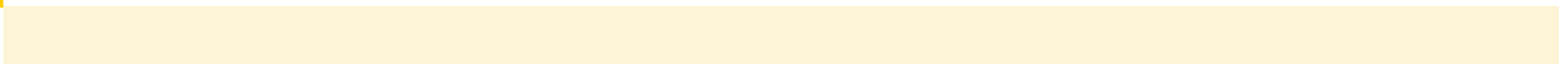




Continuous Cumulative Solutions of EPN LACs

Heinz Habrich

Federal Agency for Cartography and Geodesy





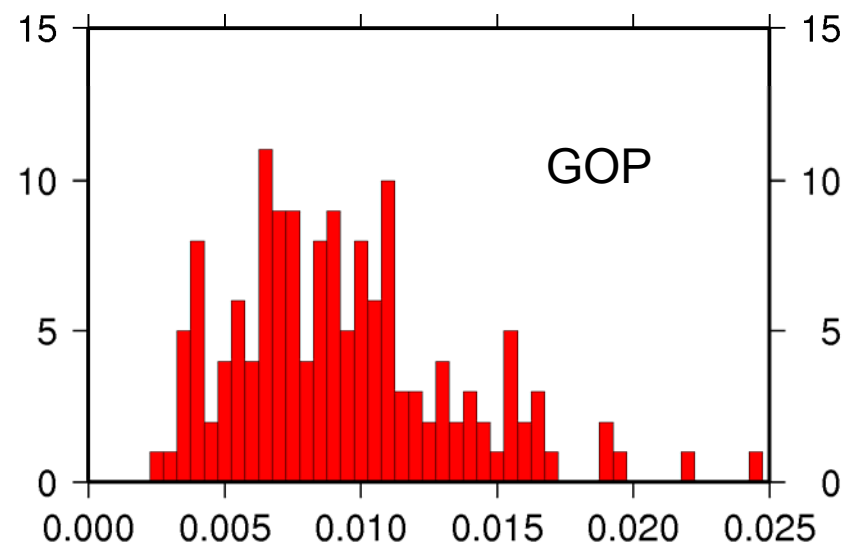
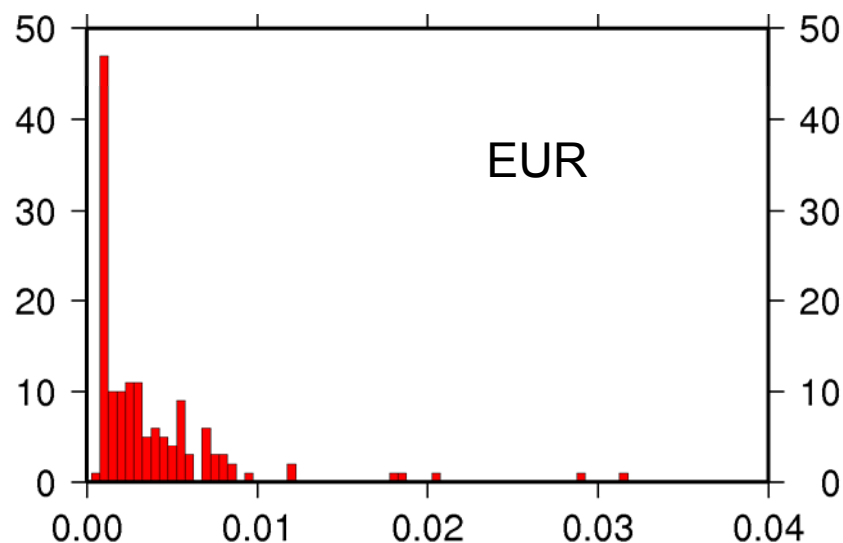
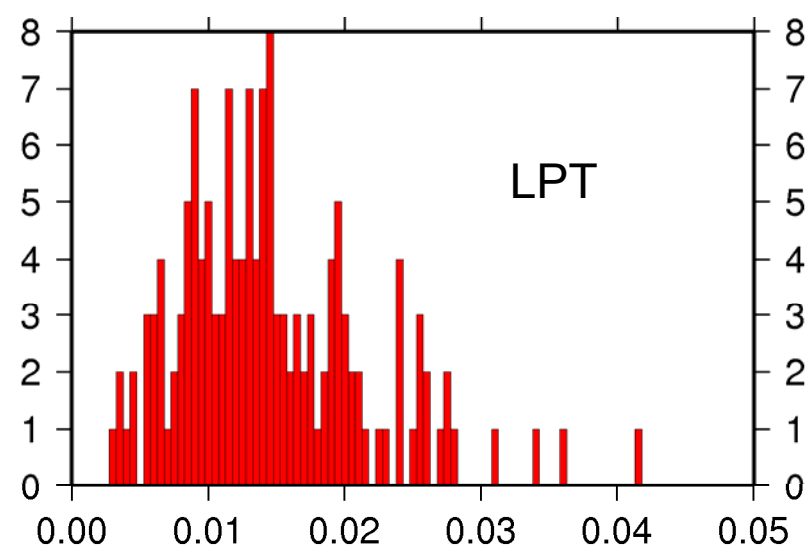
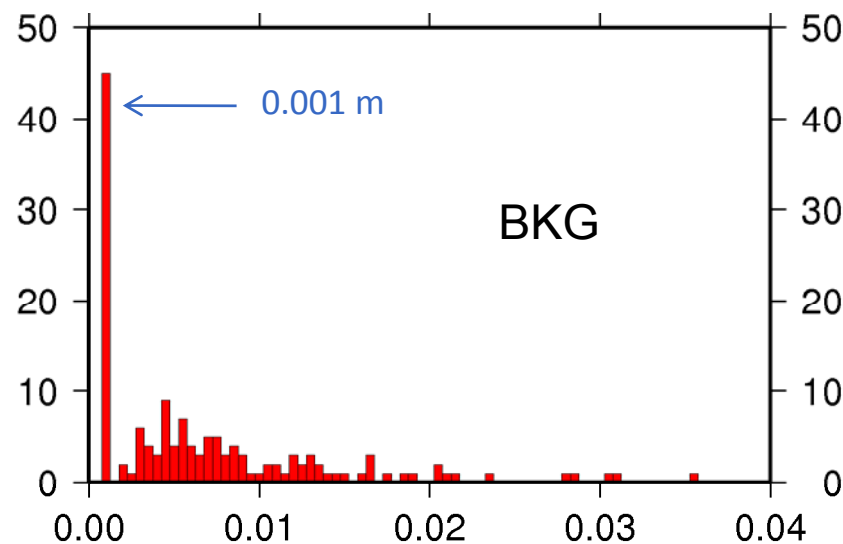
- Existing EPN solutions
 - weekly LAC sub-networks and its combination
- Presented EPN solutions
 - single LAC and preliminary EPN cumulative solution
 - weekly time line
- Development of comparison methods
 - between LAC cumulative solutions
 - detection of LAC-specific (pseudo-) inconsistencies in time series
 - between existing and new cumulative solutions
 - Candidate solutions of interest: ITRF, EPN, preliminary EPN, re-processed EPN, National Densification,...
 - Note: Various cumulative solutions will never be re-processed on the basis of common a-priori discontinuities. Synchronization is required afterwards.



- Combination of weekly solutions
 - for LACs and EUR (EPN combination) respectively
- FODITS tool
 - Find Outliers and Discontinuities in Time Series (FODITS)
 - no a-priori information about outliers and discontinuities
 - non-interactive procedure
 - FODITS enable modeling of non-linear signals
- Synchronization of solutions
 - SOLSYNC tool
 - synchronised coordinates and velocities
- Comparison of coordinates and velocities
 - Bernese GNSS Software COMPAR and HELMERT
 - STAREPORT tool

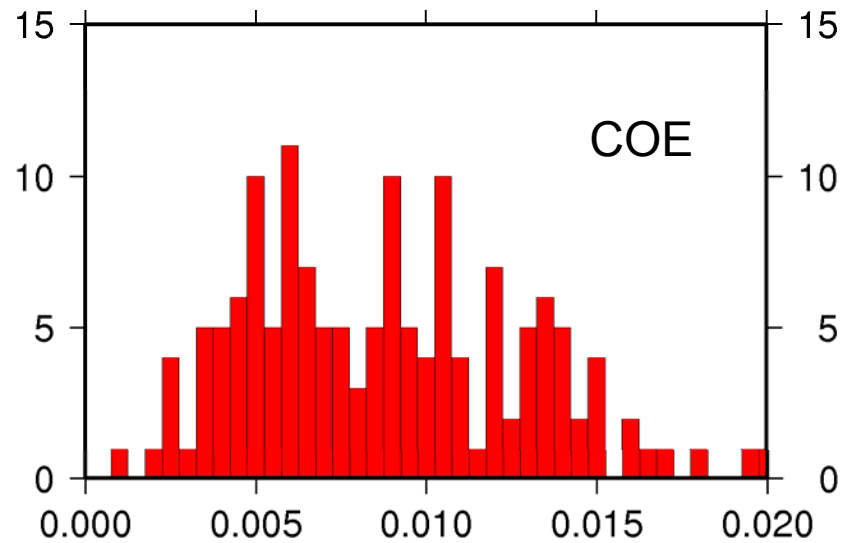
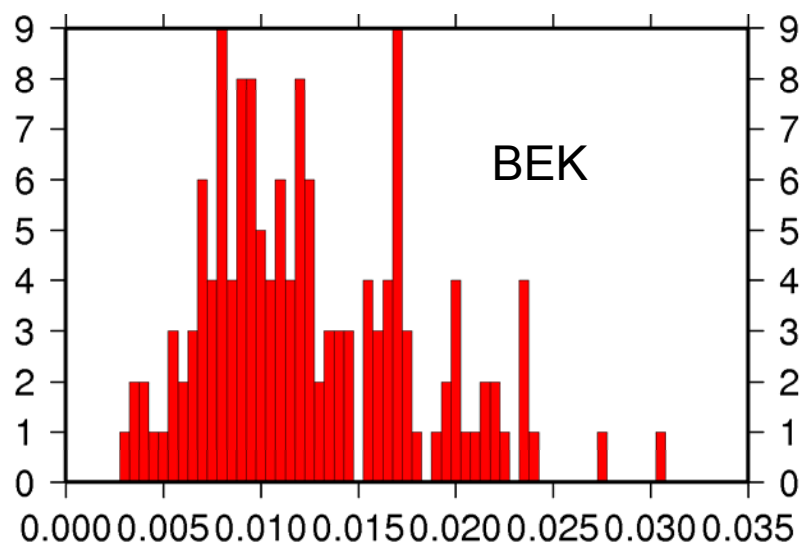
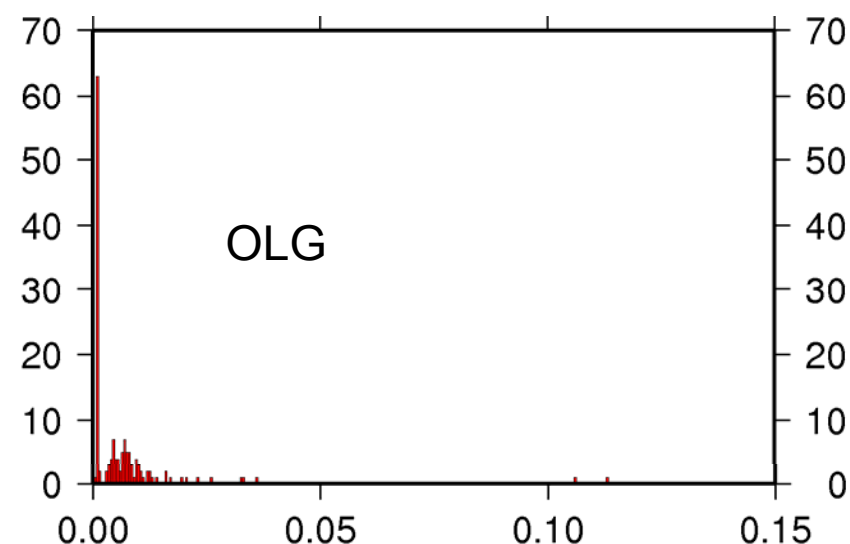
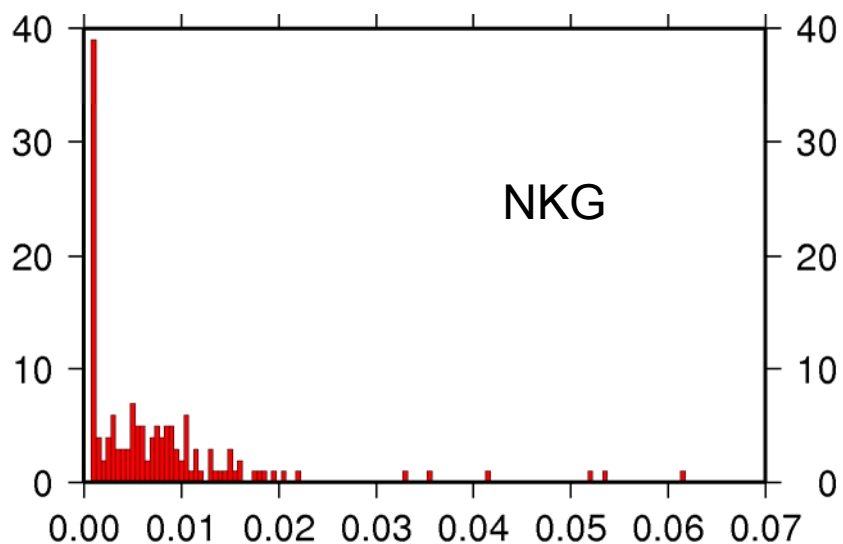


RMS of Individual Solutions



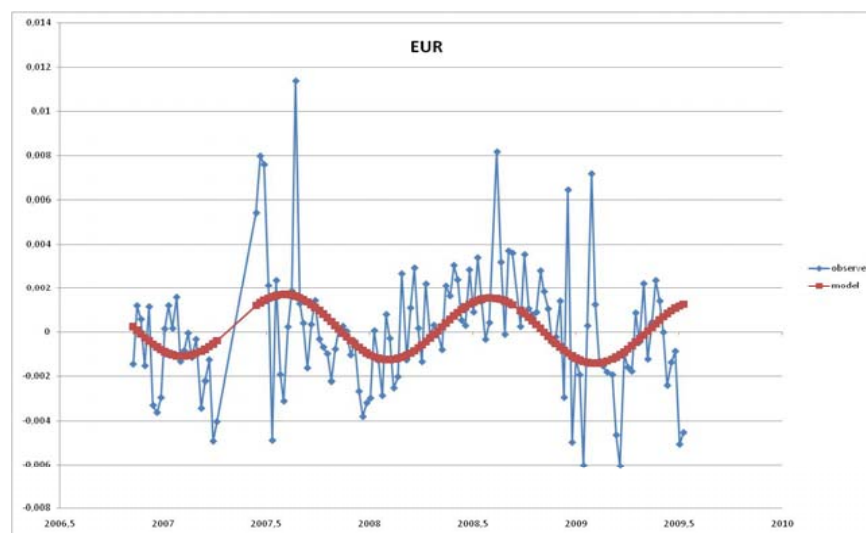
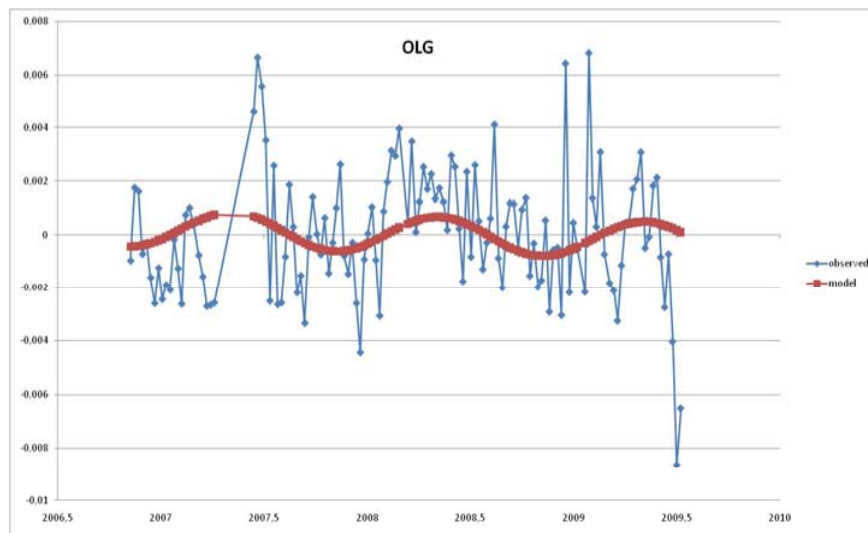
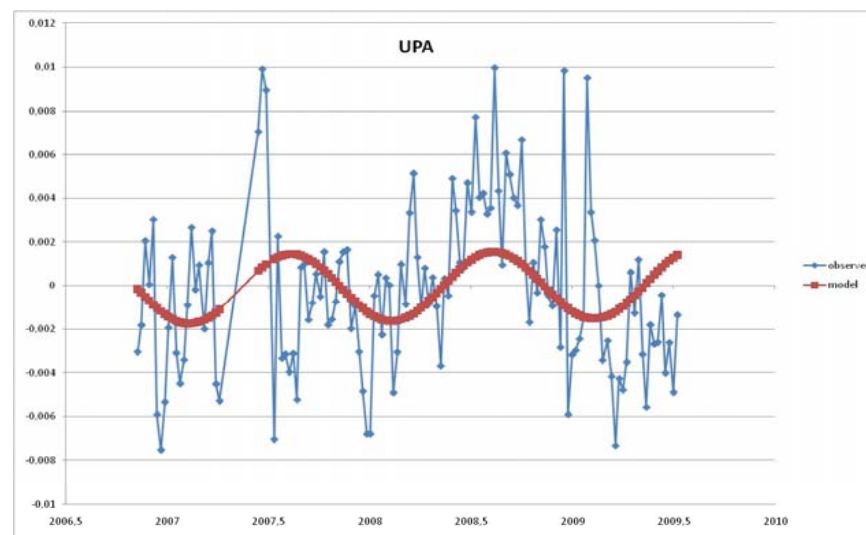
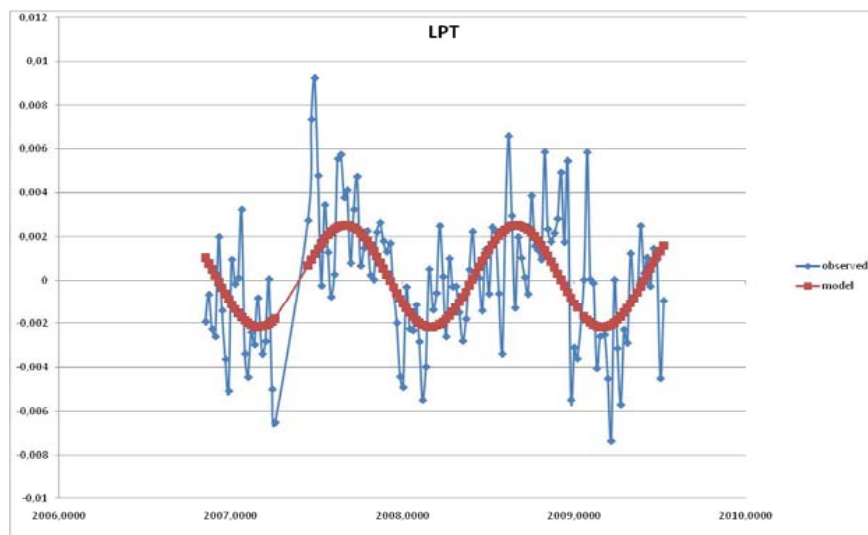


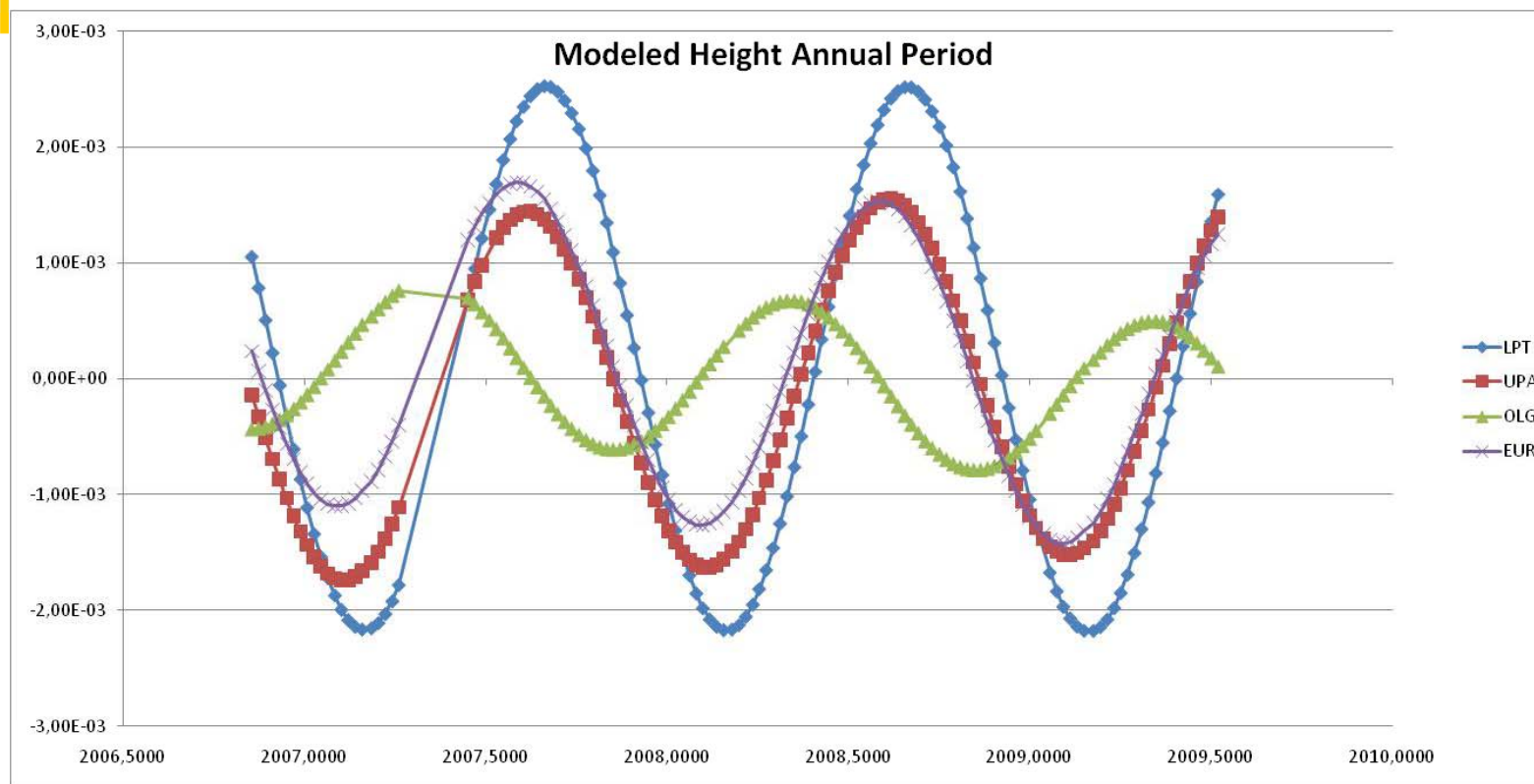
RMS of Individual Solutions





Height Station Linz





	Amplitutde	Phase
LPT	2.3 mm	282.3 °
UPA	1.6 mm	262.9 °
OLG	0.7 mm	167.8 °
EUR	1.4 mm	255.2 °



- Selection of SINEX files
 - “SOLUTION/EPOCH”: station 4-char, solution number, data start, data end
 - “SITE/ID”: DOMES no.
 - “SOLUTION/ESTIMATE”: coordinates, velocities with reference epochs respectively
- Skip zero and correct overlapping data intervals
- Synchronisation by introducing additional sol. numbers
- Remove short data intervals
- Extrapolate to new reference epoch
 - mean epoch for individual sites, common mean epoch or manually selected common epoch
- Write synchronised coordinates and velocities to file



SOLSYNC Validation ITRF2005 vs. IGS05

Program SOLSYNC

Date : Fri Oct 2 11:45:39 2009

Options:

Reference epoch option: COMMON-AUTO

Minimum data interval: 30 (days in synchronised solution)

Extended output sync. : No

SINEX files: 2

/home/euref/GPSDATA/EPNC/SOL/IGS05.SNX

/home/euref/GPSDATA/EPNC/SOL/ITF05.SNX

File /home/euref/GPSDATA/EPNC/SOL/ITF05.SNX:

Solutions with undefined data start epoch or data end epoch: 51

Overlapping data periods : 81

Synchronisation step

=====

Number of collected station solutions : 581

Number of stations : 295

Short data intervals : 210

Synchronised solutions : 513

Bounding epochs total : 95:261:00000 06:002:00000

Mean epoch total : 00:314:43200

Resulting coordinate files:

/home/euref/GPSDATA/EPNC/STA/IGS05.CRD

/home/euref/GPSDATA/EPNC/STA/ITF05.CRD

Resulting velocity files:

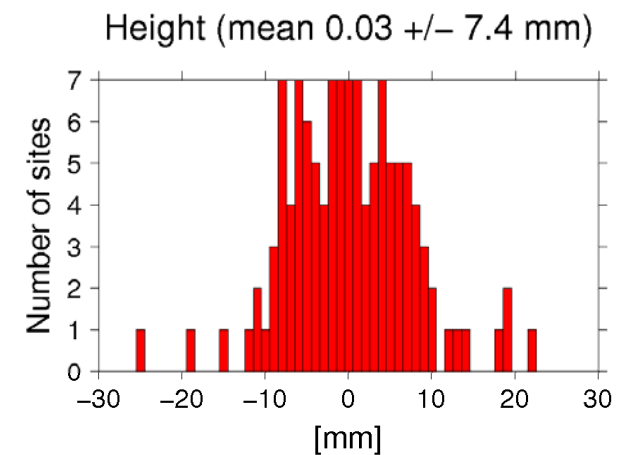
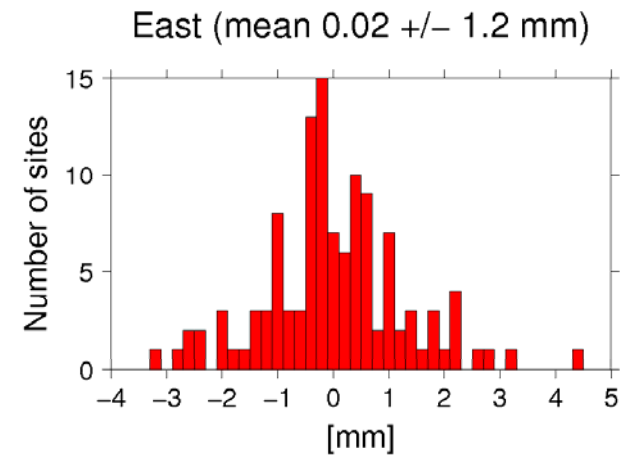
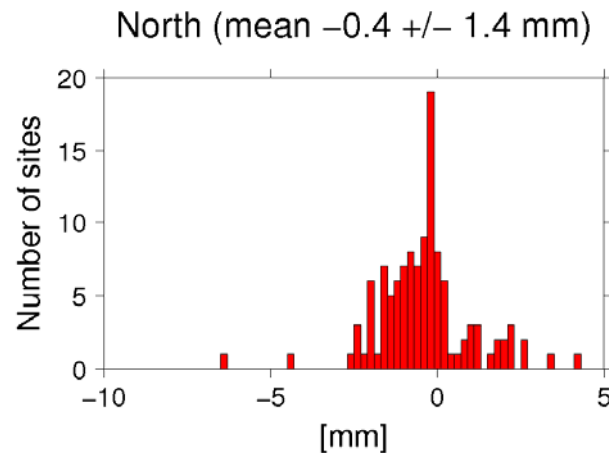
/home/euref/GPSDATA/EPNC/STA/IGS05.VEL

/home/euref/GPSDATA/EPNC/STA/ITF05.VEL



SOLSYNC Validation ITRF2005 vs. IGS05

- Coordinate differences



- Zero velocity
difference confirmed!



SOLSYNC Validation

ITRF2005 vs. EPN_C1355

Program SOLSYNC

Date : Fri Oct 2 13:38:38 2009

Options:

Reference epoch option: COMMON-MANUALLY

Reference epoch: 00 001 (yy ddd)

Minimum data interval: 30 (days in synchronised solution)

Extended output sync. : No

SINEX files: 2

/home/euref/GPSDATA/EPNC/SOL/EPN_ITRF_C1355.SNX

/home/euref/GPSDATA/EPNC/SOL/ITF05.SNX

File /home/euref/GPSDATA/EPNC/SOL/ITF05.SNX:

Solutions with undefined data start epoch or data end epoch: 51

Overlapping data periods : 81

Synchronisation step

=====

Number of collected station solutions : 748

Number of stations : 407

Short data intervals : 213

Synchronised solutions : 689

Bounding epochs total : 95:261:00000 06:002:00000

Mean epoch total : 00:314:43200

Resulting coordinate files:

/home/euref/GPSDATA/EPNC/STA/EPN_ITRF_C1355.CRD

/home/euref/GPSDATA/EPNC/STA/ITF05.CRD

Resulting velocity files:

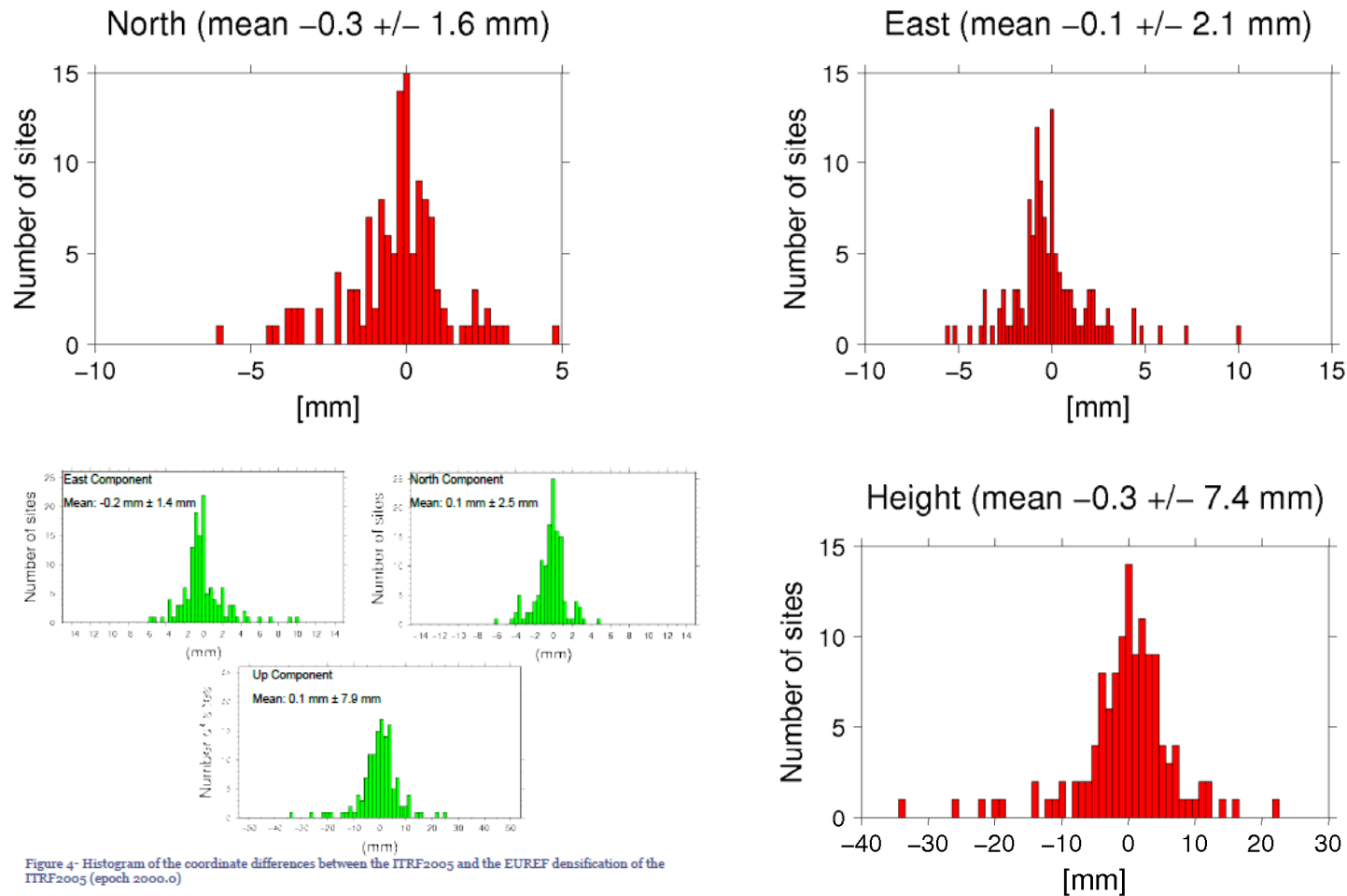
/home/euref/GPSDATA/EPNC/STA/EPN_ITRF_C1355.VEL

/home/euref/GPSDATA/EPNC/STA/ITF05.VEL



SOLSYNC Validation ITRF2005 vs. EPN_C1355

■ Coordinate differences





SOLSYNC Validation ITRF2005 vs. EPN_C1355

■ Velocity differences

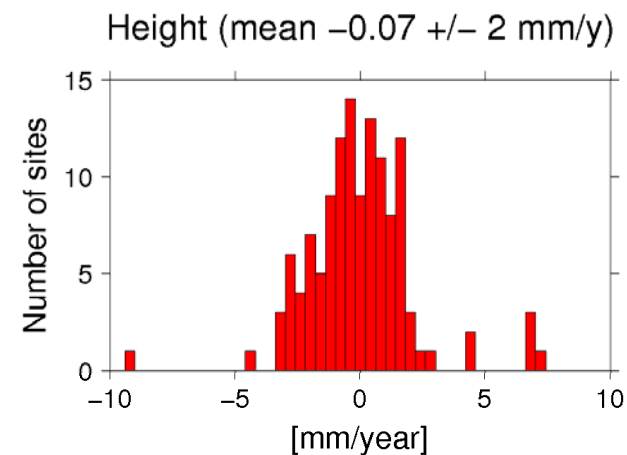
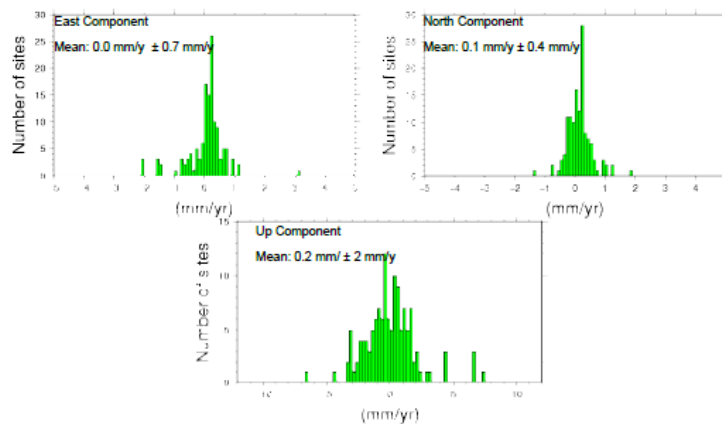
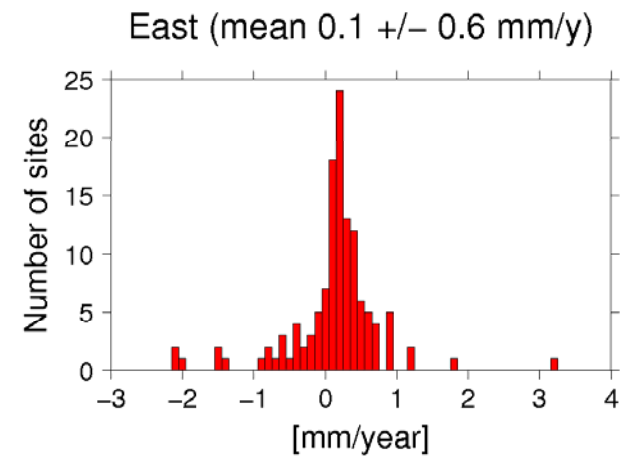
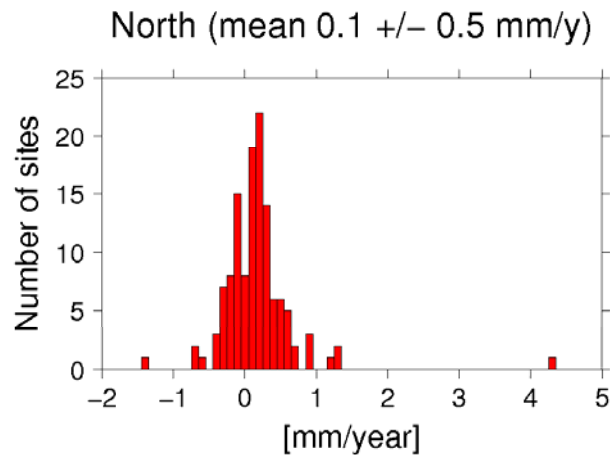
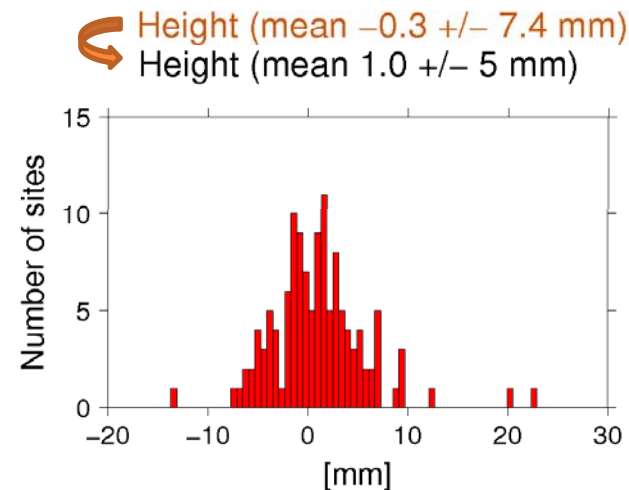
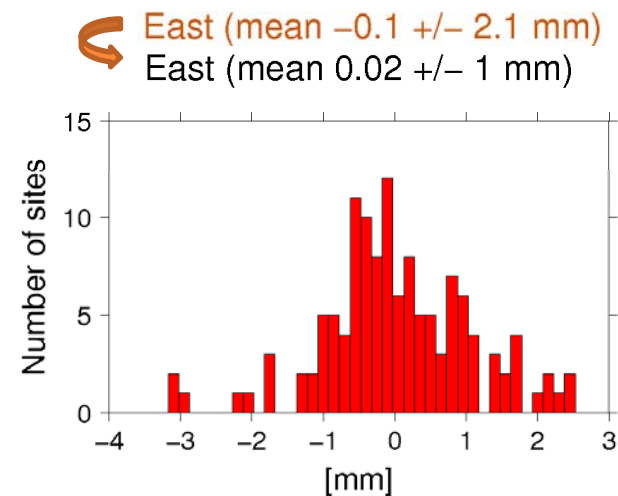
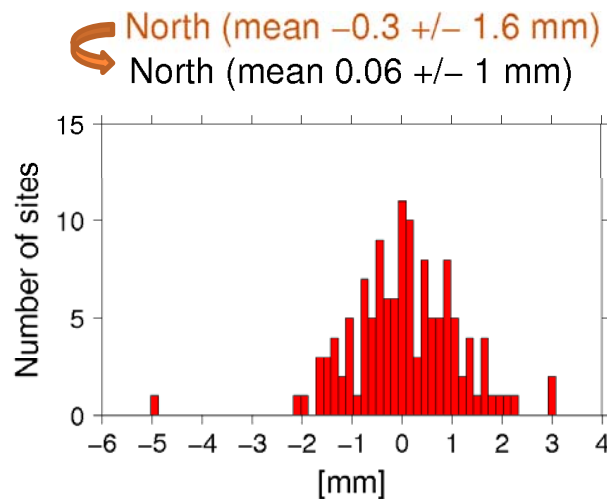


Figure 5- Histogram of the velocity differences between the ITRF2005 and the EUREF densification of the ITRF2005.



SOLSYNC Validation ITRF2005 vs. EPN_C1355

■ Coordinate differences for site-specific epochs



- No change in velocity difference!



- Generate a report for each station
 - options: a) all stations, b) stations exceeding threshold, c) manually selected stations
 - check residuals of coordinate and velocity comparison
 - check small number of solutions
 - ... (more)
- Compile recommendations, how to proceed with each individual station
 - general: guidelines for improving the combination and using the products
 - example: small number of solutions of new stations have to be accepted



STAREPORT TOOL

Example (E-mail)



LAC	#SOL	RECENT	SES	#STA	INITIAL	#JUMPS	#OUTLIER	#STA	FINAL	RMS	FINAL
BEK	144	1546	7		80	7	45		87	0.01004	m
BKG	146	1546	7		88	8	75		96	0.00962	m
COE	147	1546	7		45	3	26		48	0.01050	m
GOP	146	1545	7		49	8	20		57	0.00944	m
IGE	147	1546	7		51	5	4		56	0.00936	m
IGN	146	1546	7		53	5	6		58	0.00819	m
LPT	147	1546	7		45	3	1		48	0.00917	m
NKG	147	1546	7		50	4	21		54	0.00951	m
OLG	147	1546	7		84	5	68		89	0.00898	m
ROB	147	1546	7		57	5	4		62	0.00945	m
SGO	147	1546	7		38	2	21		40	0.01072	m
SUT	147	1546	7		51	17	161		68	0.01287	m
UPA	147	1546	7		47	3	78		50	0.00832	m
WUT	147	1546	7		75	11	67		86	0.01204	m
EUR	145	1546	7		237	24	157		261	0.00460	m



STAREPORT TOOL

Example (STAREPORT.OUT)

INPUT FILES

SOLSYNC output file: /home/euref/GPSDATA/EPNC/OUT/SOLSYNC.OUT

COMPAR summary file: /home/euref/GPSDATA/EPNC/OUT/COMPAR.SUM

COMPAR output file: /home/euref/GPSDATA/EPNC/OUT/COMPAR.OUT

Coordinate files: 15 Velocity files: 15 ADDNEQ output files: 15

Number of stations: 296

EVALUATION COMPAR SUMMARY FILE

Outlier criteria north component: 10 millimeters

 east component: 10 millimeters

 up component: 20 millimeters

Threshold exceeded -	AQUI 12757M001AC	4	S	S		13.11	4.57	23.50
Threshold exceeded -	COBA 13453M001AA	5	S	S	SS	3.31	0.86	20.92
Threshold exceeded -	HFLK 11006S003AA	4		S		1.36	1.15	203.58
Threshold exceeded -	HFLK 11006S003AE	4		S		1.59	0.39	54.80
Threshold exceeded -	PAT0 12622M001	4	S	S		7.52	9.23	28.48
Threshold exceeded -	SNEC 11519M001	6		S	SS	1.72	13.78	10.87
Threshold exceeded -	SNEC 11519M001AD	6		S	SS	2.07	10.45	3.27
Threshold exceeded -	SNEC 11519M001AJ	6		S	SS	3.92	18.06	19.56
Threshold exceeded -	SNEC 11519M001AL	6		S	SS	3.08	10.39	14.61

Number of stations exceeding threshold: 9

EVALUATION COORDINATE AND VELOCITY FILE

EVALUATION FINAL ADDNEQ OUTPUT FILE



STAREPORT TOOL

Example (COBA_13453M001AA.TXT)

COBA 13453M001AA

Summary file of COMPAR

File: /home/euref/GPSDATA/EPNC/OUT/COMPAR.SUM

Station: COBA 13453M001AA

Station	#Days	Weekday	Repeatability (mm)		
		0123456	N	E	U
COBA 13453M001AA	5	S S SS	3.31	0.86	20.92

Solution in individual coordinate files

BEK: COBA 13453M001AA	5021255.8499	-414684.7419	3898182.4632	S	08:093:43185
EUR: COBA 13453M001AA	5021255.8498	-414684.7418	3898182.4626	S	08:093:43185
IGE: COBA 13453M001AA	5021255.8476	-414684.7427	3898182.4618	S	08:093:43185
IGN: COBA 13453M001AA	5021255.8105	-414684.7377	3898182.4409	S	08:093:43185
SUT: COBA 13453M001AA	5021255.8485	-414684.7429	3898182.4607	S	08:093:43185

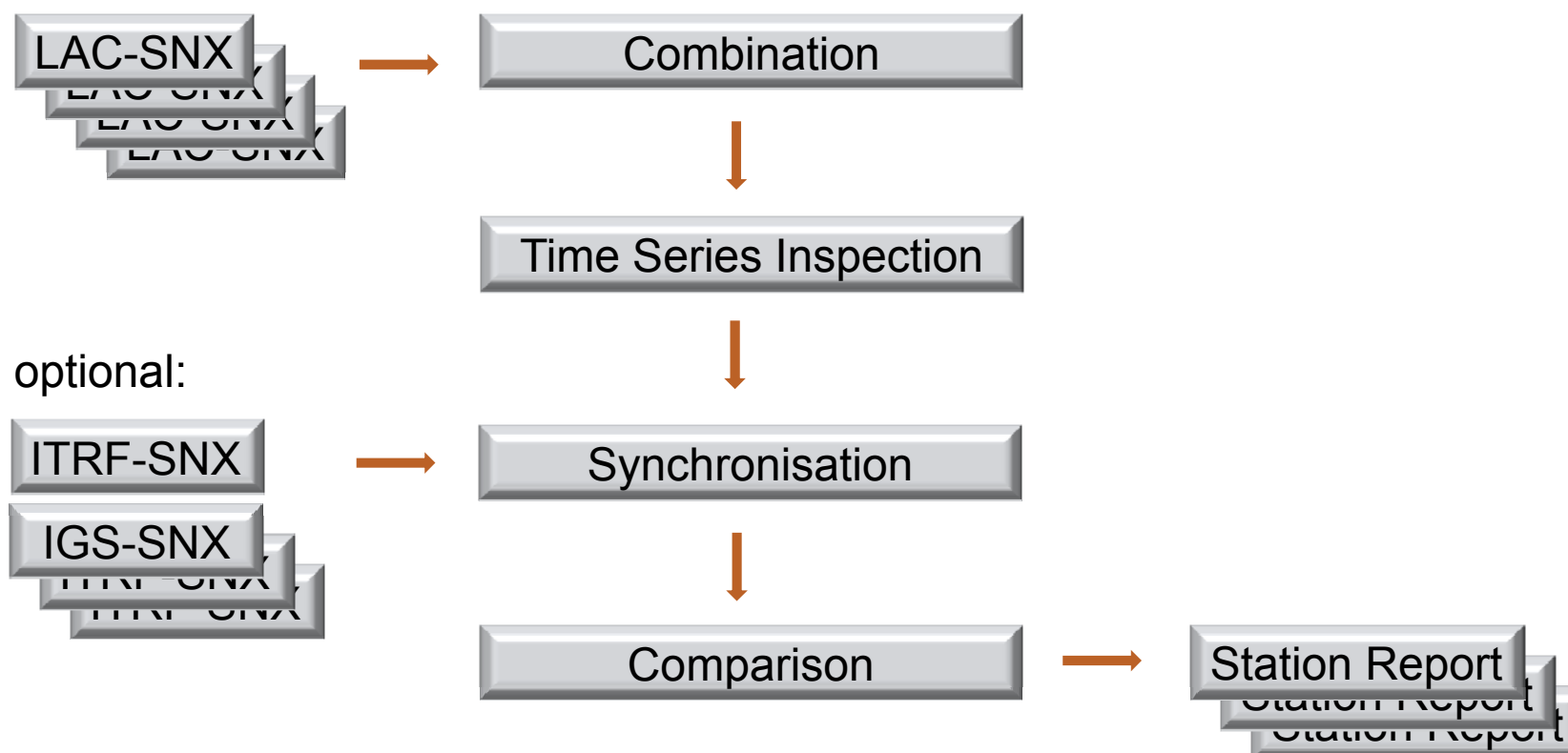
Solution in individual velocity files

BEK: COBA 13453M001AA	-0.0081	0.0203	0.0107	S	08:093:43185
EUR: COBA 13453M001AA	-0.0078	0.0203	0.0129	S	08:093:43185
IGE: COBA 13453M001AA	-0.0099	0.0192	0.0094	S	08:093:43185
IGN: COBA 13453M001AA	0.0201	0.0161	0.0266	S	08:093:43185
SUT: COBA 13453M001AA	-0.0077	0.0195	0.0125	S	08:093:43185

Small number of solutions in file /home/euref/GPSDATA/EPNC/OUT/IGN_EPNC_A2.OUT
COBA 13453M001 137 138 139 140 141 142 143 144 145 146

Recommendations for COBA 13453M001AA

This station has been affected by a small number of solutions used in the combination of the time series. This deficiency could not be improved yet and has to be treated carefully.





- “1 mm a-posteriori RMS”
 - numerical problem feasible, test with “NEQ-SINEX” recommended
- SOLSYNC
 - variation of reference epoch and corresponding results
- Station report provides user friendly information filtered to the meaningful events
- when indicated, request for re-submission of individual LAC solution and subsequent re-combination



- Improvement of weekly EPN combination
- Future daily cumulative solution to be discussed
 - “warning”-approach from “rapid daily”
 - spectral analysis of time series from “final daily”
- Approach is helpful for ongoing re-processing