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Rapid Static Positioning Using GPS and GLONASS

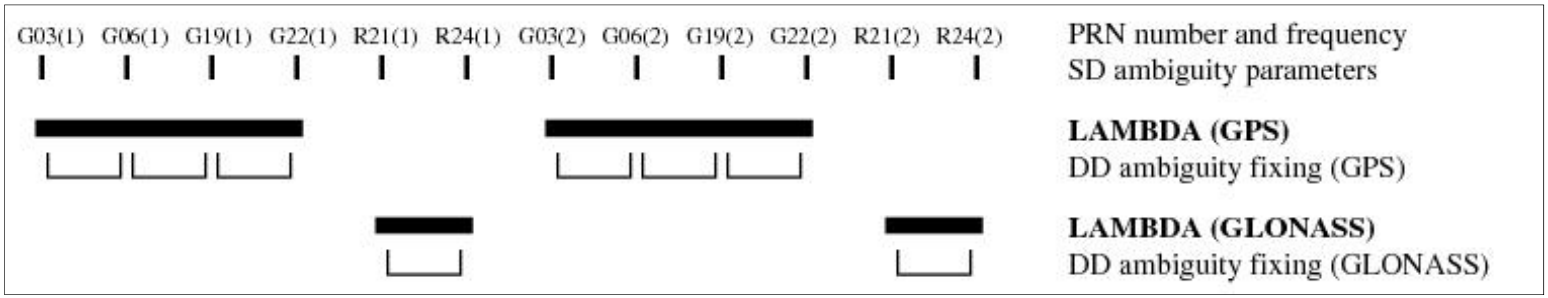
S. C. Schaer[1], E. Brockmann[1], M. Meindl[2]

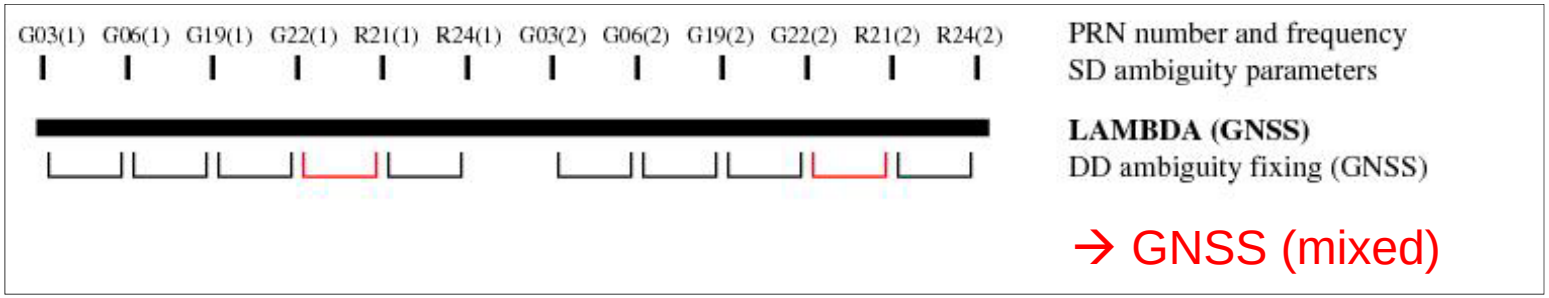
[1]Swiss Federal Office of Topography (swisstopo)
[2]Astronomical Institute of the University of Berne (AIUB)

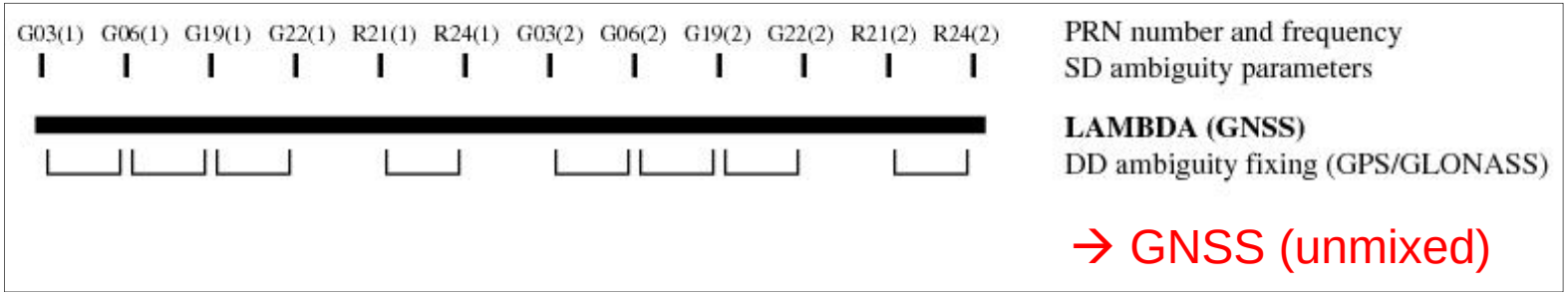
Introduction

- For rapid static positioning, combined analysis of all observed GNSS becomes more and more important in view of the steadily increasing number of active satellites (recently exceeding 50 GPS/GLONASS satellites).
- Successful ambiguity fixing for all involved GNSS is the key for this application.
- First results of an implementation of a “GNSS-capable” LAMBDA ambiguity resolution scheme into a project version of the Bernese Software are presented.

Implemented “GPS/GLONASS-Capable” LAMBDA Ambiguity Resolution Scheme(s)

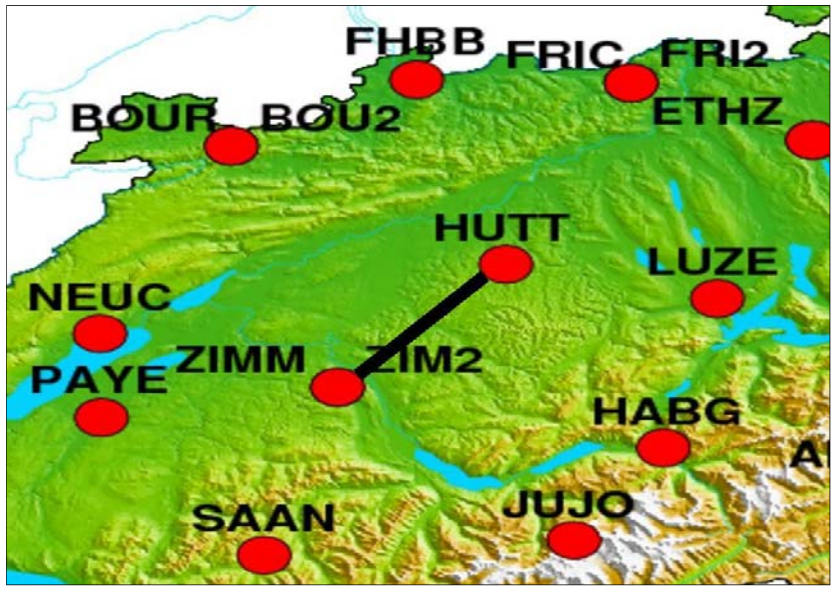






Test Data Set

Detail of the AGNES GNSS receiver network map:

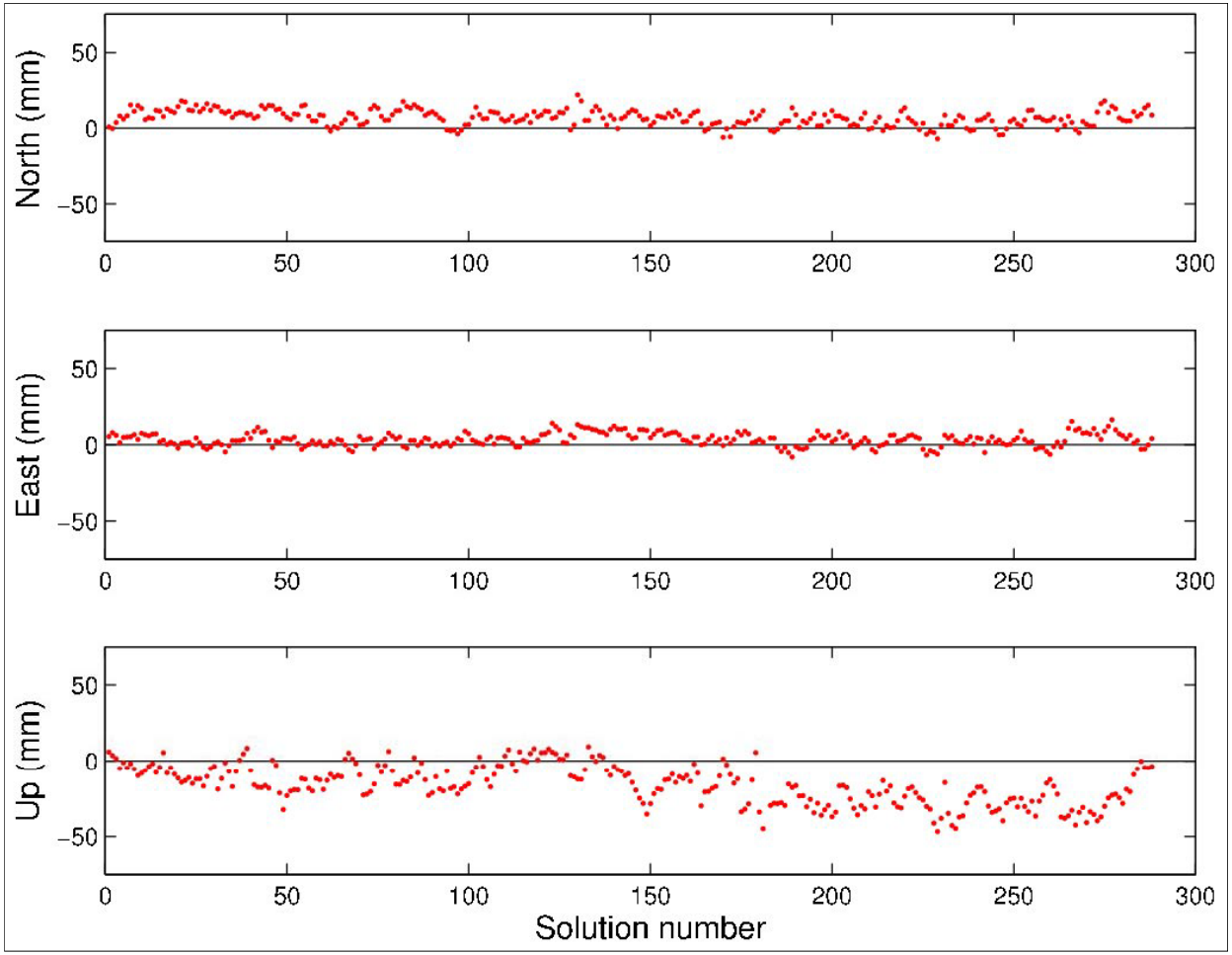


- Baseline: Zimmerwald-Huttwil (ZIM2-HUTT)
- Baseline length: approx. 41 km
- Receiver model: Trimble NetR5
- Observation data: GPS/GLONASS for day 271, 2008

Processing Options Used for GPS/GLONASS LAMBDA Ambiguity Resolution

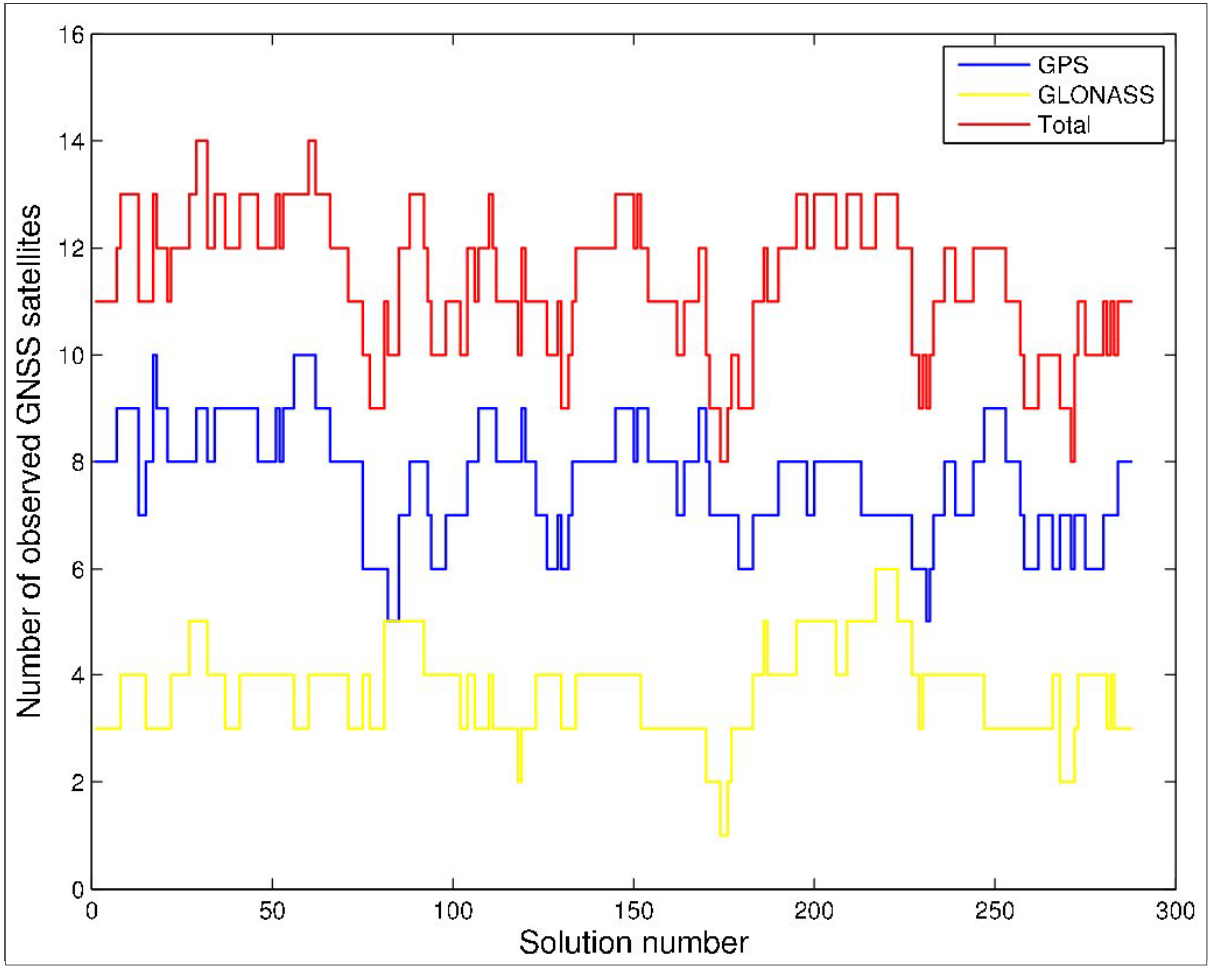
- Considered observations:
  - L1&L2 phases
  - Divided into 288 observation pieces, covering 5 min (11 epochs) each
  - Analyzed GNSS systems: **GPS-only** or **GPS/GLONASS**
  - *Elevation mask angle* used as deciding selection criterion
  - Elevation-dependent observation weighting generally adopted
- Ionosphere modeling:
  - CODE GIM model (to model deterministic part)
  - *Stochastic ionosphere parameters (SIPs)* set up with respect to each epoch and GNSS satellite involved, imposing elevation-dependent a priori constraints (of 1 cm SD delay on L1 phase at zenith)
- Troposphere modeling:
  - No troposphere ZPD parameters set up (just using a standard troposphere model)
- All introduced LAMBDA ambiguity resolution schemes tested (applying the *LAMBDA4* Fortran module)
- Handling of the GNSS ambiguity parameters on the SD level (!)
- Resulting baseline vector and relevant analysis parameters stored

ZIM2-HUTT Baseline Vector Repeatability on the Basis of GPS/GLONASS



Minel: 15 deg

Number of Observed GNSS Satellites



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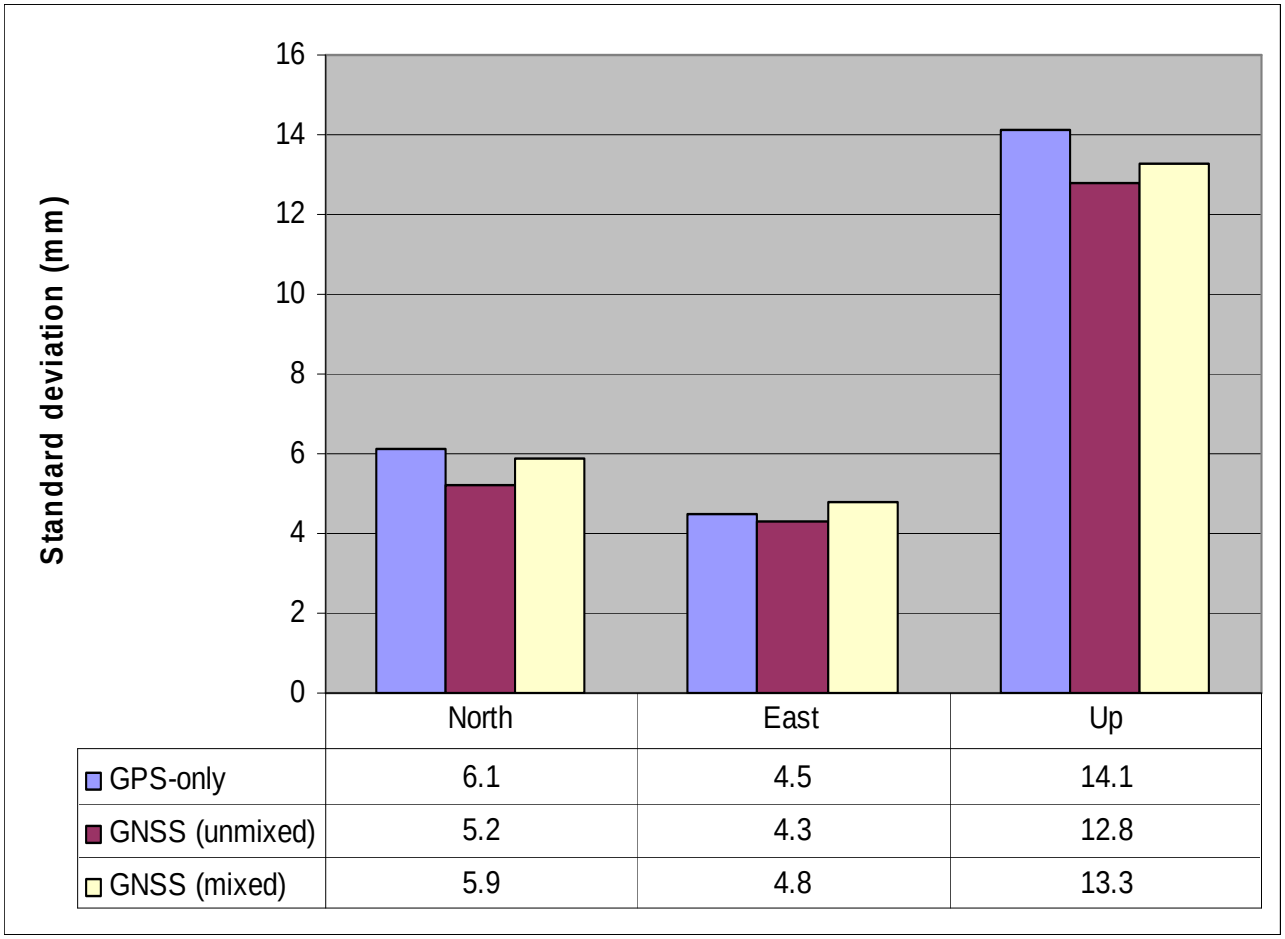
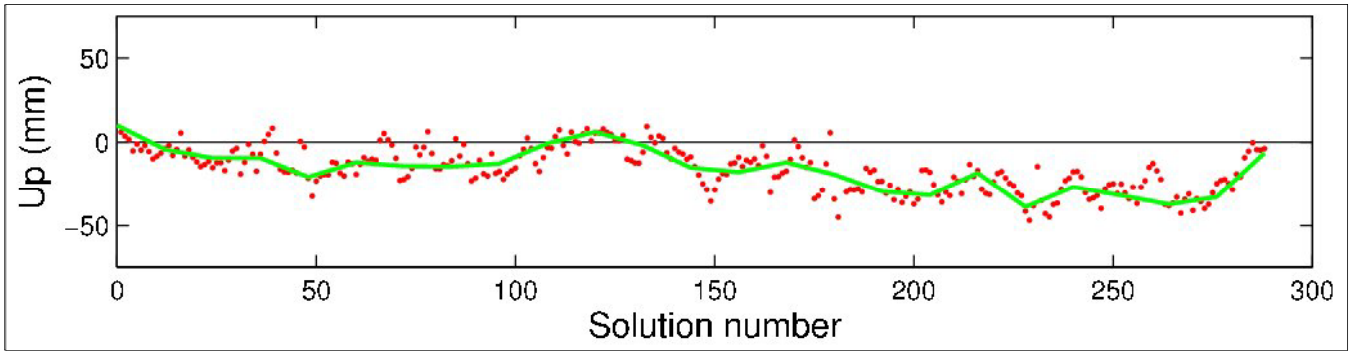
Statistics of ZIM2-HUTT Baseline Vector Repeatability Results (1)

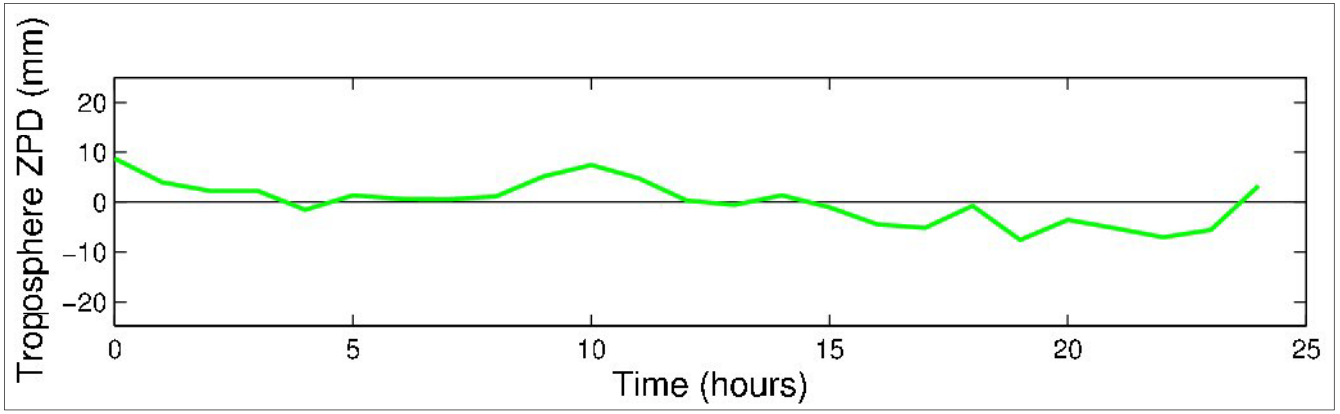


	North	East	Up
GPS-only	6.1	4.5	14.1
GNSS (unmixed)	5.2	4.3	12.8
GNSS (mixed)	5.9	4.8	13.3

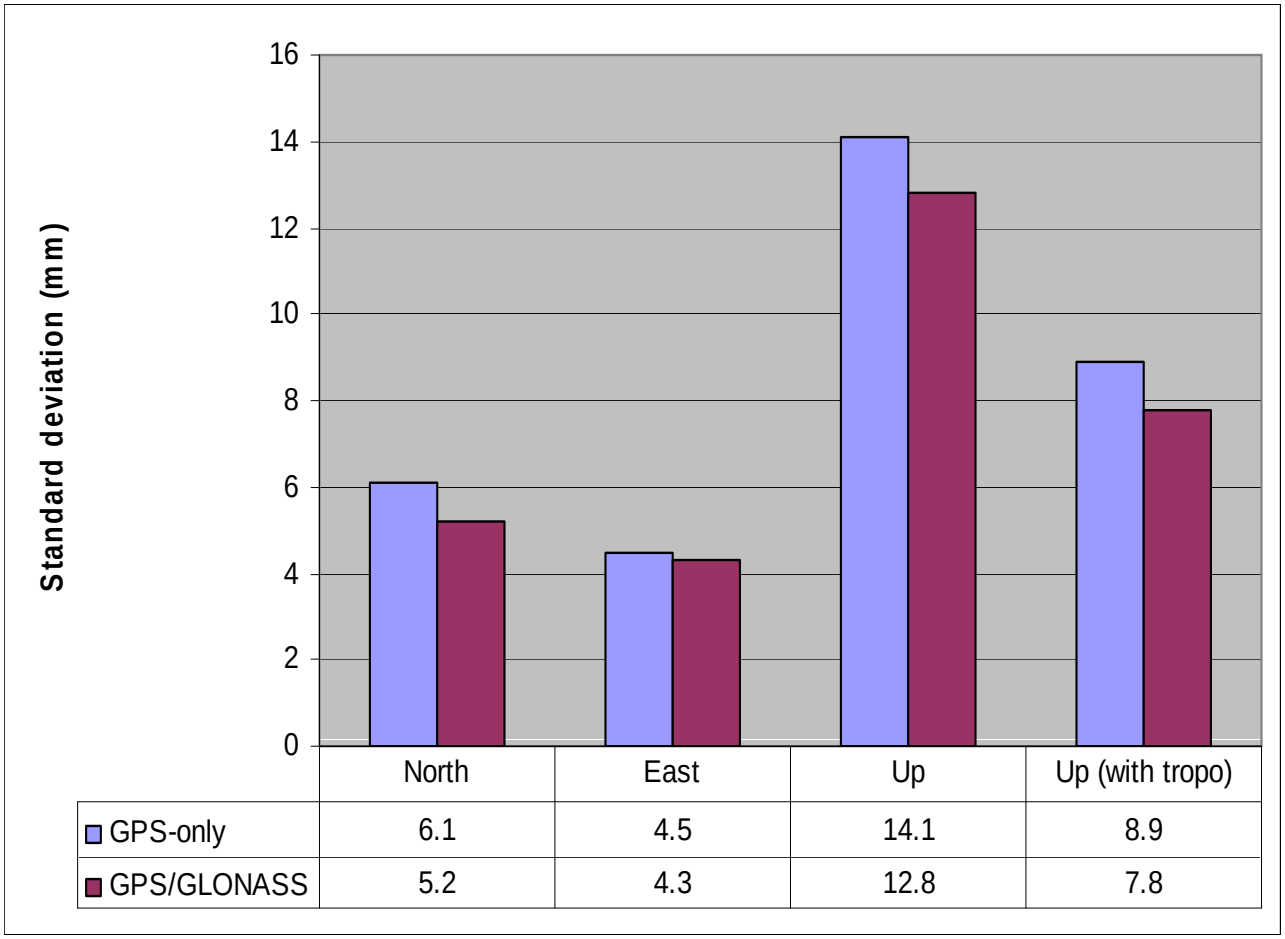
Minel: 15 deg

Remark on Baseline Vector Repeatability Results for Up Component





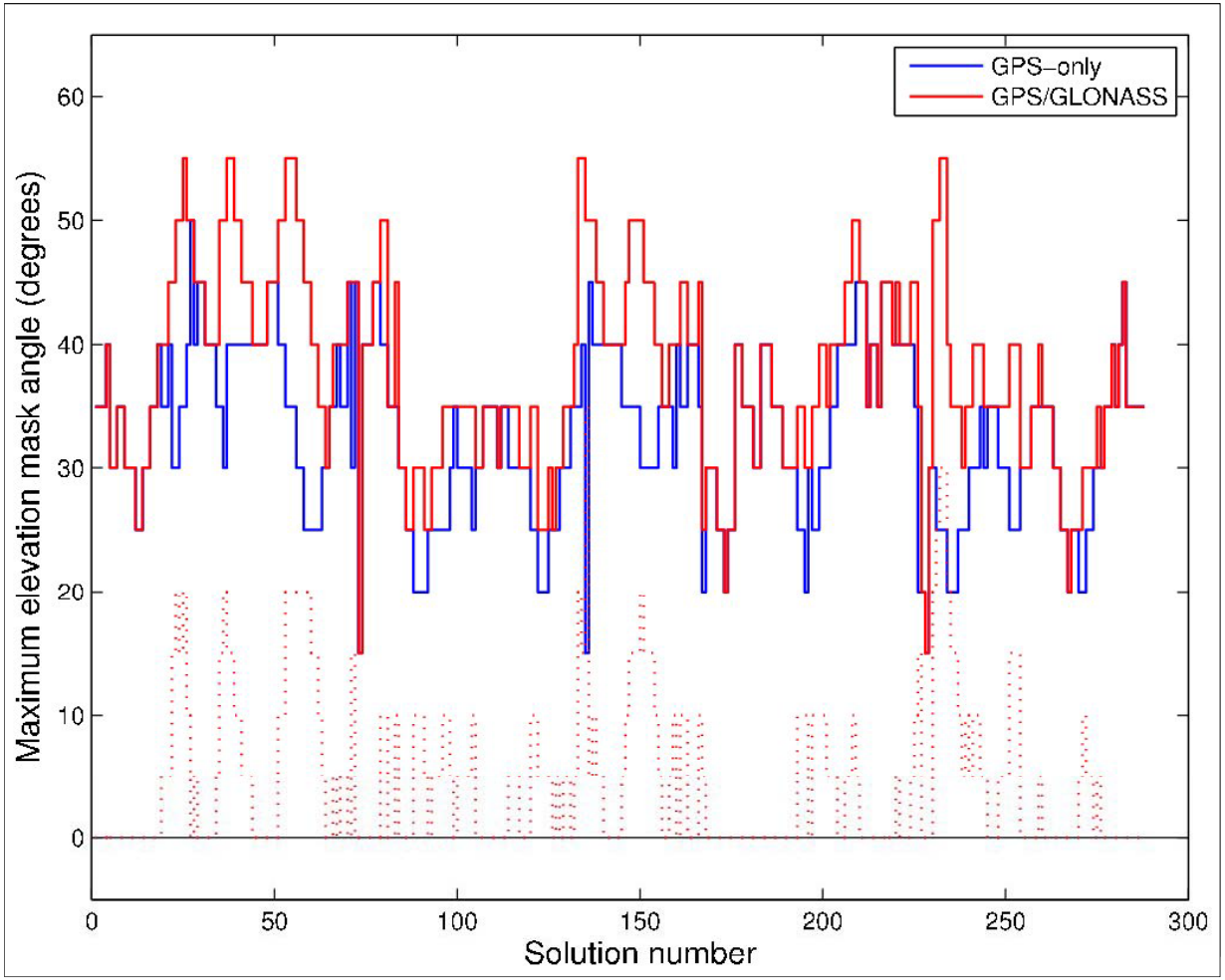
Statistics of ZIM2-HUTT Baseline Vector Repeatability Results (2)



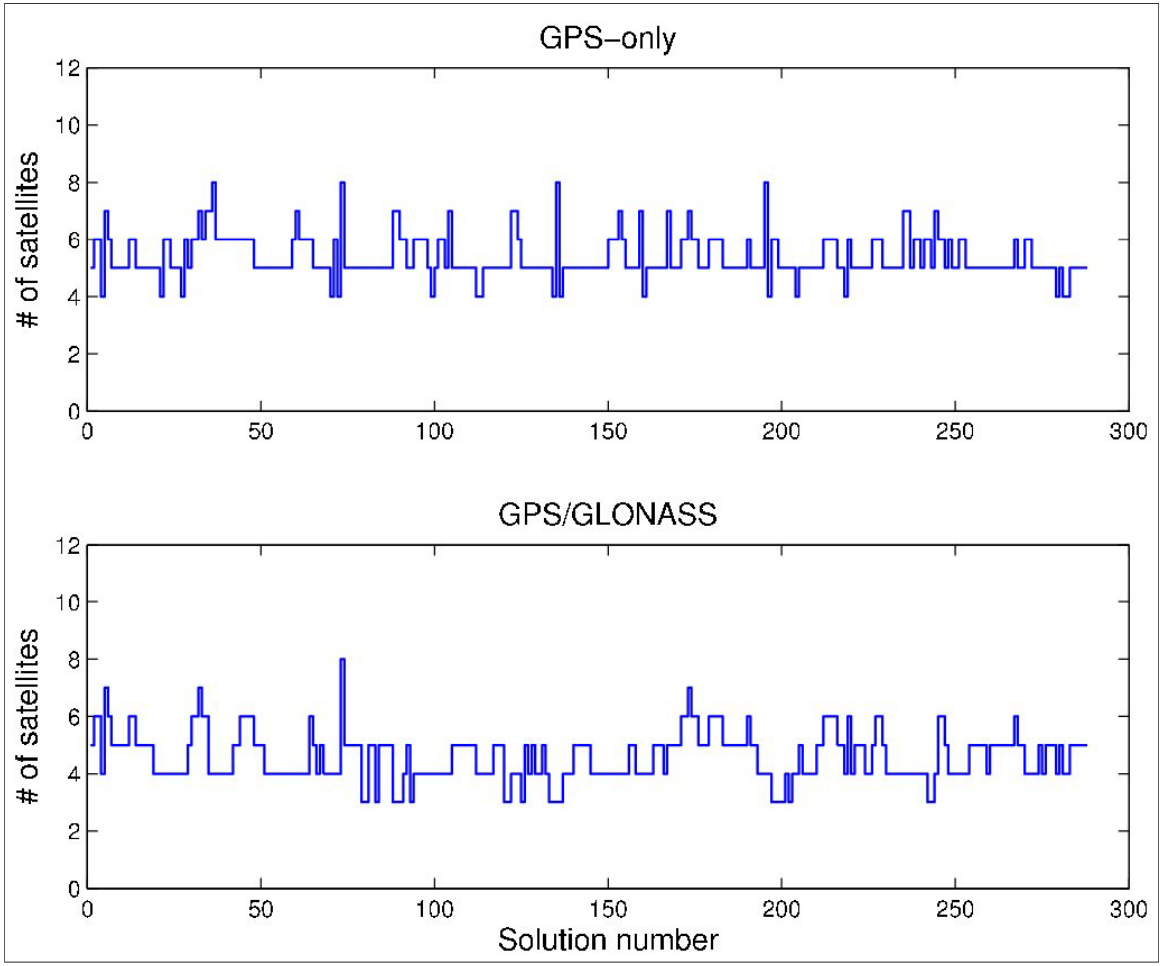
	North	East	Up	Up (with tropo)
GPS-only	6.1	4.5	14.1	8.9
GPS/GLONASS	5.2	4.3	12.8	7.8

Minel: 15 deg

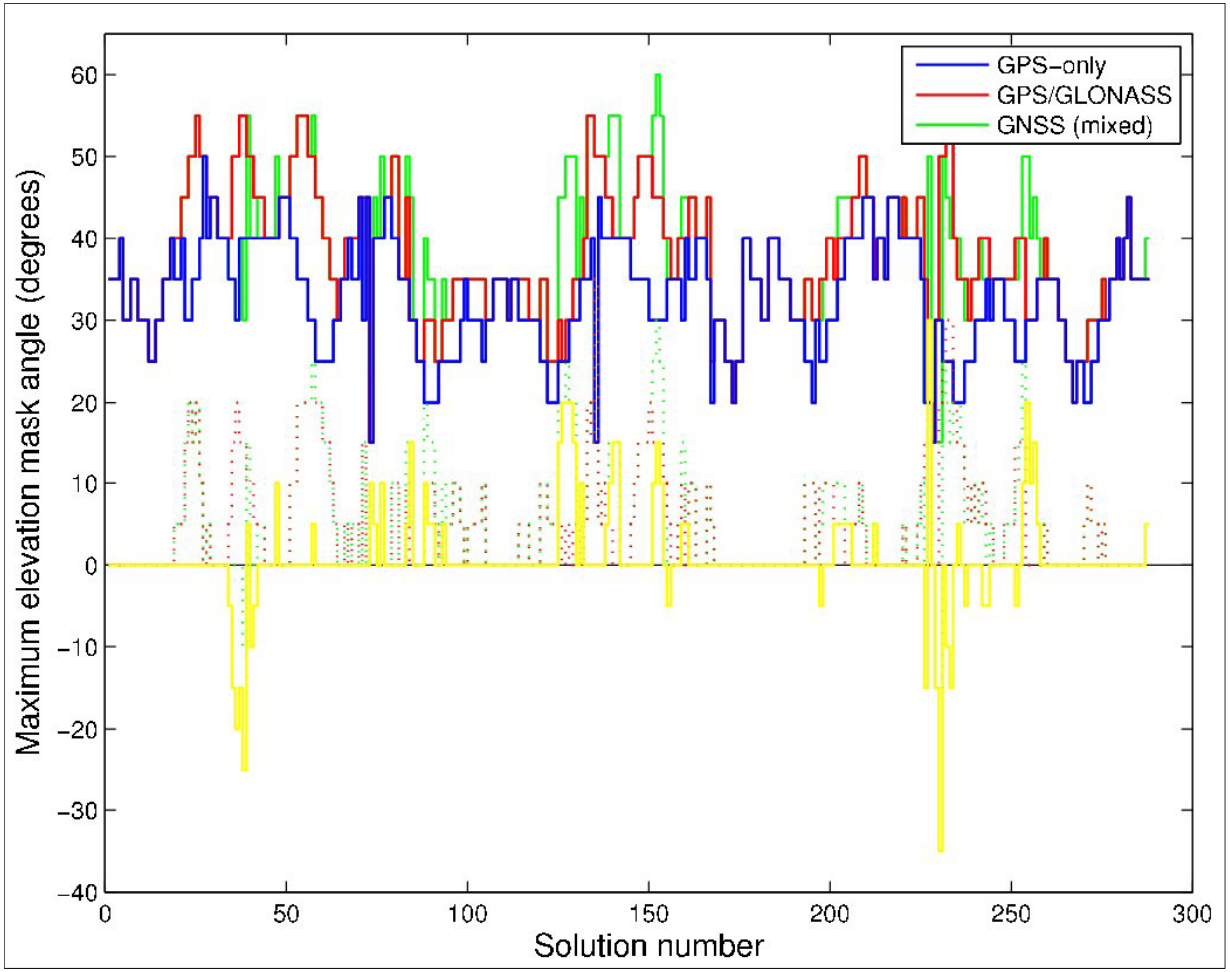
Maximum Elevation Mask Angle With Successful GNSS LAMBDA Ambiguity Resolution (1)



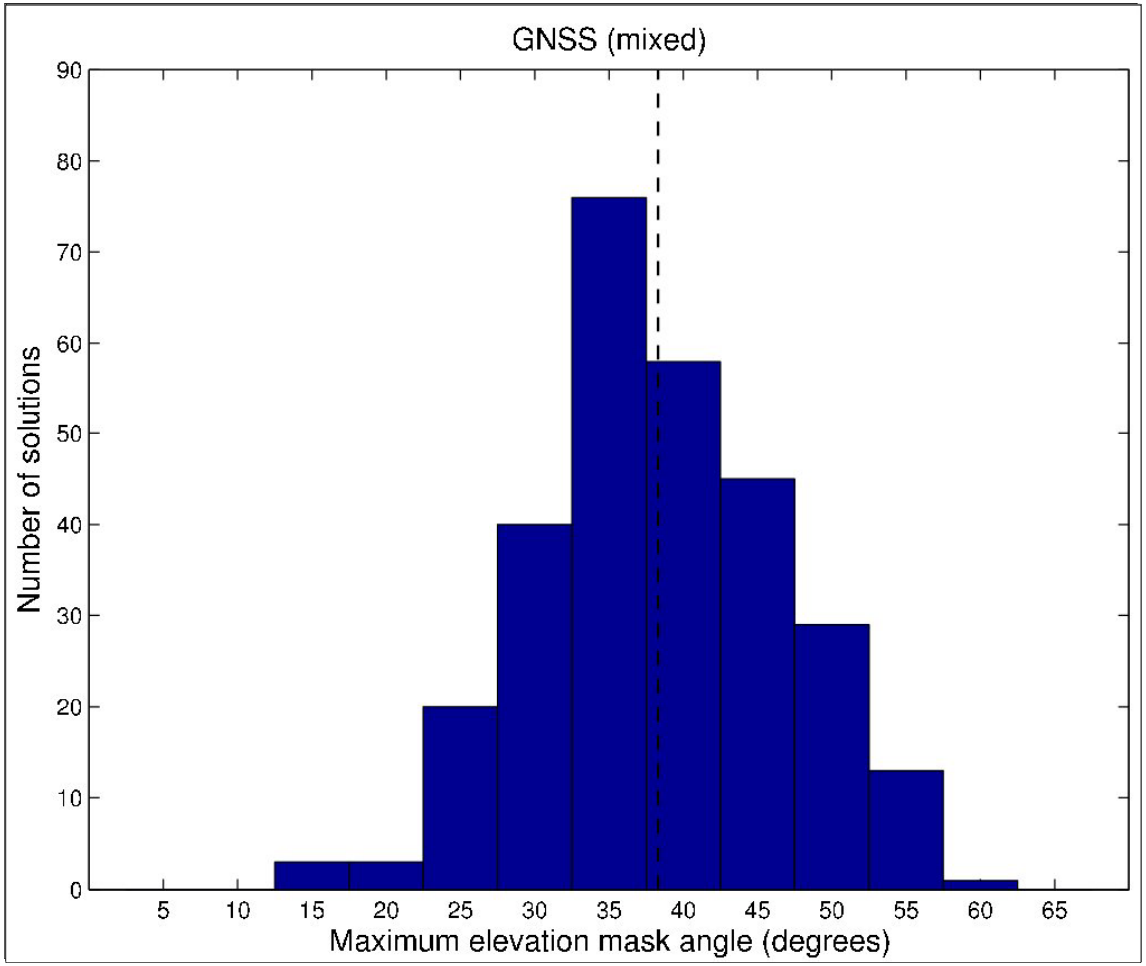
Number of Observed GNSS Satellites Above the Maximum Elevation Mask Angle



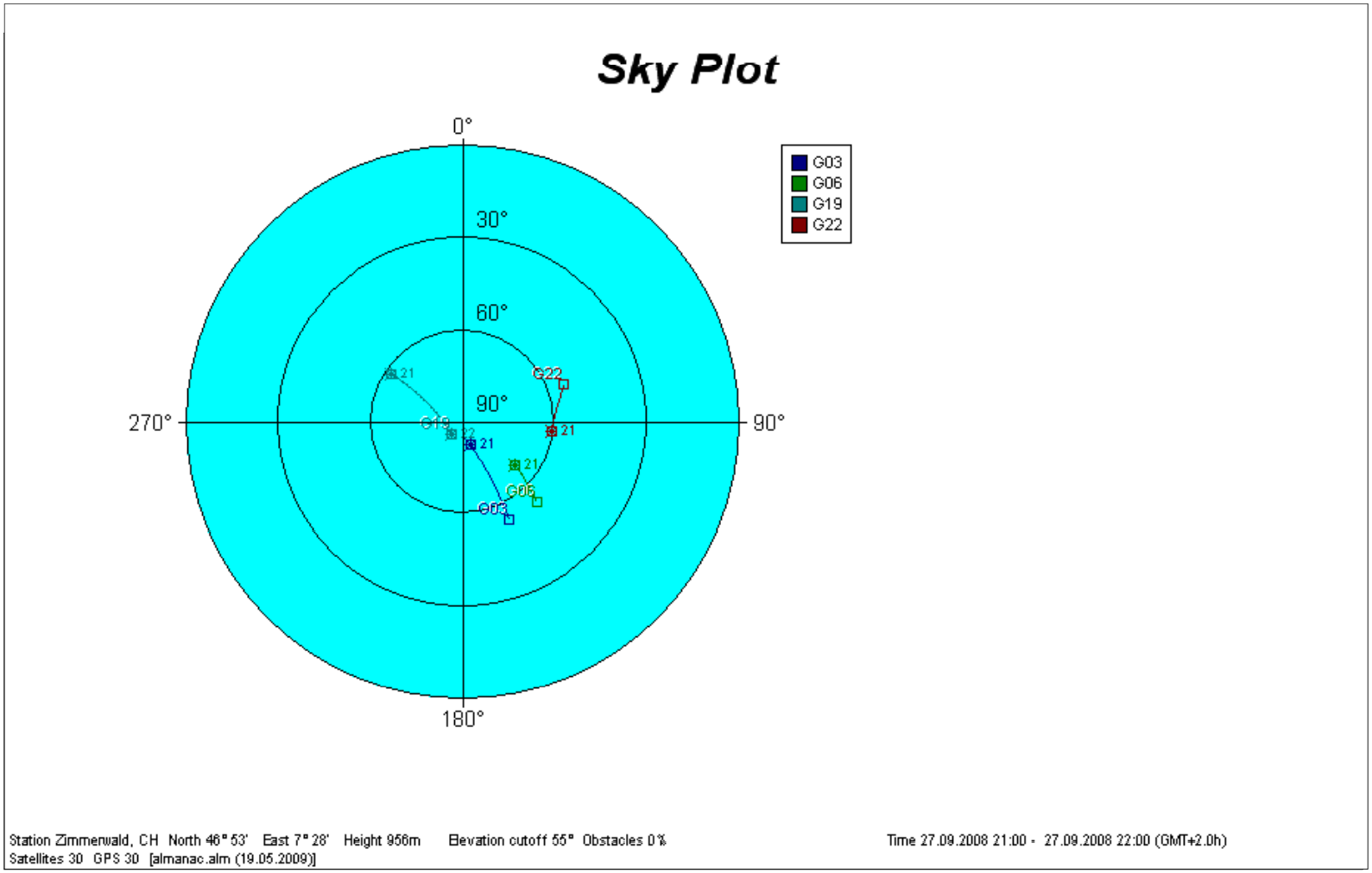
Maximum Elevation Mask Angle With Successful GNSS LAMBDA Ambiguity Resolution (2)



Histograms of Resulting Maximum Elevation Mask Angles



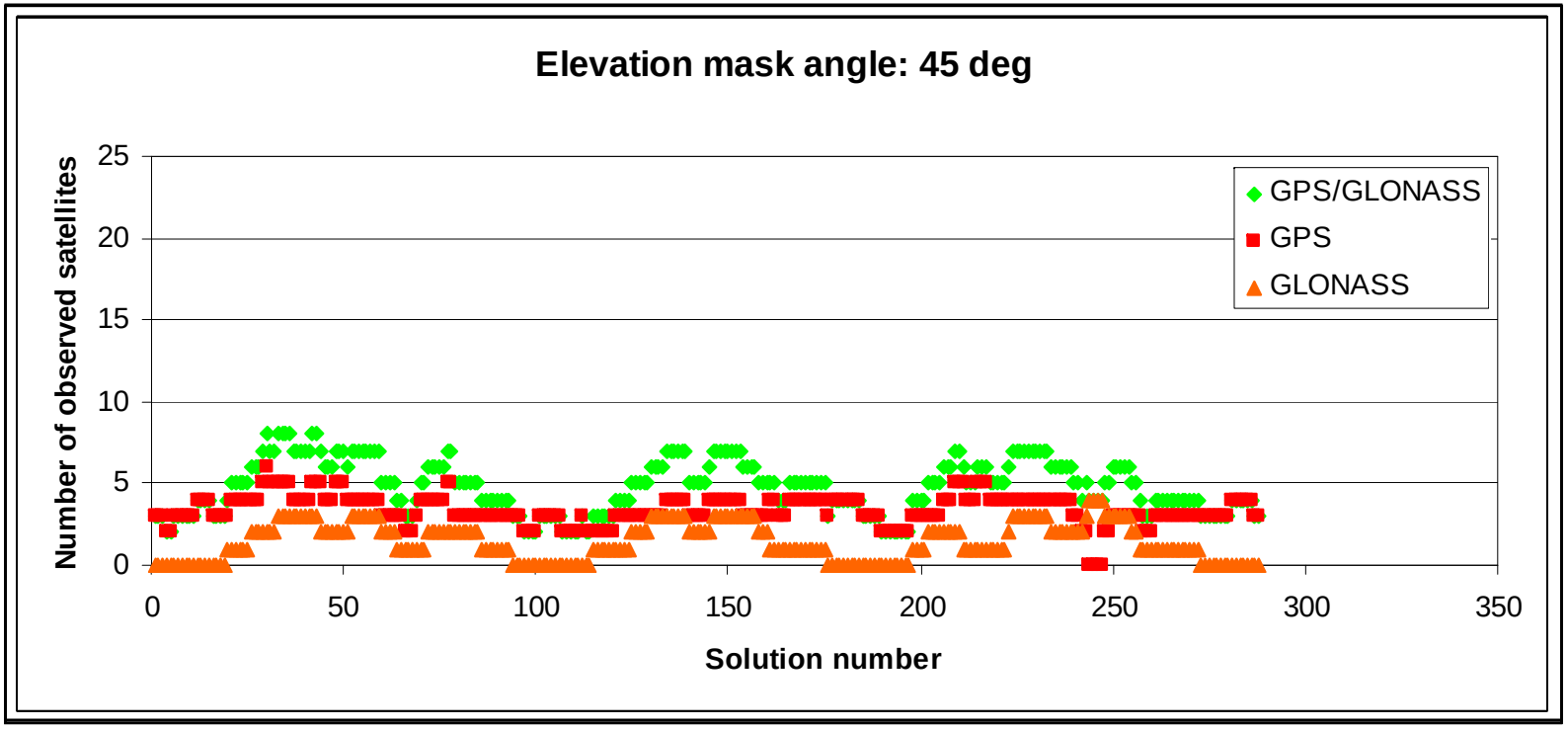
Sky Plot of Visible GPS Constellation, for 27 September 2008, 19-20 UT



Conclusions

- The implemented LAMBDA ambiguity resolution does work in the GPS-only as well as in the GPS/GLONASS-combined case.
- GPS/GLONASS-combined performance is better in terms of
  - baseline vector determination and
  - **availability** (a function of the number of satellites in view).
- Additional tests processing GPS/GLONASS observation data of receiver-mixed baselines were successful.
- Important point is: handling of the GNSS ambiguity parameters on the **single-difference (SD)**, not double-difference (DD) level.
- Intersystem GPS-GLONASS DD ambiguities should **not** be fixed to integers.
- The presented development is transferable without restriction to **multi-GNSS** LAMBDA ambiguity resolution.
- Note: Multi-GNSS ambiguity resolution is of great importance in the face of the *potential drop in the number of healthy satellites* in the GPS constellation as a result of the delay in the Block IIF program.

Number of Observed GNSS Satellites



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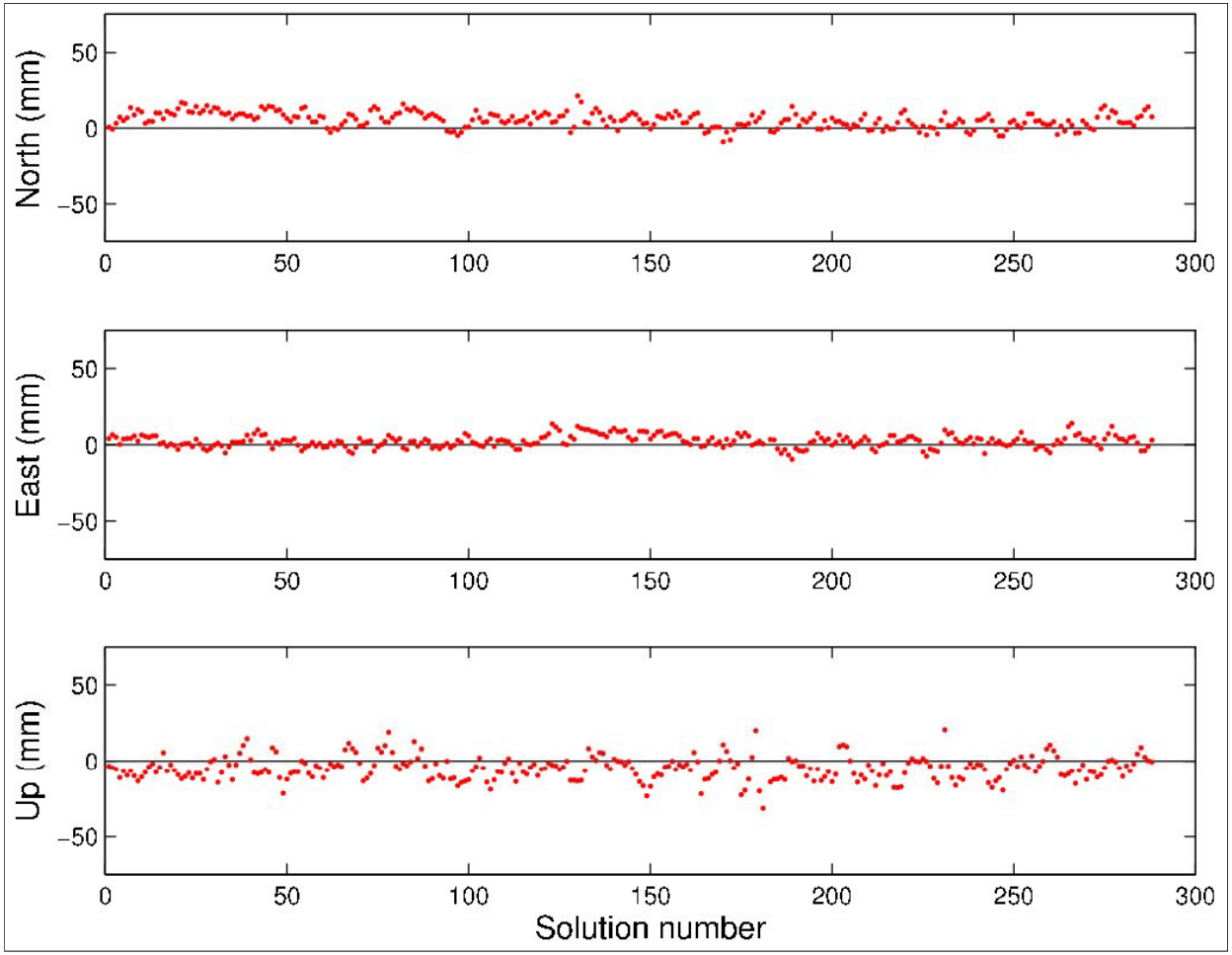

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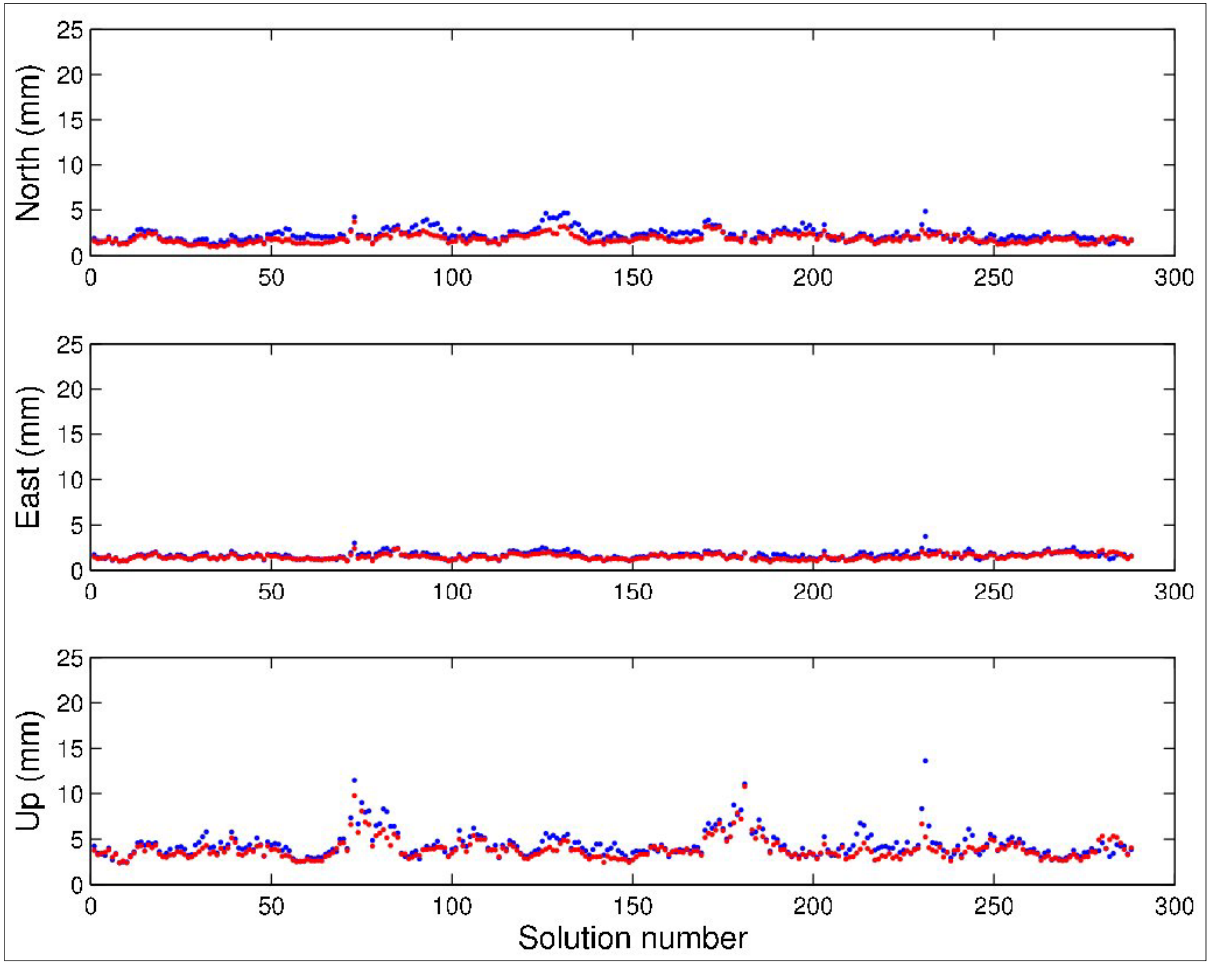
Formal Accuracy of Ambiguity-Fixed 5-Minute Solutions



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Outline

- Introduction
- Implementation of a “GNSS-capable” LAMBDA ambiguity resolution scheme(s)
- Test data set and processing options
- Discussion of the results
- Conclusions