EPN Reprocessing Activities: A Summary

Christof Völksen

Bavarian Academy of Science and Humanities
Project Geodesy and Glaciology

Motives for Reprocessing

During the period 1996 to 2017 different reference frames were realised, different standards and models applied, software changes and other things, which caused inconsistencies in the coordinate time series.

In order to avoid these inconsistencies one needs:

- One reference frame for the entire period of time
- Consistent standards and conventions are required, e.g. Antenna-PCV, Trop.-Models, IERS conventions, etc.

Results:

- Reducing inconsistencies in the time series of coordinates and troposphere parameters
- Will improve the quality of the velocity/deformation field
- Reprocessing of GNSS data is the optimal tool for studying geodynamics

  (Reprocessing is today a common approach for crustal deformation studies)

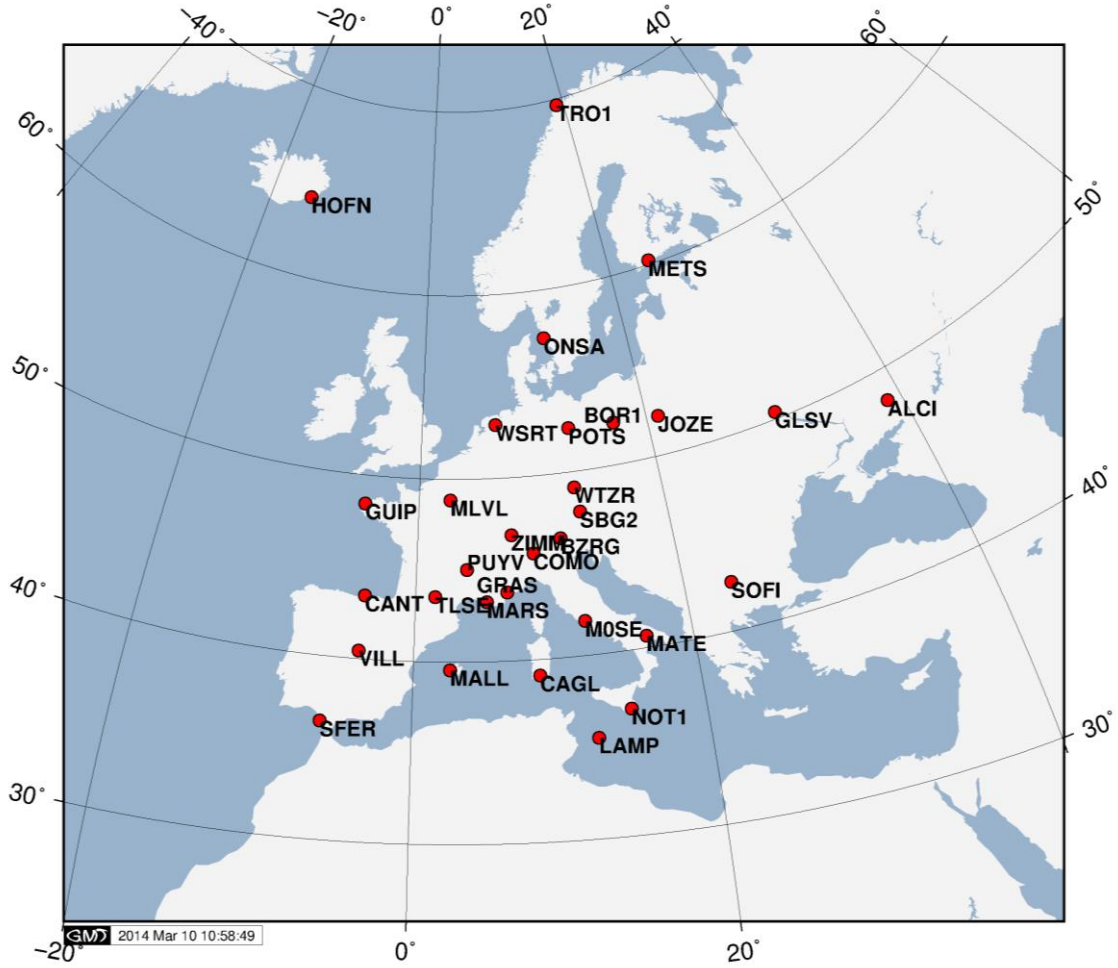
Reprocessing Activities in the past 15 Years

Year	Group
2002	University of California, R. Nikolaidis; (1991-2002)
2006	**Potsdam Dresden Group (PDR05), 1992-2005**
2007	BEK: subnetwork of the EPN (PDR05),1996 – 2005
2008	MUT/ROB: entire EPN-Network (PDR05),1996 - 2006
2008	IGS Repro1 (IGS05), 1994 – 2007 ➔ ITRF2008 ACs: CODE, EMR, ESA, GFZ, JPL, MIT, NGS, PDR, SIO
2009	EPN-Repro1 (IGS05), 1996 – 2007 (Jan.) (834-1408)
2013	IGS Repro2 (IGb08), 1994 – 2013 ➔ ITRF2014 ACs: CODE, EMR, ESA, GFZ, GRGS, JPL, MIT, NGS, SIO
2013	EPN-Repro2 (IGb08), 1996 – 2013 (834 – 1771)

Specifications EPN-Repro1

- Started in 2009 and finished by 2012
- Contributions from almost each AC
- Regional network strategy applied by using reprocessed Orbits
- Available Orbit Products realized in the IGS05
  - PDR05 (Potsdam-Dresden-Reprocessing)
  - JPL (Repro1)
  - IGS Repro1, combination of available reprocessed products
- Performing a benchmark test for optimal estimation of processing strategies (Pilot Phase)
- Covering data between 1996 and 2007 (Jan.)

Benchmark: Test of the strategies



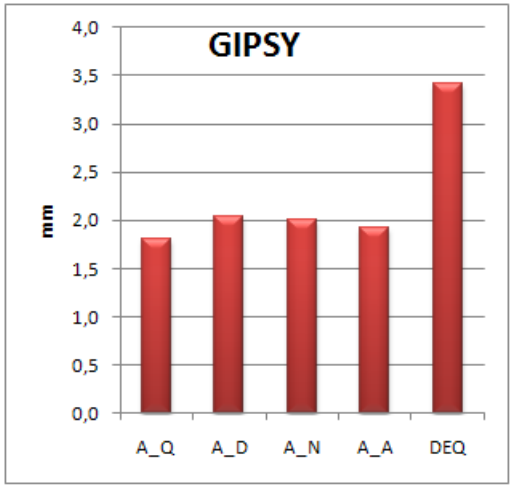
GNSS	#
GPS	32
GLONASS	21
Galileo	19

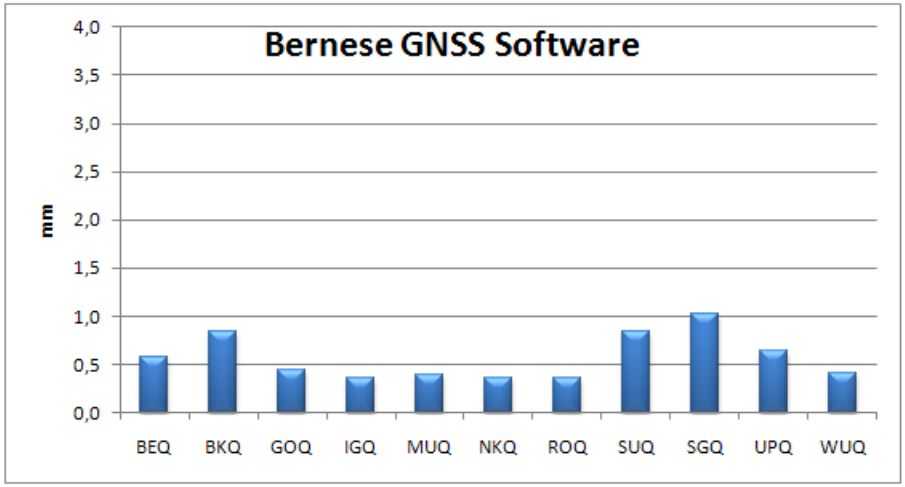
Bayerische Akademie der Wissenschaften

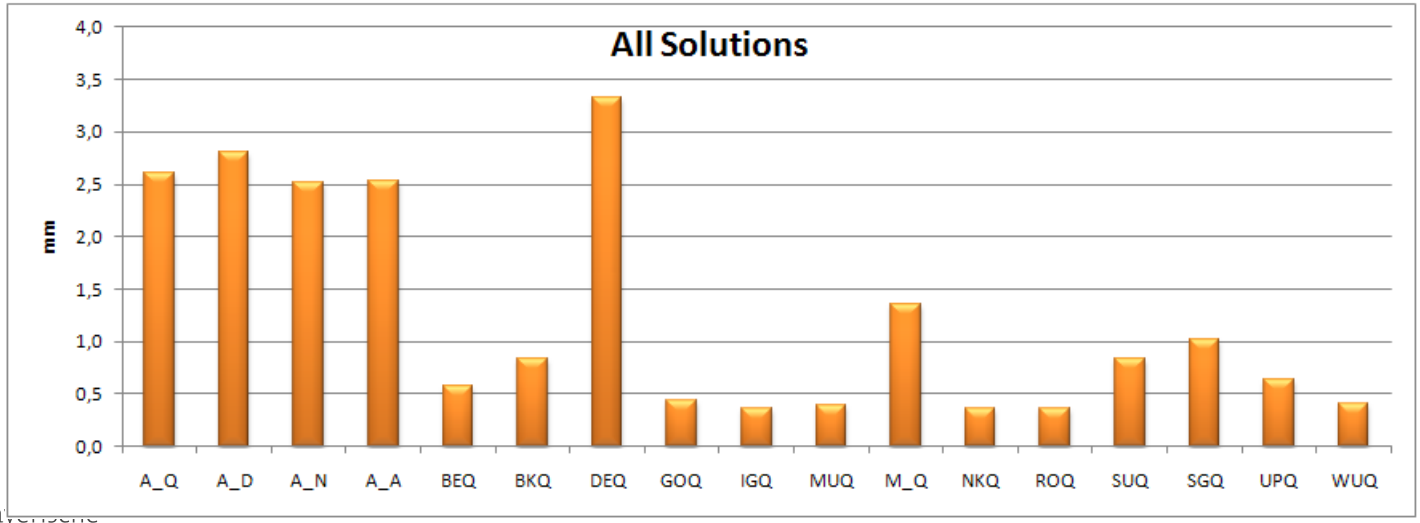
Activities for EPN-Repro1

- Data were submitted by all participating AC by the end of 2011
  - Daily coordinates and ZTDs (1996-2006)
  - Weekly coordinates (1996 – 2006)
- Contributions from14 AC
- Combination of the weekly coordinates was performed by the EPN Analysis Coordinator (H. Habrich / BKG)
- Combination of the troposhere parameters (ZTD) by the EPN Troposphere Coordinator (W. Söhne / BKG)
- Multi-Year solution provided by the Reference Frame Coordinator (A. Kenyeres) using CATREF

RMS after Combination (Benchmark Test) (EPN-Repro1)

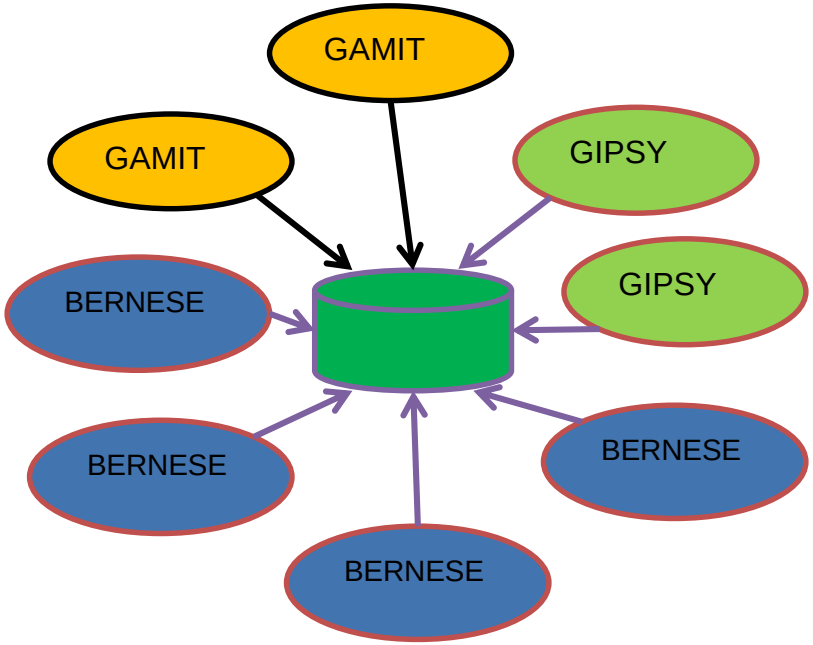






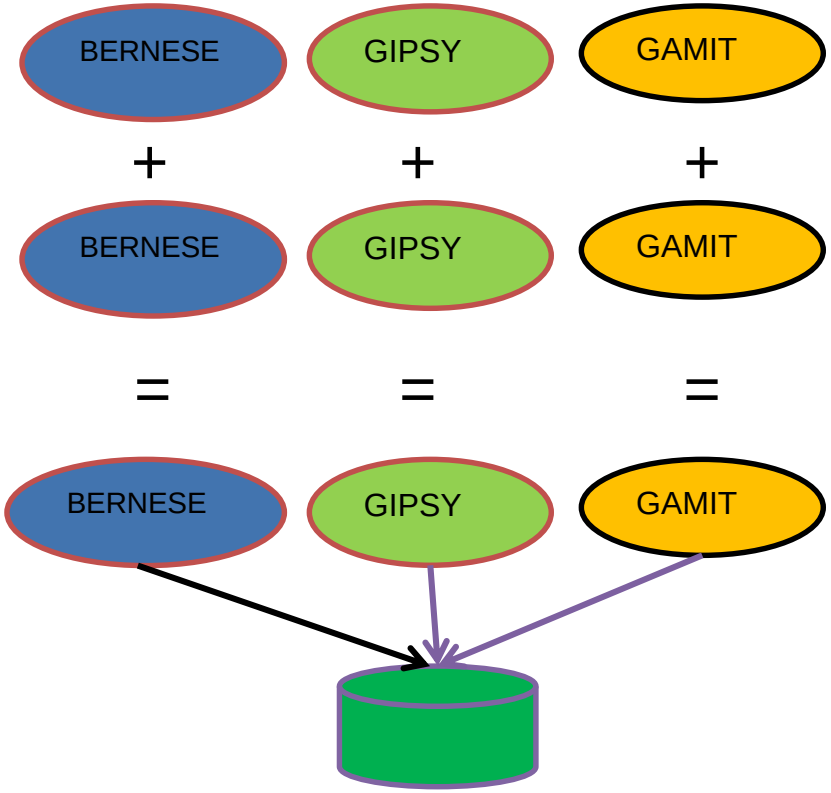
Combination of the Daily Solutions

Any daily solution



Dominated by BERNESE

By software packages



Stronger impact by GIPSY&GAMIT

Specifications EPN-Repro2

- Introduction of the **IGb08** required a new reprocessing campaign (EPN-Repro2)
- Activities in parallel to IGS Repro2, similar approach e.g.:
    - Implementation of the new IERS conventions
    - Higher order correction terms for the ionosphere
- Delayed until reprocessed products were available
- EPN uses individual calibrations while IGS uses type mean PCV
- A smaller group of ACs participates in EPN-Repro2
- GNSS observations provided by the historical archive centre at EPNCB (mandatory)

Contributors EPN-Repro2

GNSS Analysis Centres (ACs):

Full Network:

- Centro di Geodesia Spaziale, Italy (ASI) - **GIPSY**
- Geodetic Observatory Pecny, Czech Republic (GOP) - **Bernese**
- Military University of Technology, Poland (MUT) **- GAMIT**

Sub network:

- Instituto Geografico National, Spain (IGE) - **Bernese**
- Swisstopo, Switzerland (LPT) - **Bernese**

Combination of daily Normal Equations (Analysis Coordinator):

- Military University of Technology, Poland (MUT)

Combination of Troposphere Parameters (Troposphere Coordinator):

- Centro di Geodesia Spaziale, Italy (ASI)

Multi-Year-Combination (Reference Frame Coordinator):

- Satellite Geodetic Observatory,Budapest SGO

Available Solutions for EPN-Repro2

	AS0	GO0	GO2	GO4	IG0	LP0	LP1	MU0	MU1	MU4
SW	GIPSY 6.2	BSW 5.2			BSW 5.2	BSW 5.2		GAMIT 10.5		
GNSS	**G**	**G**			**G + R**	**G + R**		**G**		
SOLUTION TYPE	PPP	NET			NET	NET		NET		
STATIONS	**Full EPN+ IGS CORE**	**Full EPN**			**Part EPN**	**Part EPN + IGS(8)**		**Full EPN**		
ORBITS	**JPL R2 (prelim.)**	**CODE R2**			**CODE R2**	**CODE R2**		**CODE R2**		
ANTENNAS PCV	**IGS08**	**IGS08 + IND.**			**IGS08 + IND.**	**IGS08**	**IGS08+ IND**	**IGS08**	**IGS08+ IND**	**IGS08**
IERS	2010	2010			2010	2010		2010		
GRAVITY	EGM08	EGM08			EGM08	EGM08		EGM08		
TROPOSPHERE Estimated Param	ZTD (5min) GRAD (5min)	ZTD (1h) GRAD (6h)			ZTD (1h) GRAD (6h)	ZTD (1h) GRAD (24h)		ZTD GRAD 10	ZTD (1h) GRAD in Zenith (24h)	
MAPPING FUNCTION	VMF1	GMF	VMF 1	VMF 1	GMF	GMF	VMF1	VMF1		
ZTD/GRAD time stamp	hh:30 24 estimates/day	hh:30 24 estimates/day			hh:30 24 estimates/day	hh:00 (and hh:30) **24**(+24) estimates/day		hh:30 24 estimates/day		
IONOSPHERE	(HOI included)	CODE (HOI included)			CODE (HOI included)	CODE (HOI included)		CODE IONEX + IGRF11 (HOI included)		
REF. FRAME	IGb08	IGb08			IGb08	IGb08		IGb08		
OCEAN TIDES	FES2004	FES2004			FES2004	FES2004		FES2004		
T-ATML	NO	NO			YES	YES	YES	YES		
NT-ATML	NO	NO	NO	YES	NO	NO	YES	YES	NO	NO
ELEV. CUTOFF	**3**	**3**			**3**	**3**		**5**		
Delivered SNX/TRO Files [from week to week]	**0835-1772**	**836-1771**			**835-1816**	**835-1772**		**835-1771**		

Characteristics EPN-Repro2

- **GLONASS**:
  - available since 2003, only used in solutions by LPT and IGE
- **Different antenna PCV corrections** used in the uploaded solutions („type mean“ and „type mean + individual)
  - Available solutions offer the possibility to elaborate the difference and generate corrections
- Orbits are mostly homogeneous (CODE Repro2) with exception of ASI (using JPL reprocessed orbits)
- Mixture of solutions with or without correction for **Non-Tidal-Atmospheric Loading** (NT-ATML)
  - removed on NEQ-Level for MUT

EPN-Repro Products

- Available from BKG Server

  http://igs.bkg.bund.de
  ftp://igs.bkg.bund.de/EPNrepro1/benchmark/1381
  ftp://igs.bkg.bund.de/EPNrepro1/products/wwww
  ftp://igs.bkg.bund.de/EPNrepro2/products/wwww

- Products are used to derive updated coordinates and velocities for the entire EPN
- Used by the Troposphere Coordinator for the Evaluation of climate models

Summary and Future

- Many AC put a lot of effort and man power into the generation of the reprocessed products
- The products are used to improve the long time products of the EPN
- With the introduction of the ITRF14/IGS14 a new reference frame is introduced
- Reprocessing activities of the IGS are yet not expected for the next years
- Another reprocessing (EPN-Repro3) should be synchronized with the activities of the IGS
- The need should be carefully evaluated