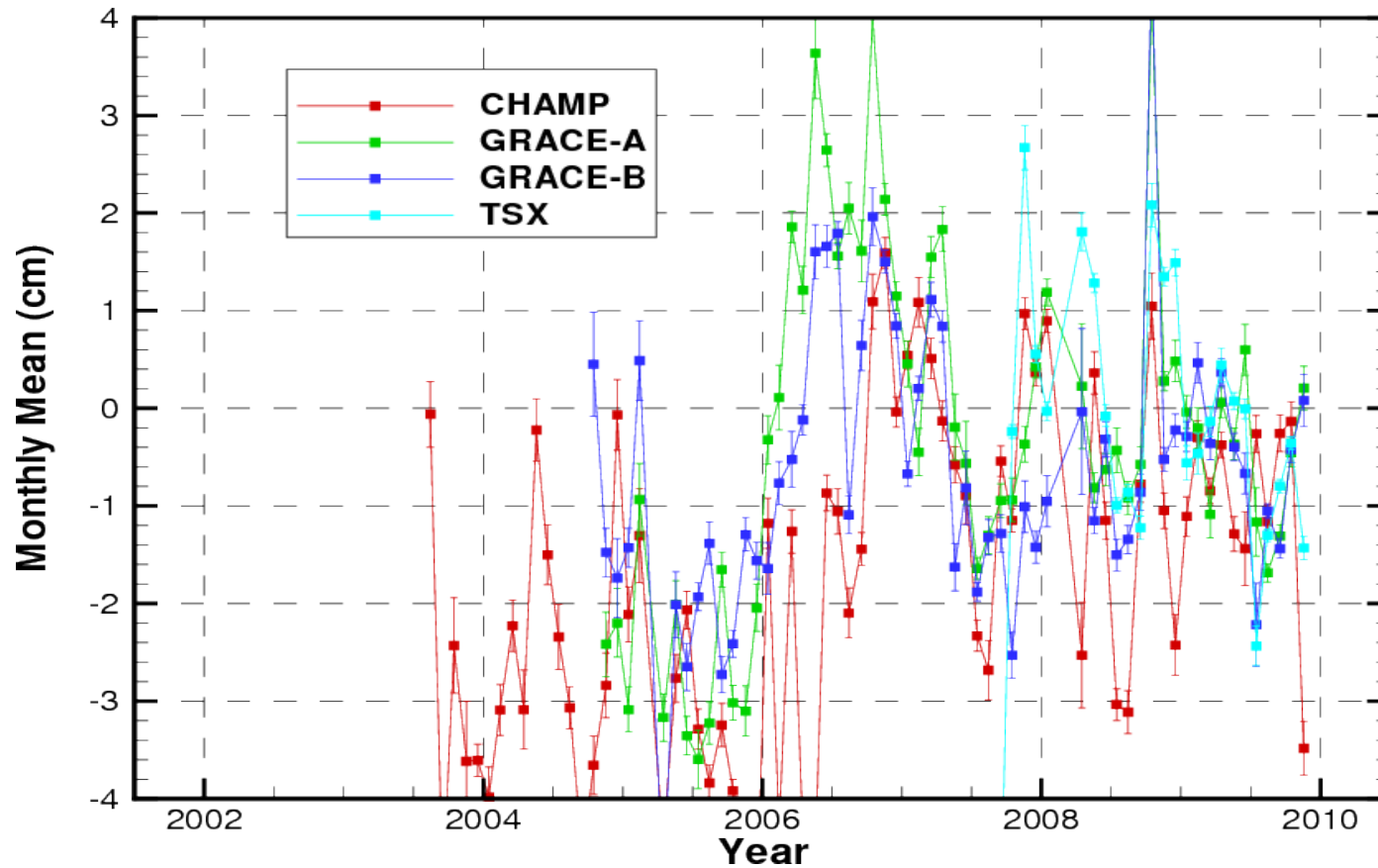
RSO SLR Residuals

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RSO SLR Residuals

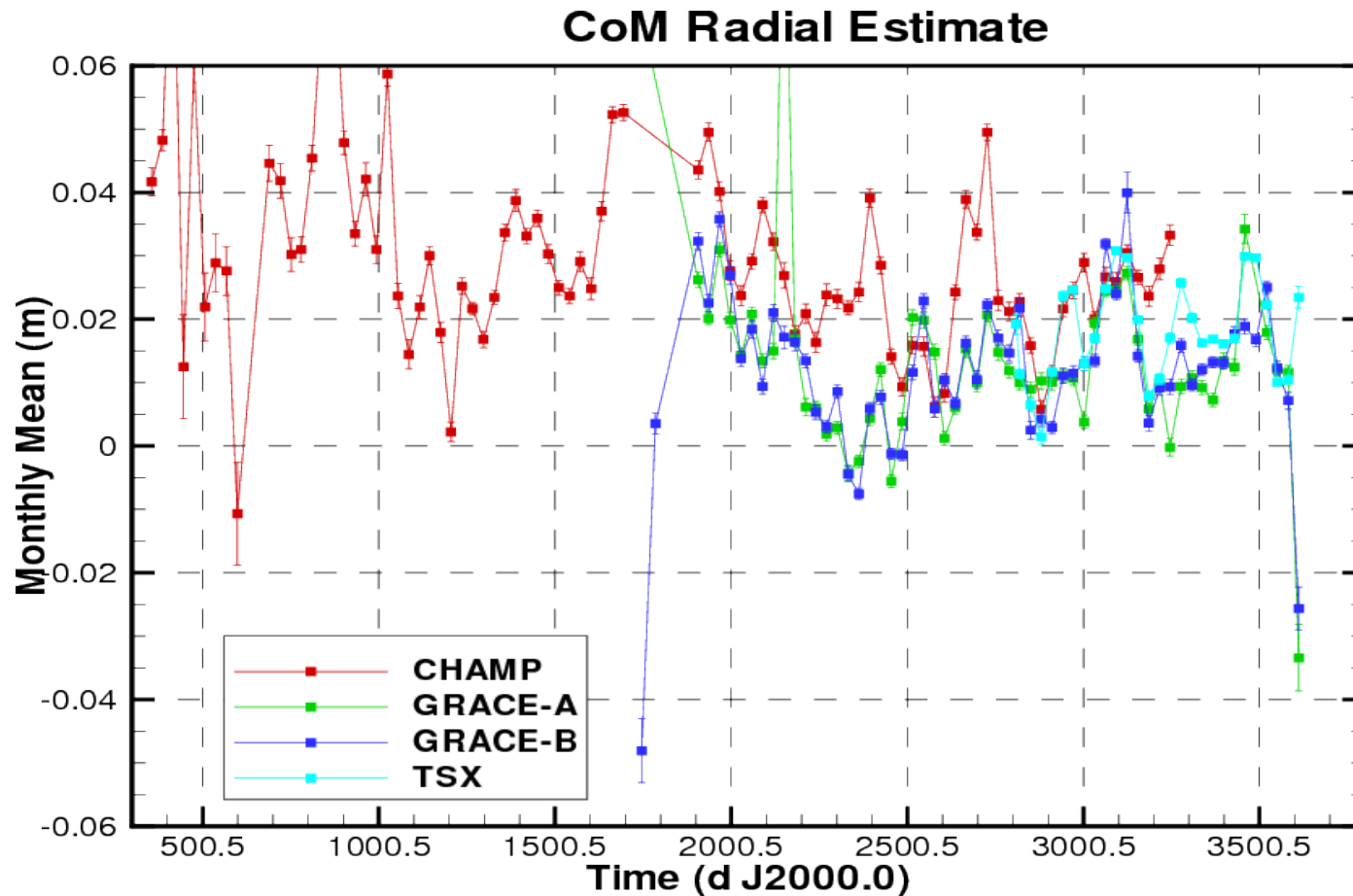
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RSO SLR Statistics

		Mean (cm)	Std. (cm)	n	
CHAMP	2002/05-2009/11	-1.2	5.4	298,883	
GRACE-A	2004/10-2009/11	-0.0	4.8	215,694	
GRACE-B	2004/10-2009/11	-0.7	4.8	204,999	
TSX	2007/08-2009/11	-0.9	4.5	208,623	
GRACE-A	2004/10-2006/05	-0.6	4.5	58,122	OCC off
GRACE-A	2006/05-2009/11	0.2	4.8	158,598	OCC on

CoM Estimates from SLR to RSO



CoM Estimates from SLR to RSO

		Radial (cm)	Normal (cm)	Transversal (cm)
CHAMP		2.8	1.4	-0.4
GRACE-A		1.2	1.0	-3.0
GRACE-B		1.2	0.3	-5.0
TSX		2.0	2.6	0.6
GRACE-A				
GRACE-A	JPL	0.7	-0.1	0.2
GRACE-B	JPL	0.4	0.1	0.1

Conclusions

- RSO shows a cm-level radial bias between SLR and GPS for all satellites
- An orbit comparison of TSX with GSOC shows no biases
- A GPS phase center offset as determined by ground field calibration (Montenbruck, 2008) would map strictly into 5.2 cm radial bias