

GNSS Analysis with Galileo Observations in the Subnetwork of the BEK Analysis Centre

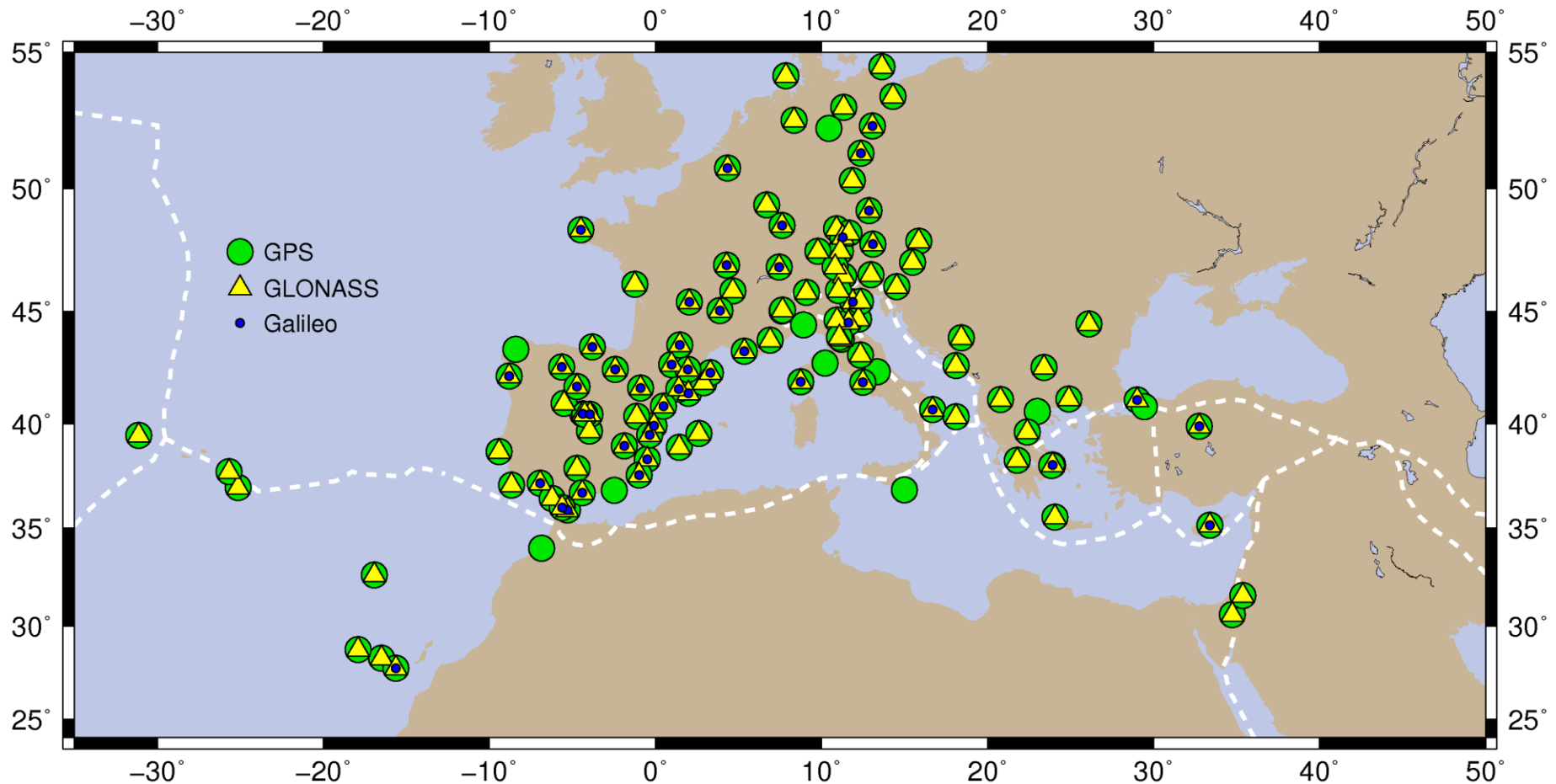
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- Analysis follows the EPN guidelines for ACs
- The operational analysis is performed with GPS and GLONASS observations only
- Since September 2017 (GPS-Week 1975) also Galileo is analysed with Bernese 5.2 as an additional product (3Char-Id.: BEX)
- This product is not included in the combination of the final EPN products (based on the recommendations of the last AC workshop)
- The presentation will focus on the inclusion of Galileo data in the BEK subnetwork and will discuss its impact



Beidou, QZSS and SBAS are not considered here

- Checking RINEX3 availability (RINEX3 is recommended for Galileo)
- Use long long file names for the RINEX3 observations
 - (e.g. WTZR1220.18O ->
WTZR00DEU_R_20181220000_01D_30S_MO.crx.gz
- Replace RINEX2 observation files by RINEX3 files of the same site
- Use MGEX (**M**ulti **G**NSS **E**Xperiment) products from CODE (\$D/COM), Satellite orbits and ERP
- The GFZ-Tool [gfzrnrx](#) might be used in the future to convert RINEX2 into RINEX3 and create long filenames

System	1975 / 2017		1999 / 2018	
	Sites	# SV	Sites	# SV
GPS	54/54	32	59/59	32
GLONASS	53/54	26	58/59	25
Galileo	51/54	18	58/59	19
Beidou	35/54	18	42/59	24
QZSS	2/54	2	3/59	4
SBAS	26/54	14	31/59	14

Remaining Galileo observations in RINEX-2 files:

COBA, KELY, LROC, SALA ,SCOR, SFER, SJDV

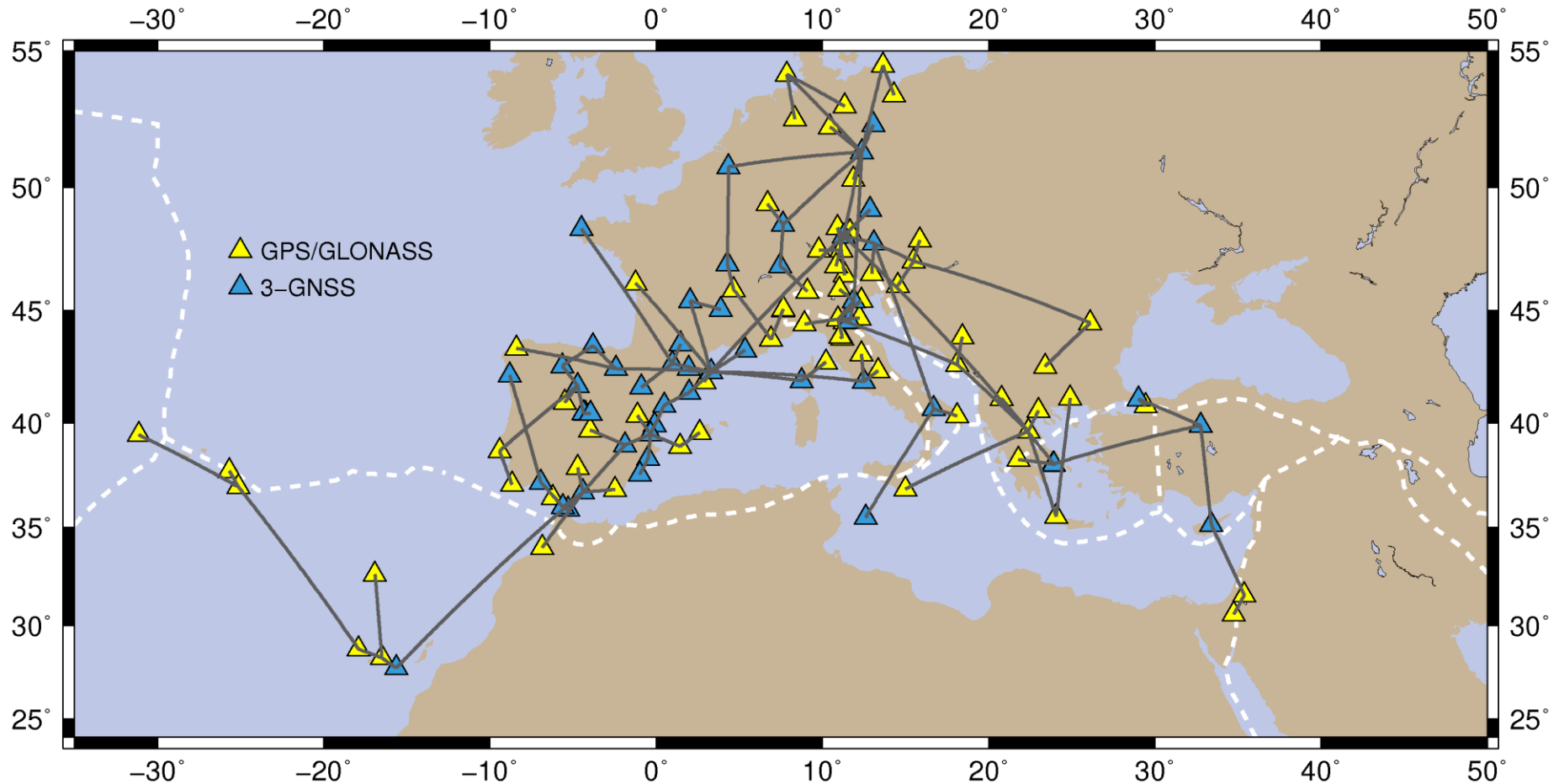
Conversion with *gfzrn*x is possible, but not tested yet.

Some measures have to be taken prior to the analysis:

- Define OBS_GAL.SEL for signal selection (multi to dual frequency)
- Adopt INPUT-file for RNXSMT (add Galileo)
- Check file *RECEIVER*. and include Galileo (“GRE”) for the following receivers:
 - JAVAD: TRE_G3TH,
 - LEICA: GRX1200+GNSS, GR10, GR25, GR30 & GR50
 - Septentrio: POLARX4, PolarX4TR, and POLARX5
 - Trimble: NETR9
- Use release 2017-08-28 of Bernese 5.2!

- Galileo-PCV-Corrections for receiver antennas are only partially available
- A large number of receiver antennas needs to be recalibrated (GPS/GLONASS only available)
 - Robot or chamber calibrations
- In this study the PCV for Galileo signals for ground antennas are replaced by GPS (L_1/L_2)
- Offsets for the transmitting Galileo antennas were estimated by two ACs (GFZ and DLR, see Steigenberger et al. 2016)
- The meta data provided through **IGS14_IOV.atx** and **ANTEX_GAL_FOC_IOV.atx** are not considered

Network of Baselines (BEX)

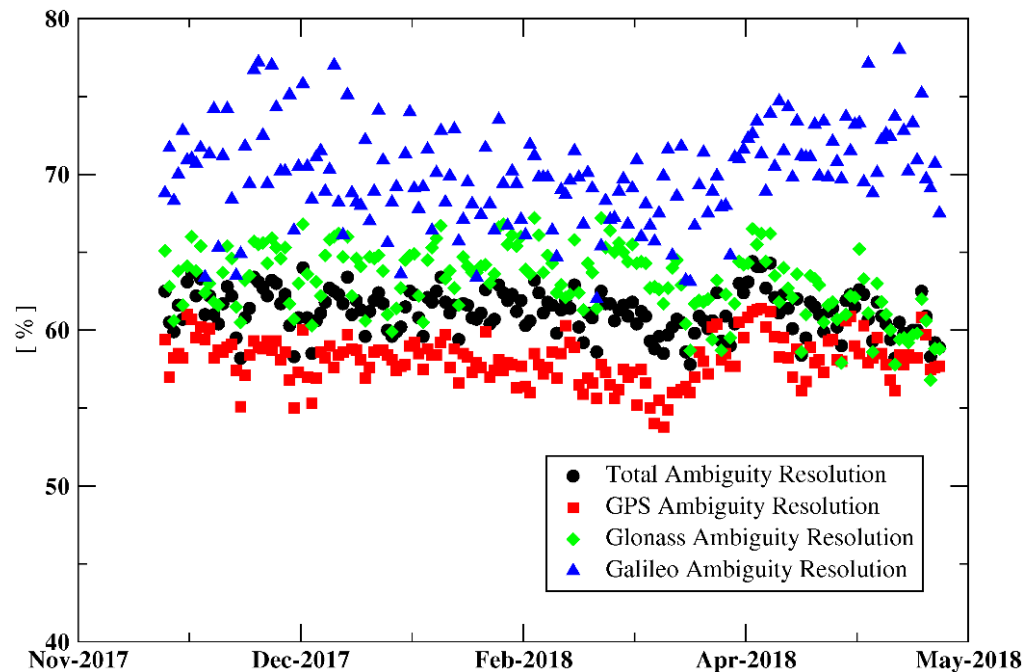


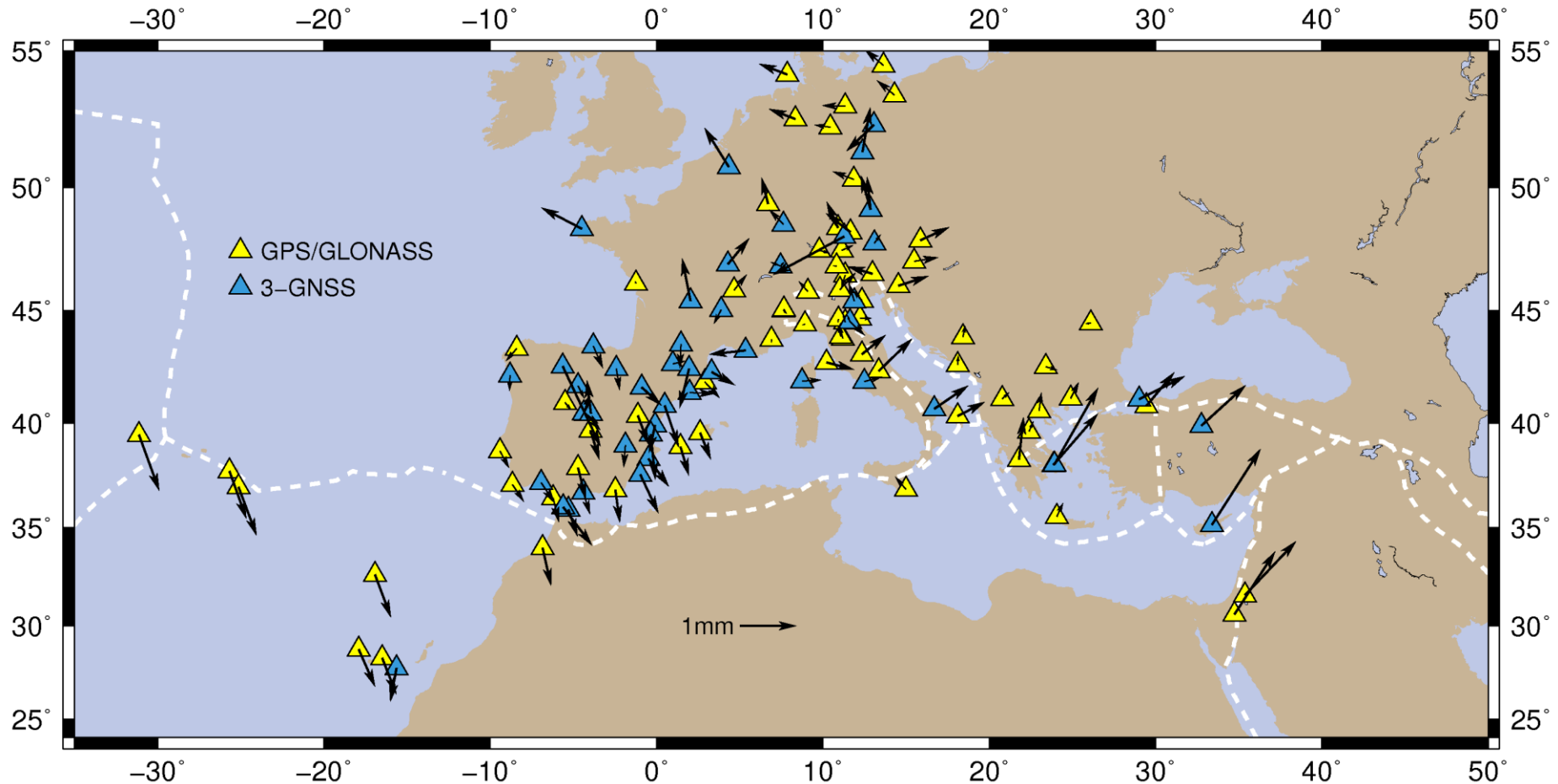
Observations:

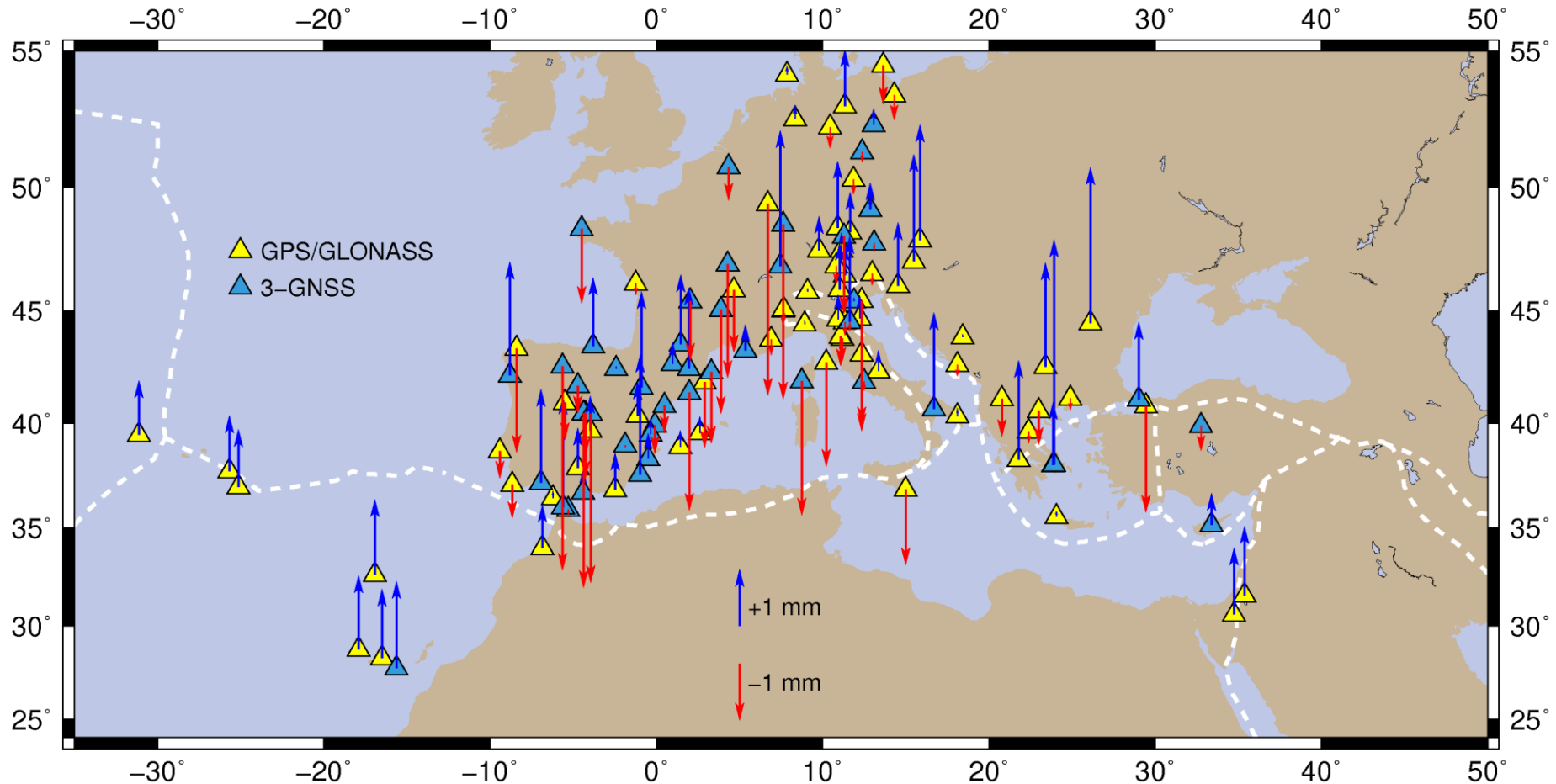
System	SVs per Epoch	3-GNSS Stations	Entire mixed Network
GPS	8.1	43 %	57 %
GLONASS	6.3	33 %	32 %
Galileo	4.4	24 %	11 %

Ambiguity Resolution Rate - Week 1975-1995:

System	Amb.-Resolution
GPS	$58.1 \pm 1.5 \%$
GLONASS	$63.1 \pm 2.2 \%$
Galileo	$70.1 \pm 3.1 \%$
Average	$61.2 \pm 1.4 \%$





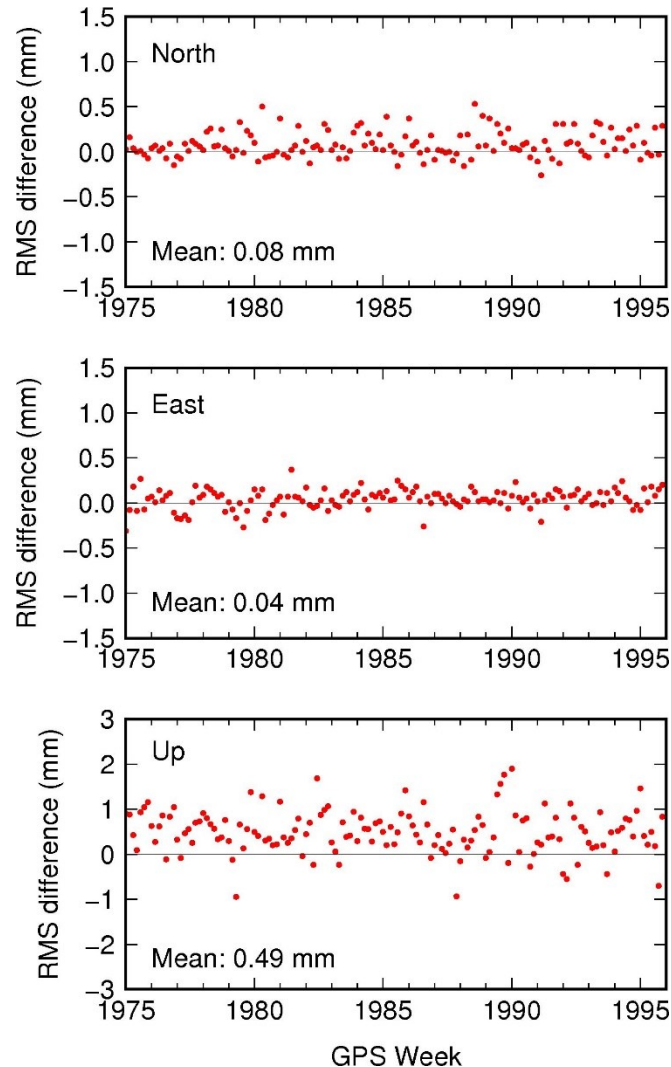


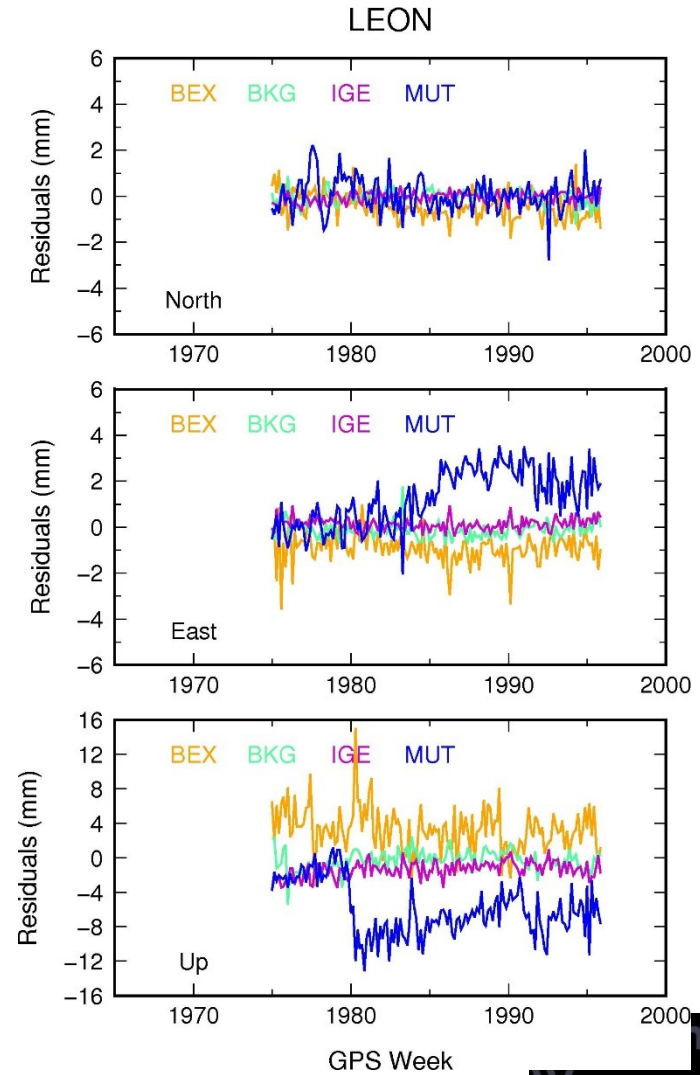
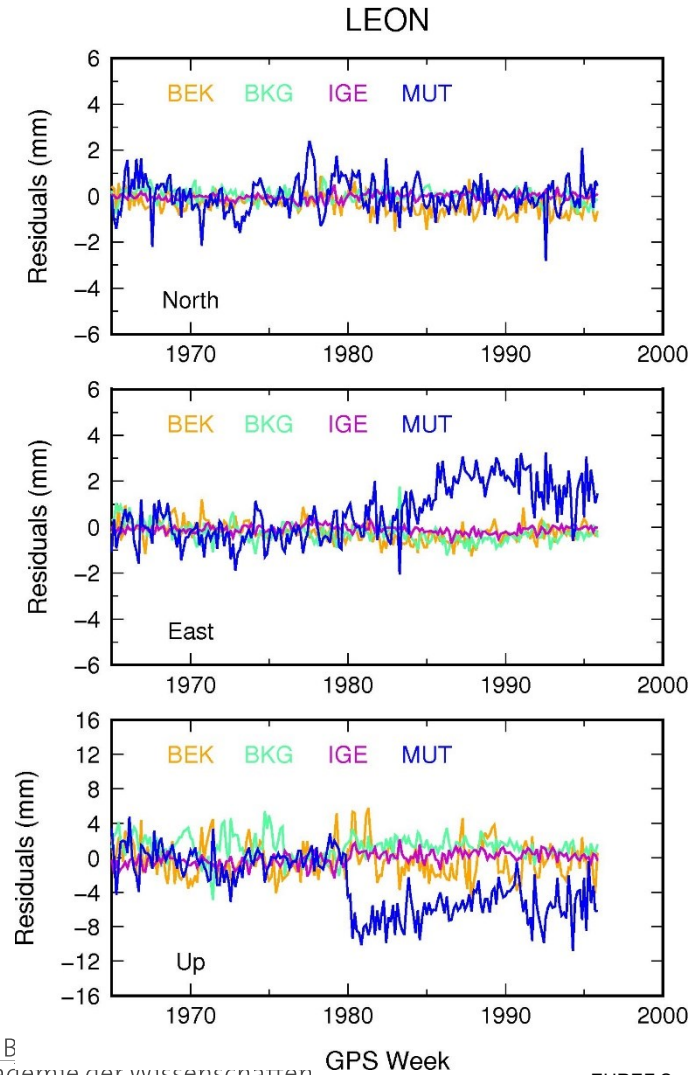
- BEX (3-GNSS) daily solutions were combined with operational EPN AC solutions (15 ACs) for a period of 21 weeks (GPS weeks 1975–1995)
- Position residuals obtained for new (BEX) and operational (BEK) daily solutions with respect to combined solutions are compared
- The impact of new solutions on combined positions was also inspected

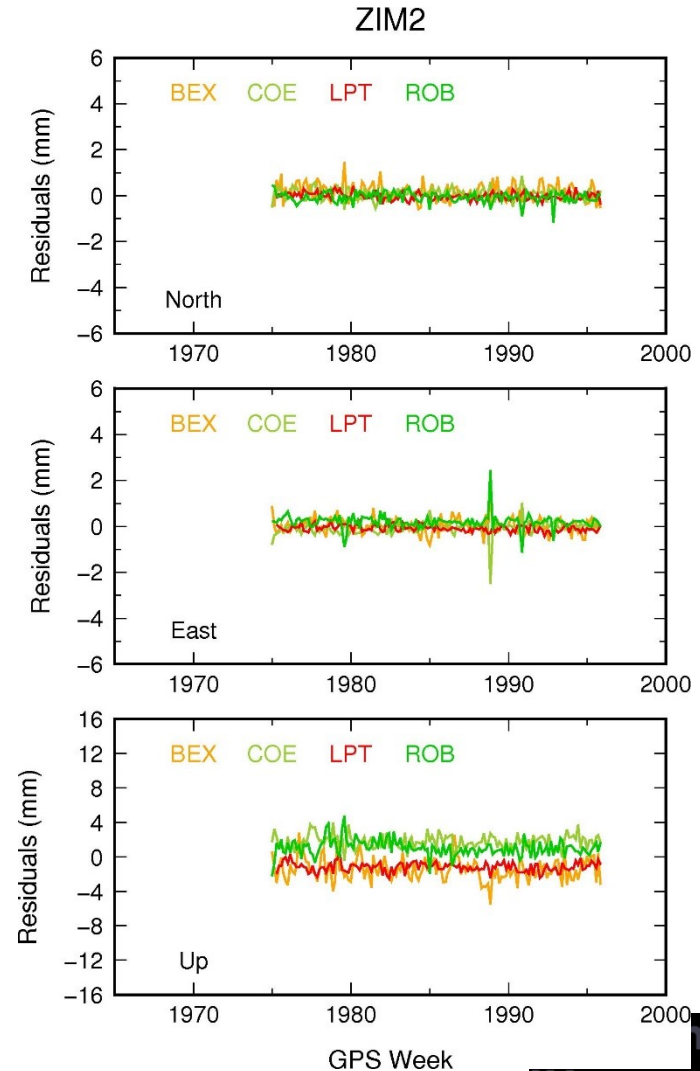
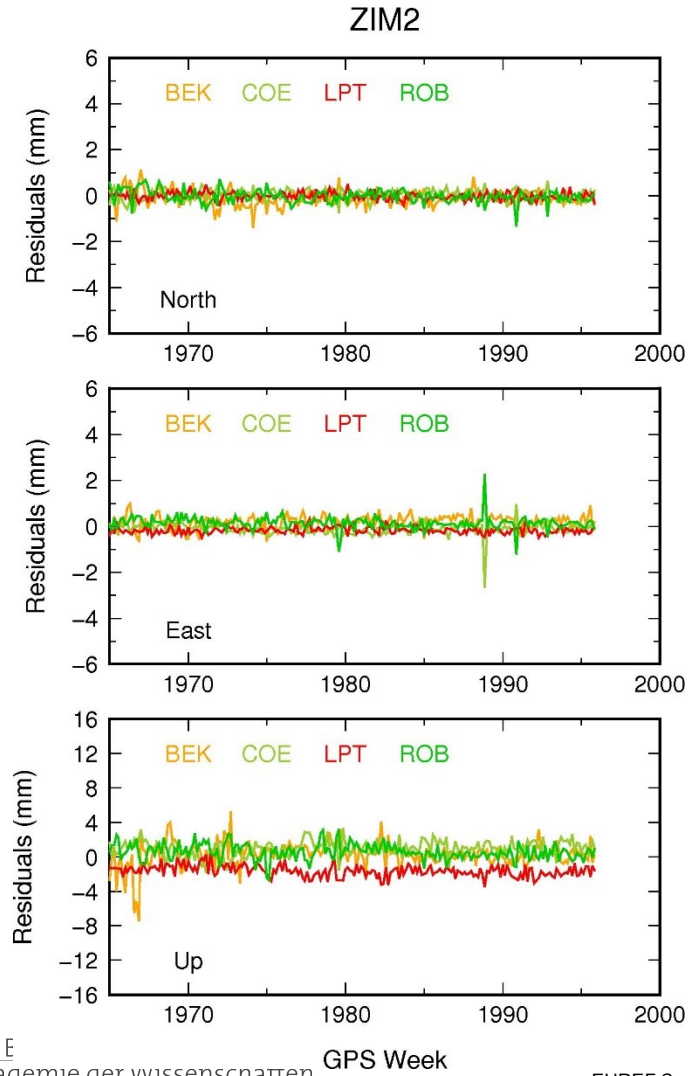
Mean RMSs of daily station position residuals with respect to combined solutions:

Solution type	North (mm)	East (mm)	Up (mm)
BEX (with Galileo)	0.51	0.47	2.08
BEK	0.43	0.42	1.59
Ratio	1.19	1.12	1.31

- For each BEK and BEX daily solution, station position residuals are computed wrt. to the resulting combined solution.
- On the basis of the residuals, RMS were computed for each BEK and BEX solution.
- Differences in RMS are shown in the right figure

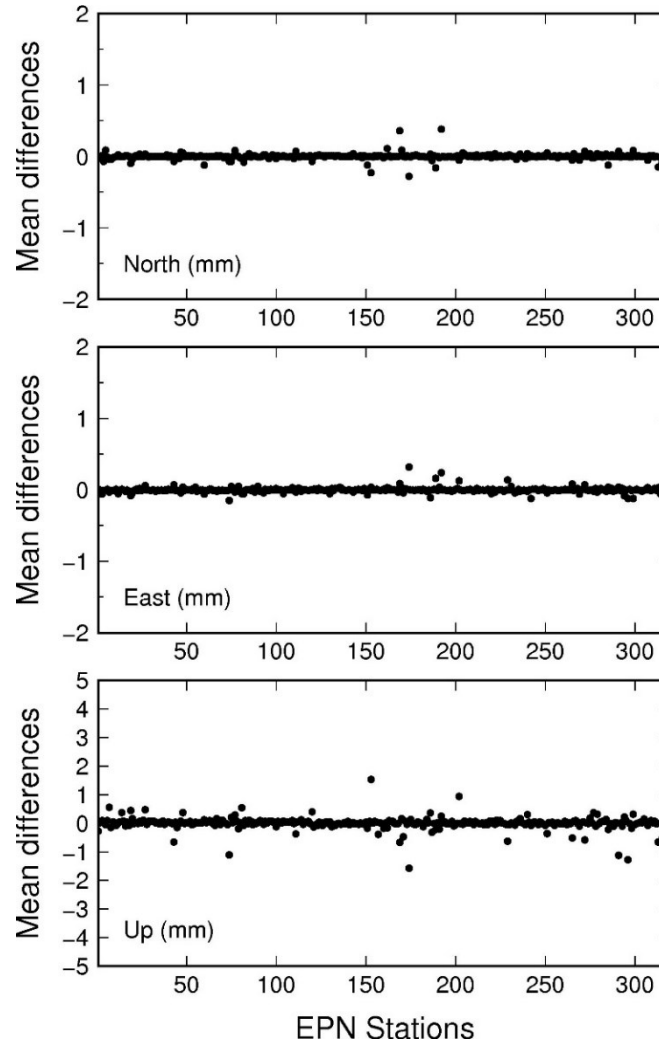






Mean position differences between combined positions obtained with:

- new (BEX-3GNSS) and
- operational solutions (BEK-2GNSS)



- The analysis of Galileo observations can be easily integrated in Bernese 5.2
- The mean RMS of new BEX solutions with respect to combined solutions is slightly higher than the RMS of operational solutions
- The impact of new solutions on mean combined positions is small, and does not exceed 0.5 mm in horizontal components and 2 mm in the vertical component
- Only a few antennas are calibrated for Galileo signals, which remains as a big problem
- The full integration of Galileo data into the operational analysis requires the complete correction models for the Galileo observations