

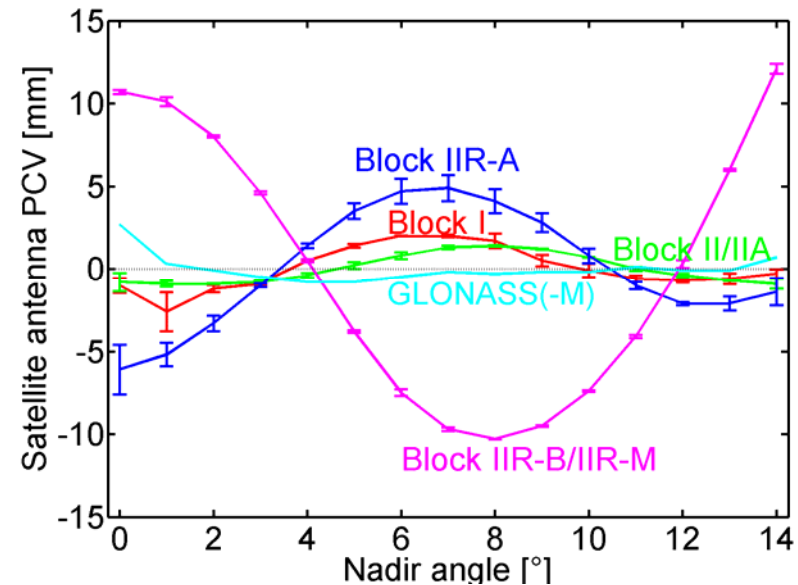
# **Estimation of GPS satellite antenna z-offsets from reprocessed SINEX files**

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# Transition to absolute phase center modeling

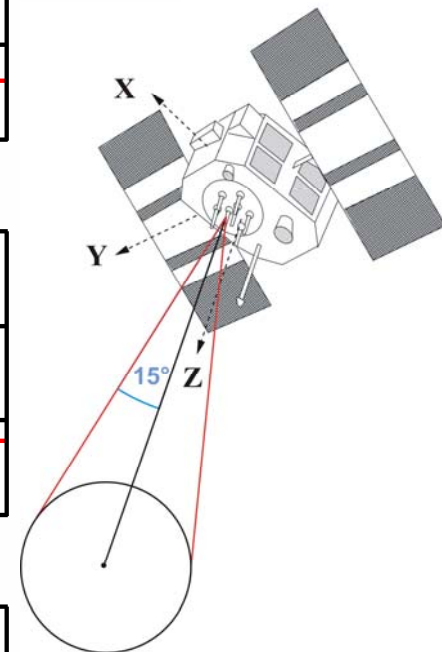
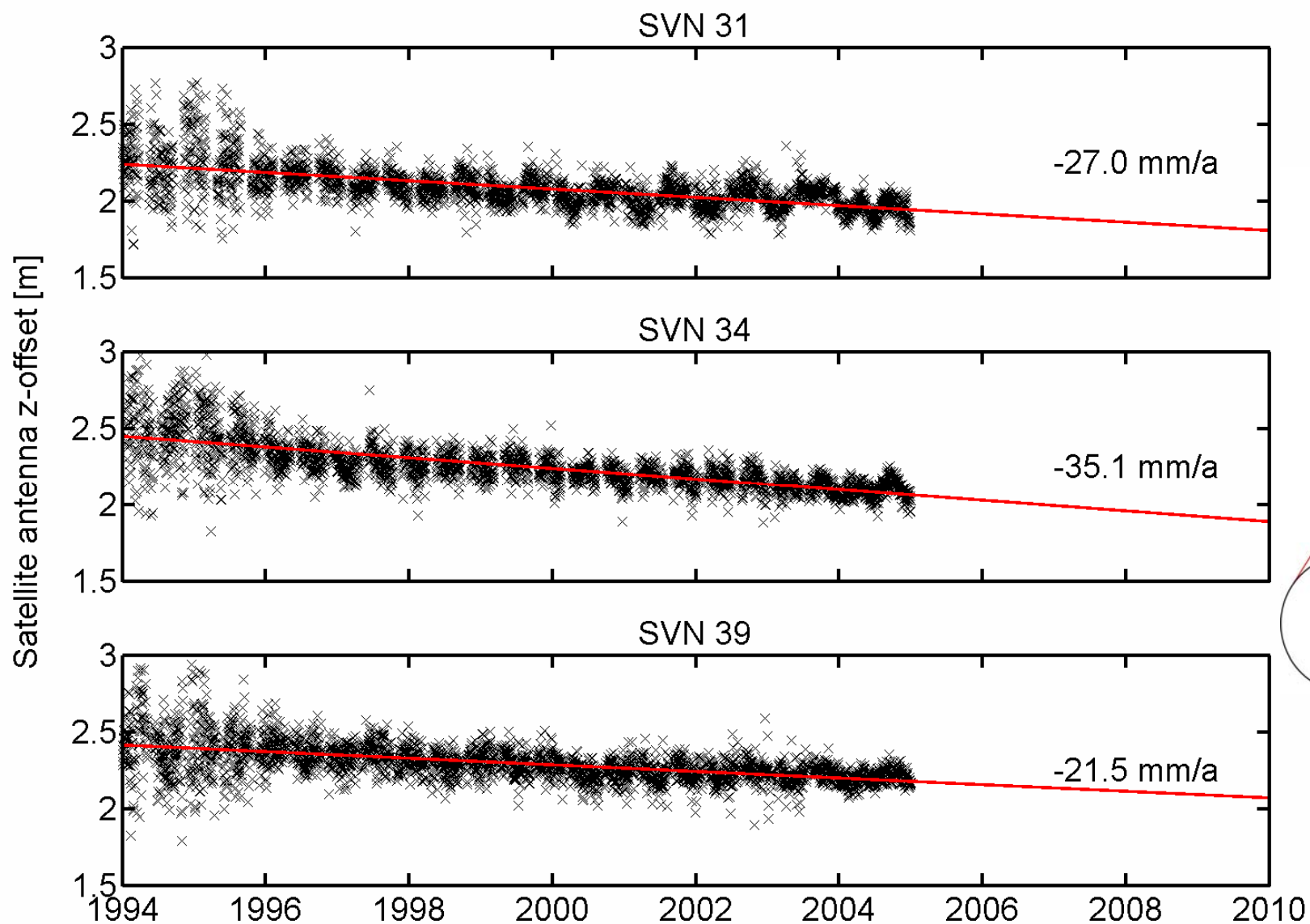
Model	Receiver antenna			Satellite antenna	
	PCO	PCV	Radome	PCO	PCV
<b>igs01.pcv</b> (1996-2006)	<b>relative</b> to reference antenna <b>AOAD/M_T</b>		<b>ignored</b>	block-specific	<b>ignored</b>
<b>igs05.atx</b> (2006-2010)	<b>absolute</b> , i.e., independent of a reference antenna		considered, if calibration available	satellite-specific	block-specific



# igs05.atx deficiencies

- Solutions to derive **satellite** antenna corrections were aligned to IGb00 (IGS realization of ITRF2000), but not to ITRF2005
- **Absolute receiver** antenna corrections were applied, whereas IGb00 was based on **relative** corrections
- Radome calibrations were **not considered**, but added to igs05.atx later on
- Error of about 0.8 mm/a (Ray et al., 2004) in the mean vertical velocity of IGb00 caused significant trend in z-offset time series: vertical drift of **1 mm/a** → z-offset drift of about **20 mm/a**
- z-offsets had to be trend-corrected to a given epoch (2000.0)

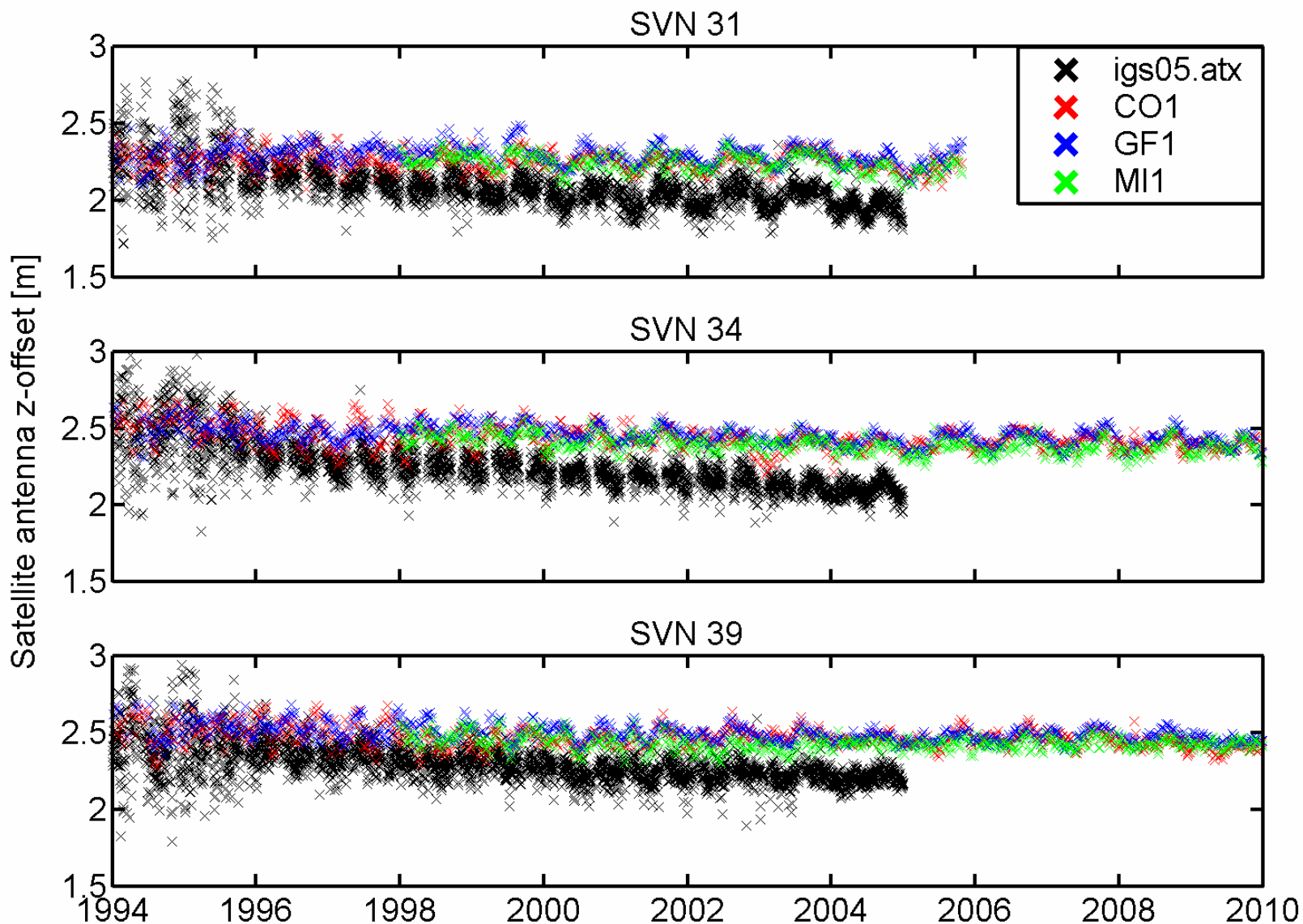
# z-offset time series for igs05.atx



# Recomputation from reprocessed SINEX files

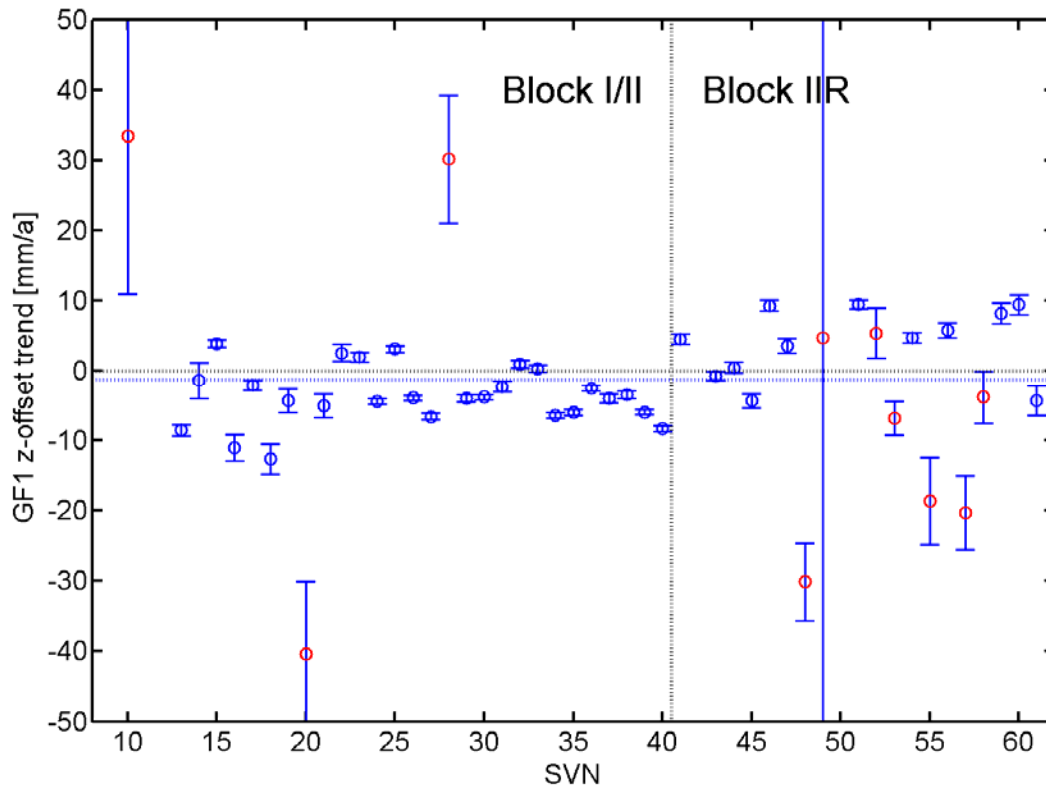
- **Consistent** GPS solutions from first IGS reprocessing campaign:
  - 1994-2007: repro1 period
  - 2008-2010: consistent operational solutions
- Weekly SINEX files of **four** IGS Analysis Centers contain phase center offset estimates: CODE, GFZ, MIT, NRCan (tbd.)
- SINEX format does not allow for phase center variations so far
- Preliminary results with **ITRF2008P** kept fixed
- Benefit from recomputation:
  - z-offsets consistent with ITRF2008
  - more data
  - more analysis centers
  - z-offset estimates for the latest satellites

# z-offset time series from weekly SINEX files



TUM time series for igs05.atx based on **daily** solutions!

# Remaining z-offset trends



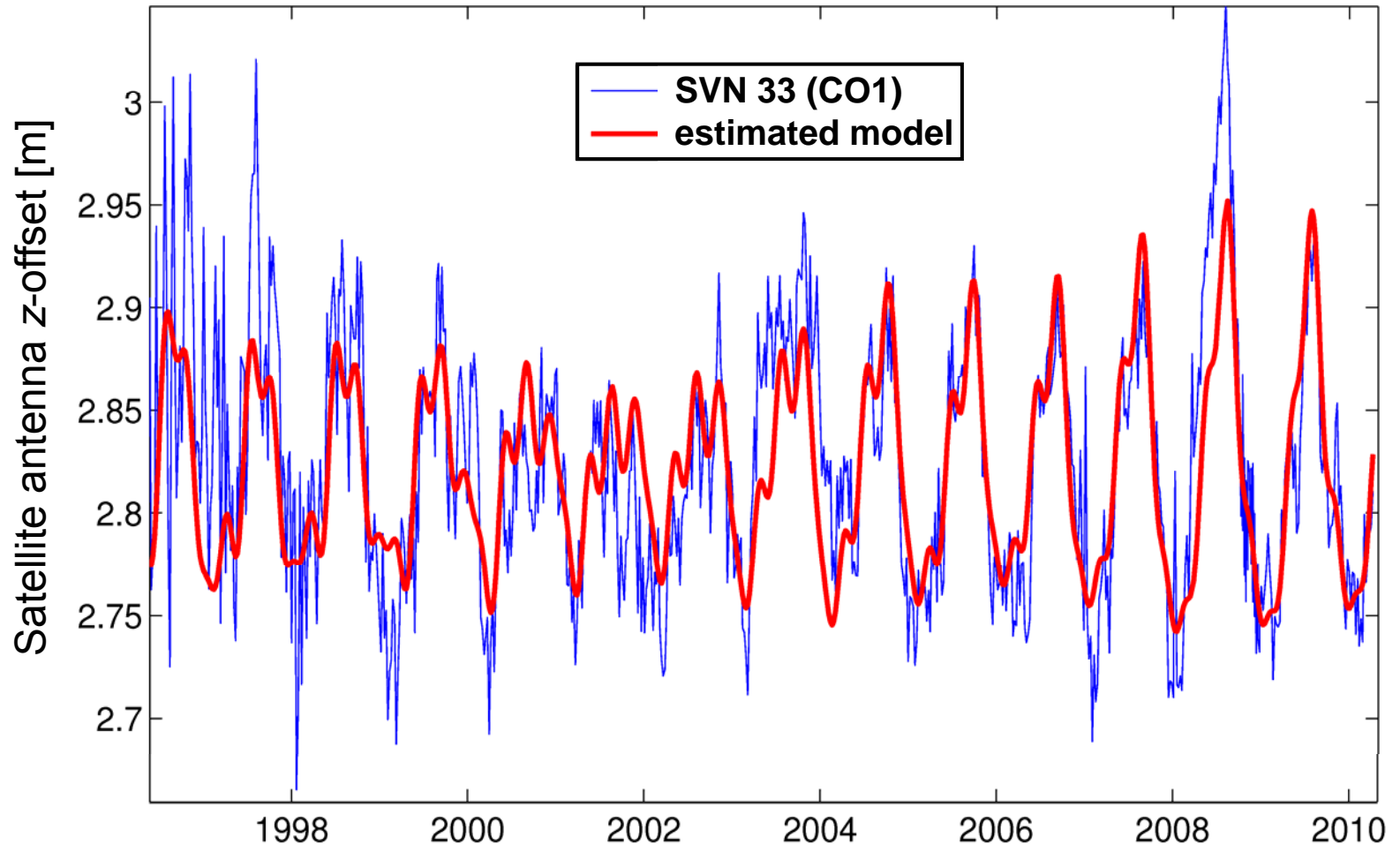
Trends [mm/a]	igs05.atx (Schmid et al., 2007)	igs08.atx
CODE/ TUM	<b>-24.8</b>	<b>-4.9</b>
GFZ	<b>-22.0</b>	<b>-1.3</b>
MIT	----	<b>-1.9</b>

Altamimi et al. (AGU 2009):

Scale rate agreement between VLBI and SLR: 0.06 ppb/a

**$\pm 0.03$  ppb/a** correspond to a z-offset trend of about  **$\pm 4$  mm/a**

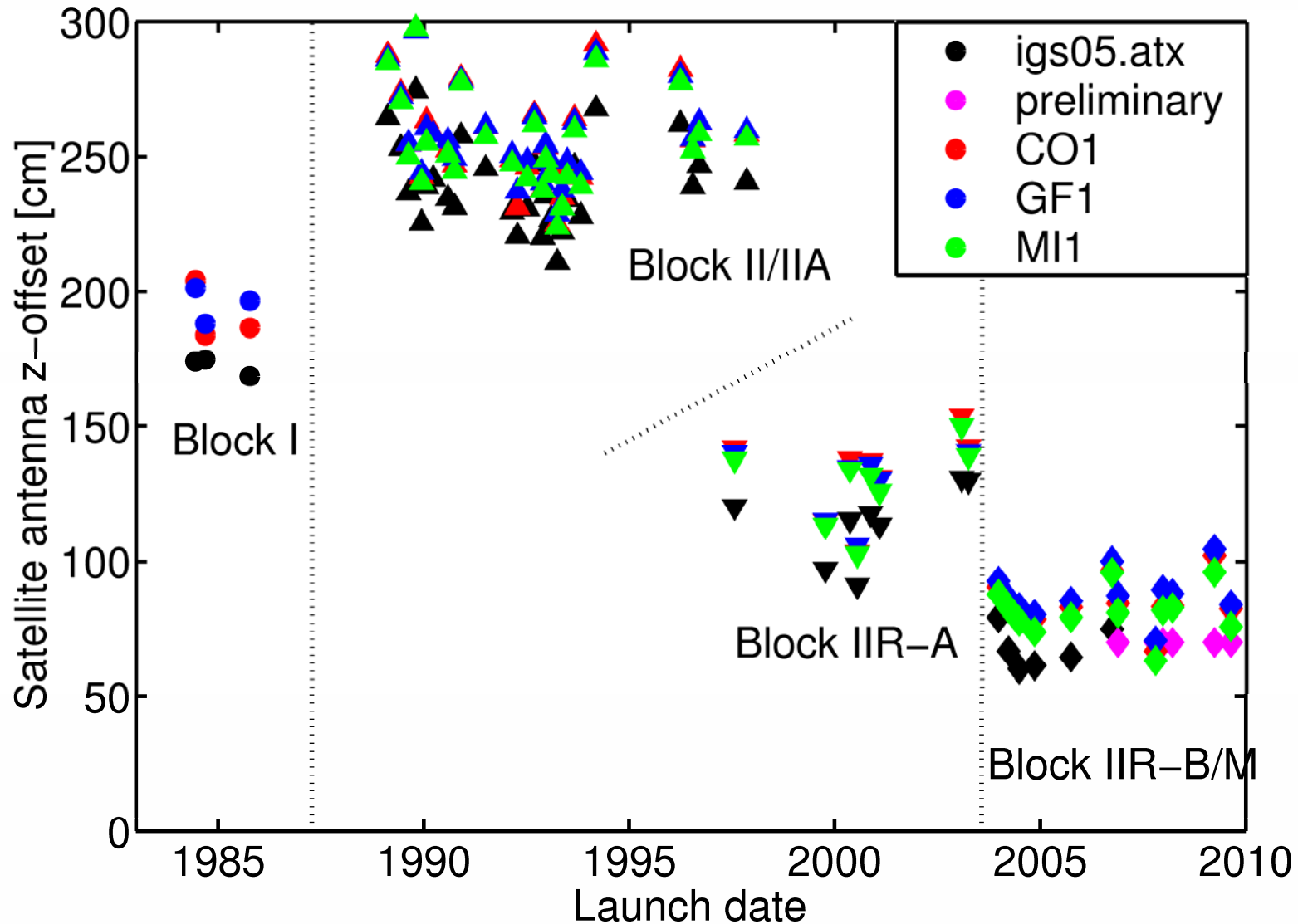
# Draconitic and/or annual periods



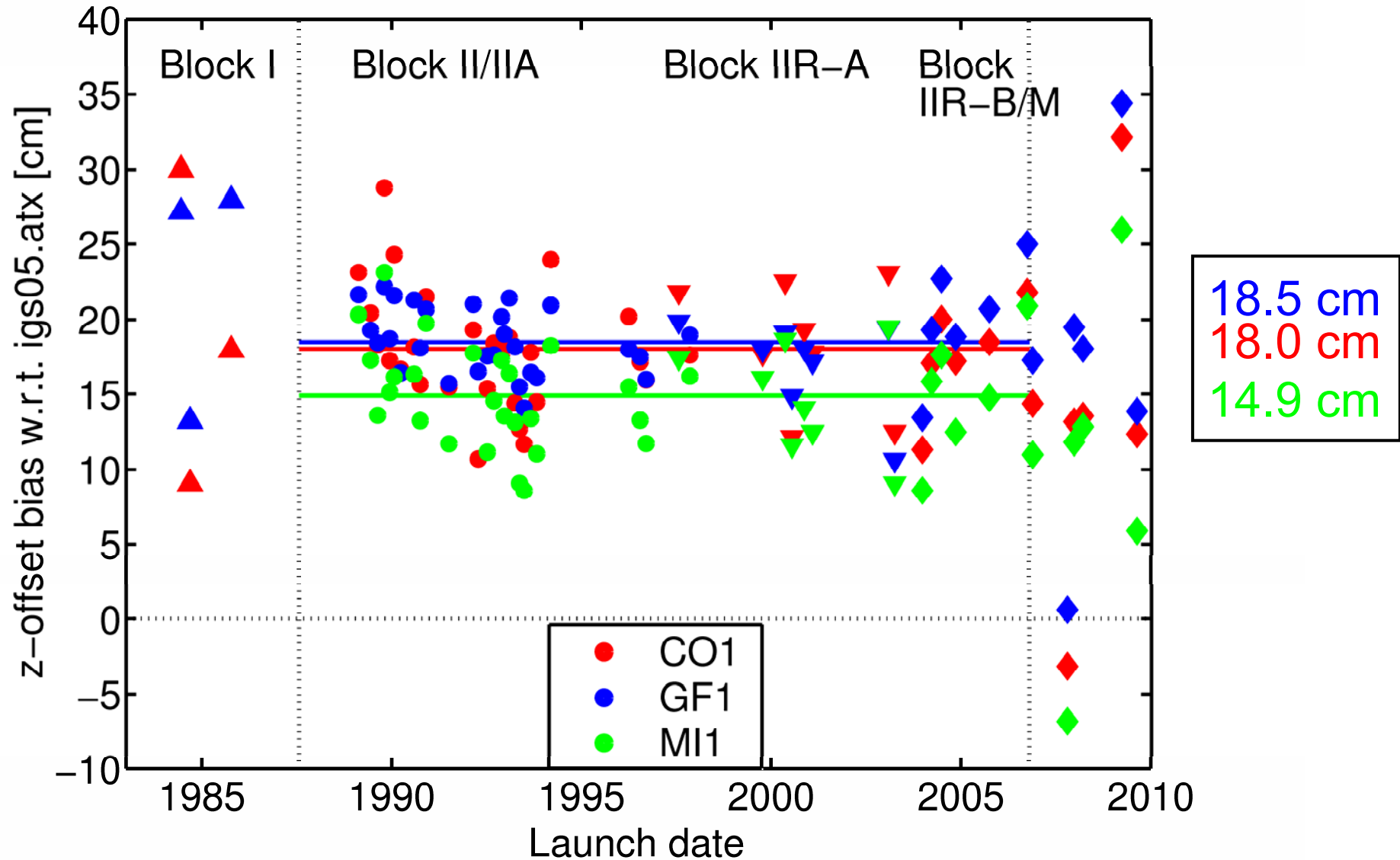
Estimated:

- quadratic variation for amplitude of the **draconitic year**
- **3rd and 4th harmonics** of the draconitic year

# Absolute GPS z-offsets by launch date



# z-offset bias w.r.t. igs05.atx (I)



## z-offset bias w.r.t. igs05.atx (II)

- Bias w.r.t. igs05.atx:
  - CODE: **18.0 cm**  $\pm$  4.4 cm
  - GFZ: **18.5 cm**  $\pm$  3.4 cm
  - MIT: **14.9 cm**  $\pm$  3.5 cm
- Bias between GFZ and CODE/TUM:
  - igs05.atx (Schmid et al., 2007): **about 4 cm**
  - igs08.atx: **0.5 cm**
- Altamimi et al. (2010):  
Scale difference between ITRF2008P and ITRF2005: -1.13 ppb
- Zhu et al. (2003):  $\Delta z$  [m]  $\approx$  -0.13  $\Delta$ scale [ppb]  
**-1.13 ppb** correspond to about **+14.5 cm**
- Part of the bias between CODE/GFZ and MIT possibly due to single fixed satellite offsets in the MIT solutions

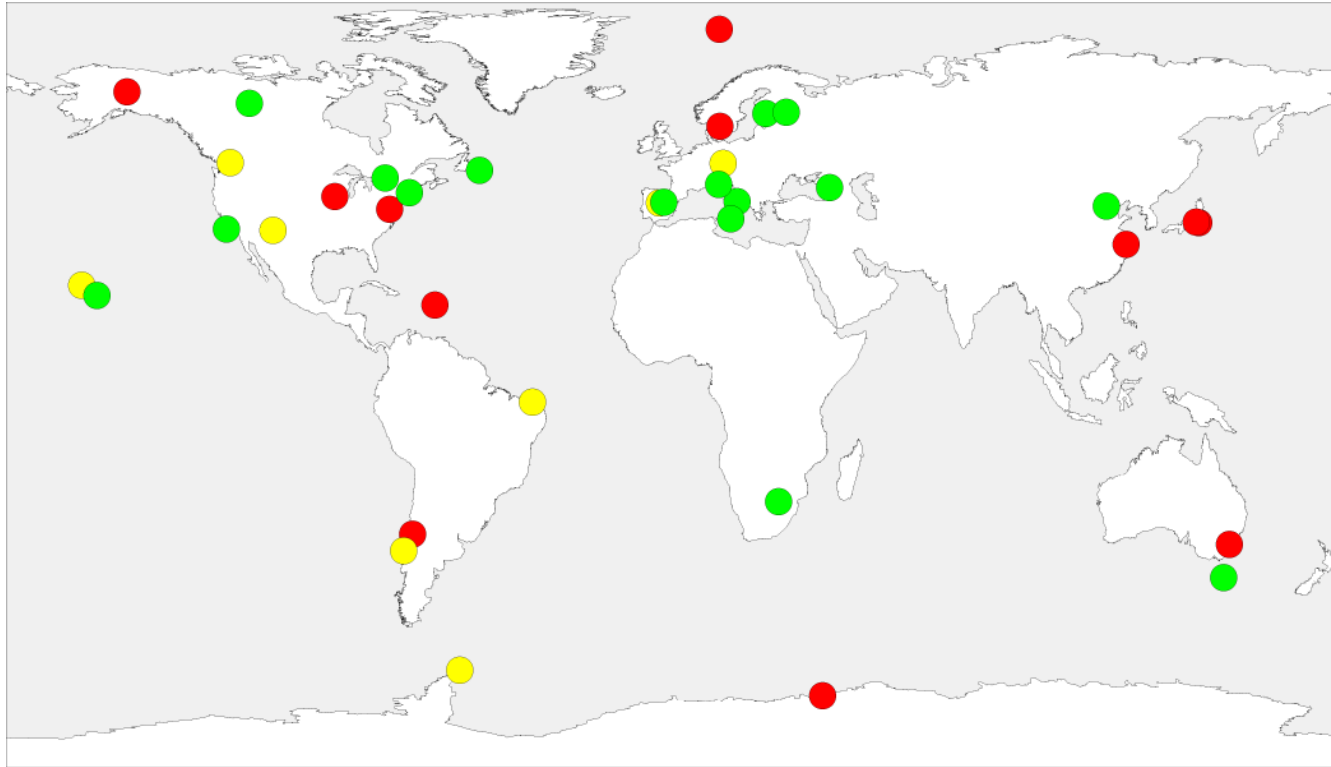
# Uncalibrated antenna/radome combinations

- Together with the switch to igs08.atx, new receiver antenna calibrations will be considered
- Quality of calibrations for the antennas within the IGS network will be improved, but stays far from perfect:

<b>Model</b>	<b>absolute</b> calibration	<b>converted</b> field calibration	<b>uncalibrated</b> antenna/ radome combination
igs05.atx	62%	18%	20%
igs08.atx	<b>69%</b>	<b>11%</b>	<b>20%</b>



# Local ties GPS-VLBI



SANT



TSKB



ONSA

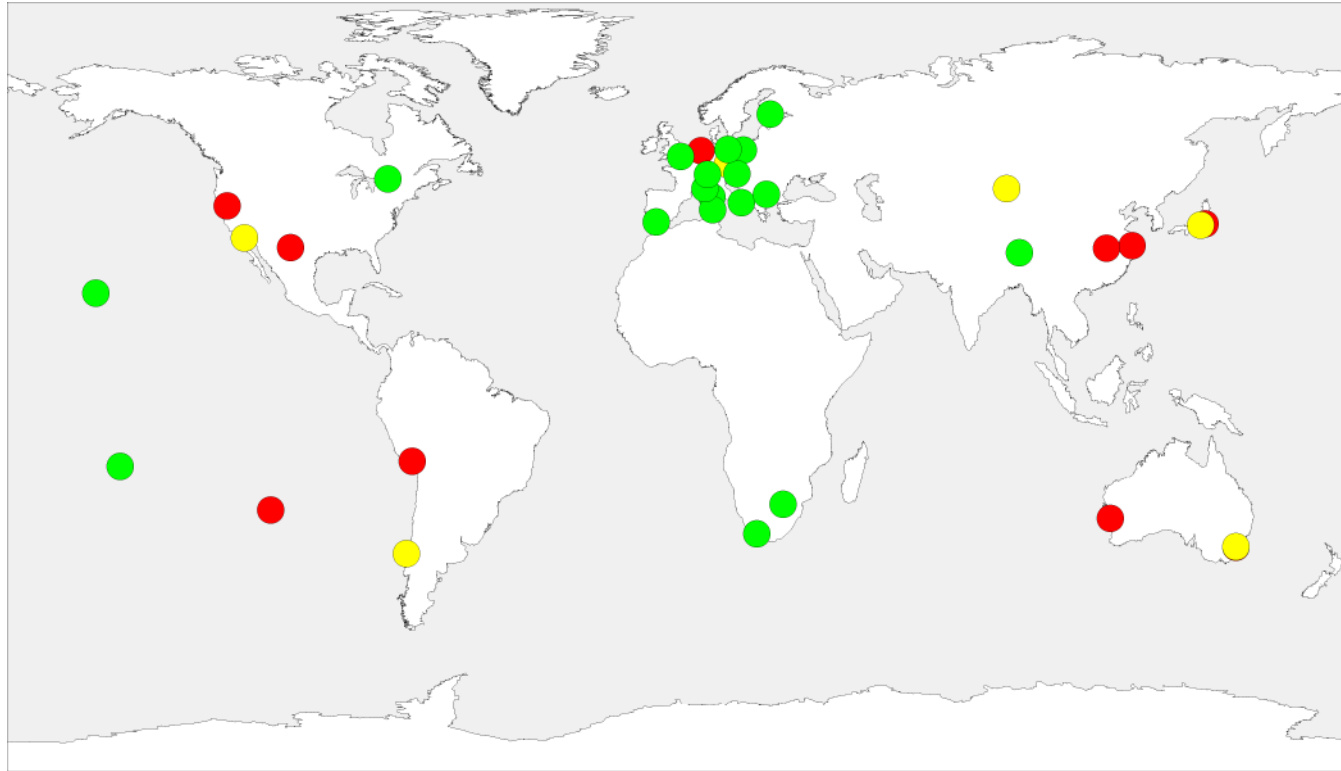


FAIR



GODE

# Local ties GPS-SLR



AREQ



EISL



QUIN



WUHN

# Conclusions

- **Consistency between ITRF2008/IGS08 and igs08.atx** will be far better than between IGS05 and igs05.atx
- Remaining GPS satellite antenna **z-offset trends** are within the range of the scale rate agreement between VLBI and SLR
- **z-offset biases between ACs** are much smaller than demonstrated in previous studies
- **z-offset bias w.r.t. igs05.atx** can mainly be explained by scale change of about 1.1 ppb
- **GLONASS corrections** from separate CODE/ESA solution
- Ex post update of receiver antenna calibrations causes slight **inconsistencies between reference frame and igs08.atx**
- **Uncalibrated radomes** remain a problem, especially at local tie sites