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Processing Combined GPS/GLONASS Data at swisstopo's Local Analysis Center

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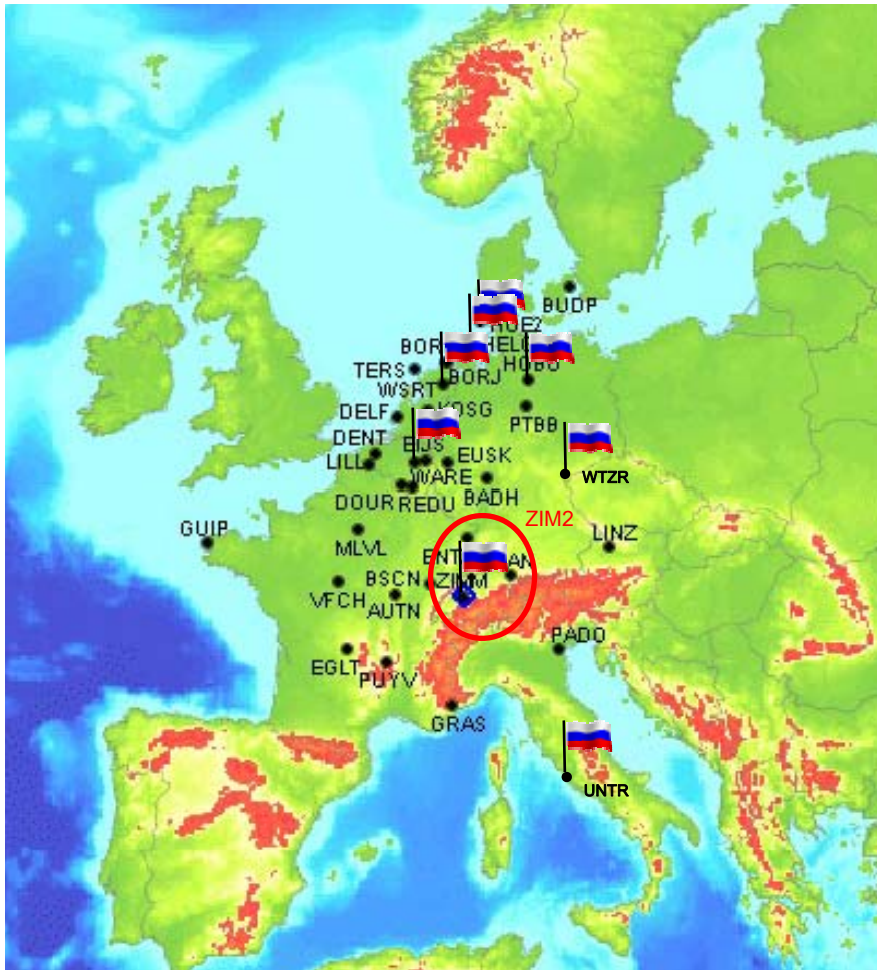
GLONASS data used for EUREF solutions

- swisstopo‘s official contribution based on GLONASS data since GPS week 1400 (Nov. 2006)
- Increase from 4 to 8 GNSS stations in swisstopo’s sub-network compared to last year
- New Swiss EUREF site ZIM2 providing GNSS data
- GLONASS ambiguity fixing implemented since August 2007
- Orbit information used from CODE (no combined product available from IGS)



Current GNSS status of the AGNES network

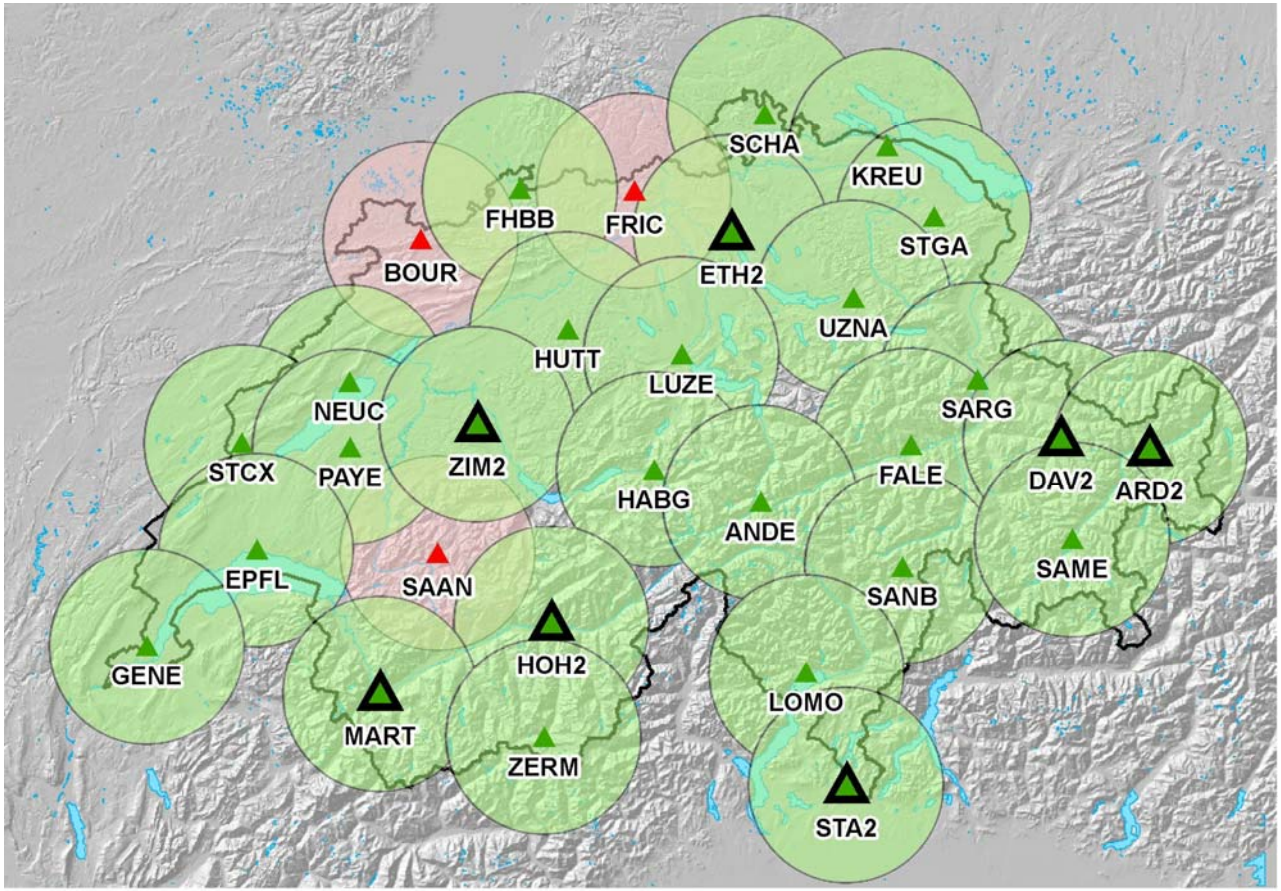
▲ „Normal station“:
GNSS receiver and antenna installed

▲ „Double station“:
New antenna mount for GNSS antenna
GNSS and GPS run simultaneously

▲ „Double station“:
GNSS not yet installed

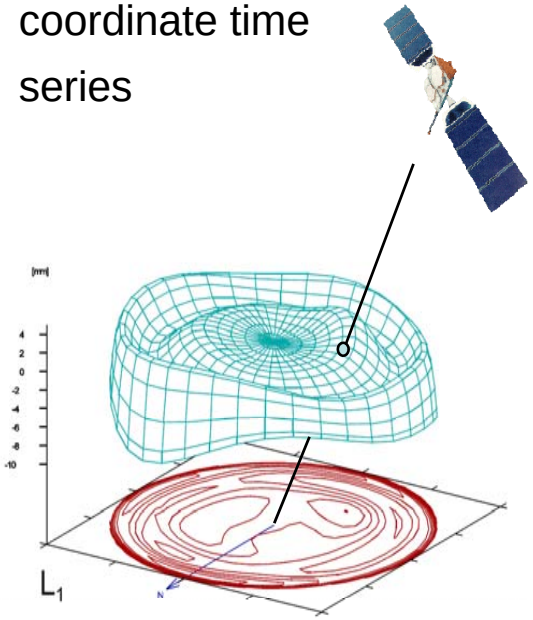
New equipment:

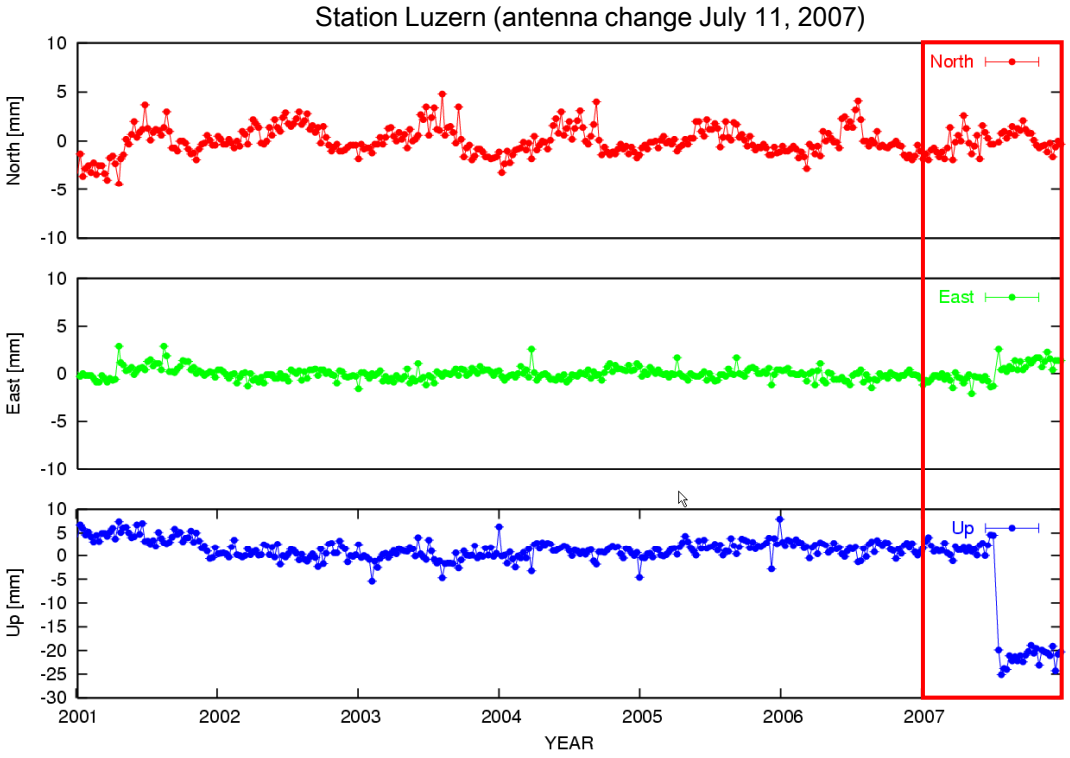
Trimble NetR5 receivers and Zephyr GNSS antennas



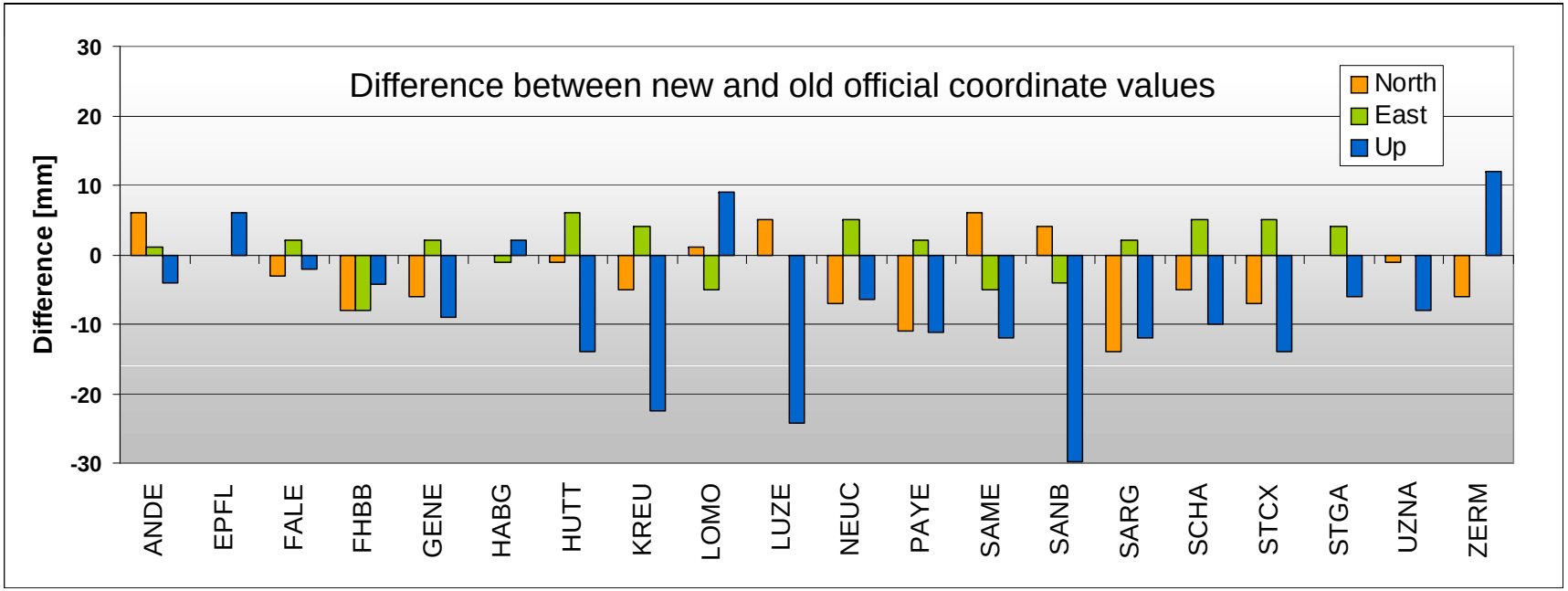
Reference frame stability: Coordinate jumps due to antenna change

The change to GNSS capable antennas caused jumps in the coordinate time series





Reference frame stability:
New coordinates for AGNES reference sites



- Total difference is the sum of antenna change, station movement since last determination, and rounding effects of the old coordinates

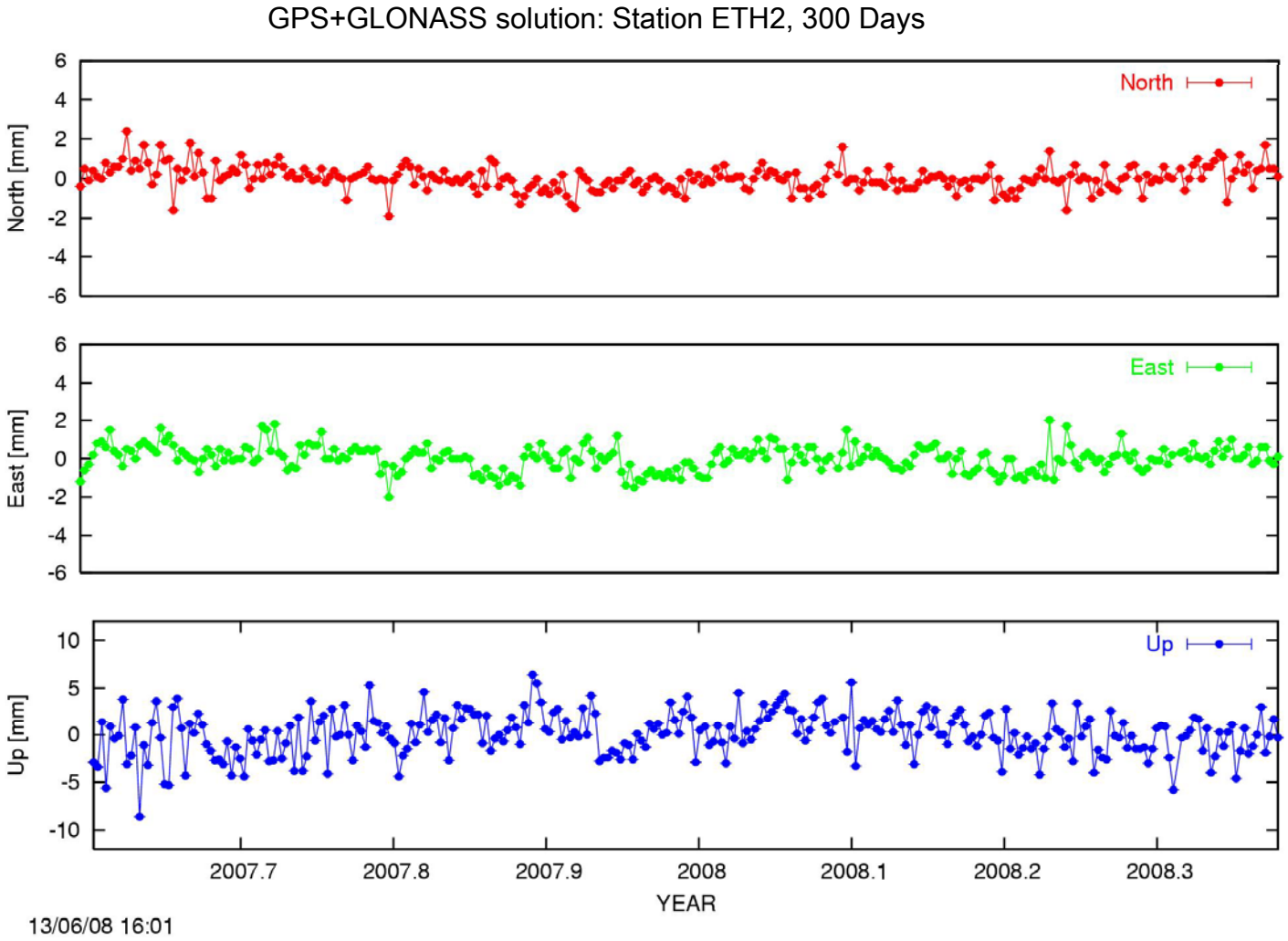
→ Double stations help to ensure the consistency of the national reference frame during transition time

Post-processed daily solutions of the AGNES network

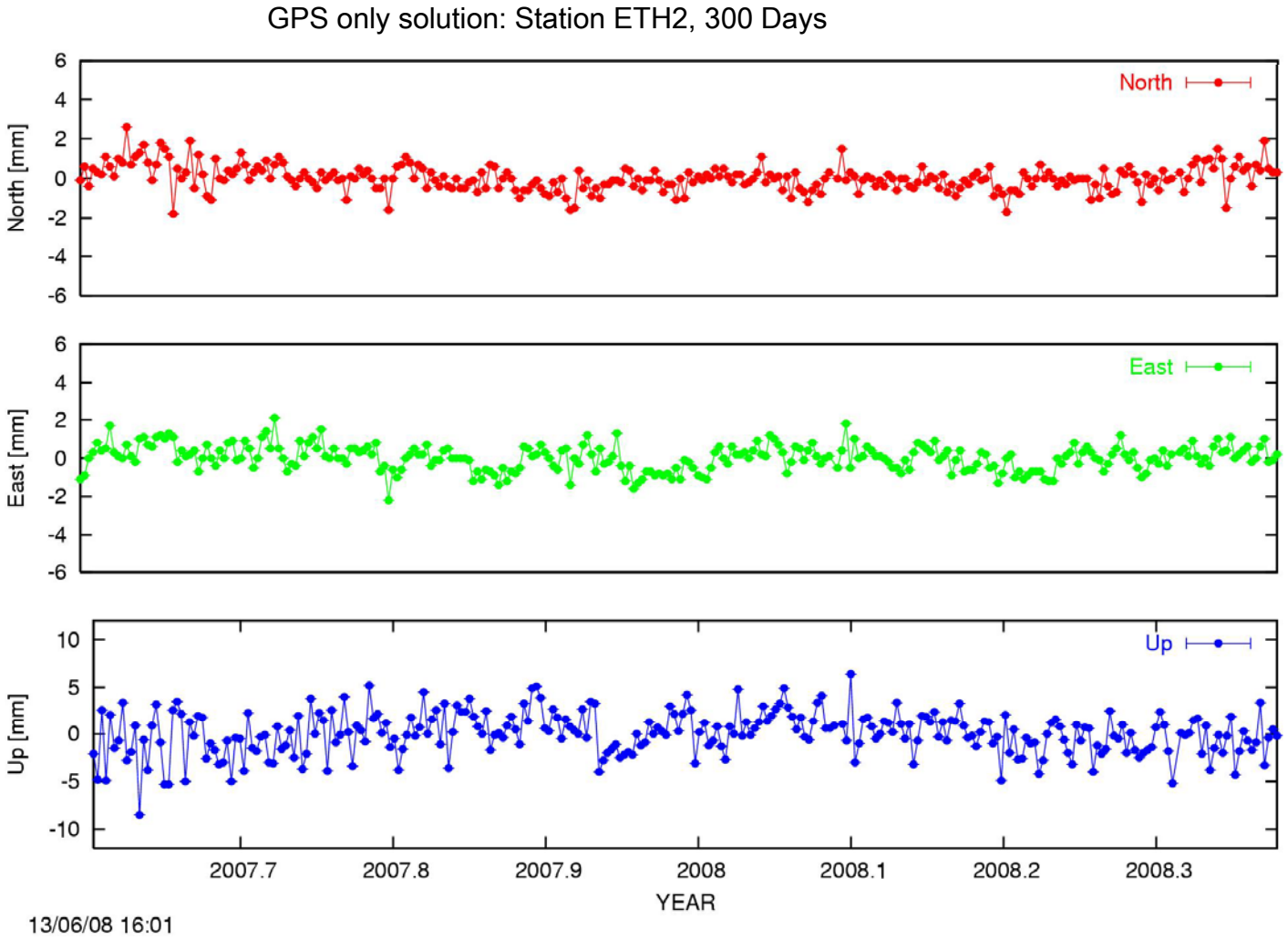
- Evaluate the performance of different solution types, amongst others:
  - GPS only solution
  - GLONASS only solution
  - GNSS solution (combined on NEQ level)

  with individual (GPS) antenna calibration values
- Time series of 23 GNSS observation sites
- Covered time period of 315 days (July 07 to May 08)
- Data processing with Bernese GNSS Software 5.0+

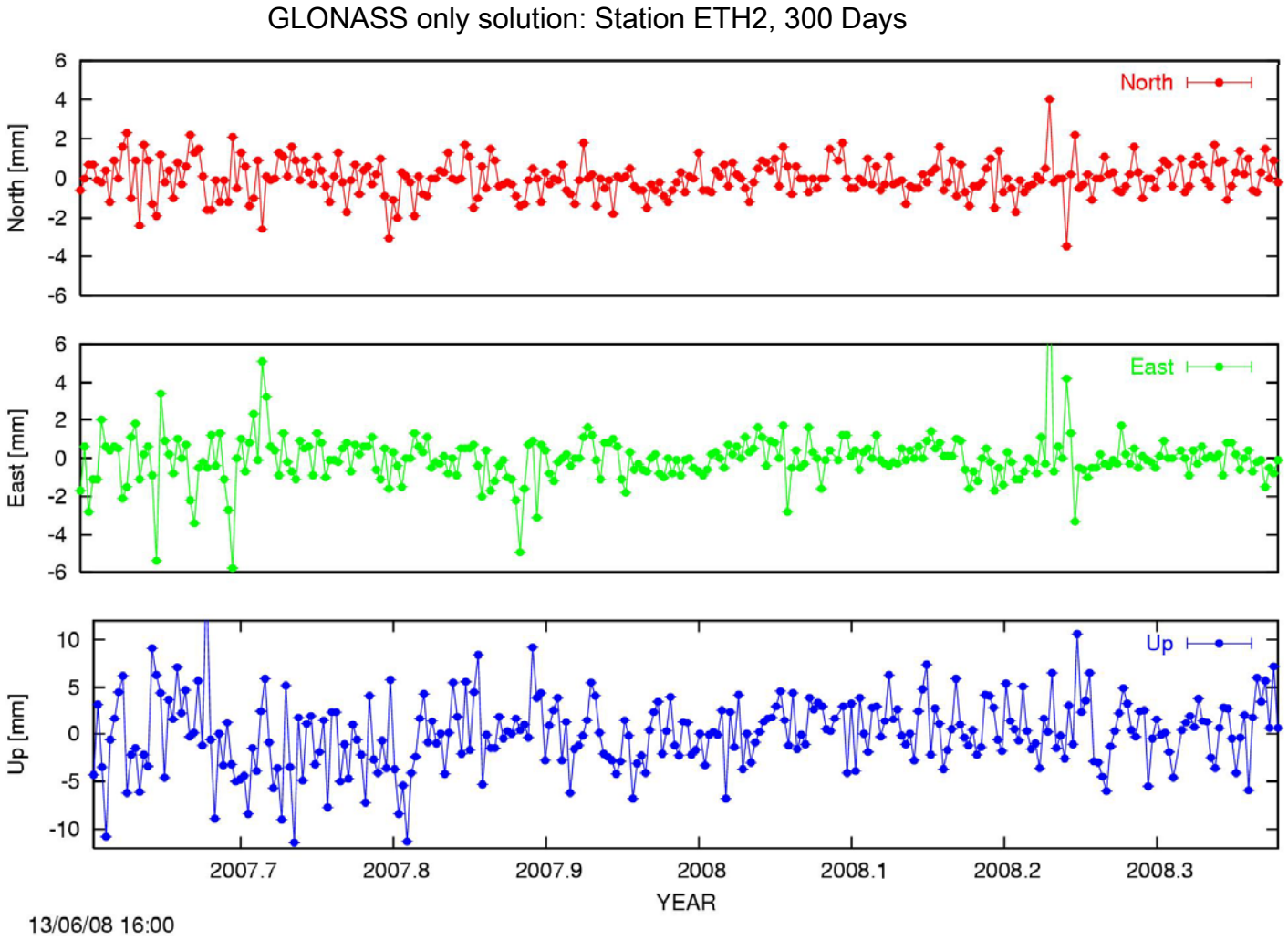
Post-processing of the AGNES network: GPS+GLONASS solution



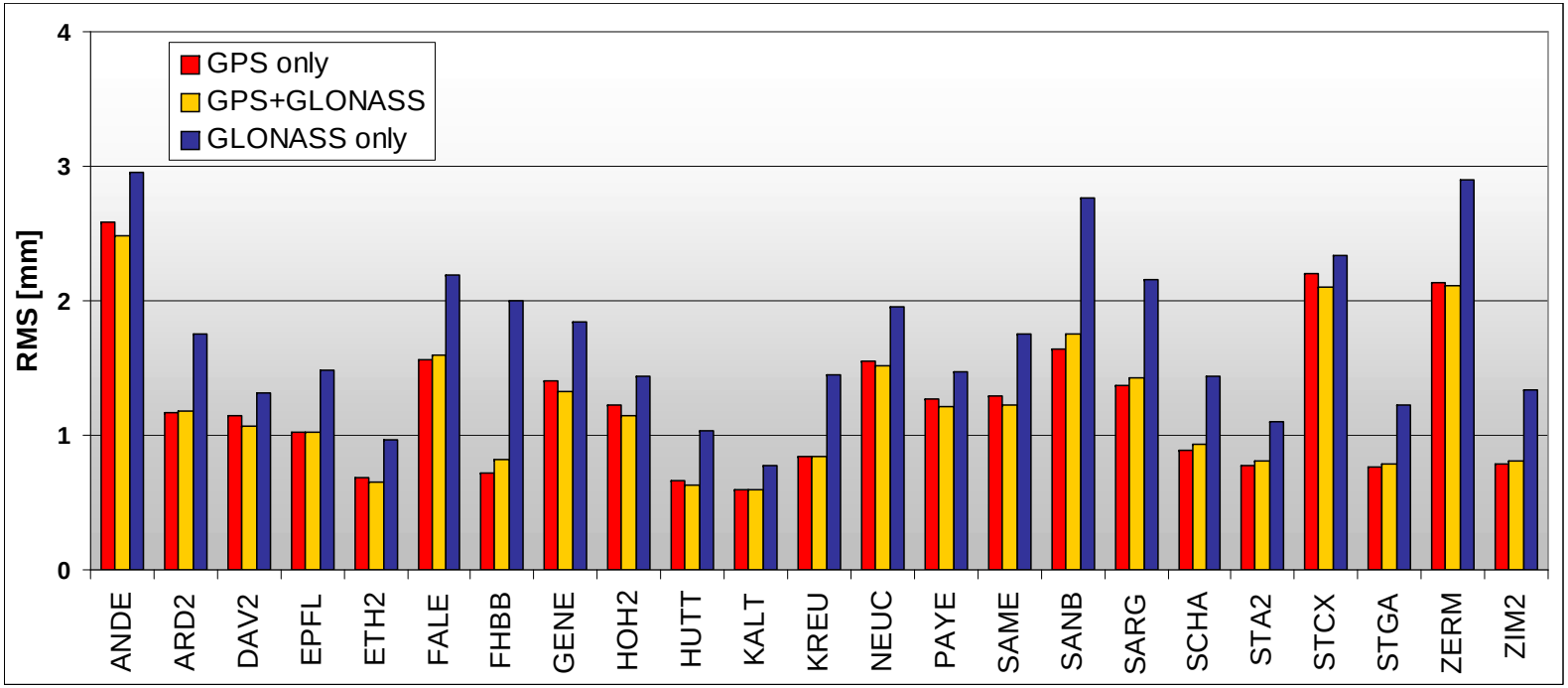
Post-processing of the AGNES network: GPS only solution



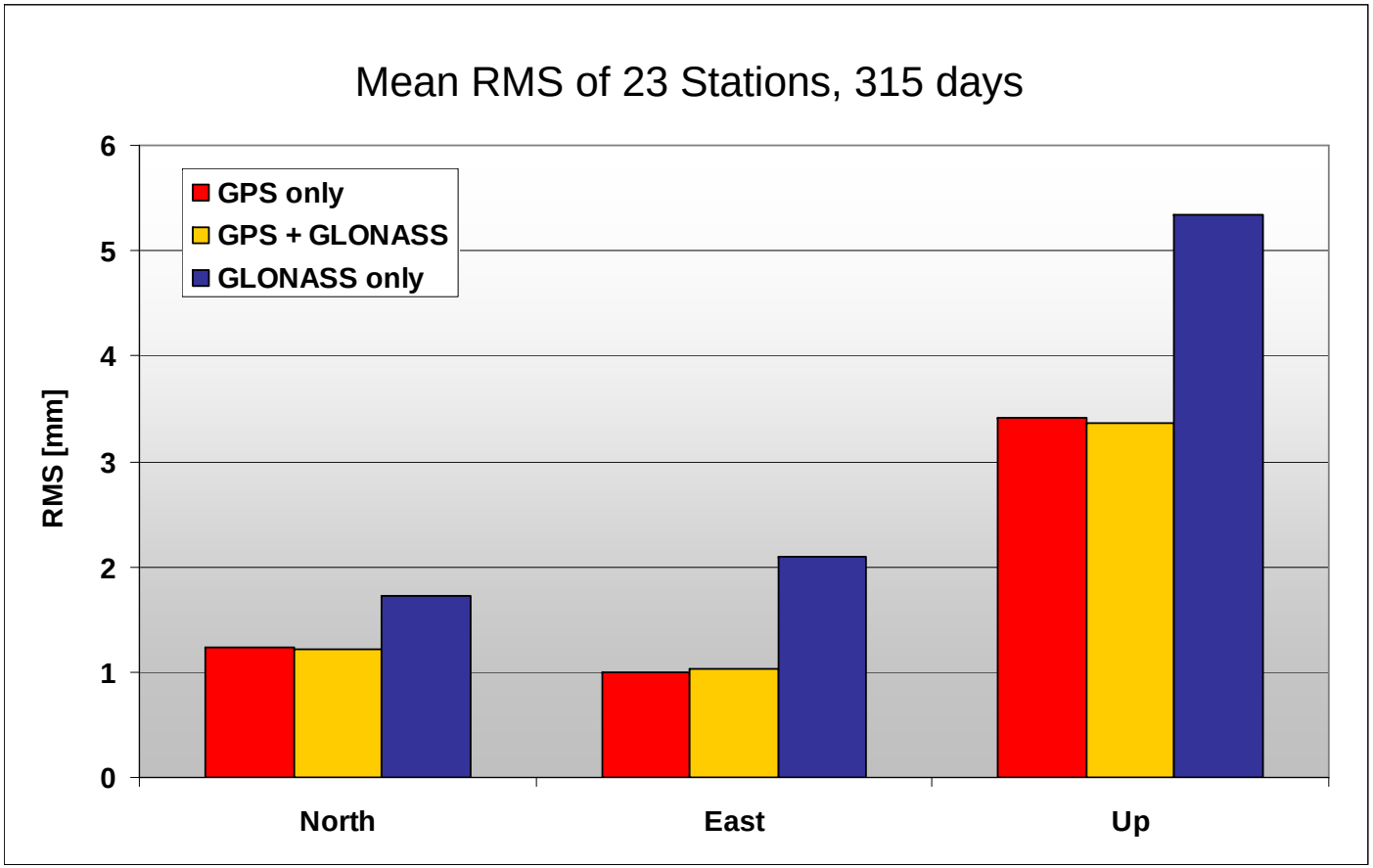
Post-processing of the AGNES network: GLONASS only solution



Post-processing of the AGNES network: Repeatability of the North component



Post-processing of the AGNES network: Summary of the repeatability values



Post-processing of the AGNES network: Coordinate consistency between the solutions

RMS of Helmert Transformations (3 translation parameters):

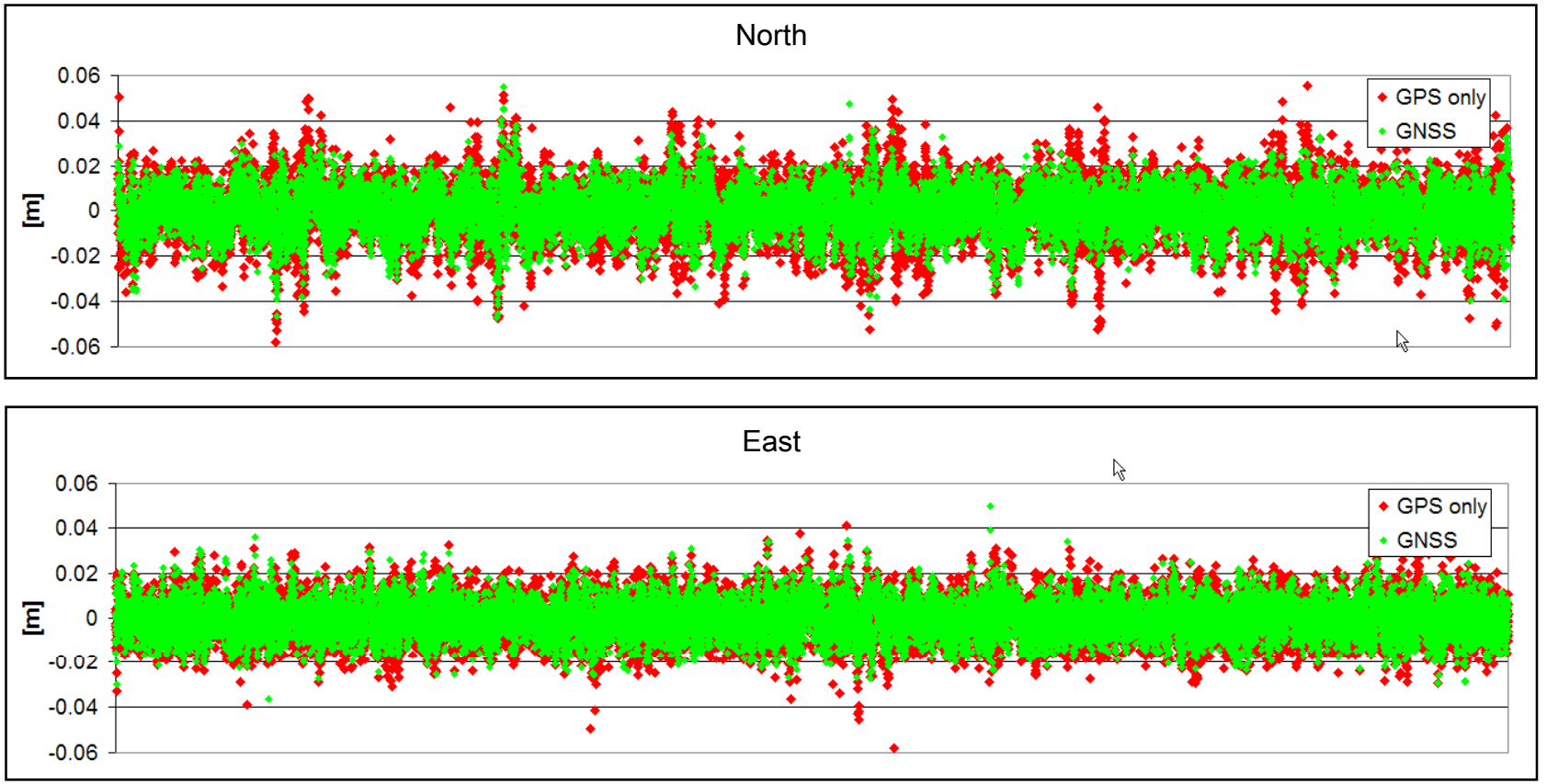
	North [mm]	East [mm]	Up [mm]
GPS vs. GNSS	0.3	0.2	0.8
GLONASS vs. GNSS	0.7	1.0	2.7
GPS vs. GLONASS	1.0	1.2	3.4

Kinematic solutions: Approach

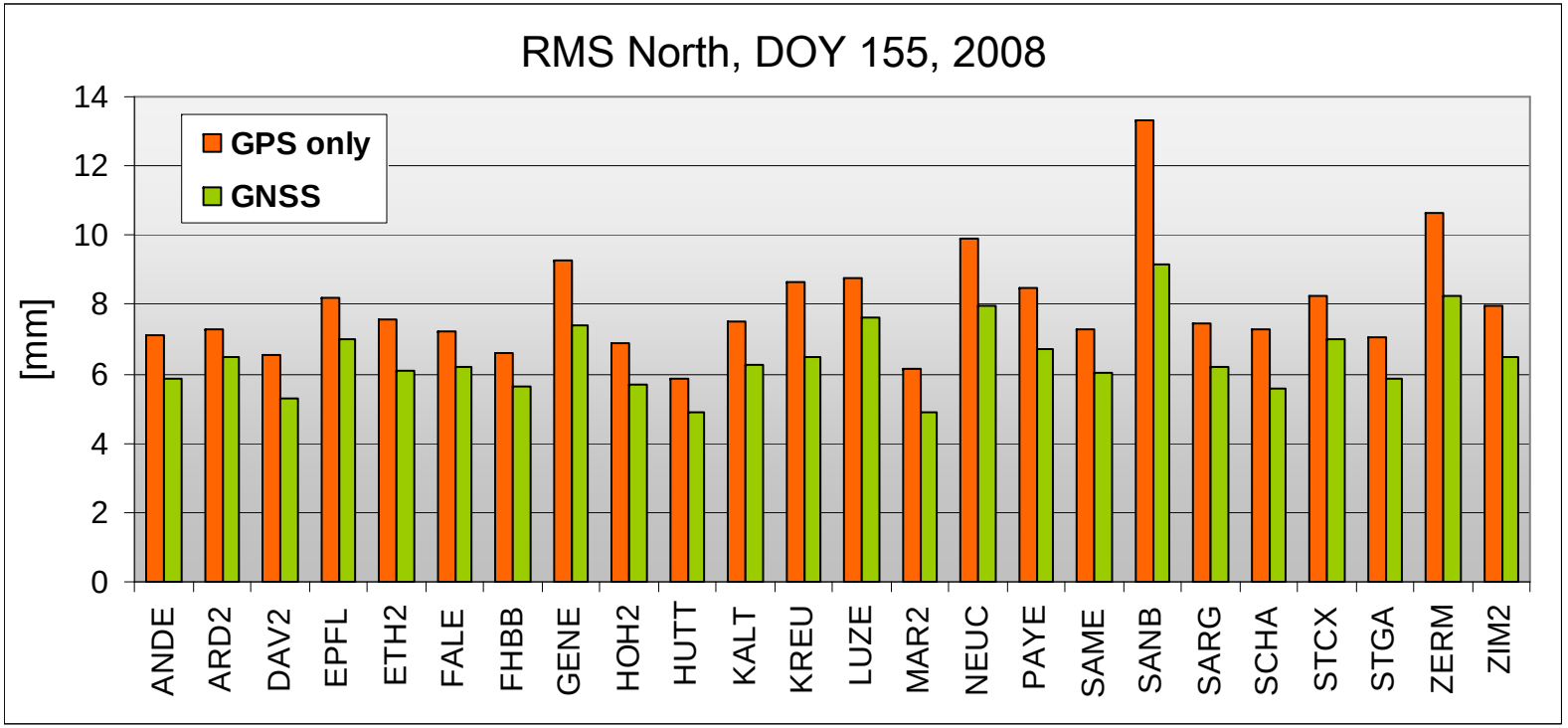
- Data processing in hourly batches (for 7 days)
- Ambiguities and troposphere parameters introduced from a post-processed 8-hour-solution
- Estimation of epoch-wise coordinates (every 30 seconds) for all AGNES sites, fixing European sites
- Comparison of a GPS only solution with a GNSS solution
- Simulating the measuring in kinematic positioning mode

Kinematic solutions:
Residuals of GPS vs. GNSS solutions

Station San Bernardino, 7 days, 19‘000 position estimates



Kinematic solutions: Influence of GNSS on RMS values



- Improvement for all sites in all components when using additional GLONASS observations

Kinematic solutions: Improvement using additional GLONASS data

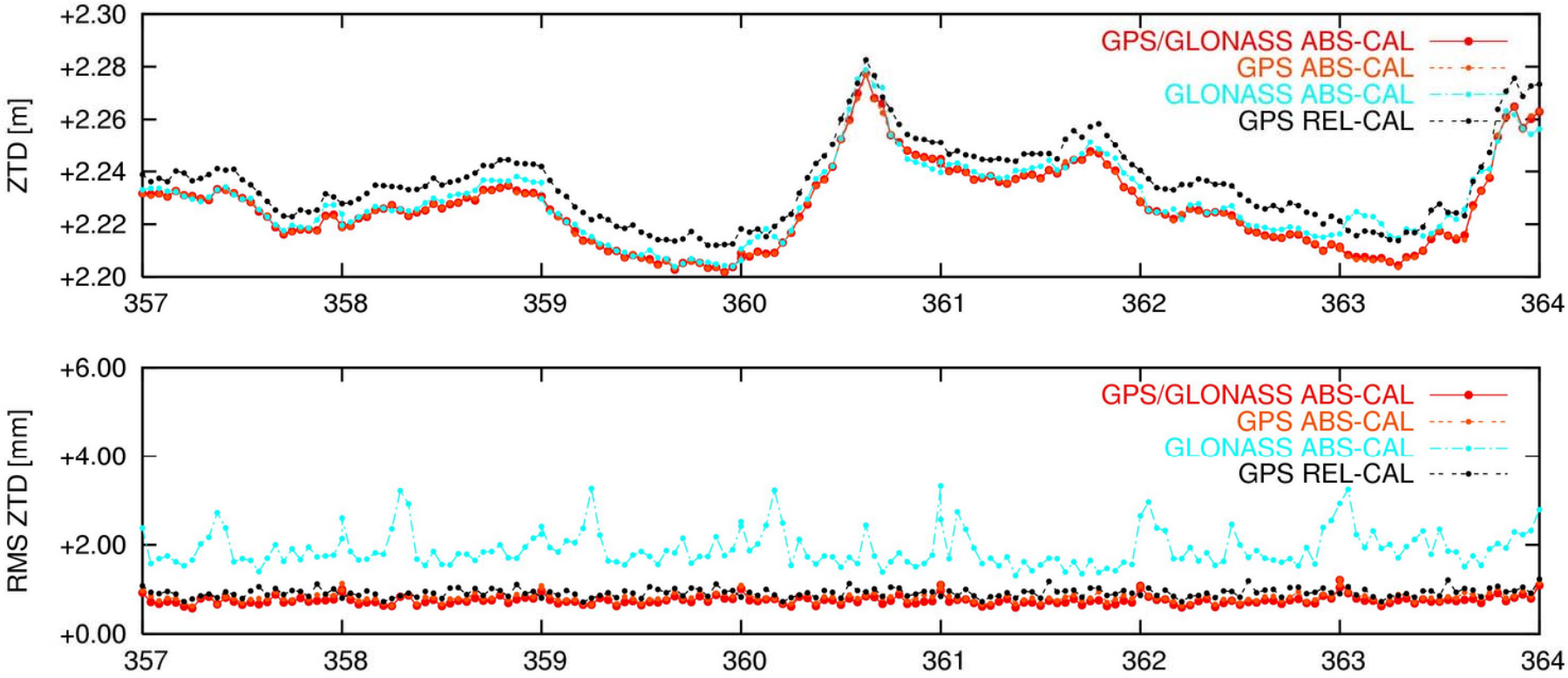
Mean values of 7 days, 24 stations:

	North	East	Up
RMS GPS	7.3 mm	5.4 mm	12.4 mm
RMS GNSS	6.0 mm	4.8 mm	10.8 mm
Improvement	17 %	11 %	13 %

Gain up to 30% for North, 13% for East, and 16% for Height component for stations in mountainous regions

Influence of GLONASS on the estimation of tropospheric parameters

Comparison of the Zenith Total Delays, Station ETH2, December 23 to 30, 2007



Conclusions

- AGNES network almost completely re-equipped with GNSS receivers/antenna during last year
- GNSS data is routinely processed for EUREF, AGNES, and near-realtime solutions
- On daily level, the GPS and GNSS solutions are almost on the same level, although the GLONASS only solution performs remarkably well
- In kinematic mode, additional GLONASS data help to improve the coordinate estimates