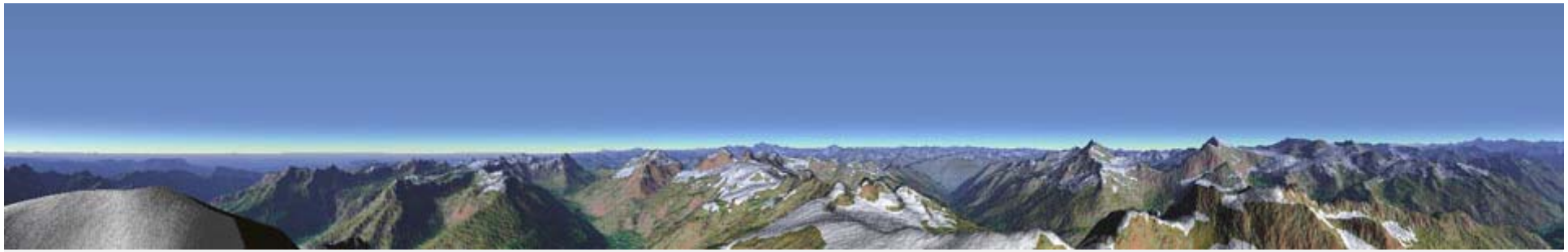


swisstopo

Bundesamt für Landestopografie
Office fédéral de topographie
Ufficio federale di topografia
Uffizi federal da topografia

Issues Related to the Use of Absolute GPS/GLONASS PCV Models

S. Schaer[1], U. Hugentobler[2]

[1]swisstopo/AIUB
[2]AIUB

List of Anticipated Model Changes for EUREF LAC Analysis

- Consideration of radome codes of receiver antennas
- Use of IGS05 APCV model
- Switch to ITRF2005 (or IGS05) reference frame
- Estimation of horizontal troposphere gradient parameters (specific to each station involved)
- Ocean tidal loading (OTL) model update (FES2004)
- Inclusion of GLONASS observations*
- Use of low-elevation data (down to 3º)
- Refined SINEX generation procedures

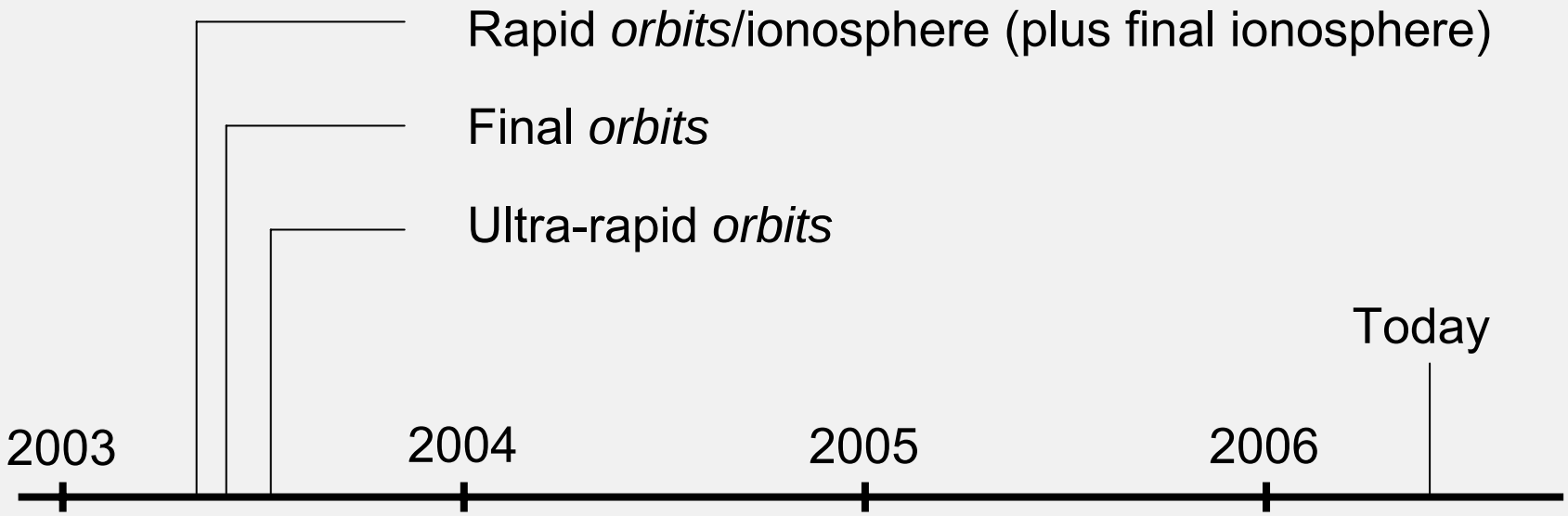
*Processing of GLONASS is supported by RNX2SNX BPE example.

Outline

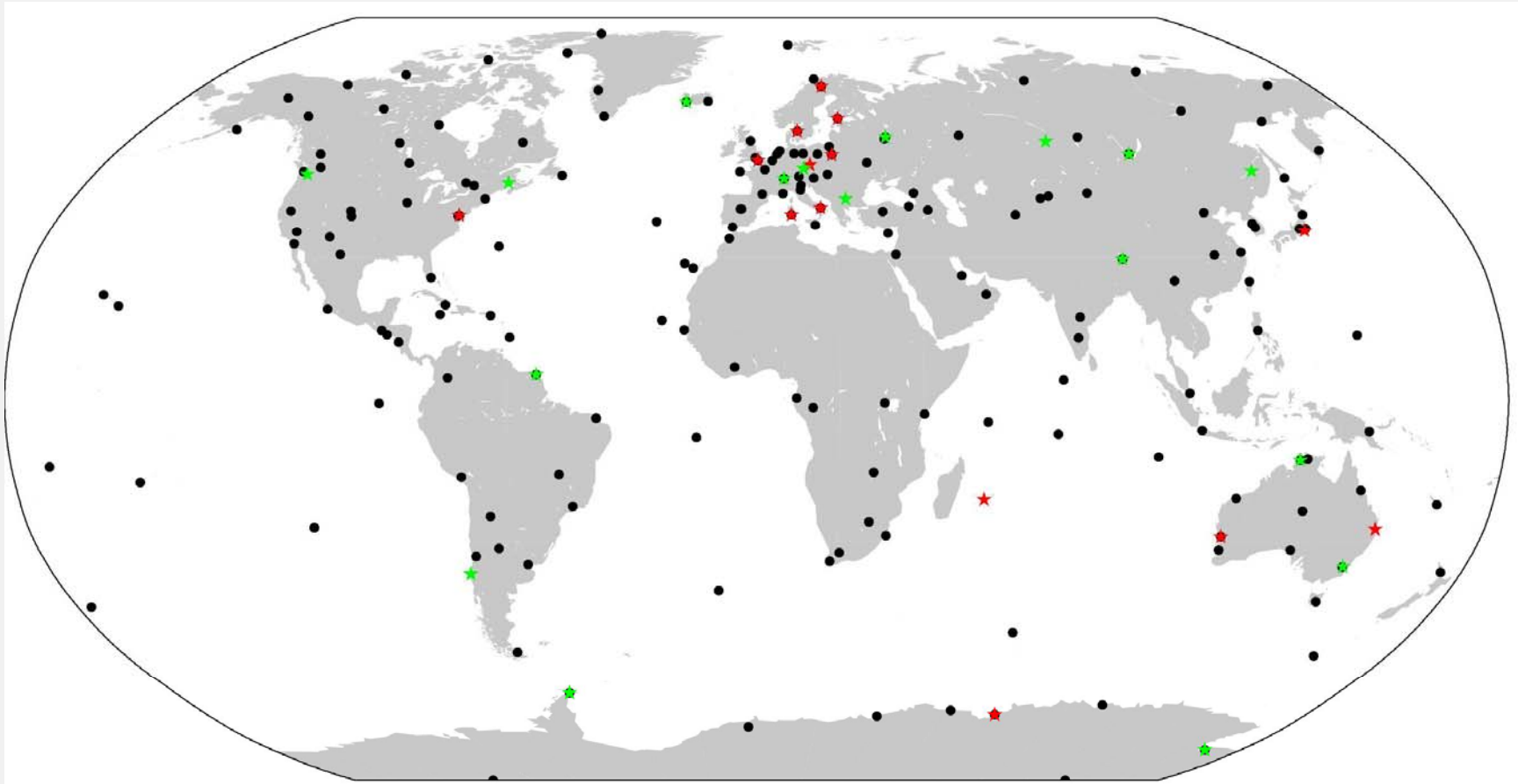
- Overview of the GNSS analysis activities at CODE
  - GNSS orbit product lines
  - Current IGS GNSS receiver network
  - Evolution of GPS/GLONASS satellite constellation
- Characteristics of the new APCV model
  - From “relative” to “absolute” PCV modeling
  - GPS/GLONASS PCV results as generated at CODE
- Validation of APCV model using GNSS observation data
- Summary and conclusions

CODE's GNSS Orbit Product Lines

Combination on the observation level: GPS and GLONASS orbits are generated simultaneously in a rigorous GNSS analysis, ensuring best possible consistency between GPS and GLONASS orbits.

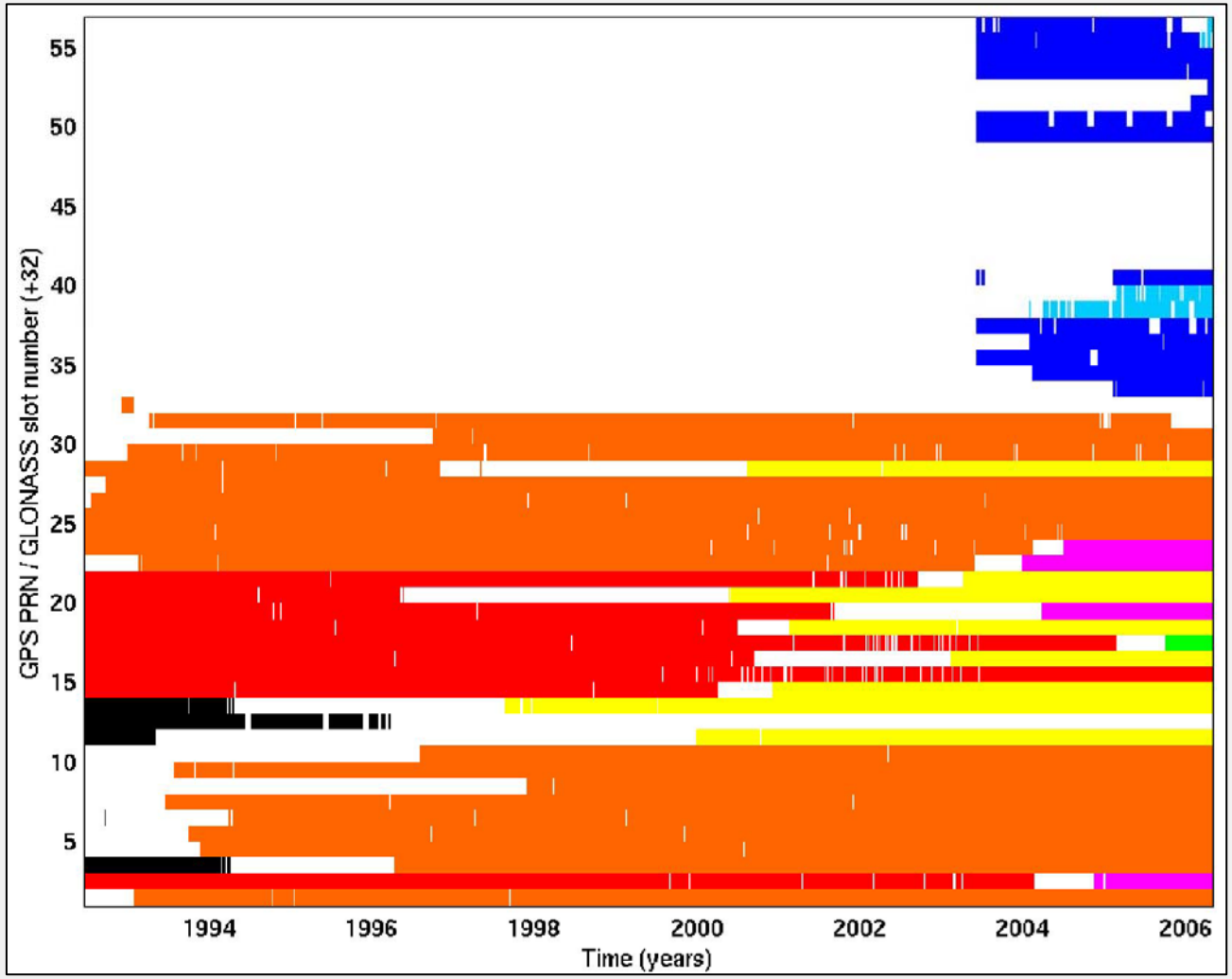


IGS/IGLOS Tracking Network as Considered in CODE´s Final GNSS Analysis

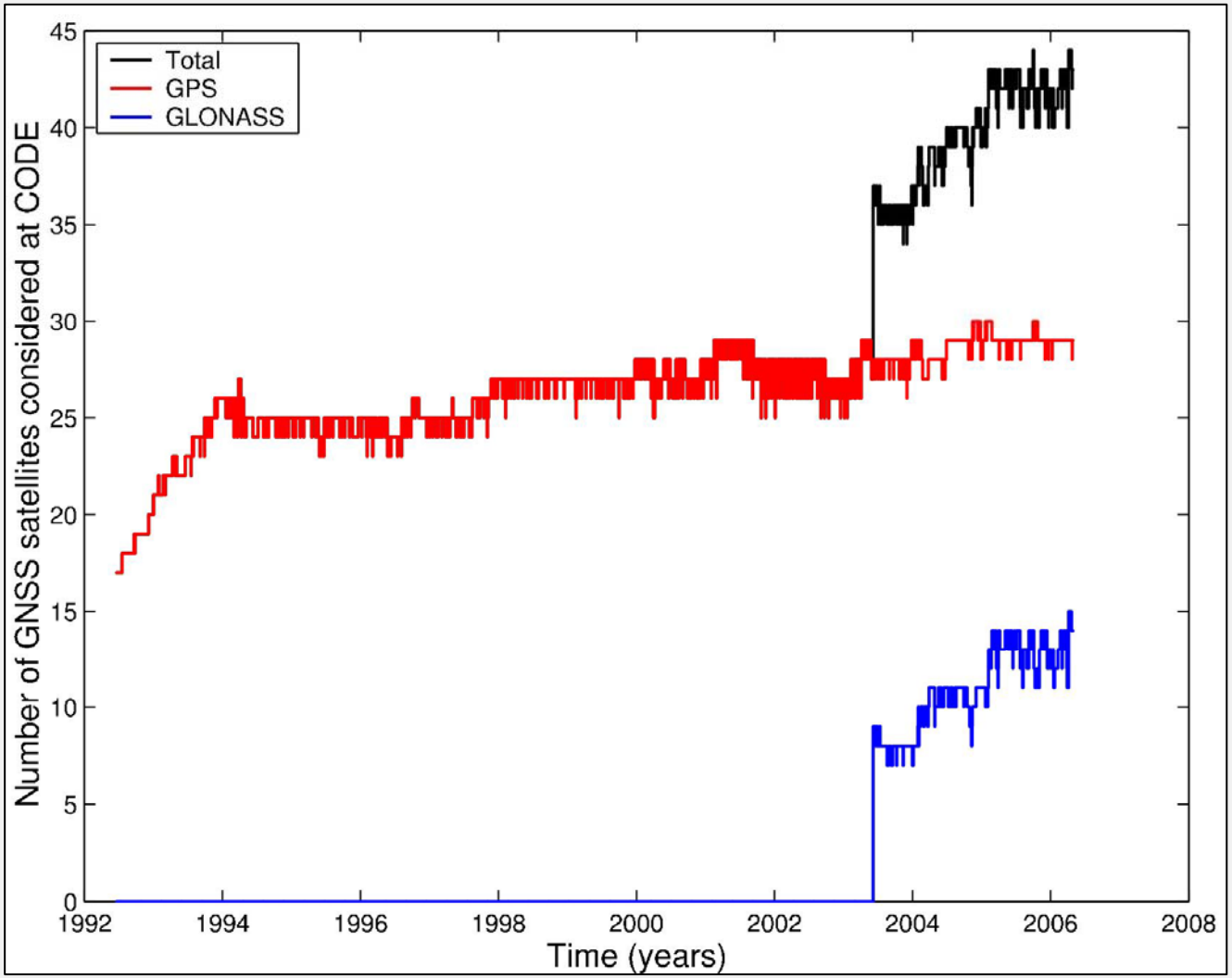


Legend: GPS-only – GPS/GLONASS – **AIV**-GPS/GLONASS

Evolution of GPS/GLONASS Satellite Constellation (1)



Evolution of GPS/GLONASS Satellite Constellation (2)



GNSS Satellite and Receiver Antenna PCV Models

GPS Block IIR

Old: *Relative* PCV model (igs_01.atx):

- L1/L2 receiver antenna offsets/variations (rel. to AOAD/M_T)
- GNSS satellite antenna offsets ("geometrical" values)
- Radome codes of receiver antennas are *not* considered

Zenith distance angle

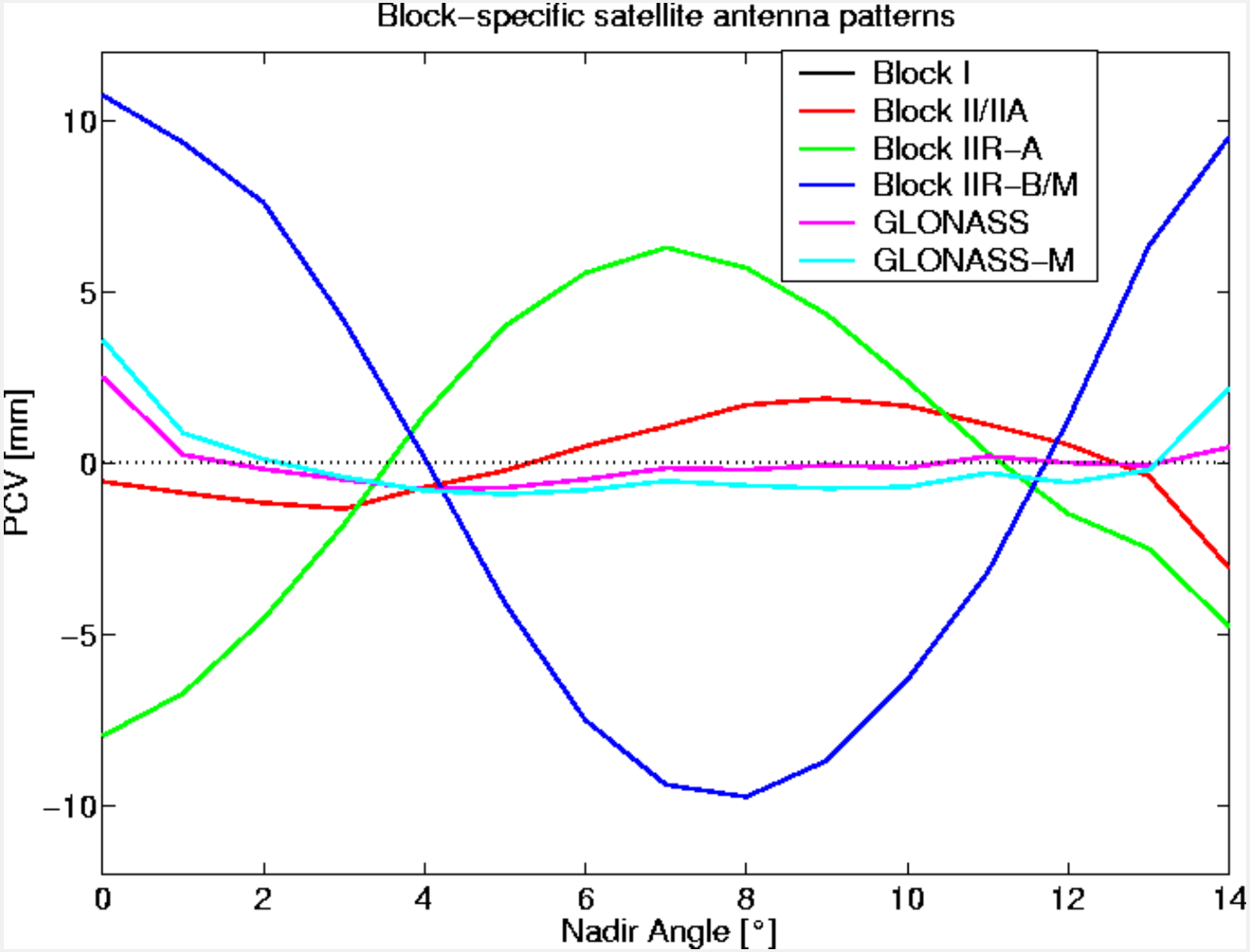
Nadir angle (up to 14º)

GNSS antenna at AZCO (with CONE radome)

New: *Absolute* PCV model (igs05_1365.atx):

- L1/L2 receiver antenna offsets/variations (Geo++)
- LC GNSS satellite antenna (Z-)offsets/variations (GPS: GFZ/TUM / GLONASS: CODE)

Absolute PCV Patterns for Both the GPS and the GLONASS Satellite Constellation, Computed at CODE



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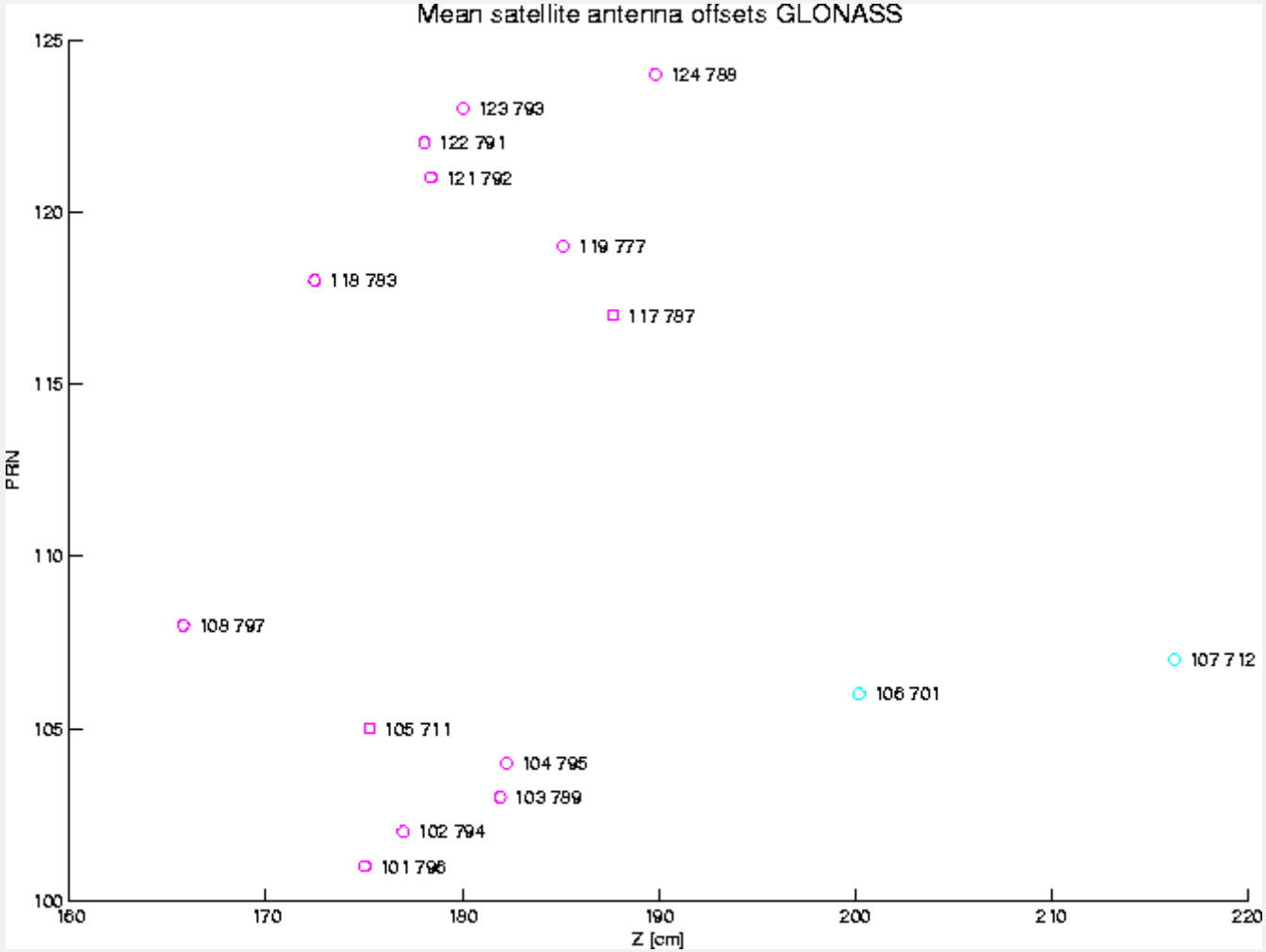
Mean (Z) Satellite Antenna Offsets for the GLONASS Constellation, Computed at CODE



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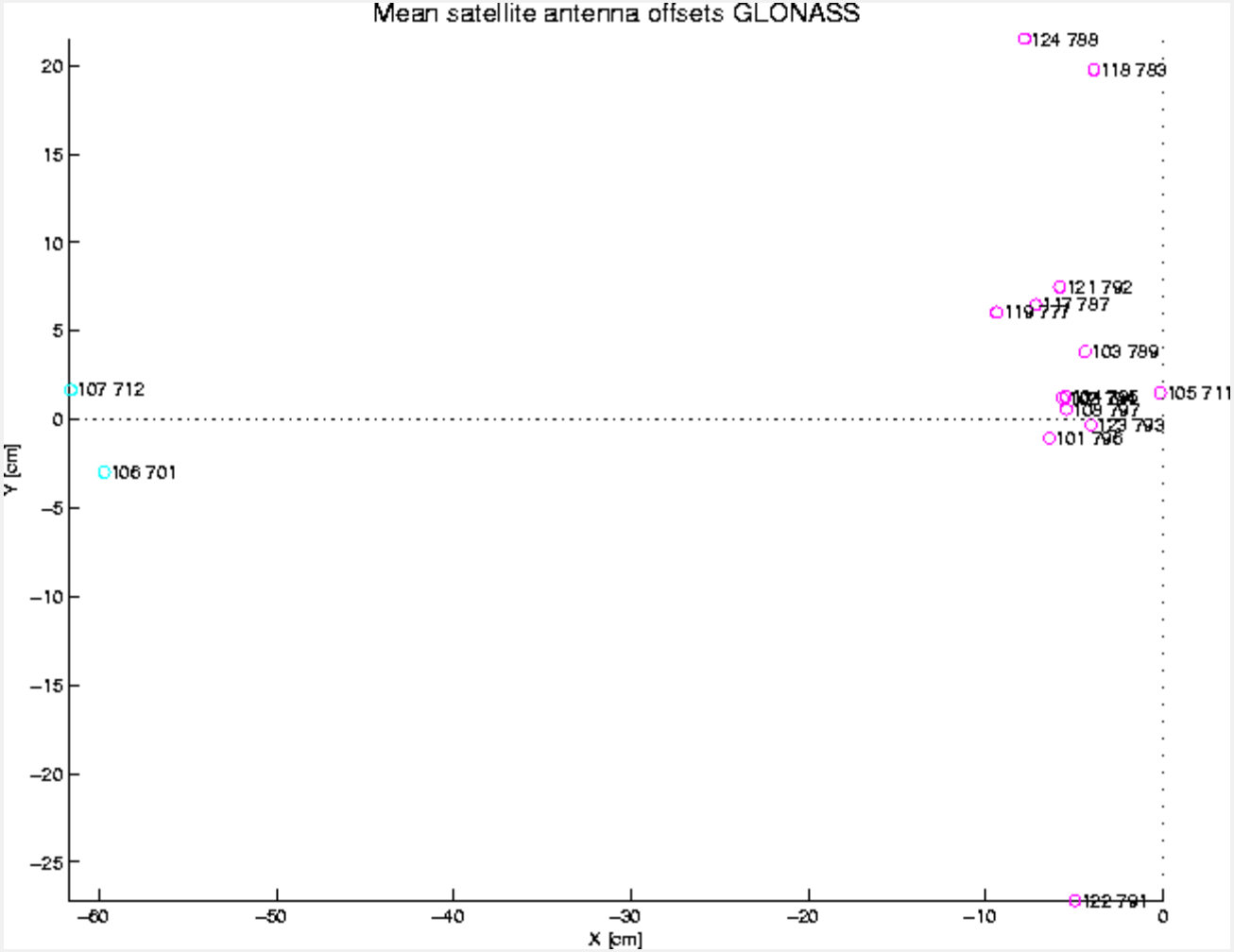
Mean X and Y Satellite Antenna Offsets for the GLONASS Constellation, Computed at CODE



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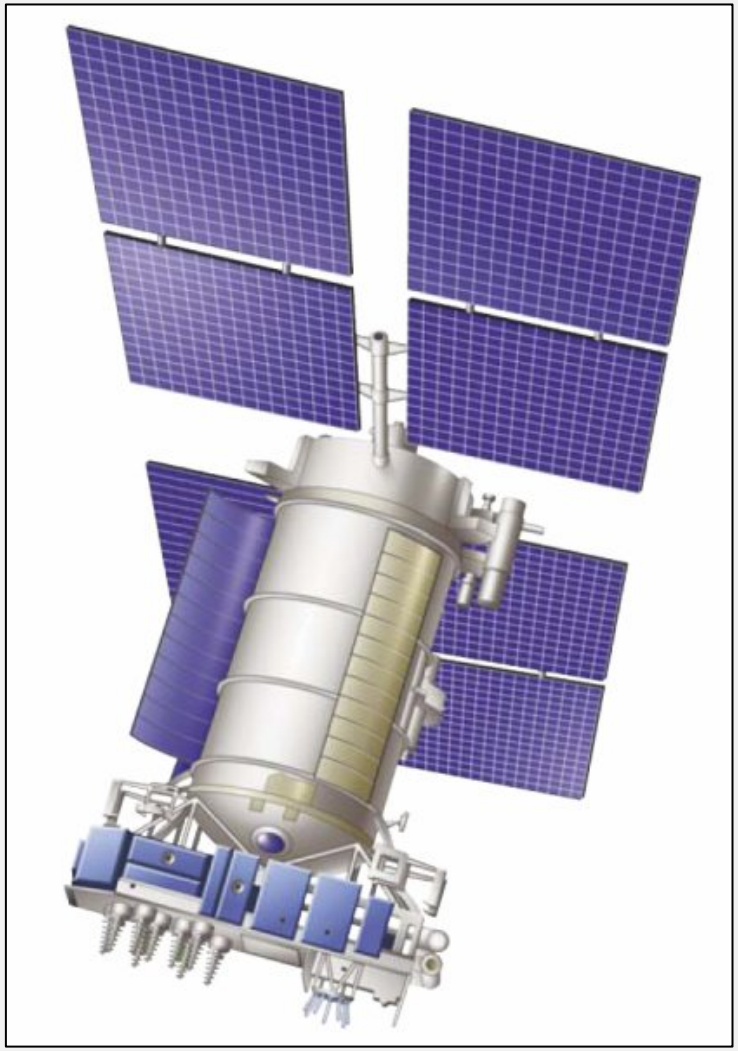
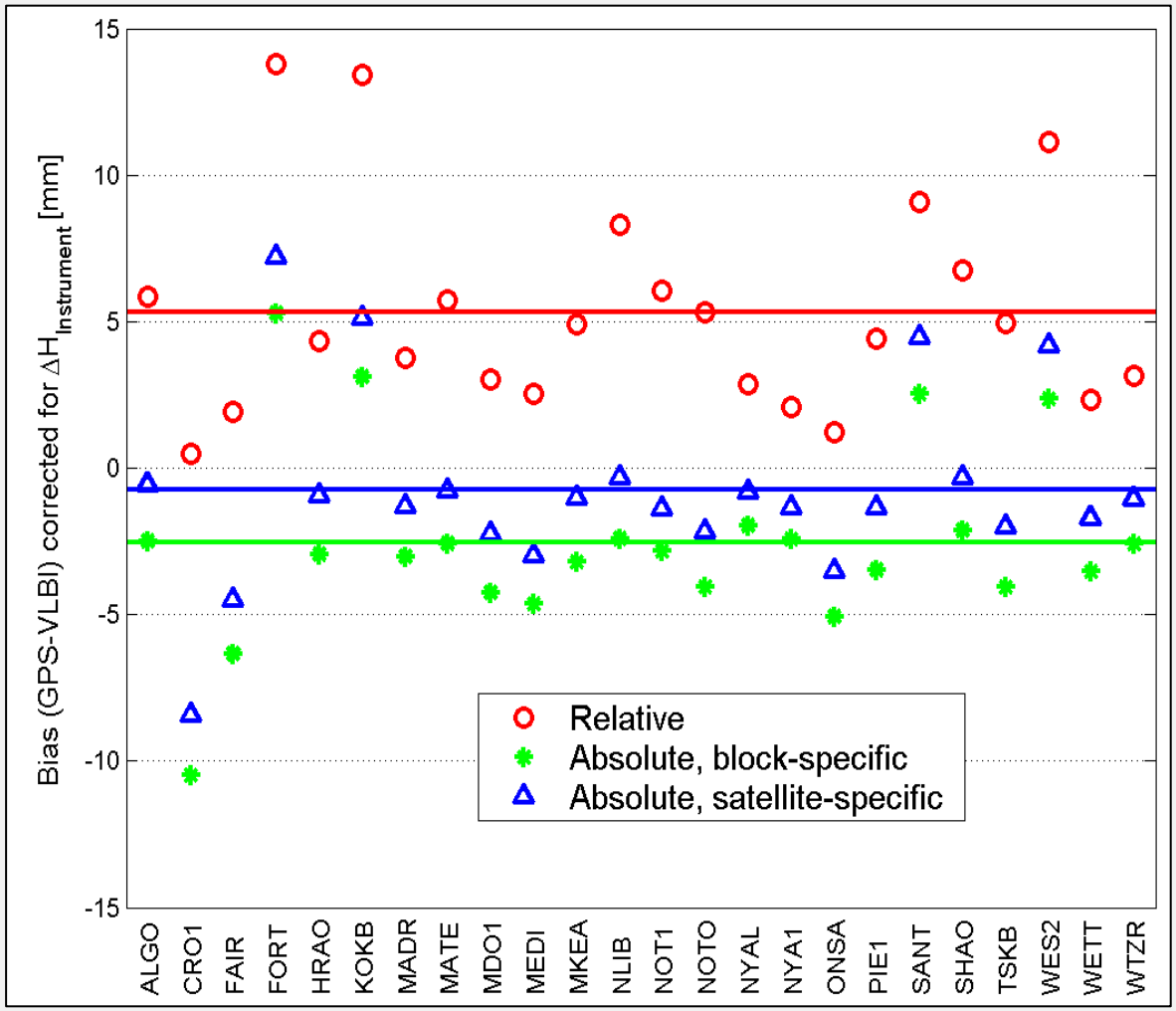
Sketch of a GLONASS-M Spacecraft



Effect of PCVs on Troposphere Parameters



Mean biases:

+5.3 mm

-0.8 mm

-2.5 mm

Excluded due to large ΔH: HARK, HART, URUM

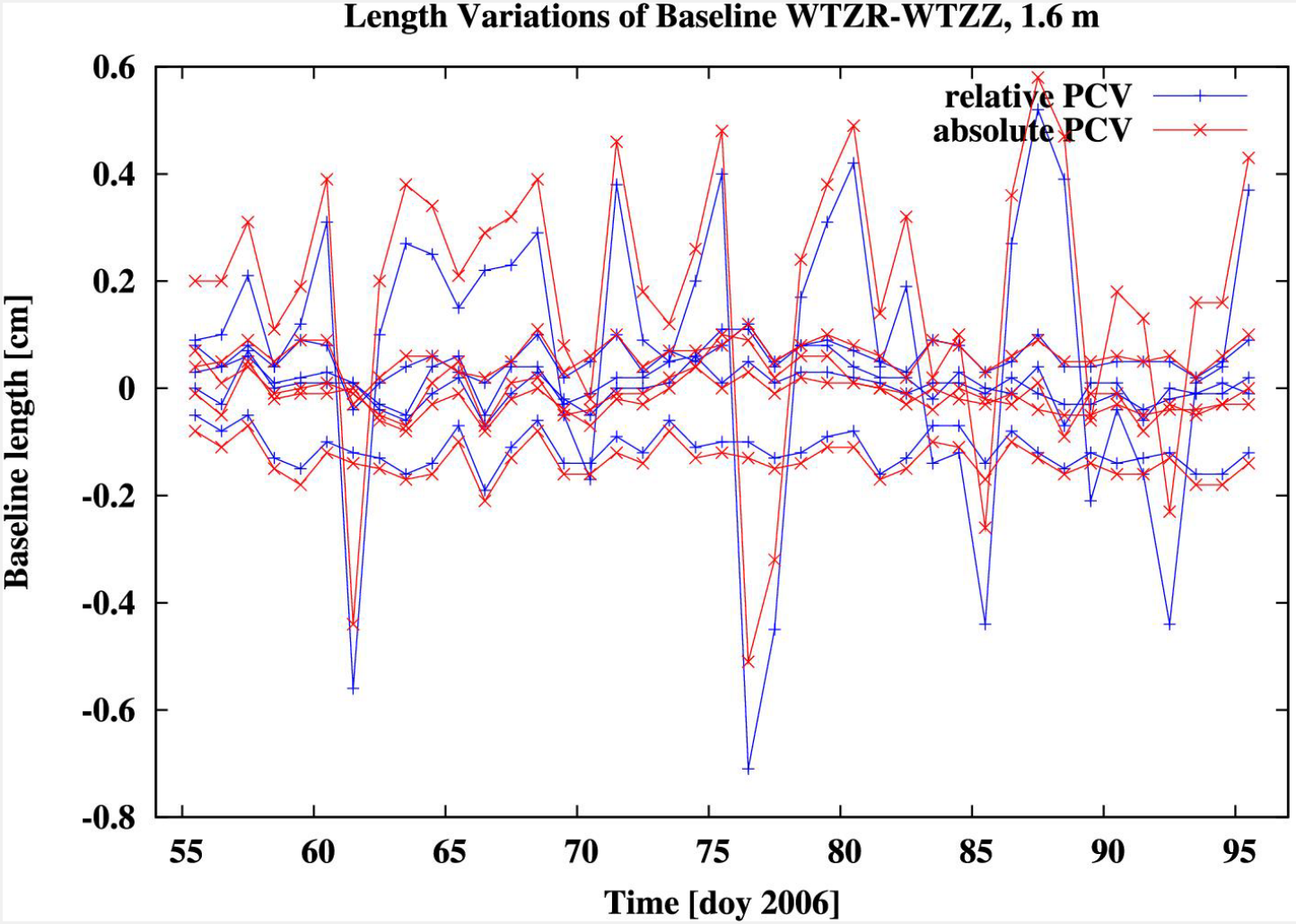
Courtesy: P. Steigenberger (GFZ), R. Schmid (TUM)

Validating the New Absolute PCV Model Using GPS and GLONASS Observation Data

- Global solutions were computed with regard to the relative and the absolute PCV model, specifically using observation data from
  - GPS1*: GPS Block II/IIA satellites (without PRN29)
  - GPS2*: “GPS1” minus first 6 satellites plus GPS Block IIR-B
  - GNSS: all GPS and all GLONASS satellites
  - GPS: all GPS satellites
  - GLO*: all GLONASS satellites
- 24-hour solutions were generated (performing POD for all involved satellites).
- A time period of 41 days was considered (days 055-095, 2006).

*Solutions include 15 satellites.

Effect on GNSS Analysis Results: Baseline Lengths (1)



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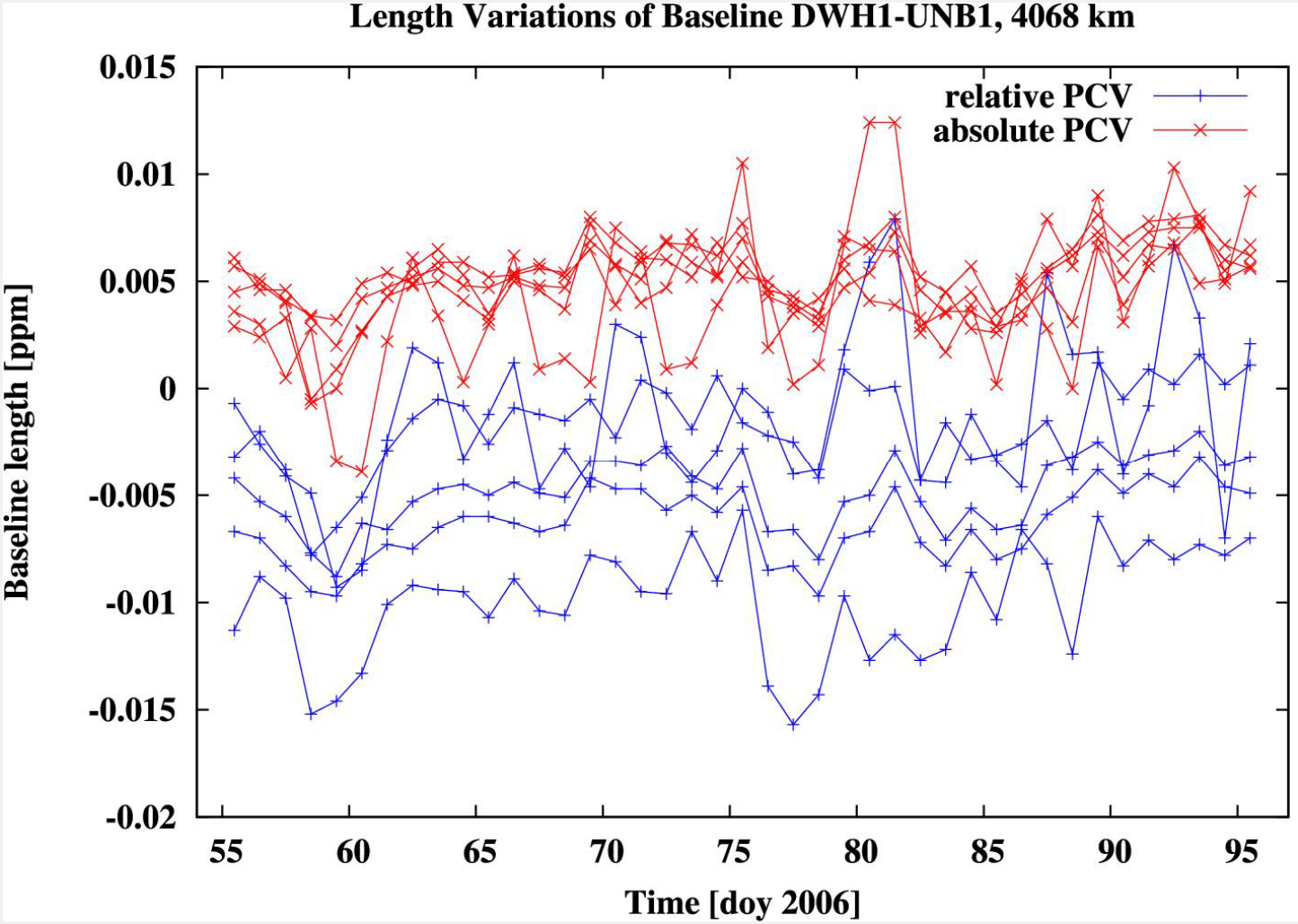
Effect on GNSS Analysis Results: Baseline Lengths (2)



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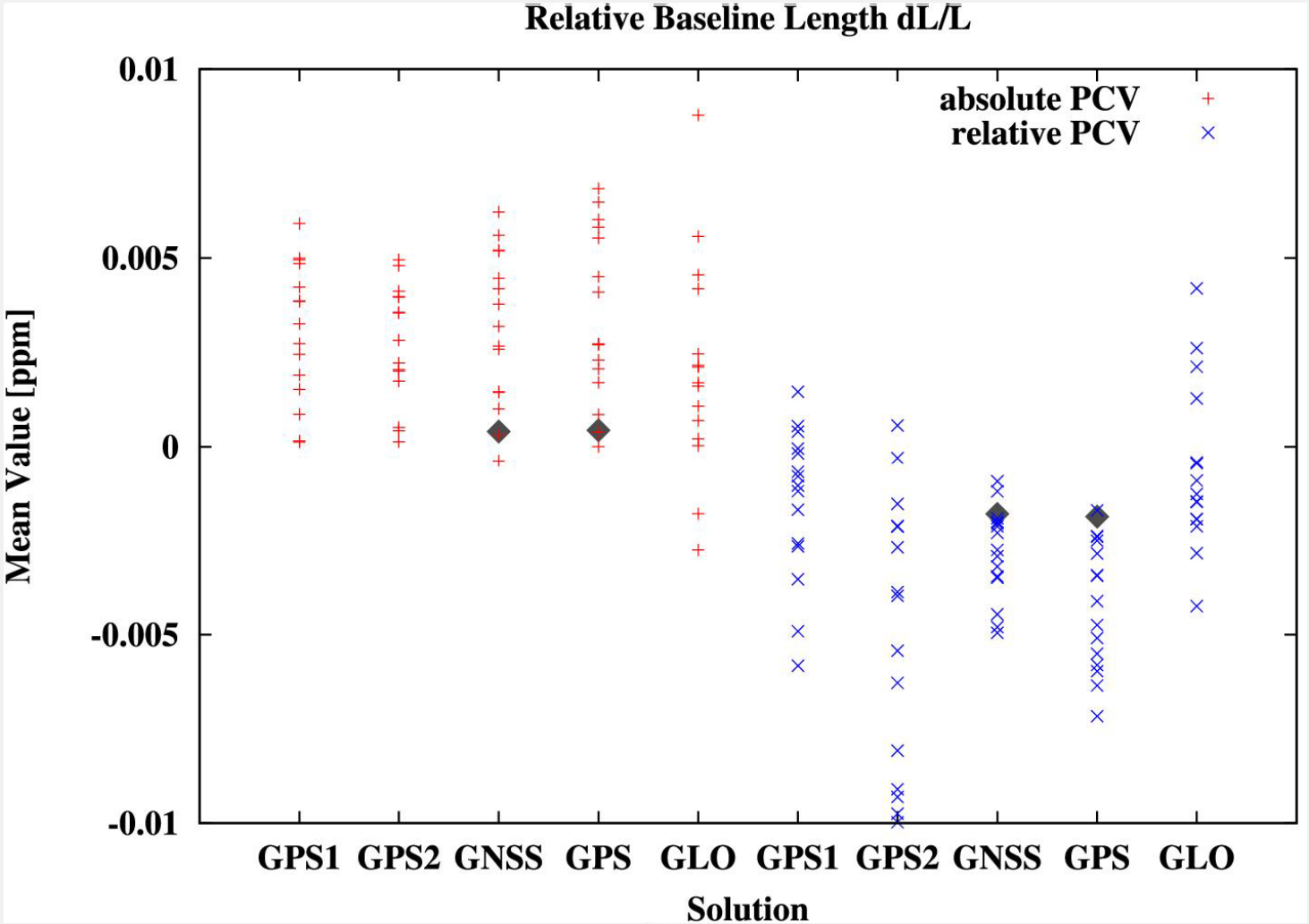
Effect on GNSS Analysis Results: Baseline Lengths (3)



Global scale:

+2 ppb

RMS of UW:

-8–10% (-6%)

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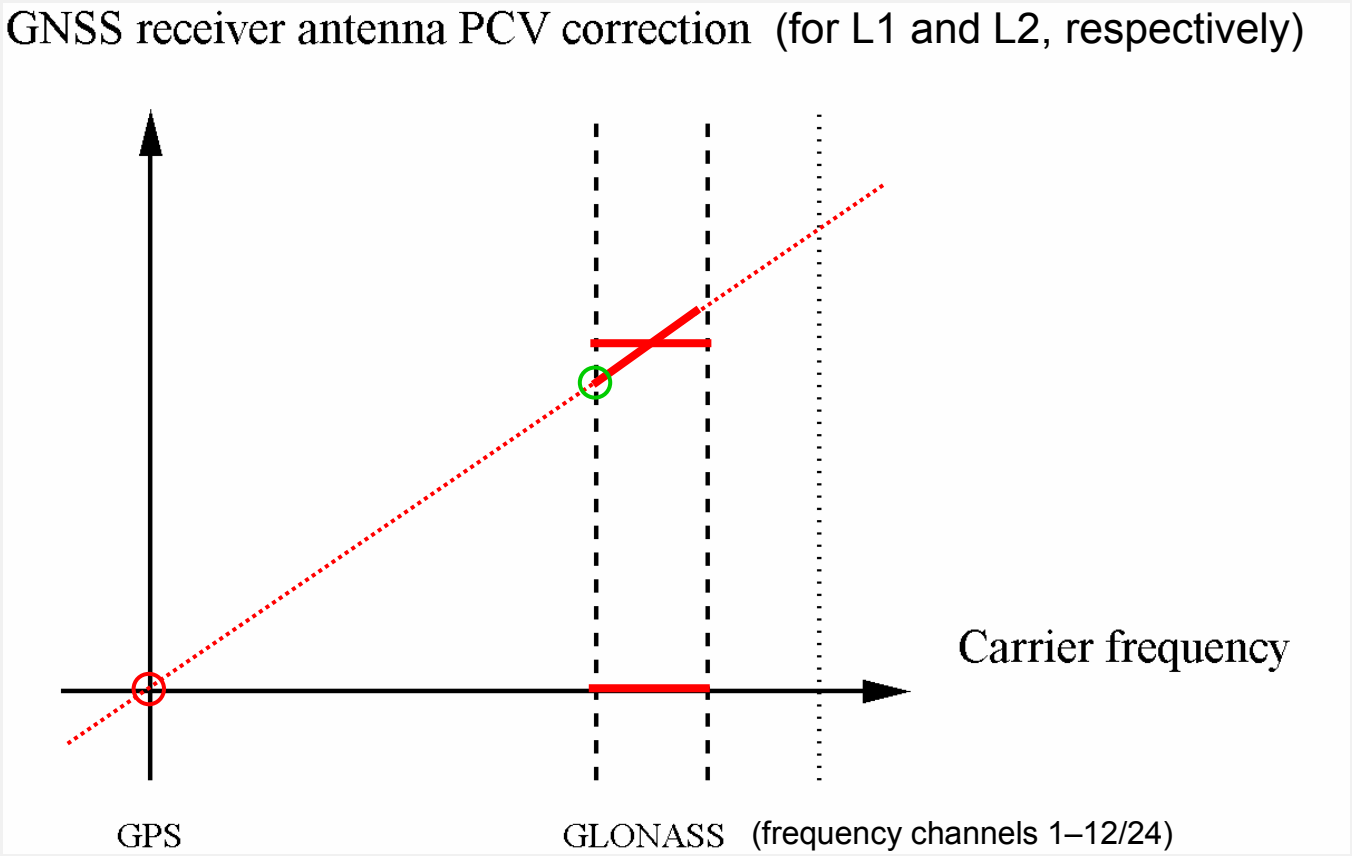
Receiver Antenna Calibration for GLONASS Frequencies



Remark: Corresponding L1/L2 calibration results were already presented by Geo++.

Open question: Handling in ANTEX (reference frequency, slope(s)). ► **Galileo (!)**

Summary and Conclusions (1)

- Transition to the absolute PCV model IGS05 within the IGS analysis community may be expected in parallel with the switch to ITRF2005 (more precisely: IGS05).
- We demonstrated beneficial effect of the new PCV model on GPS/GLONASS-combined analysis results, yielding to better consistency (independent of the selection of GNSS satellites used for analysis).
- The corresponding model change will give a break in all GNSS time series. Discontinuities in station coordinate results will give a break in the TRF realization. Question: Should the EUREF LACs start to use the IGS05 TRF realization?
- Reprocessing capability becomes more and more important for all users of IGS products interested in best possible time series results. It is obvious that for a next ITRF release, the GNSS analysis community must be prepared for that.
- Model changes are unavoidable: next relevant improvements in CODE's analysis will concern, e.g., troposphere modeling (GMF, slightly different gradient model, refined ZPD a priori model).

Summary and Conclusions (2)

- Further PCV model improvements, or updates may be anticipated, specifically in terms of
  - additional, or new receiver antenna (radome) calibration results,
  - satellite PCV modeling (X and Y offsets, azimuth dependency, GLONASS satellite frequency changes …),
  - receiver antenna calibrations specific to GLONASS frequencies, etc.
- We think it is a must to have the PCV model corrections for all GNSS stations to be included in ITRF solutions in *one common, publicly available* ANTEX file (preferably at the IGS CB).
- Maintenance of the ANTEX PCV model file(s) igsYY_WWWW.atx was an issue at the recent IGS workshop in Darmstadt, Germany.
- The instructions (promised at the recent EUREF LAC meeting in Padua, Italy) on how to prepare/update relative/absolute PCV files using the new Bernese ANTEX converter will follow asap.
- CODE as well as swisstopo are ready to switch to the IGS05 GNSS PCV model.

PCV File Update Mechanism for Bernese V5.0 Users

(0)

SATELLIT. Model name: IGS_01

PHAS_ccc.REL (or PHAS_IGS.REL)

(1)

SATELLIT.I01 Model name: IGS_01

PHAS_ccc.I01 / I01.ATX / cccc.STA

(2)

SATELLIT.I05 Model name: IGS05_1365

PHAS_ccc.I05 / I05.ATX / cccc.STA

SATELLIT.$(PCV) with V_PCV=Iyy

PHAS_ccc.$(PCV) / $(PCV).ATX

Legend:

Files to be downloaded regularly

File to be updated by hand (using igs_01.pcv)

Files to be updated regularly/automatically using the new ANTEX converter (PHCCNV)

Remark:

PHAS_COD.Iyy (V5.0) files are made available

File source: ftp://ftp.unibe.ch/aiub/BSWUSER50/GEN/