Reprocessing of a Global GPS Network

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Experiences and Results from a Joint Project at TU Dresden and TU Munich

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Outline

→ **Basic Facts: Database and Software**

→ **Processing Scheme and Resources**

→ **Modeling Approaches**

→ **Results**

→ **Conclusions**

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Basic Facts

Time period: January 1994 – October 2005

GPS data: 195 nominal GPS stations

Software: modified *Bernese GPS Software Version 5.0*

Strategy: modified processing scheme adapted from *CODE IGS Analysis Center*

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Processing Scheme: 1-Day Solution

Preprocessing

- code smoothing
- triple difference phase screening
- phase double difference residual screening

Ambiguity free solution

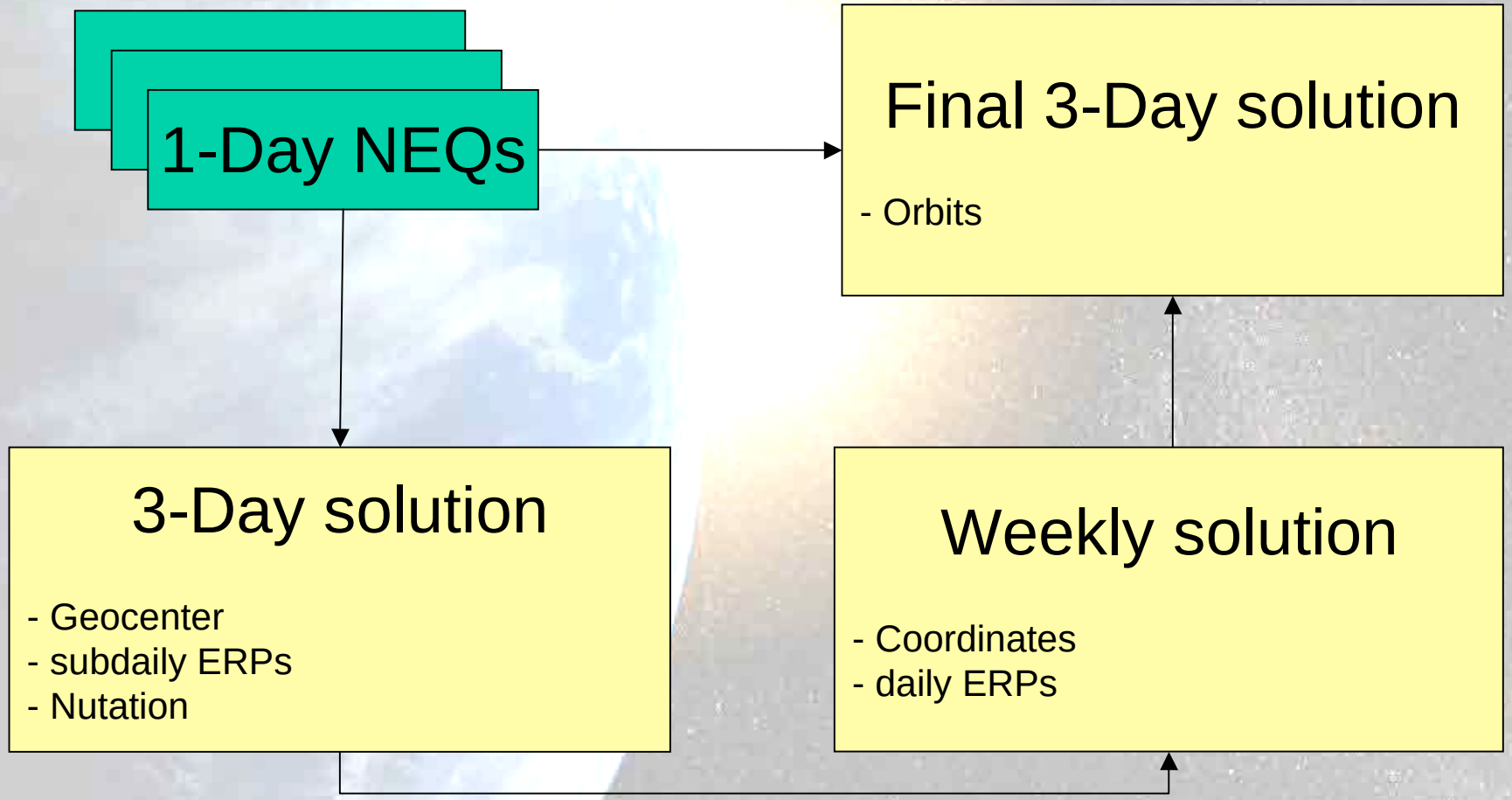
Ambiguity resolution

- Melbourne Wübbena
- Wide-Lane/Narrow-Lane
- Quasi-Ionosphere-Free
- direct L_1 and L_2

Ambiguity fixed solution

1-Day NEQ

Processing Scheme: Multiday Solution



Estimated Parameters

ZD-code observations → Global Ionosphere Maps
P1-P2 Differential Code Biases
P1-C1 Differential Code Biases

DD-phase observations → Station Coordinates
Station Troposphere
Satellite Orbits
Satellite PCVs
Earth Rotation
Nutation

Processing Resources

- Cluster of Linux PCs (PIV 3GHz)
  - 1-Day solution ~ 2.5h
  - 3-Day solution ~ 0.5h
  - 7-Day+3-Day final solution ~ 2h
- Disk space
  - data pool ~ 250GB
  - approx. 45GB per year (~20GB daily NEQ)
- Working hours ~ 15000 man hours
  - 40% software development and processing setup
  - 40% data handling and screening
  - 20% analysis of results and publication
- Results
  - 3 complete processing runs up to now
  - ~ 20 additional solutions (PCV,IMF,HOI) based on 1-Day solutions

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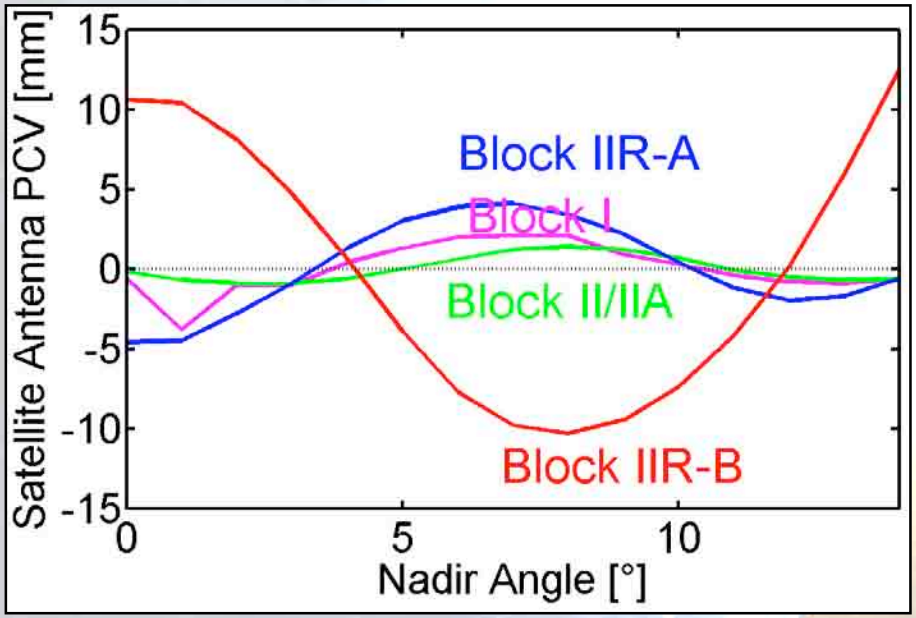
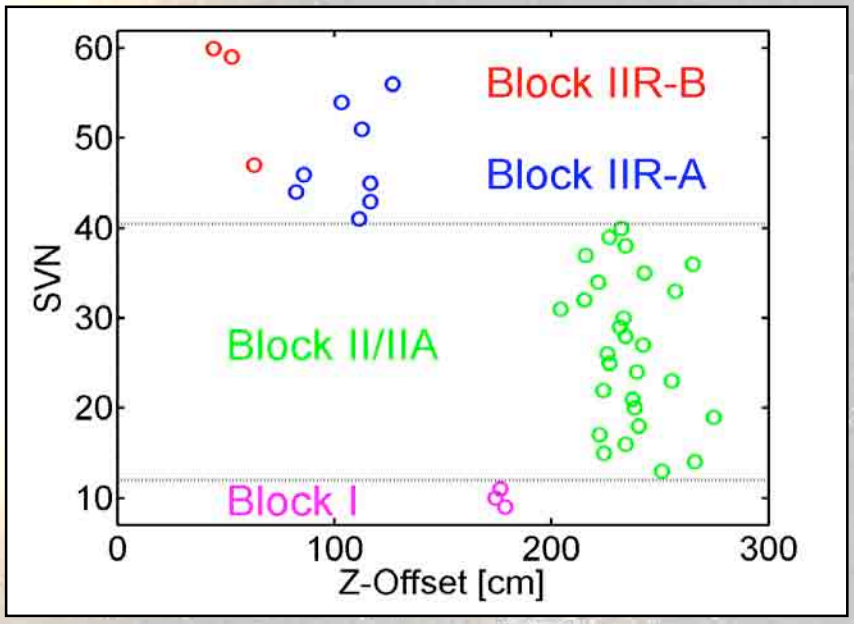
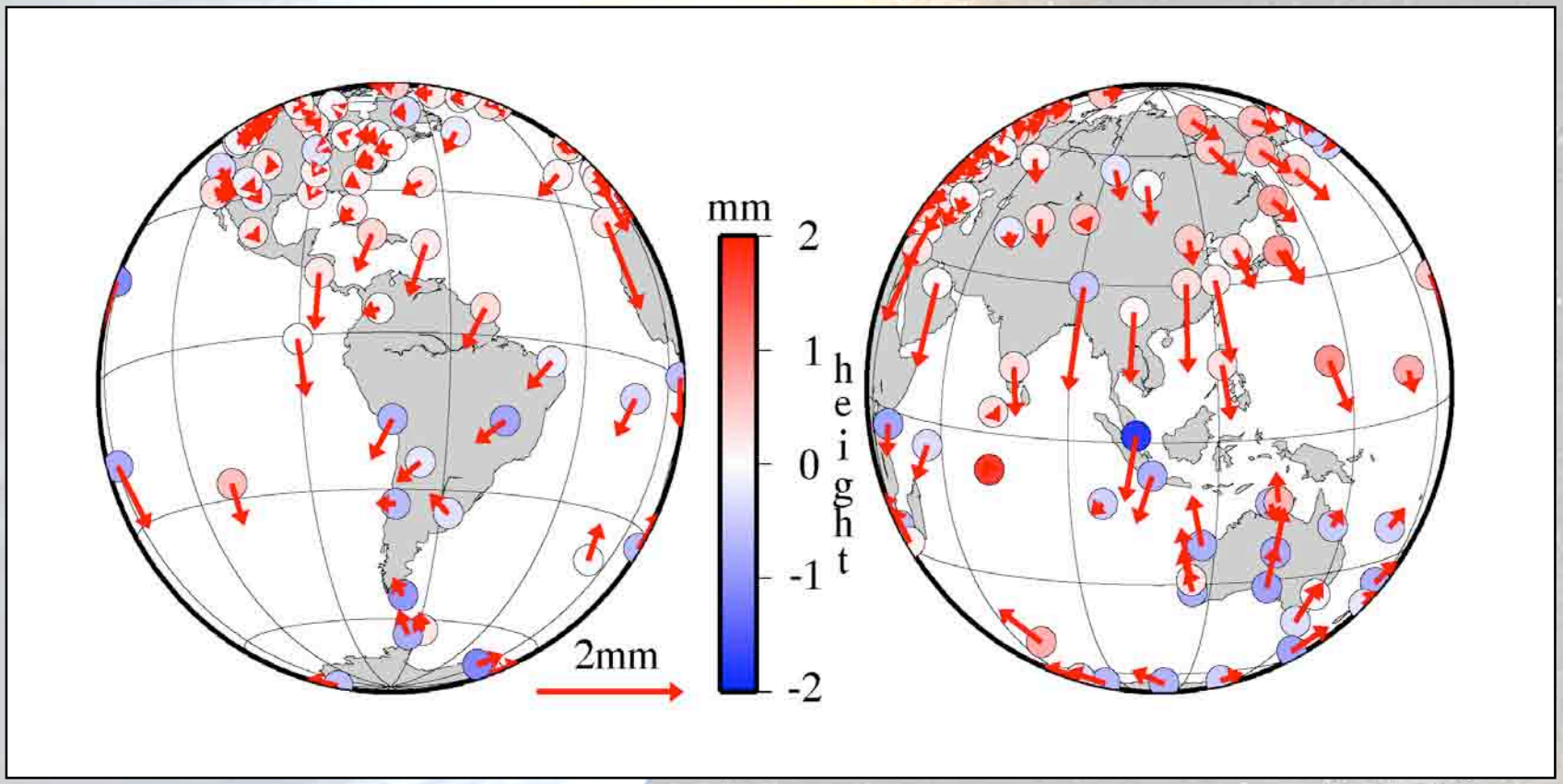
Satellite Antenna PCVs and Offsets





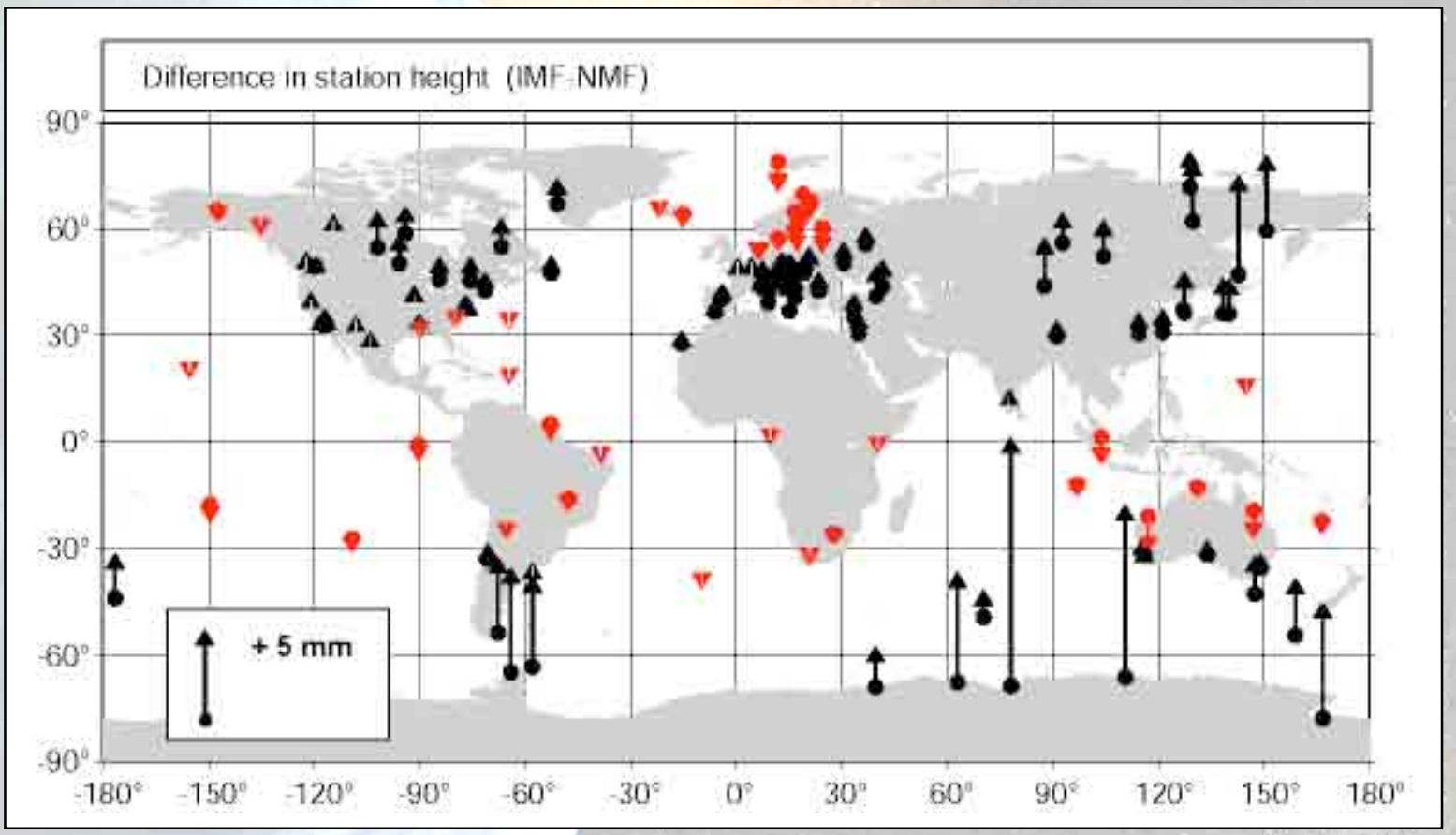
Satellite antenna phase center variations and offsets estimated from global GPS solutions using absolute calibrations for receivers

Higher-order ionospheric terms



mean coordinate residuals due to application of 2nd and 3rd-order ionospheric terms for the year 2002

Isobaric mapping function (IMF)



mean effect on station height component between solutions using IMF and NMF for the year 2002

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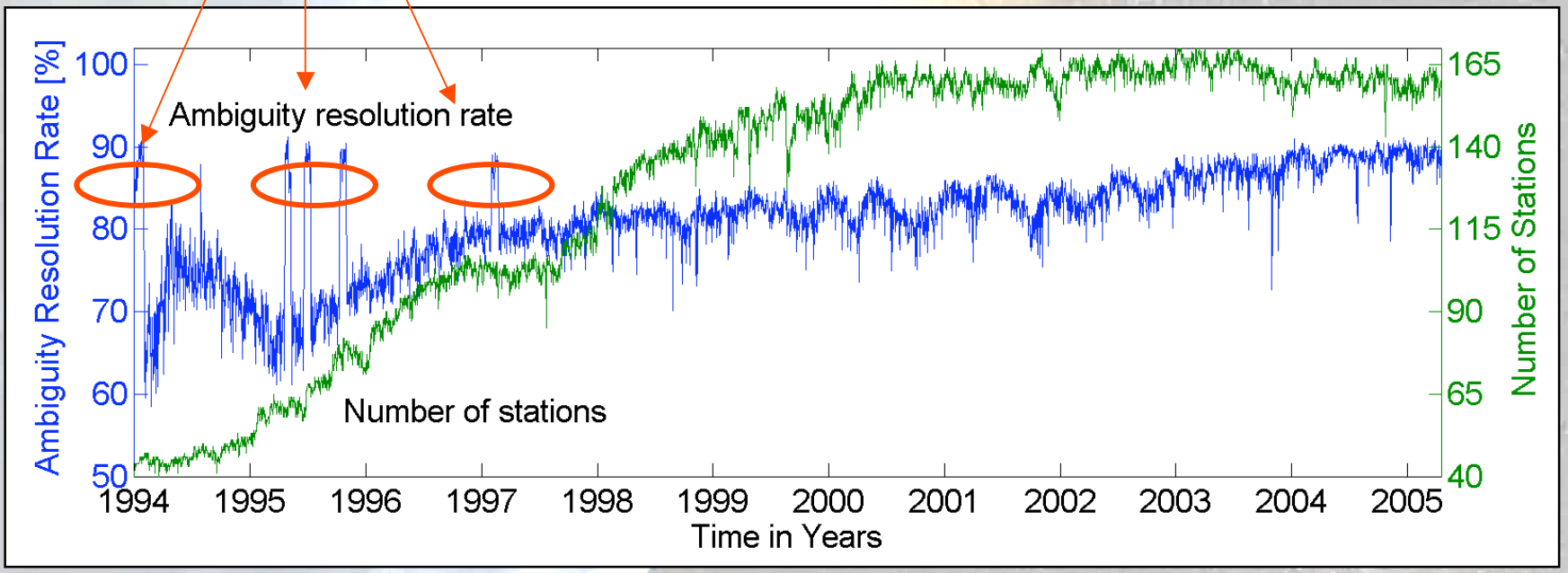
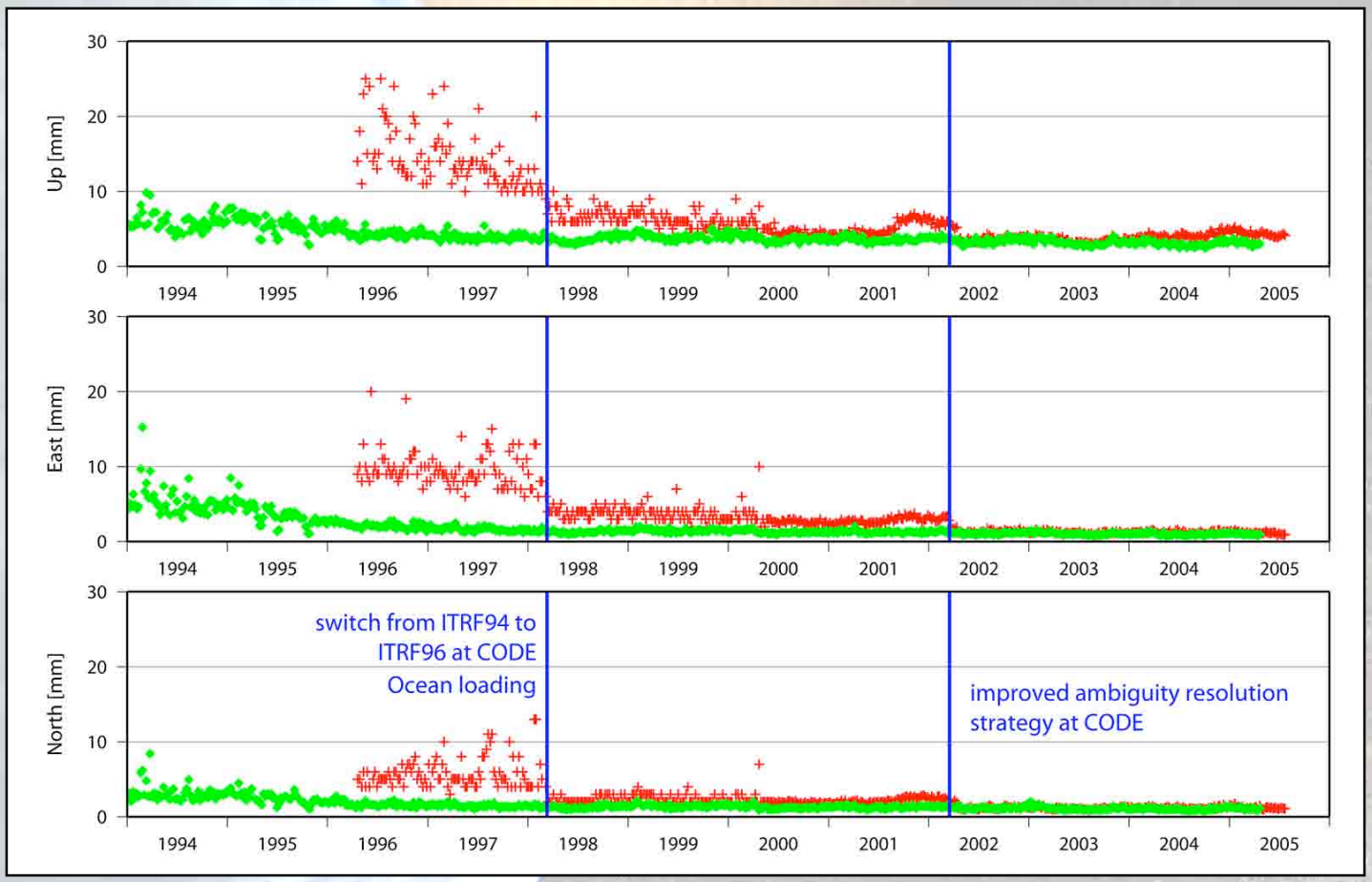
Ambiguity resolution rate

anti-spoofing switched off



best ambiguity resolution without P-code encryption

Coordinate repeatability



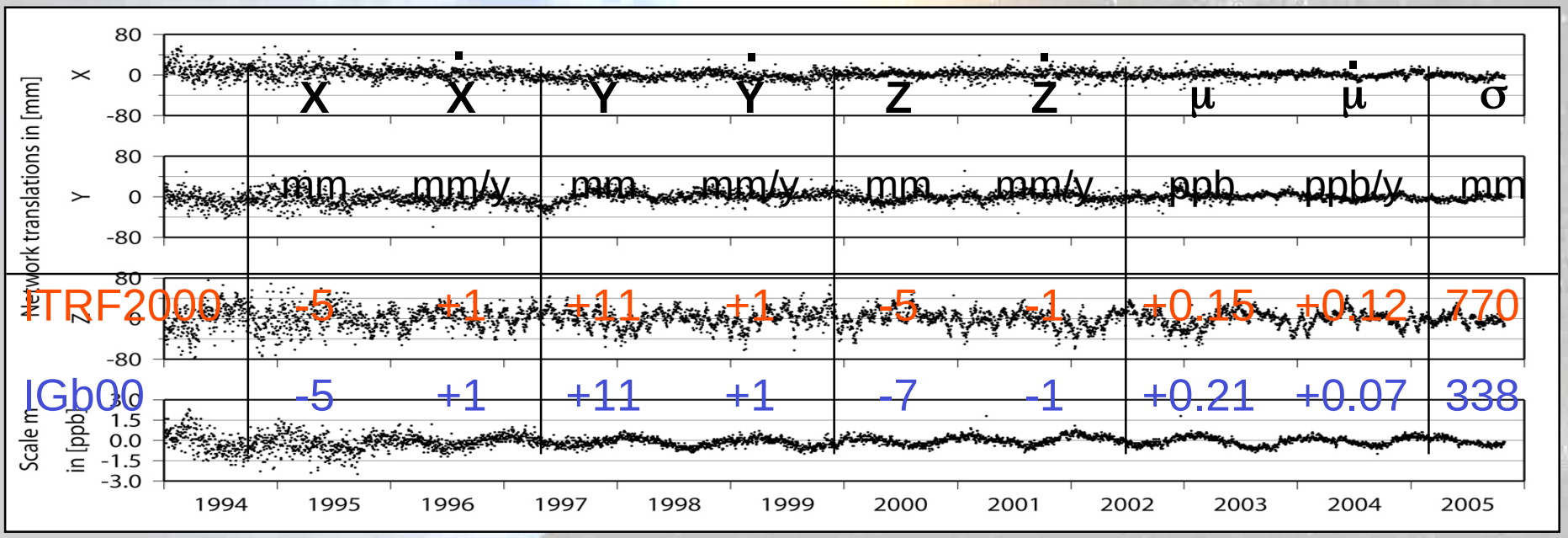
repeatability of reprocessed 3-day coordinate solutions (CODE time series for comparison)

GPS Reference Frame

Datum Definition:

- origin **defined** as center of mass orbited by satellites
- network **translations** + **time derivatives**: estimated
- network **rotations** + **time derivatives**: NNR → IGb00
- **scale** + **time derivative**: estimated

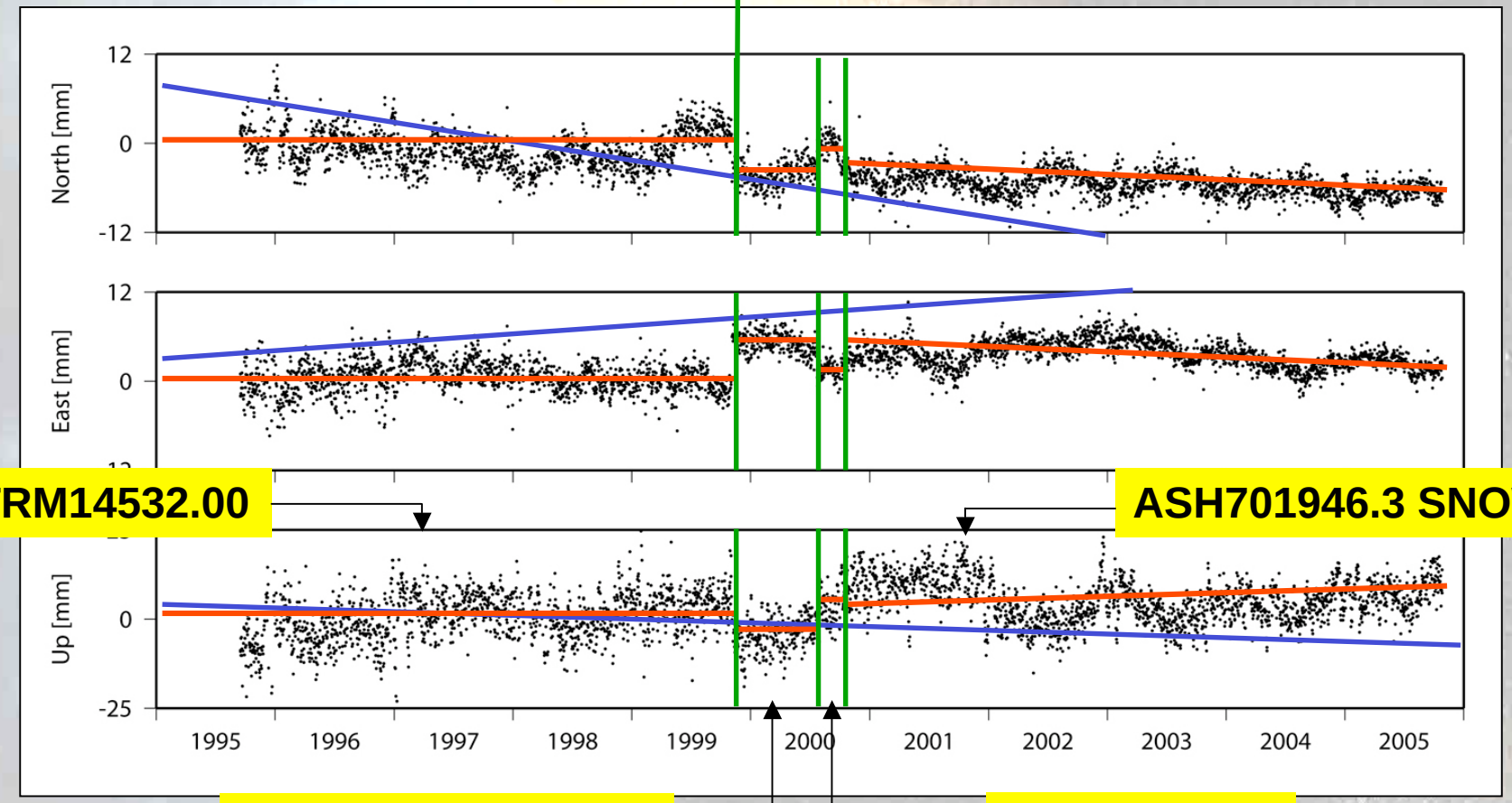
2. Comparison with existing terrestrial reference frames



GOPE 11502M002

Receiver elevation cutoff: 15°

Receiver elevation cutoff: 5°



TRM14532.00

ASH701946.3 SNOW

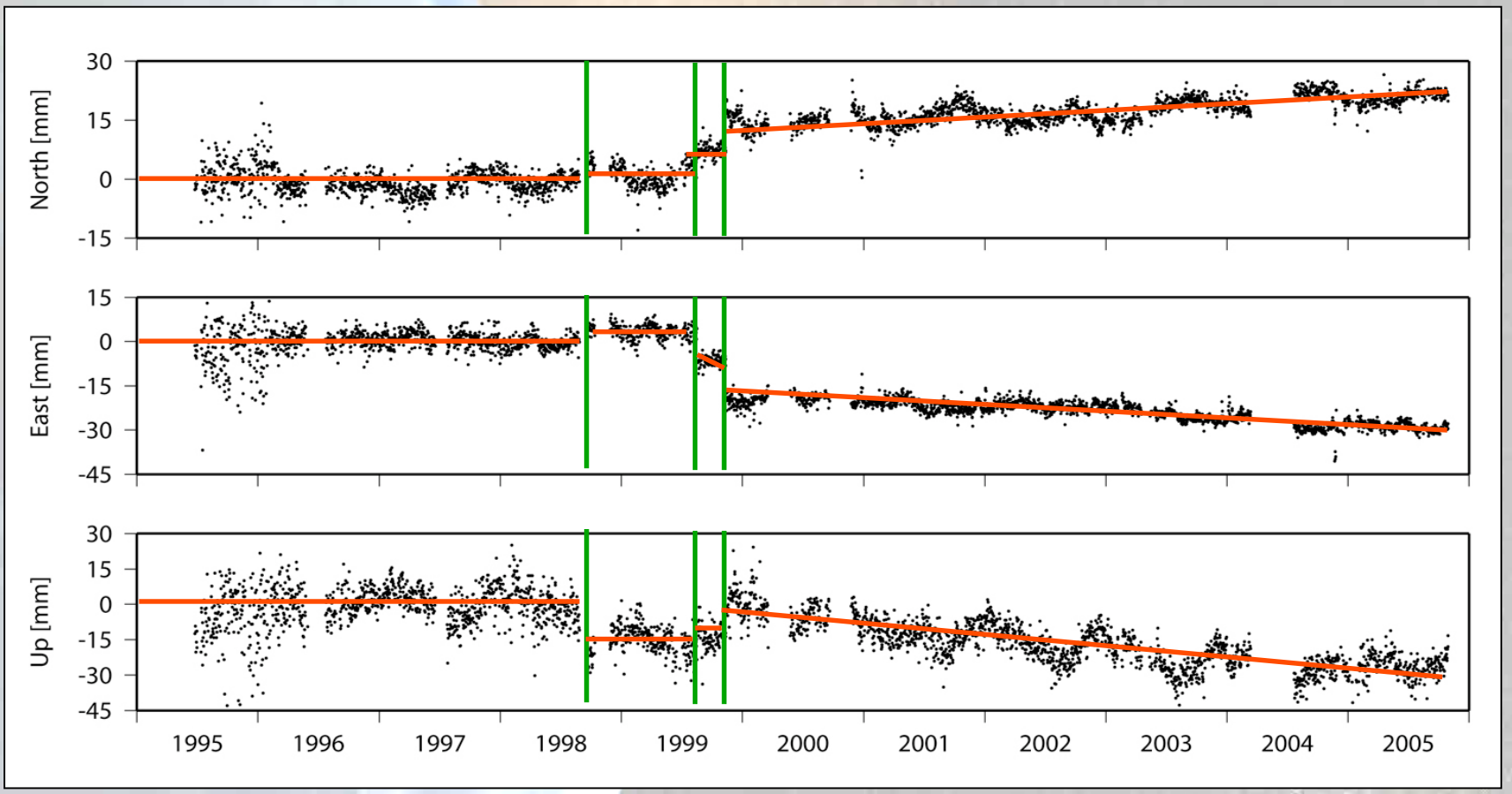
ASH701073.3 SNOW

reprocessing

TRM14532.00

IGb00

ANKR 20805M002



	Δv_{NEU} [mm/y]			Δx_{NEU} [mm]		
1. 19.09.1998 (ant/rec)	0.0	0.0	0.0	1.5	2.8	-15.6
2. 17.08.1999 (eq.)	0.8	-10.8	-5.7	5.0	-8.9	4.3
3. 12.11.1999 (eq.)	1.5	-1.9	-4.5	6.3	-9.7	7.9

Conclusions

- **Reprocessing results** reveal significant **improvements in quality and homogeneity** of the estimated parameter time series.
- A **consistent and stable reference system realization** benefits from **homogeneously reprocessed GPS solutions.**
- **Advanced modeling** (PCVs, ionosphere, troposphere) should be **considered** to become **standard**.
- **Parameter time series** provide valueable information for refined **geophysical interpretation** but shows also **non-geophysical effects**.
- **Automated reprocessing** capabilities allow for a rerun in a convenient way.

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References

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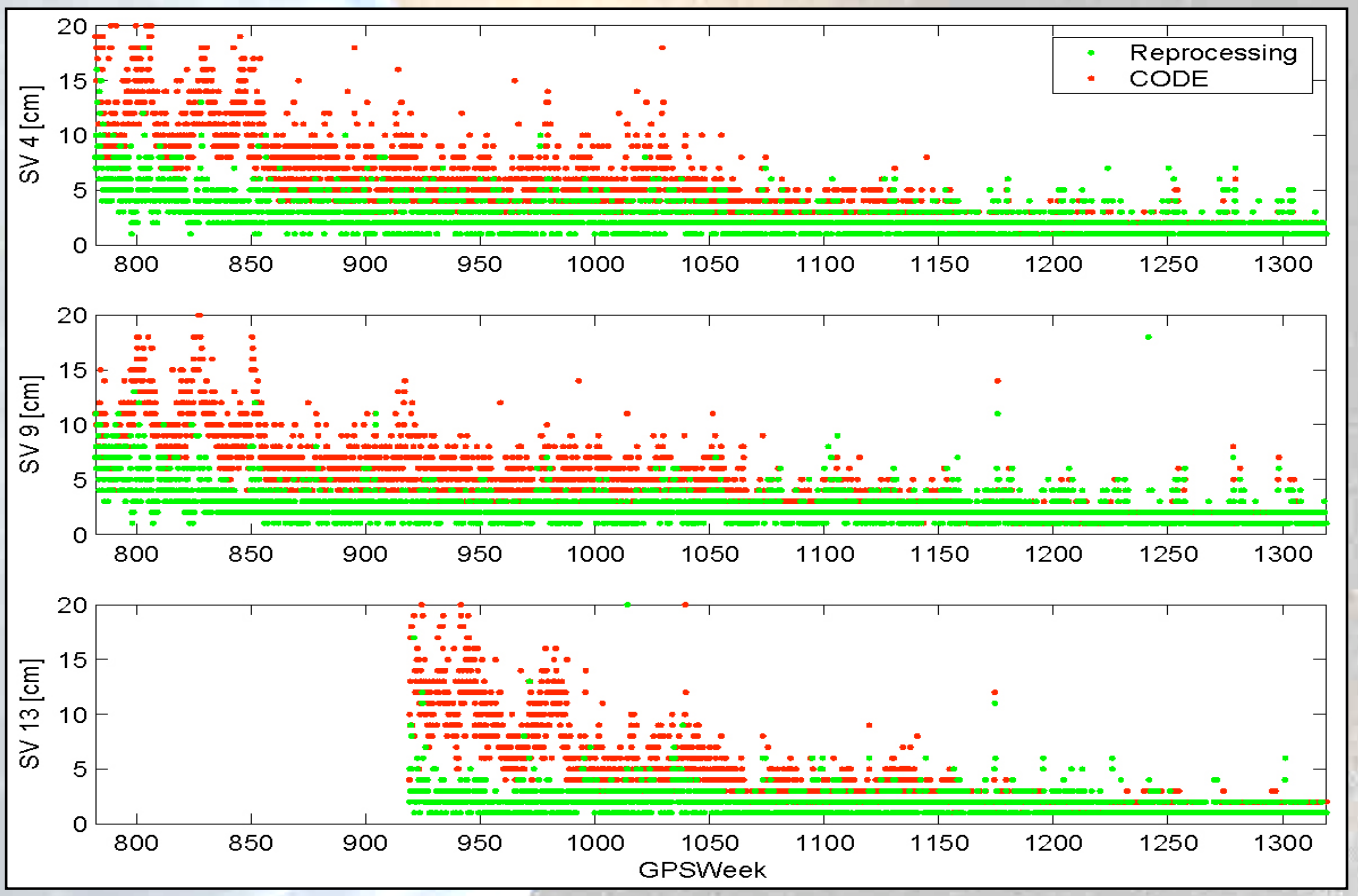
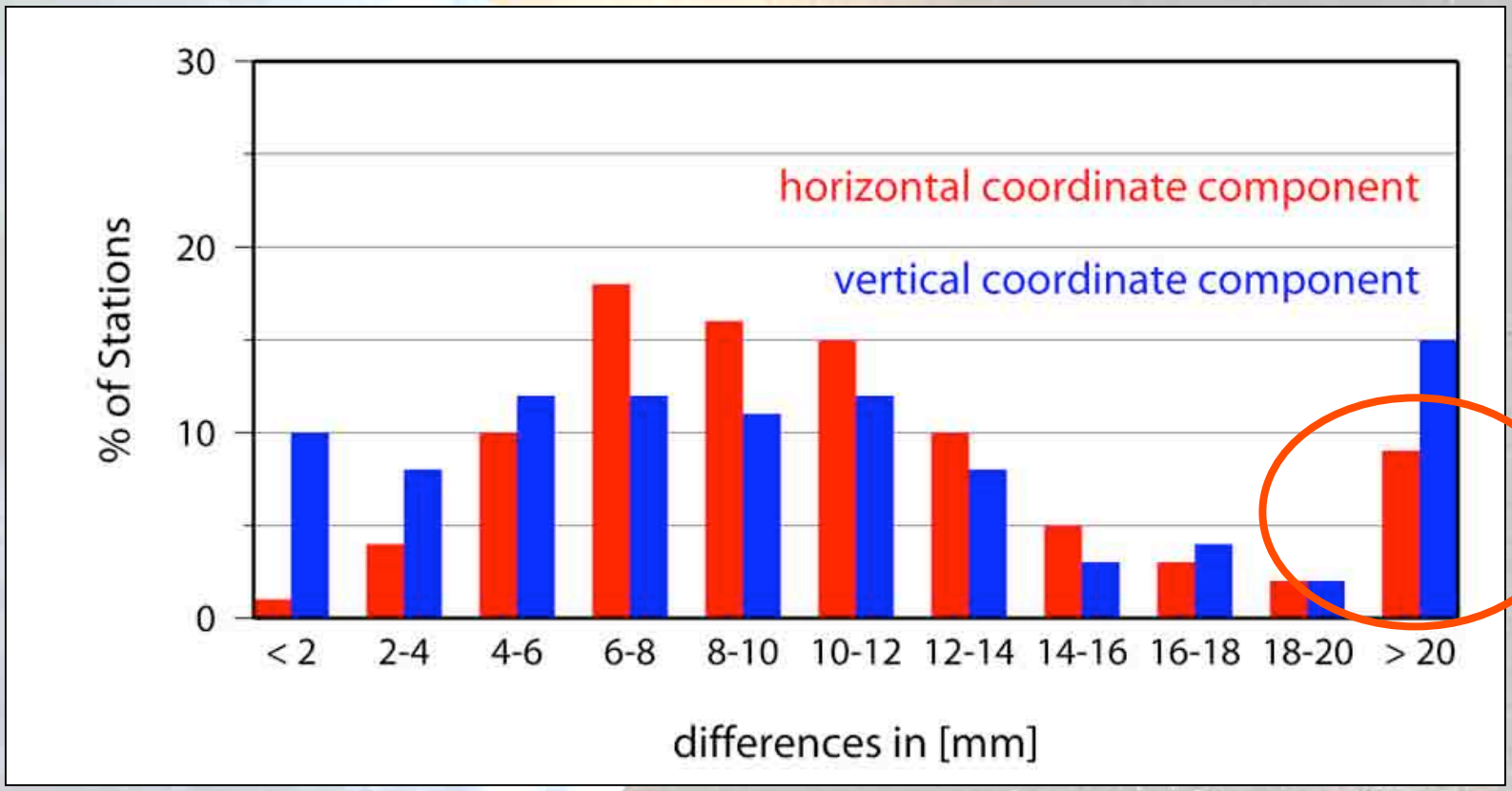
Vey, S., M. Fritsche, R. Dietrich, M. Rothacher, A. Rülke, P. Steigenberger, (2006), *Influence of mapping function parameters on global GPS network analyses – comparison between NMF and IMF, GRL,* doi:10.1029/2005GL024361

Orbit repeatability



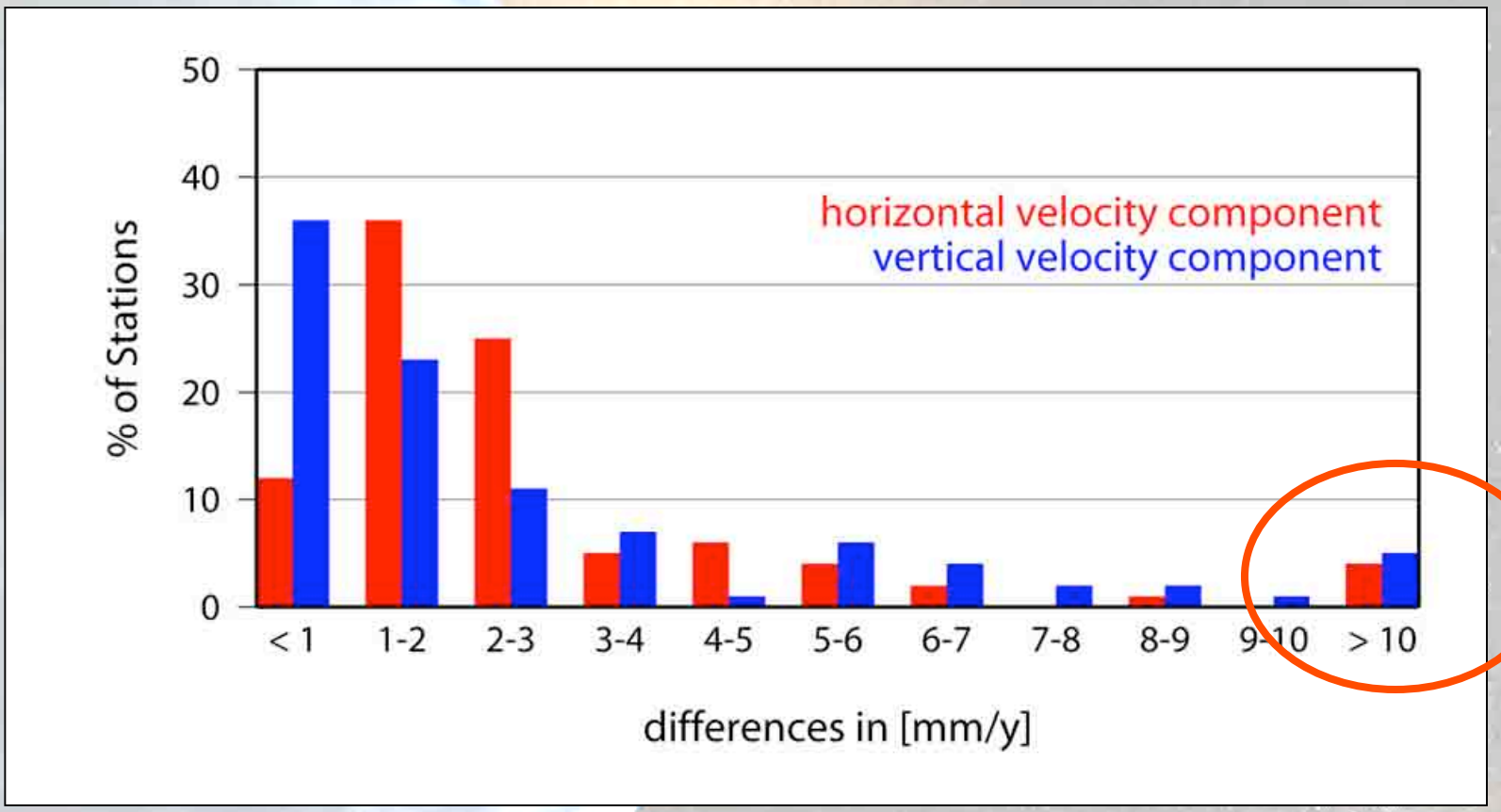
repeatability of reprocessed 1-day orbit solutions
based on moving 3-day fits (CODE for comparison)

Coordinate comparison with ITRF2000



COCO	50127M001	2000/06/18 M 7.6 Indian Ocean earthquake
DARW	50134M001	2001/10/19 + 2001/12/14 antenna change
FAIR	40408M001	2002/11/03 M 7.9 Denali fault earthquake

Velocity comparison with ITRF2000



AREQ	42202M005	2001/06/23 M 7.9 Arequipa, Peru Earthquake
INEG	40507M001	observed: 12.1999-03.2002
TRAB	20808M001	observed: 2000-2005