Interactions of the IGS reprocessing and the IGS antenna phase center model

Ralf Schmid, Peter Steigenberger, Urs Hugentobler
Technische Universität München, Germany

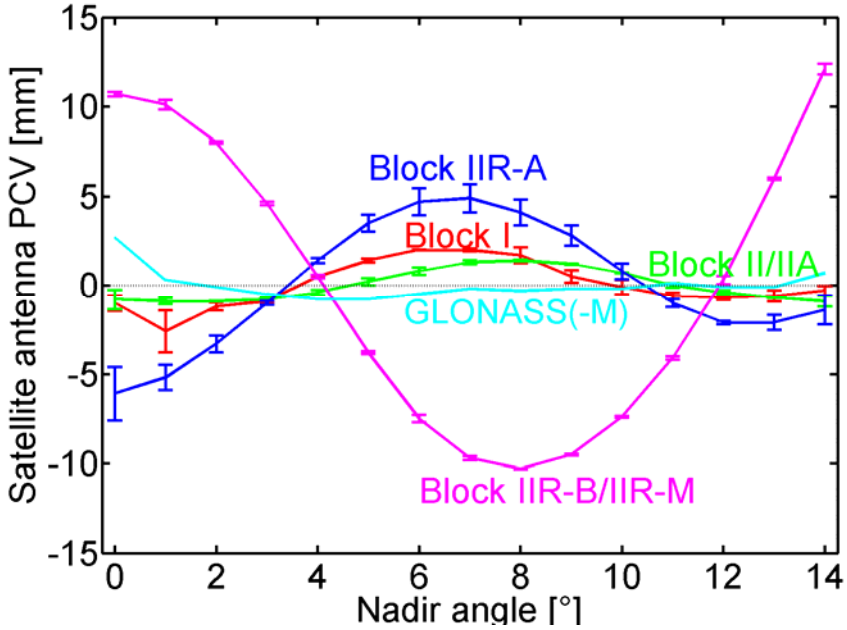
Rolf Dach
University of Bern, Switzerland

Martin Schmitz
Geo++ GmbH, Garbsen, Germany

Florian Dilßner
European Space Operations Centre, Darmstadt, Germany

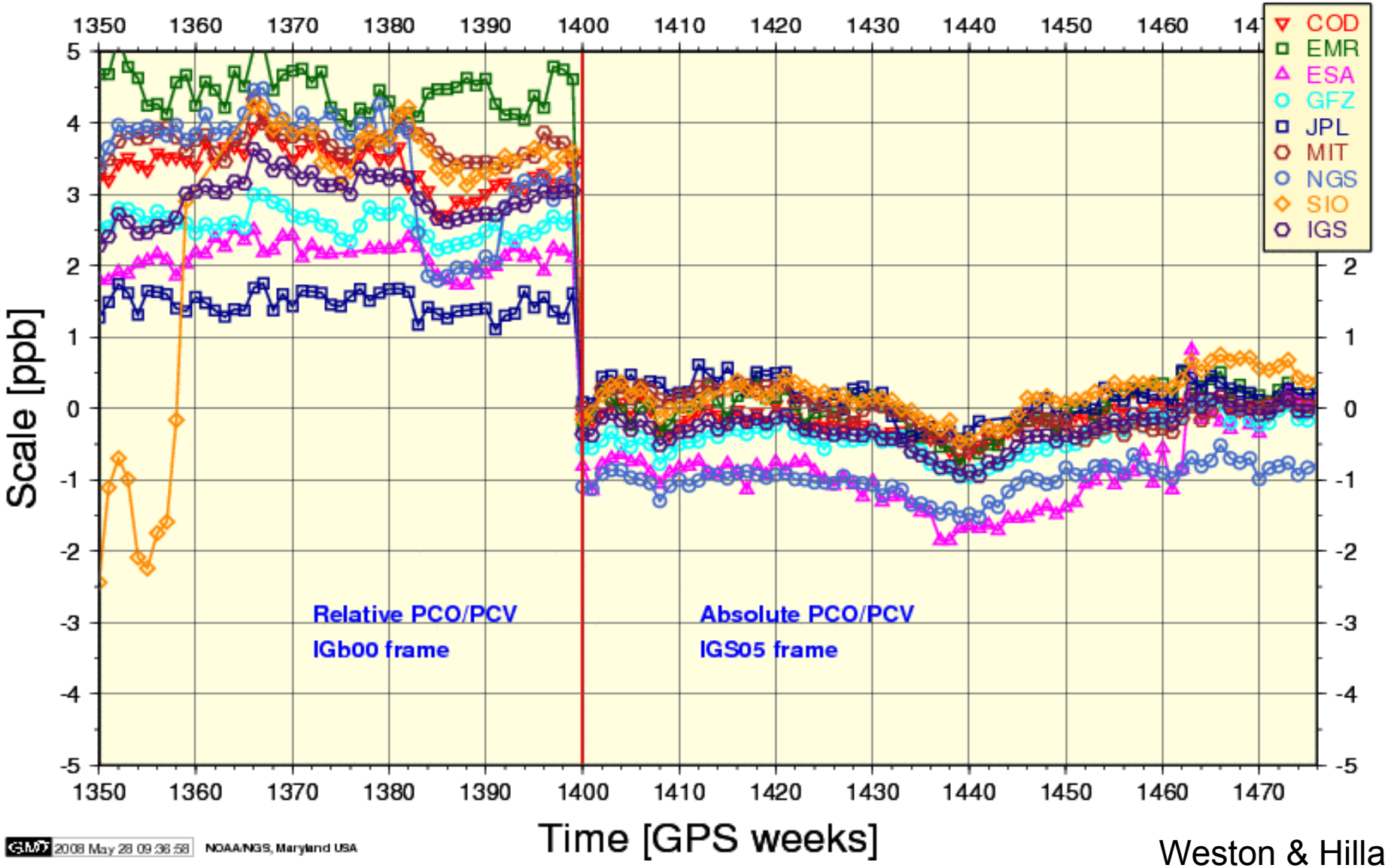
Transition to absolute phase center modeling

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



Discontinuities in time series (week 1400)

TRF scale difference w.r.t. IGb00/IGS05



Weston & Hilla (2008)

Timeline: antenna model vs. IGS reprocessing

2005	Estimation of GPS satellite antenna corrections with scale fixed to IGb00 (based on **relative** receiver antenna corrections); radome calibrations added afterwards
2006	GLONASS satellite antenna corr. from **separate** solution
5 Nov 2006	**Switch** from relative to absolute antenna model and from IGb00 to IGS05; IGS05 station coordinates corrected for differences from parallel AC processing
Feb 2008	Start of first IGS reprocessing campaign repro1 with igs05.atx **unchanged**; repro1 period: 1994-**2007**
2010	Compilation of igs08.atx using repro1 SINEX files and operational solutions (**2008**-2010)

Benefit from IGS reprocessing

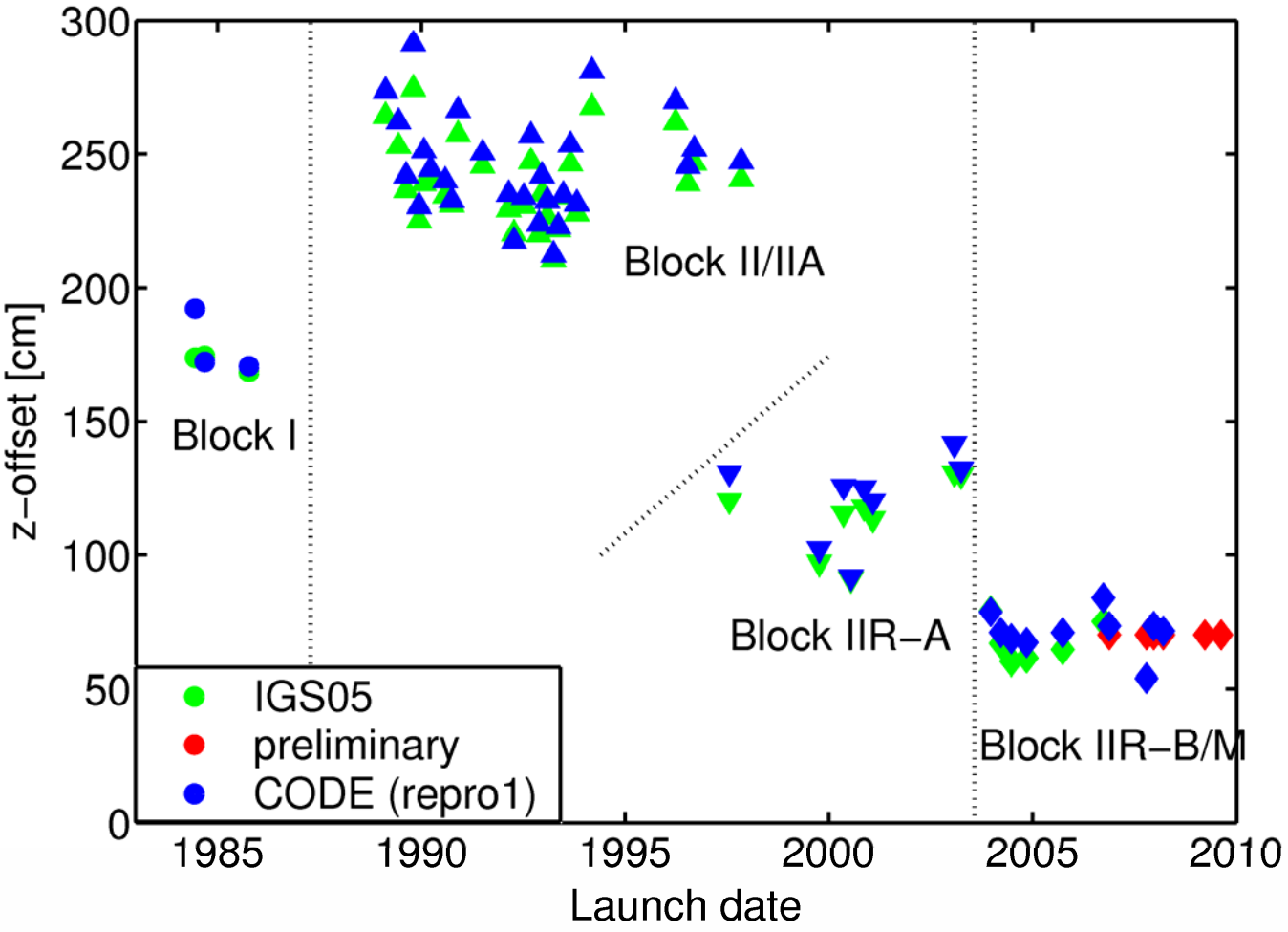
- Repair of **discontinuities** (e.g., in week 1400)
- Update of **receiver** antenna corrections (up to five years old) before or after the reprocessing campaign
- repro1 started without an update of the antenna model
  - pros: consistency between repro1 and operational solutions
  - cons: inconsistency between new reference frame and antenna model, if update afterwards
- Update of **satellite** antenna corrections
  - new satellite-specific *z*-offsets for latest satellites
  - based on longer time span: 11 years → 16 years
  - more analysis centers: 2 → 3-5 (GPS); 1 → 2 (GLONASS)

First IGS reprocessing campaign repro1

Phase center estimates in repro1 AC SINEX files:

Analysis Center	GPS satellite antennas		GLONASS satellite antennas	
	PCO	PCV	PCO	PCV
CODE		**SINEX format** extension necessary → no update	GLONASS observation data will probably be considered for follow-up campaign **repro2** → separate solution necessary	
NRCan				
ESA				
GFZ				
JPL				
MIT				
NGS				
PDR				
SIO				

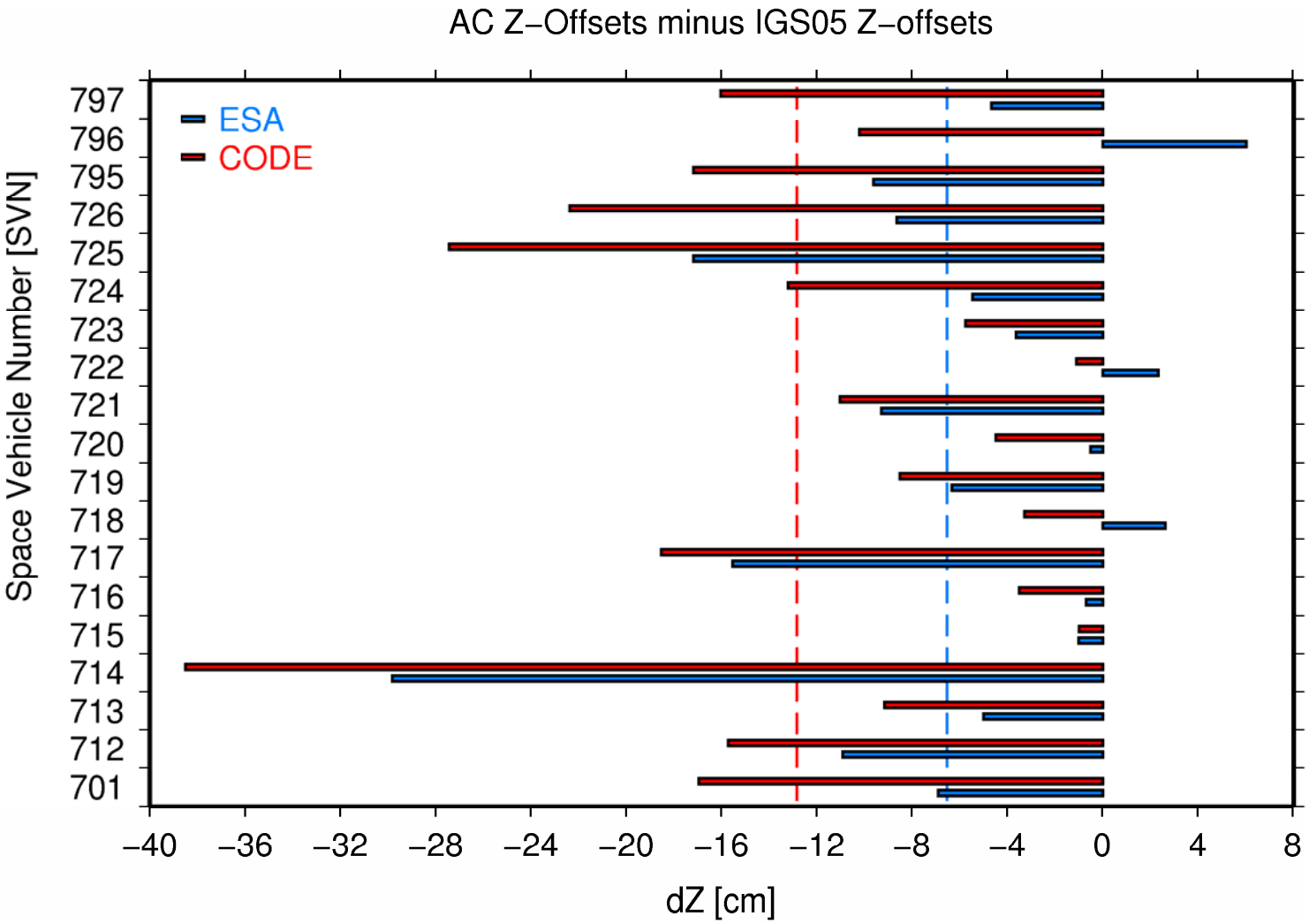
GPS satellite antenna *z*-offsets



Mean **bias**:
5.4 cm

- **dm level biases** between individual analysis centers
- estimation of satellite-specific *z*-offsets for the latest satellites
- deviation of about 15 cm from block mean value for SVN55

GLONASS satellite antenna corrections



Time span:
ESA: 1.5 a
CODE: 6.5 a

Mean **bias**:
6.3 cm

- GLONASS constellation completely changed since 2005/06
- scale difference partly due to differing albedo modeling
- impact on station coordinates: **< 1 mm** (small impact of GLONASS)

Receiver antenna calibrations

GPS:

- additional robot calibrations (e.g., for **TPSCR3_GGD**)
- impact on station coordinates: up to **several mm**
- update for 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 combined GPS/GLONASS stations
- impact on station coordinates: **< 1 mm**

Timeline for igs08.atx

- Jan/Feb 2010: generation of IGS08 **reference frame**
- Feb/Mar 2010: back-solve repro1 (1994-2007) SINEX files and operational solutions (2008-2010) with ITRF2008/IGS08 kept fixed to get **GPS satellite antenna *z*-offsets**
- Mar 2010(?): long-time combined solutions by CODE and ESA with GPS *z*-offsets kept fixed to get **GLONASS satellite antenna *z*-offsets/PCVs**
- Apr 2010: compilation of igs08.atx (satellite and **receiver antenna corrections**, including GLONASS-specific values)
- Apr/May 2010: analysis of **coordinate jumps** due to antenna model update by certain analysis centers
- May 2010: adoption of new IGS reference frame and igs08.atx in operational solutions

Conclusions

- **Consistency between ITRF2008/IGS08 and igs08.atx** will be far better than between IGS05 and igs05.atx
- Ex post update of receiver antenna calibrations causes slight **inconsistencies between reference frame and igs08.atx**
- Transition to igs05.atx was much more dramatic, but accompanied by an extensive parallel AC processing
- Improved percentage of IGS stations with state-of-the-art calibrations, whereas **uncalibrated radomes** remain a problem
- Highly improved GLONASS satellite antenna corrections (more satellites/tracking stations/analysis centers)
- **SINEX format extension** desirable in order to estimate satellite antenna PCVs from repro2 SINEX files

Thanks for your attention!

Kellyville, Greenland