GNSS Analysis at the BEK AC

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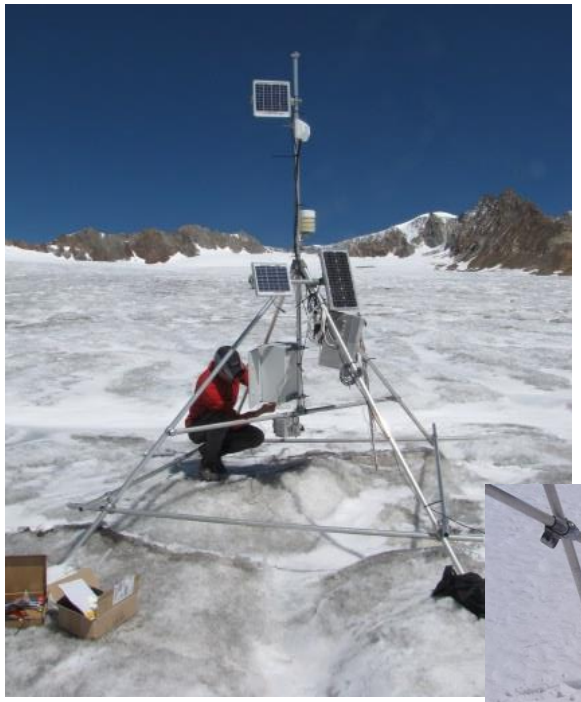
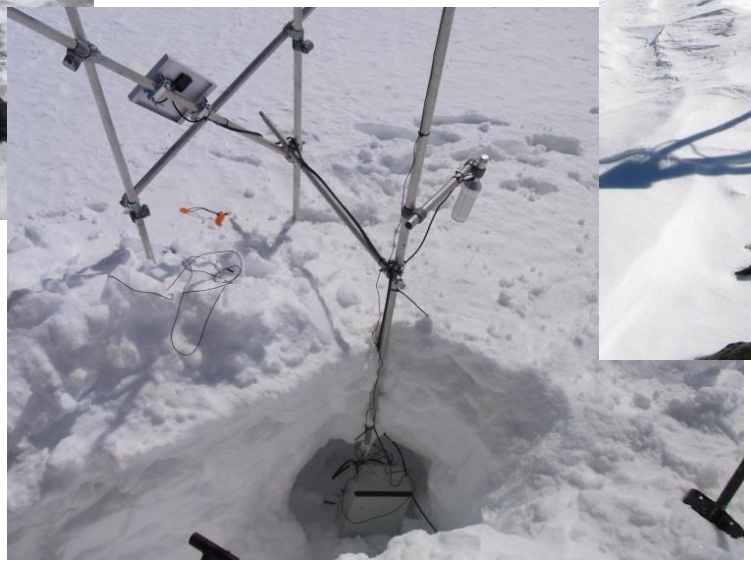
Project Geodesy and Glaciology

From BEK to Project on “Geodesy and Glaciology“

- ***B**ayerische **E**rdmessungs **K**ommission* (BEK) founded at the BAdW in 1868 within the international project “Mitteleuropäische Gradmessung”
- Since 1980 financed through the „Akademienprogramm“ (foreseen until 2030)
- The German Council of Sciences and Humanities (WR) proposed 2004 that funding by the “Akademienprogramm” will only be provided for Humanities and not for Natural or Engineering Sciences
- Response: Joining the BEK and Commission for Glaciology and forming the Commission on Geodesy and Glaciology (**KEG**) in 2010
- Reforming the BAdW 2013
  - Changing from “Commissions” to “Projects”
- Today: **Project Geodesy and Glaciology** with Emphasis on Glaciology

Impressions from the new research field





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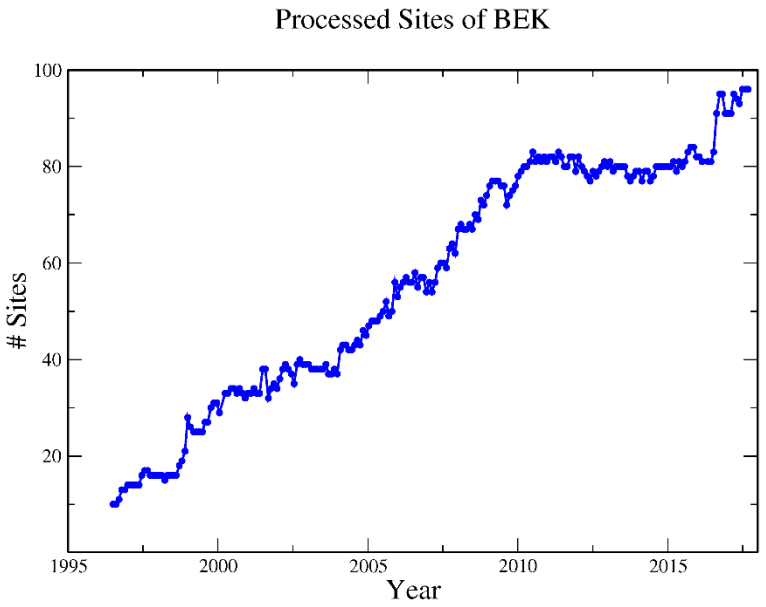
BEK as Analysis Centre (AC)

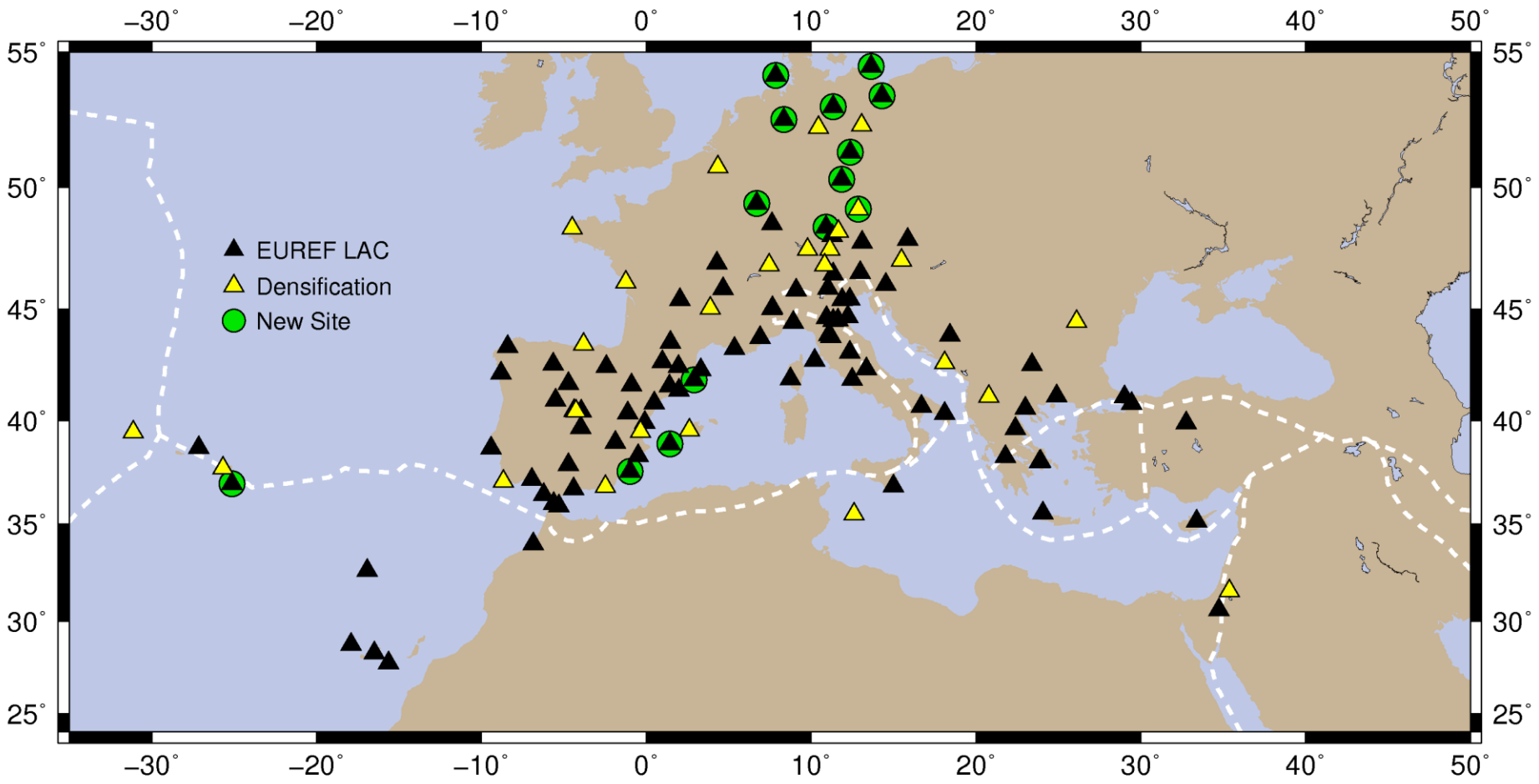
- First contributions from 1996 to 2001 by Walter Ehrnsperger
  - Continuation of RETrig, Satellite Network West
- The focus of the BEK network is the Mediterranean
- Starting with 13 station in 1996 and enlarging the network continuously
- Last increase of the network carried out by integrating 9 Germans sites (today almost 100 stations are contained in the BEK network)
- Other EPN-Sites used for densification

Non EPN-Sites are also included, these are:

- Alps, special area of interest
- Bavarian SAPOS network
- Other sites



Site Distribution in the BEK-Network



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Analysis at BEK

- Parallel to the standard products also rapid products are provided since April 2010 (Week 1579)
- Analysis is performed on a new Linux computer (*Ubuntu 14.04 LTS*)
  - RAPID since week 19604
  - FINAL since week 1966
- Analysis follows the EPN guidelines for ACs
- CODE – Products are used for the analysis
- The analysis is performed with GPS and GLONASS data
- Individual PCV as available from epnc_14.atx are used
- VMF introduced in week 1967 (Final)

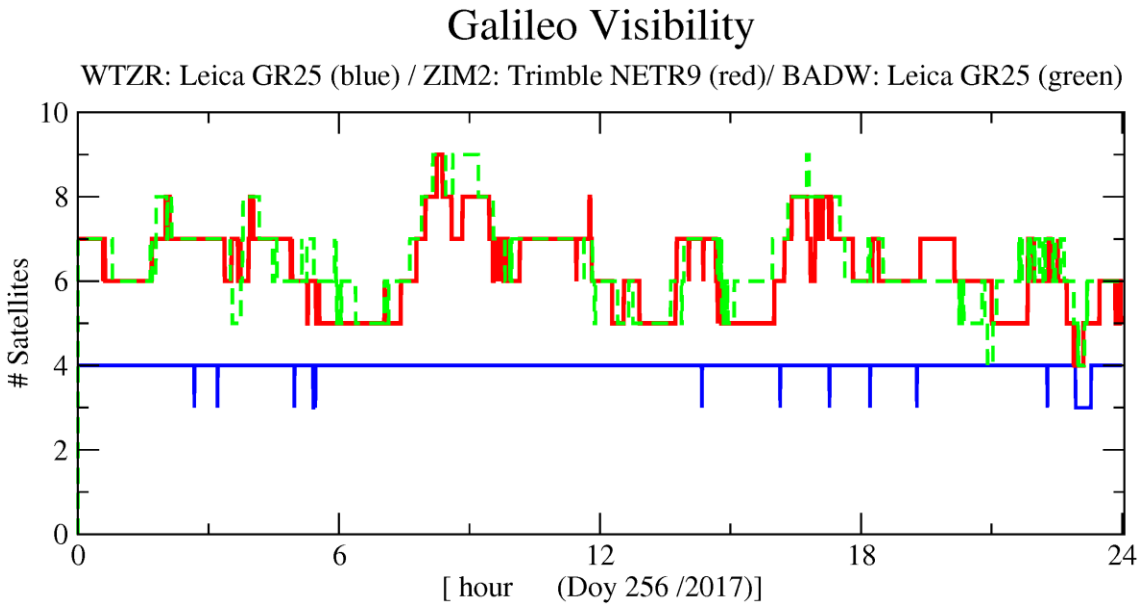
Integrating Galileo

GNSS Satellites:

GPS: 32

GLONASS: 23

Galileo: 18



Galileo Satellites

IOV: 11,12,19, (20)

FOC: 01-05,07-09, 22,(24),26,30

FOCe: 14,18

BEK^{+}-Network:

GPS only:	16
GPS/Glonass:	61
GPS/Glonass/Galileo:	47

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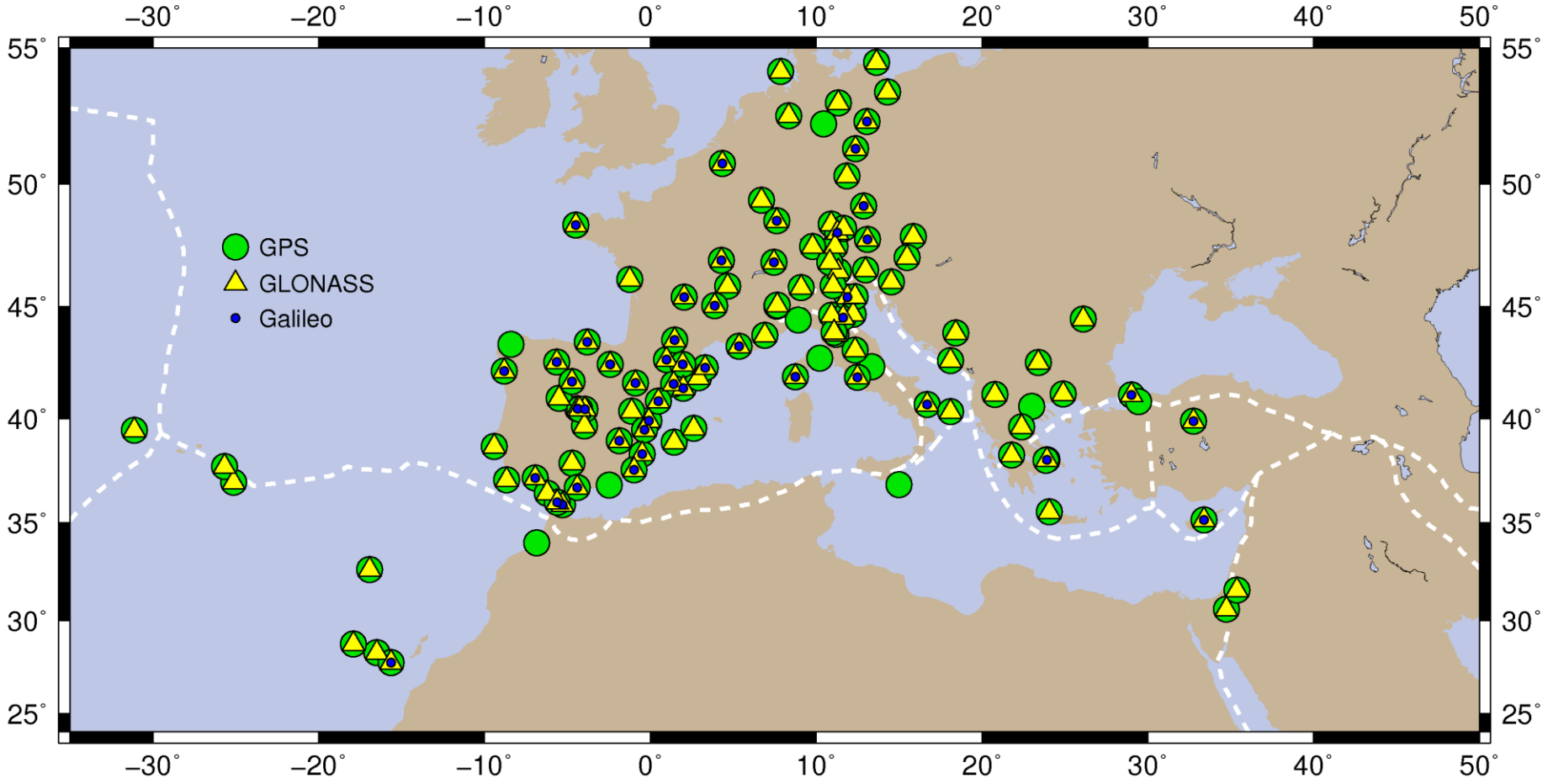
GNSS Availability



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Analysing Galileo using BERNESE 5.2

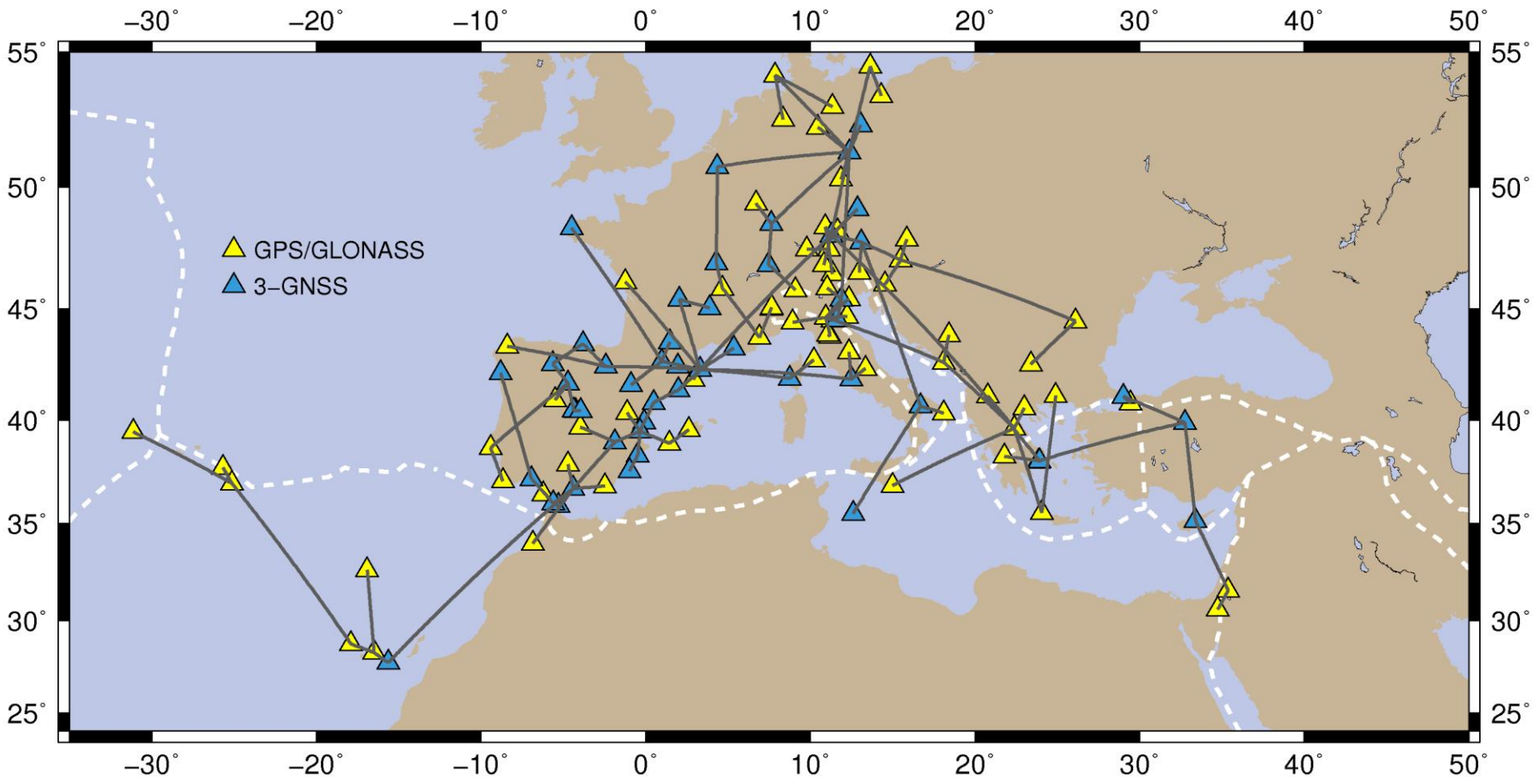
- Checking RINEX3 availability (RINEX3 is recommended for Galileo)
- Using MGEX products from CODE ($D/COM)
- Define OBS_GAL.SEL for signal selection (only dual frequency)
- Adopt INPUT-file for RNXSMT (add Galileo)
- Check file RECEIVER. and include Galileo (“GRE”) for the receivers:
  - JAVAD: TRE_G3TH,
  - LEICA: GRX1200+GNSS, GR10, GR25, GR30 & GR50
  - Septentrio: POLARX4 and PolarX4TR
  - Trimble: NETR9
- Create new PCV table using GPS for Galileo corrections (+ indiv.)

Use Release 2017-08-28 of Bernese 5.2!

PCV Corrections for Galileo

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

Network of Baselines



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Galileo Observations and Ambiguities

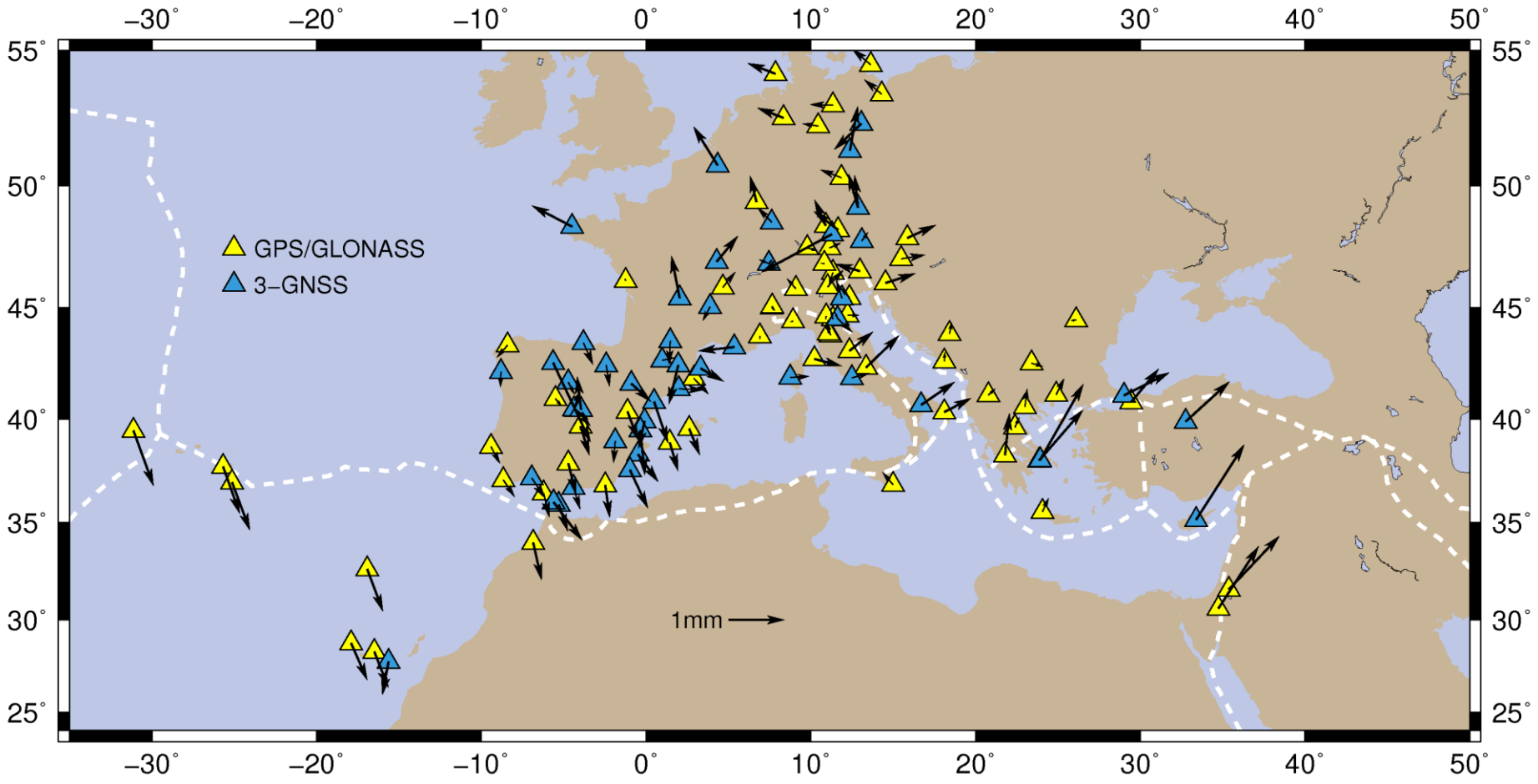
Conditions for DOY 267, 2017:

System	Observations		Ambiguities (WL)	
GPS	581117	56.8 %	4467	51.6 %
Glonass	331448	32.4 %	3503	40.4 %
Galileo	110154	10.8 %	690	8.0 %

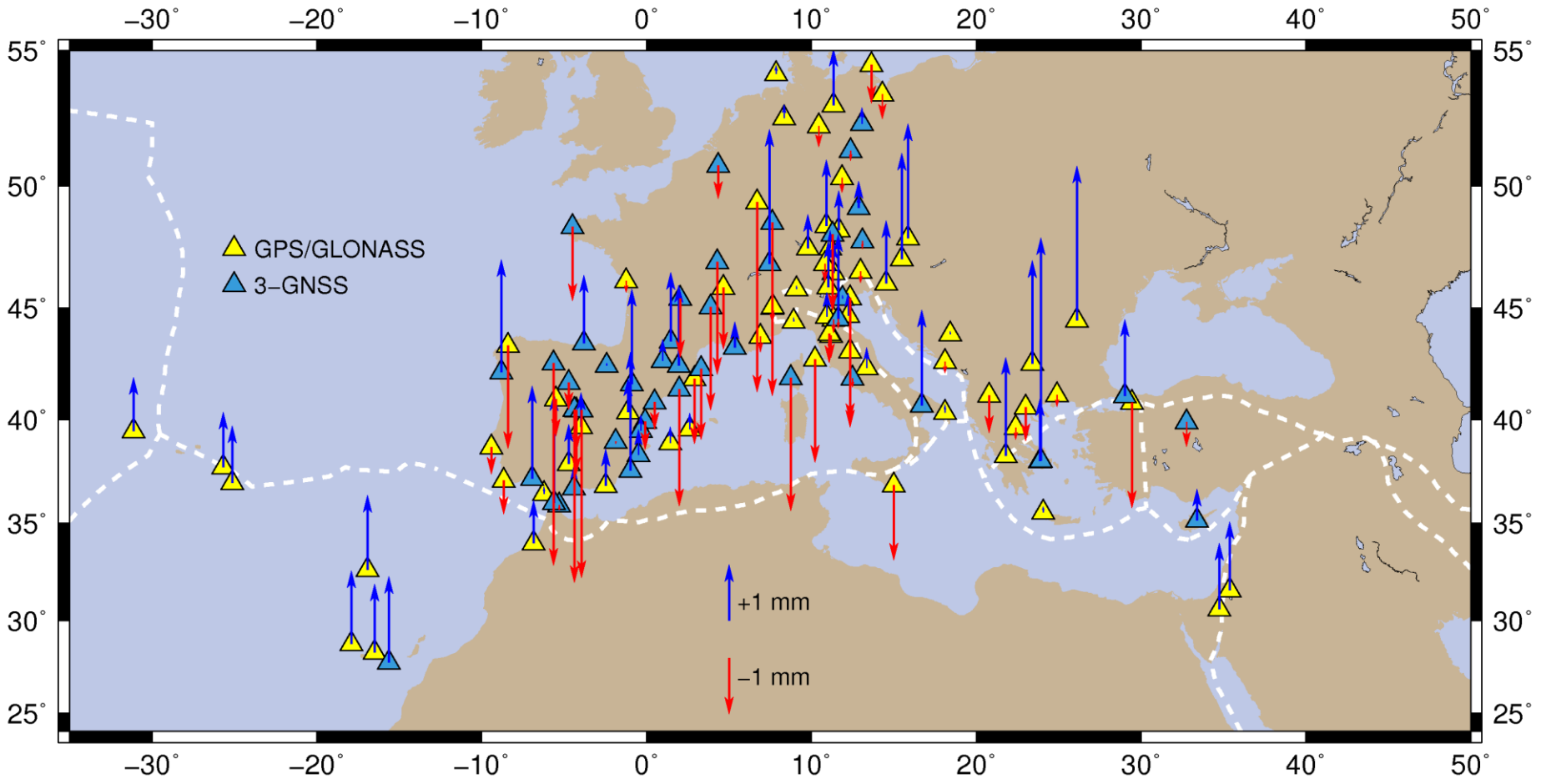
Ambiguity Resolution Rate - Week 1967:

DOY	GPS	GLONASS	Galileo
267	59.0	61.8	67.1
268	58.5	62.5	66.3
269	59.2	63.6	68.7
270	58.6	61.2	70.2
271	56.1	59.9	60.6
272	57.5	61.1	63.8
273	58.4	61.8	68.8

3-GNSS versus 2-GNSS Horizontal



3-GNSS versus 2-GNSS Vertical



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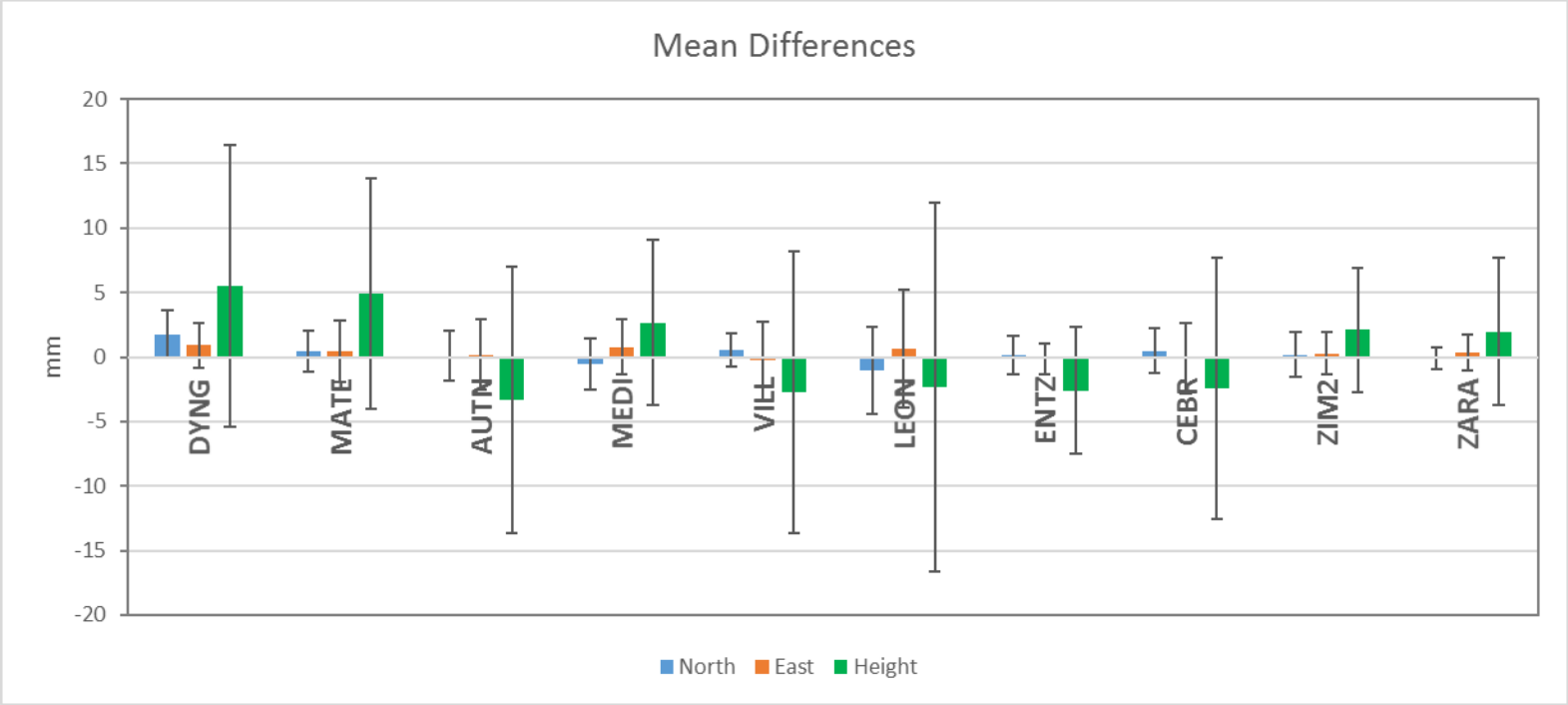
Differences between 3-GNSS and 2-GNSS

Mean Differences computed based on daily solutions for 10 sites:



Mean over all stations:

North [mm]	East [mm]	Height [mm]
0.06 +/- 0.45	0.02 +/- 0.35	0.08 +/- 1.31

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Summary and Outlook

- BEK network covers the Mediterranean, the Alps and large parts of Germany with almost 100 EPN-sites (more sites can be included)
- The analysis is updated for IGS14 and follows the guidelines for EPN Analysis Centres
- The analysis of Galileo observations can be easily integrated
- The Galileo meta data provided by **IGS14_IOV.atx** and **ANTEX_GAL_FOC_IOV.atx** are not yet included (IGS14_1972.atx)
- Some receivers are not perfectly adopted for Galileo and Beidou
- The impact of Galileo observations on the coordinates is still small (number of observation)
- Only a few antennas are calibrated for Galileo signals, which remains an issue