Updated phase center corrections for satellite and receiver antennas

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igs05.atx vs. igs08.atx

	igs05.atx	igs08.atx
GPS satellite antennas	11 years of data, 2 ACs	16 years of data, 4 ACs
	solutions aligned to IGb00 (based on relative phase center corr.)	solutions aligned to IGS08, i.e., full consistency with reference frame
	trend-correction due to error in mean vertical velocity of IGb00	no common *z*-offset trend
	radome calibrations not considered	available radome calibrations applied
	block mean values for satellites launched since 2006	satellite-specific estimates for 8 latest satellites
GLONASS sat. ant.	15 months of data, 1 AC	7/2.5 years of data, 2 ACs
Receiver antennas	robot calibrations for about 60% of the IGS stations	robot calibrations for about 70% of the IGS stations
	GPS-specific corrections only	GPS- and GLONASS-specific corrections

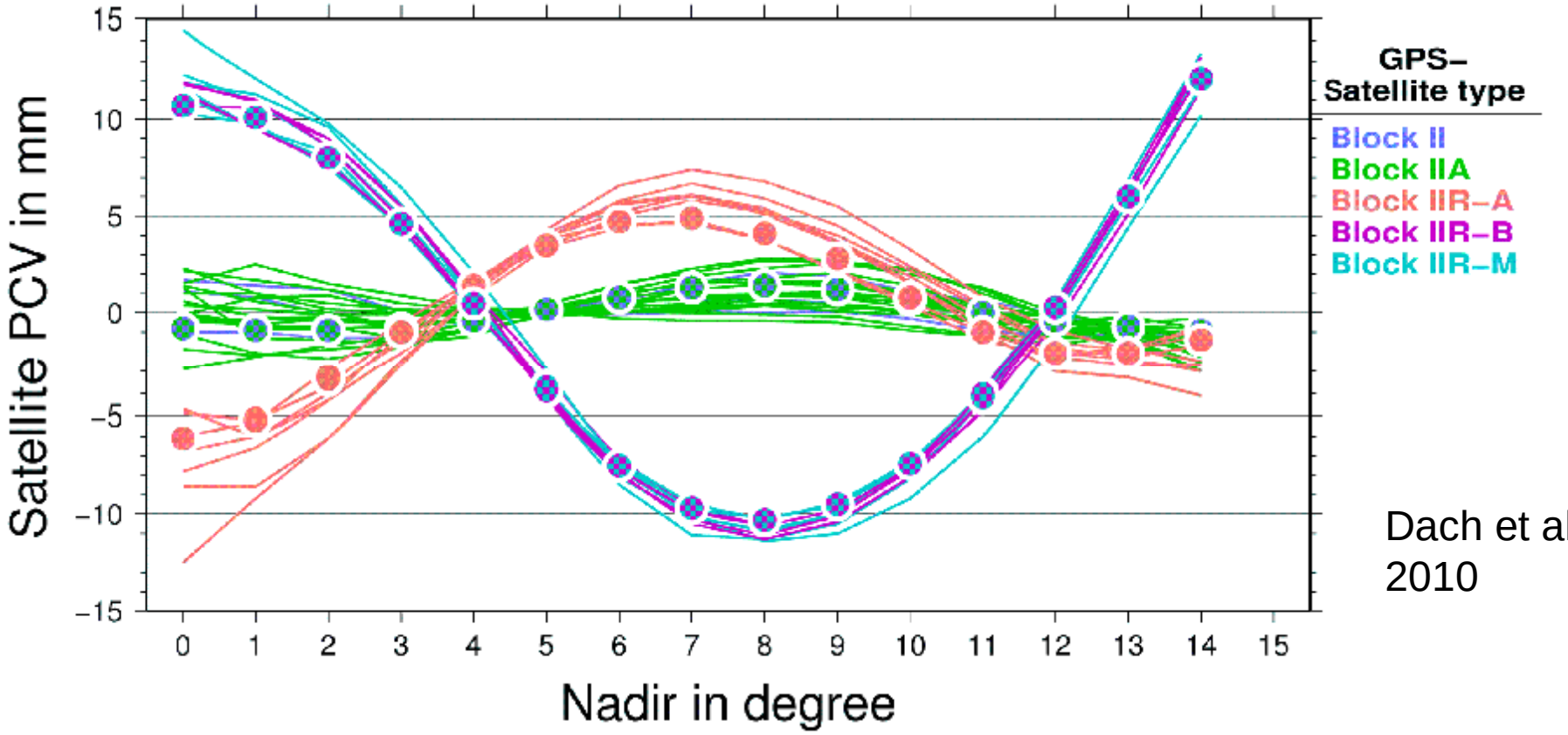
repro1 processing strategy

	CODE	GFZ	MIT	NRCan
Elevation cut-off	3°	7°	10°	10°
Weighting	$1/\cos^2(z)$	$1/2\sin(e)$ for $e < 30°$	$a^2+(b^2/\sin^2(e))$	none
Meteo data	GPT	GPT	GPT	ECMWF 6 h grids
Zenith delay	Saastamoinen dry	Saastamoinen dry + wet	Saastamoinen dry + wet	ECMWF dry + wet
Mapping function	GMF dry	GMF dry + wet	GMF dry + wet	NMF dry + wet
Zenith parameters	2 h continuous with GMF wet	1 h constants with GMF wet	2 h continuous with GMF wet	5 min stochastic ZTD
Gradient parameters	24 h NS + EW continuous	24 h NS + EW constants	NS + EW vary linearly	5 min stochastic

Griffiths et al., 2009

GPS satellite antenna PCVs

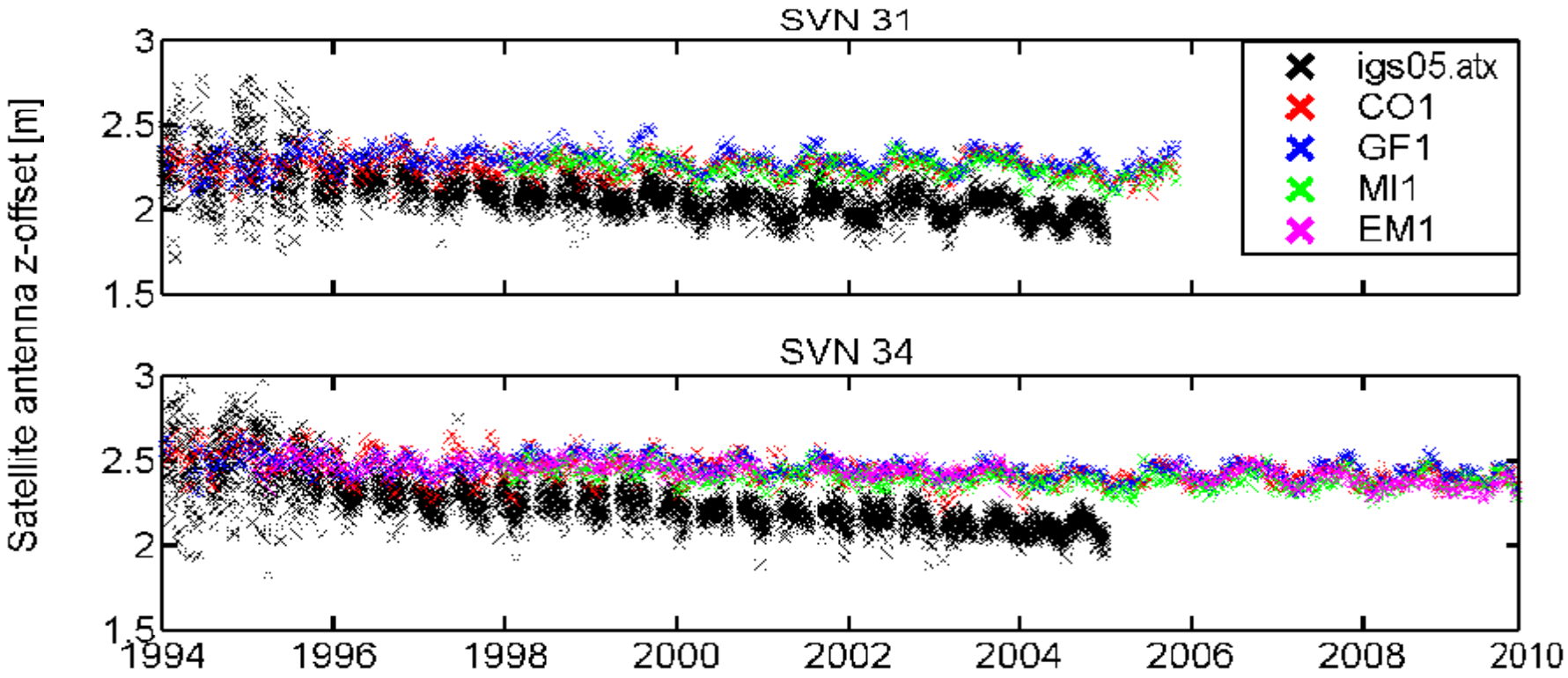
- SINEX format does not allow for antenna PCVs so far
- Impossible to derive PCVs consistent with *z*-offsets from SINEX files, i.e., **PCVs from igs05.atx will be kept**
- PCVs from current CODE solution still show good agreement



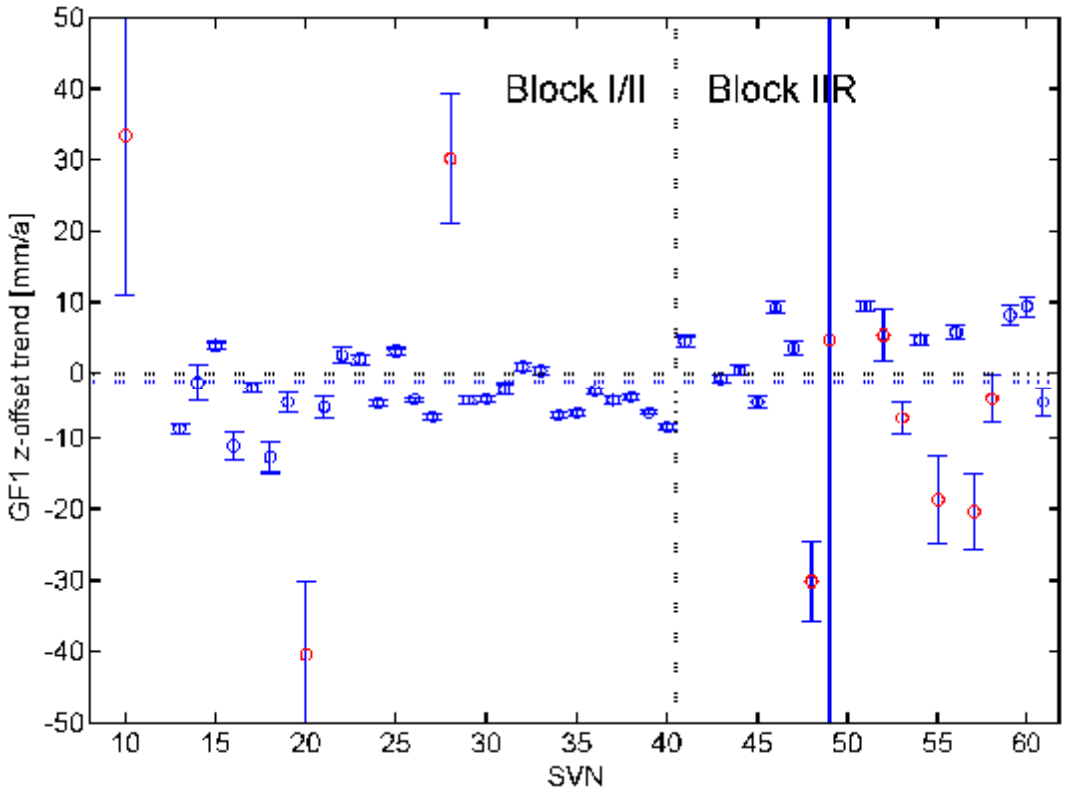
Dach et al., 2010

GPS satellite antenna PCOs

- Different scatter: daily (igs05.atx) vs. weekly estimates (repro1)
- **Trend** due to error in mean vertical velocity of IGb00 has more or less **disappeared**
- Certain **satellites fixed** in MIT and NRCan solutions (e.g., SVN 31)
- Preliminary results with **ITRF2008P** kept fixed



Remaining *z*-offset trends

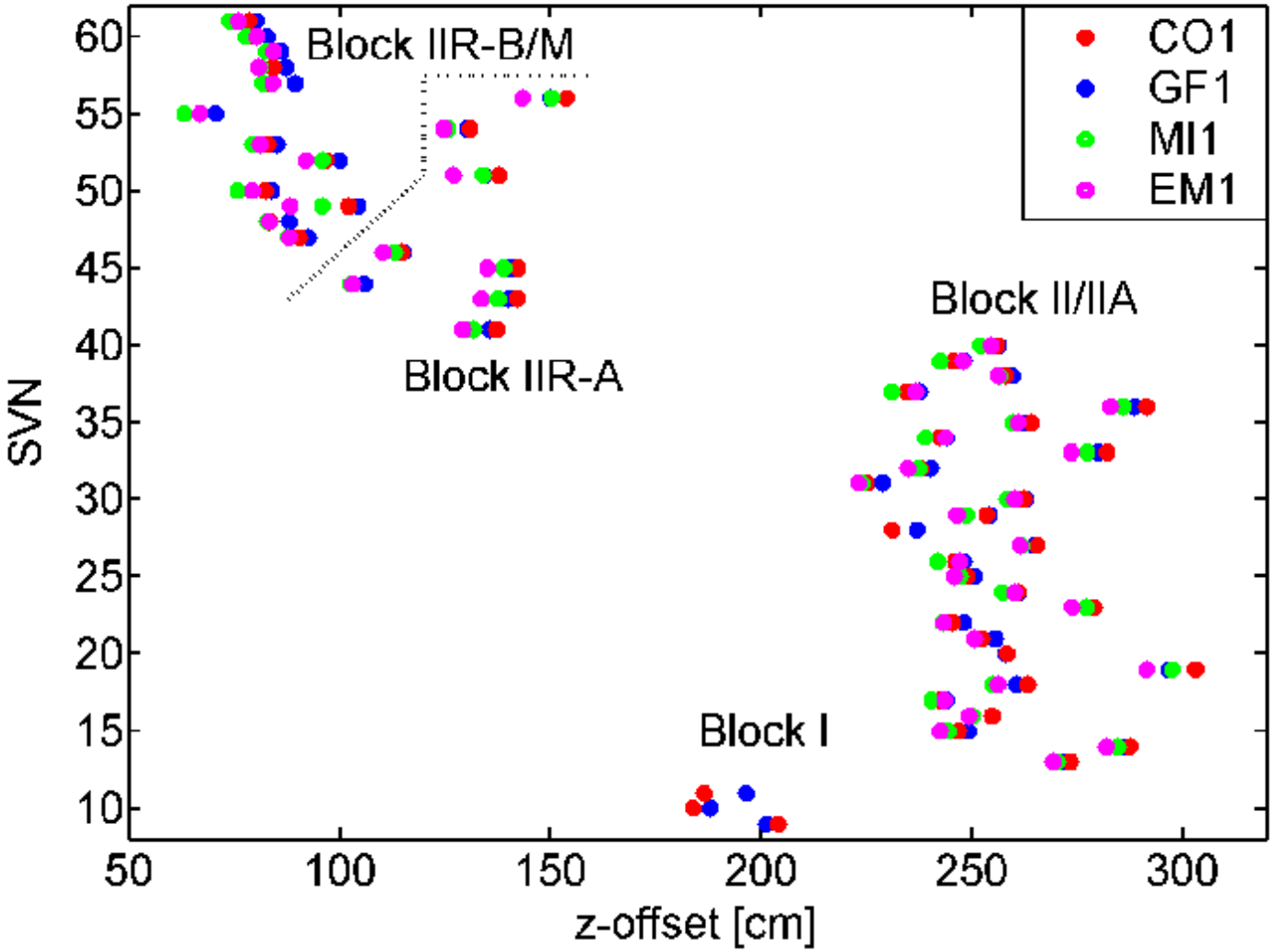


Trends [mm/a]	igs05.atx (Schmid et al., 2007)	igs08.atx
CODE/ TUM	**-24.8**	**-4.9**
GFZ	**-22.0**	**-1.3**
MIT	----	**-1.9**
NRCan	----	**-3.9**

Altamimi et al. (AGU 2009):
Scale rate agreement between VLBI and SLR: 0.06 ppb/a

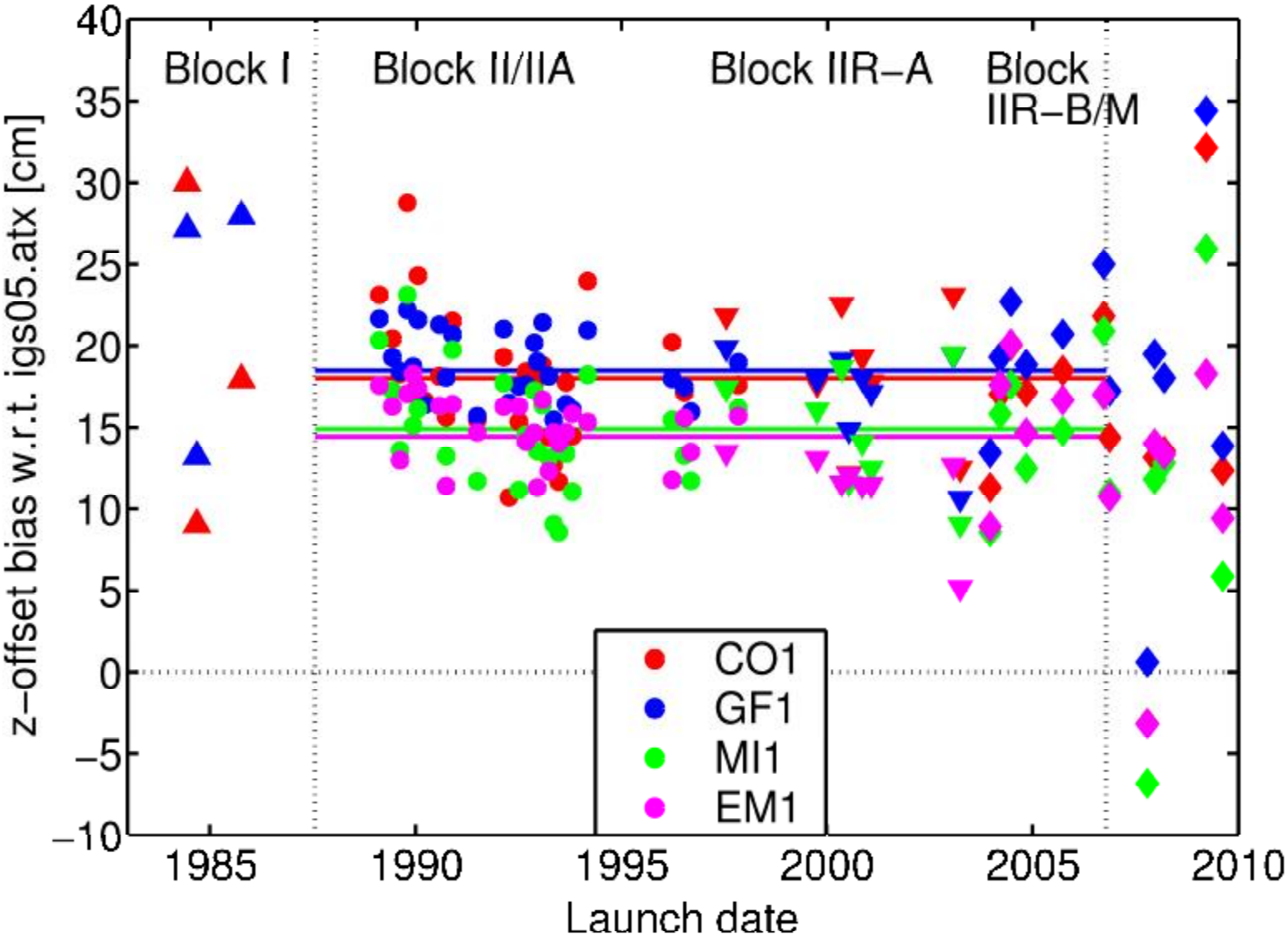
→ **± 0.03 ppb/a** correspond to a *z*-offset trend of about **± 4 mm/a**
→ GPS tends to support the SLR scale rate

Absolute GPS *z*-offsets by SVN



Differences between ACs are much **smaller than satellite-to-satellite differences** within each block

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

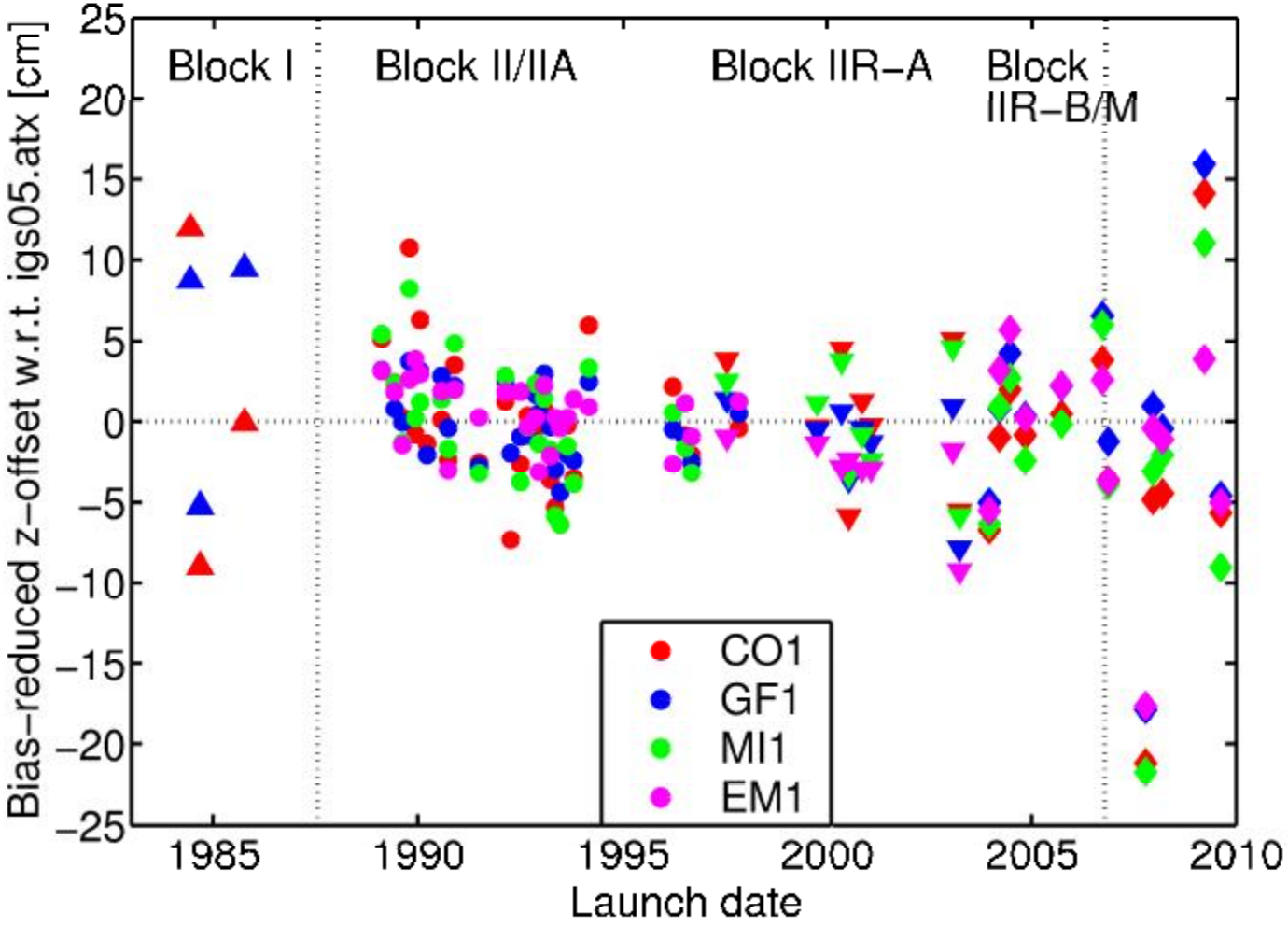


18.5 cm
18.0 cm
14.9 cm
14.4 cm

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

- Bias w.r.t. igs05.atx:
  - § CODE: **18.0 cm** ± 3.9 cm
  - § GFZ: **18.5 cm** ± 2.7 cm
  - § MIT: **14.9 cm** ± 3.5 cm
  - § NRCan: **14.4 cm** ± 2.8 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 ITRF2005 and ITRF2008**P**: -1.13 ppb
- Zhu et al. (2003): **-1.13 ppb** correspond to about **+14.5 cm**
- Part of the bias between CODE/GFZ and MIT/NRCan possibly due to certain fixed satellite offsets in the MIT/NRCan solutions

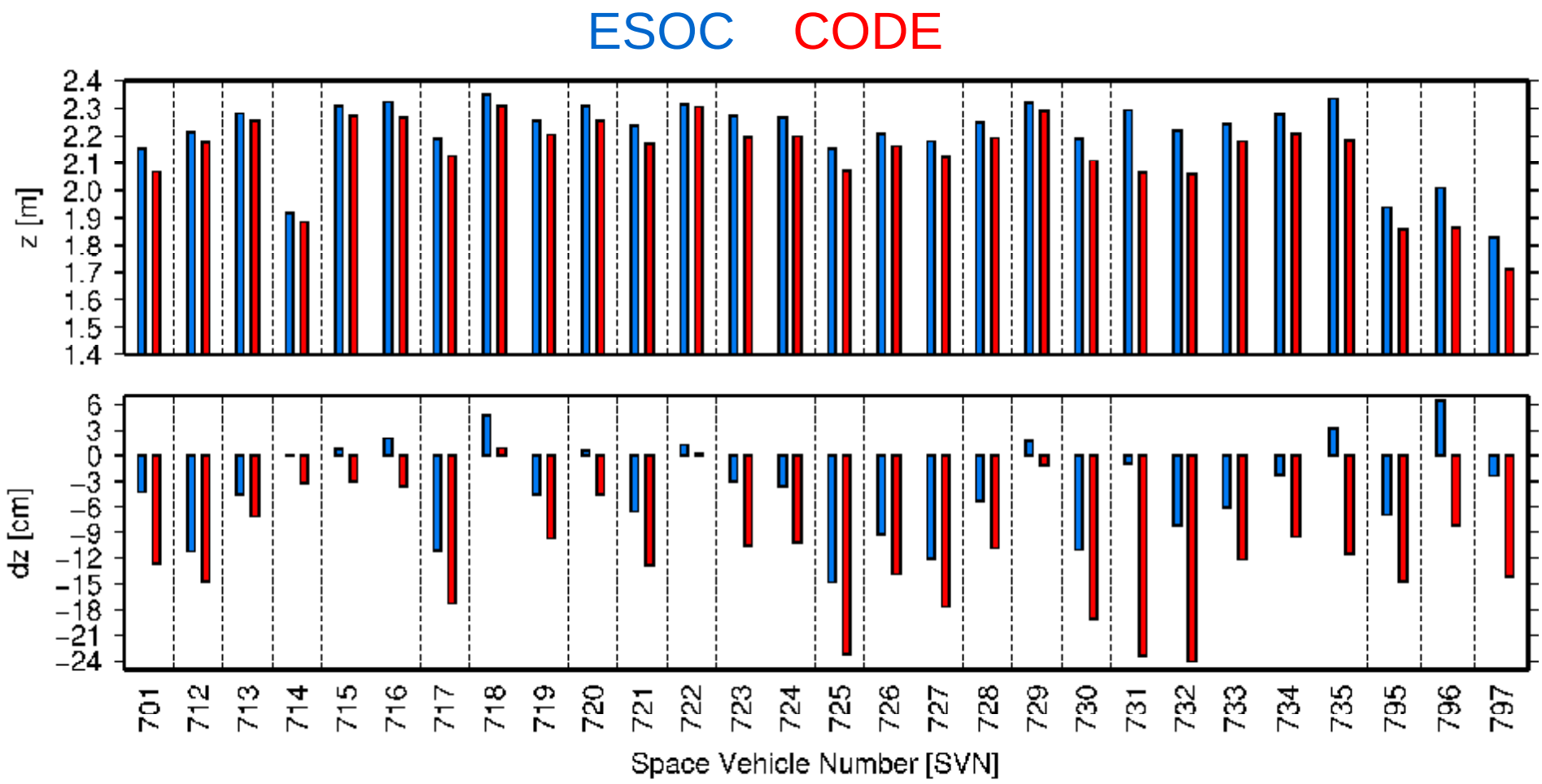
Bias-reduced *z*-offsets w.r.t. igs05.atx



→ igs08.atx and igs05.atx agree at the **±5 cm** level

→ **Preliminary values** for Block IIR-B/M were not too bad

GLONASS satellite antenna corrections



Mean bias between ESOC and CODE: 7.3 cm

Receiver antenna calibrations

GPS:

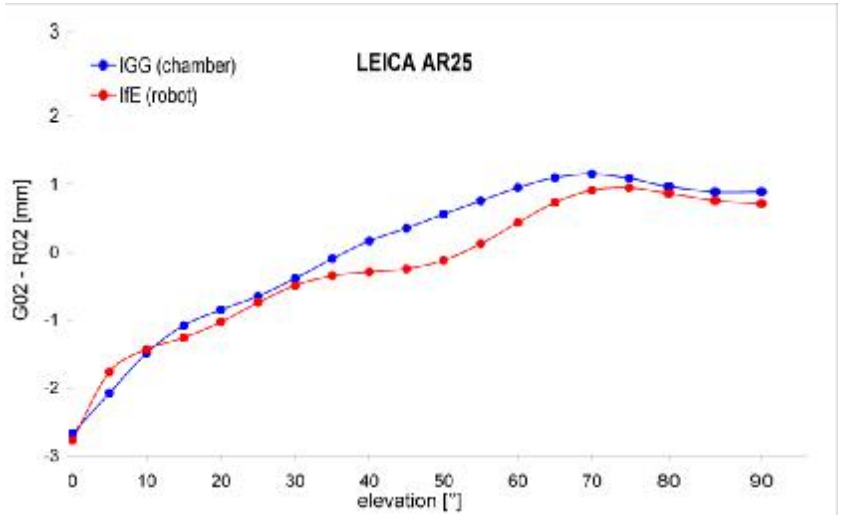
- 15 additional robot calibrations (e.g., for **TPSCR3_GGD**)
- update for 61 existing robot calibrations

Statistics for stations in the IGS network (December 2009):

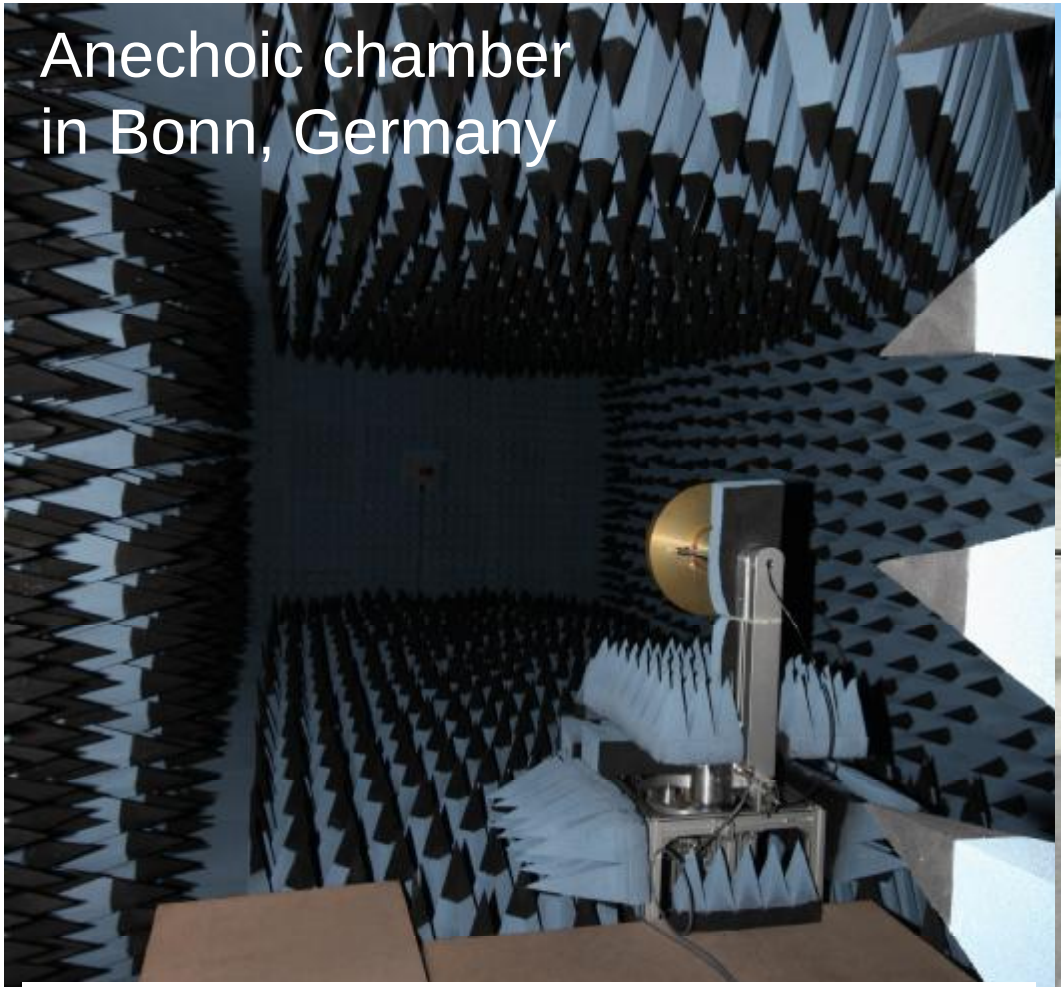
Model	**absolute** calibration	**converted** field calibration	**uncalibrated** antenna/ radome combination
igs05.atx	62%	18%	20%
igs08.atx	**69%**	**11%**	**20%**

GLONASS:

- GLONASS-specific calibrations not considered so far
- available for about **60%** of the GPS/GLONASS stations



New absolute calibration institutions



Oral presentation by **Becker et al.**: Anechoic chamber calibrations of phase center variations for new and existing GNSS signals and potential impacts in IGS processing

Poster presentation by **Bilich et al.**: GNSS absolute antenna calibrations at the National Geodetic Survey

Antenna format updates

ANTEX:

- Allow for **frequency-specific GLONASS** calibrations?
- How to store receiver-dependent **carrier-to-noise patterns** CN0?
- Necessary to store **near-** and/or **far-field effects**?
- Header of a single antenna type does not allow for calibrations from different institutions/antenna samples/etc.

SINEX:

- Add GLONASS-specific receiver antenna corrections (additional **`SITE/GLO_PHASE_CENTER`** block)
- Allow for **satellite antenna phase center variations**?

antenna.gra:

- Define **antenna northing**

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 uncertainty of the ITRF2008 scale rate; GPS closer to SLR
- ***z*-offset bias w.r.t. igs05.atx** can mainly be explained by scale change of about 1.1 ppb
- ***z*-offset biases between ACs** are small and probably caused by single fixed offset values in certain AC solutions
- Highly improved **GLONASS satellite antenna corrections** (more satellites/tracking stations/analysis centers)
- **Uncalibrated equipment** is still a big problem
- Reference Frame Working Group has to check the impact of **updated receiver antenna calibrations** on IGS08


Thanks for
your attention!
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