



ITRF2005 Densification

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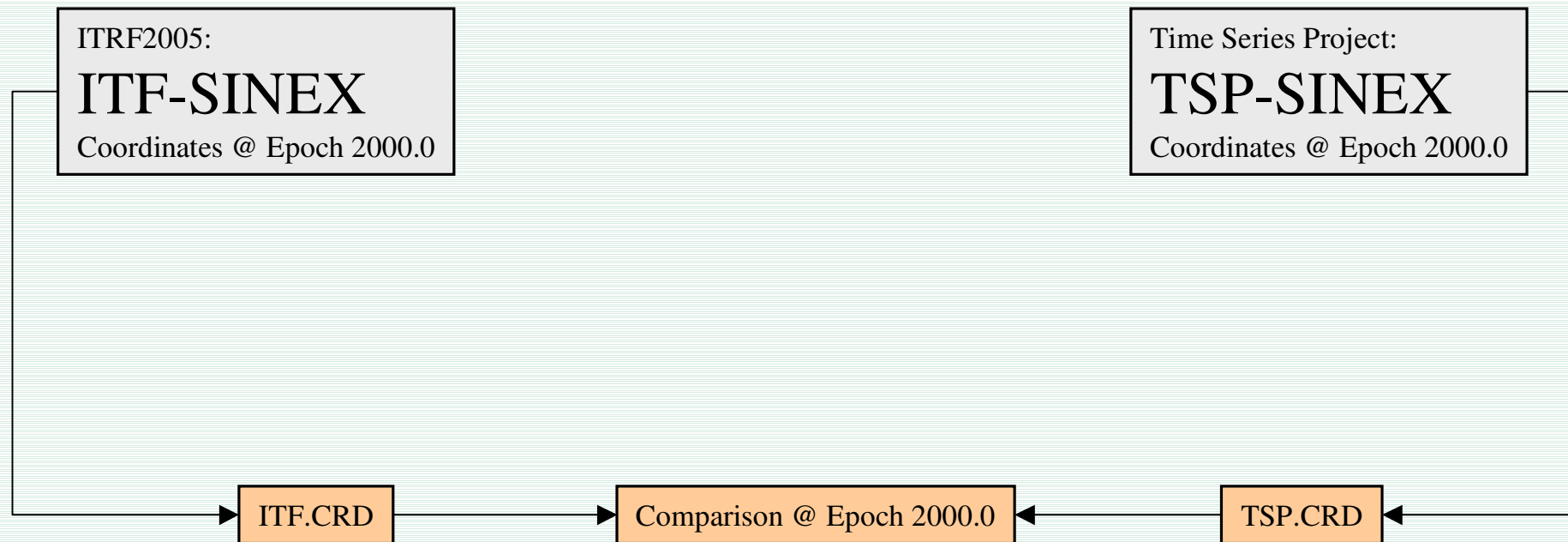
- Network densification of ITRF2005 for Europe
- Observation interval to be conform with the ITRF2005 data → weeks 860 to 1355 has been combined
- Definition of discontinuities → conform with ITRF2005 → for non-ITRF2005 sites of EPN discontinuities according to EPN Time Series Project
- No combination of EPN and ITRF2005 planned → significance of datum definition
- Resulting coordinates and velocities will be compared to time series project

- ITF-Solution:
 - ITRF2005 solution as available from ftp://itrf.ensg.ign.fr/pub/itrf/itrf2005/ITRF2005_IGS-TRF.SNX.gz
 - Built with CATREF software
- AC-Solution:
 - Multi-year solution for EPN weekly combined SINEX files, calculated by the EPN AC
 - Built with Bernese GPS Software v5.0
- TSP-Solution:
 - Multi-year solution for EPN-weekly combined SINEX files, calculated within the EPN Time Series Project
 - Built with CATREF software

- Difficulty of different formats for station discontinuities:
 - CATREF uses „SINEX style“ format
 - Bernese software uses the so-called STA-file
 - No software to convert between the two formats available
- Comparison concept considers SINEX format
 - Station coordinate and velocity files converted from SINEX files of each available solution with the Bernese software
 - New solution numbers for stations are added in the resulting coordinate and velocity file automatically as soon as it occurs in the SINEX file.
 - Thus harmonized coordinates and velocities w.r.t. discontinuities have been prepared.

- Different solution epoch of coordinates and velocities in SINEX
 - Bernese: 1996.5 (first observation epoch)
 - CATREF: 2000.0 (~ mean epoch selected)
 - Extrapolation of coordinates to common epoch before comparison

- „Heavily constraint“: Coordinates and velocities of reference sites constrained with 0.1 mm to ITRF2005
- Minimum constrained condition and free network solutions for comparison



Helmert Transformation ITF – TSP @ Epoch 2000.0

NUMBER OF PARAMETERS : 3
 NUMBER OF COORDINATES : 372
RMS OF TRANSFORMATION : 3.4 MM

PARAMETERS:

TRANSLATION IN X	:	0.3	+-	0.3	MM
TRANSLATION IN Y	:	-0.4	+-	0.3	MM
TRANSLATION IN Z	:	0.1	+-	0.3	MM

NUMBER OF ITERATIONS : 2

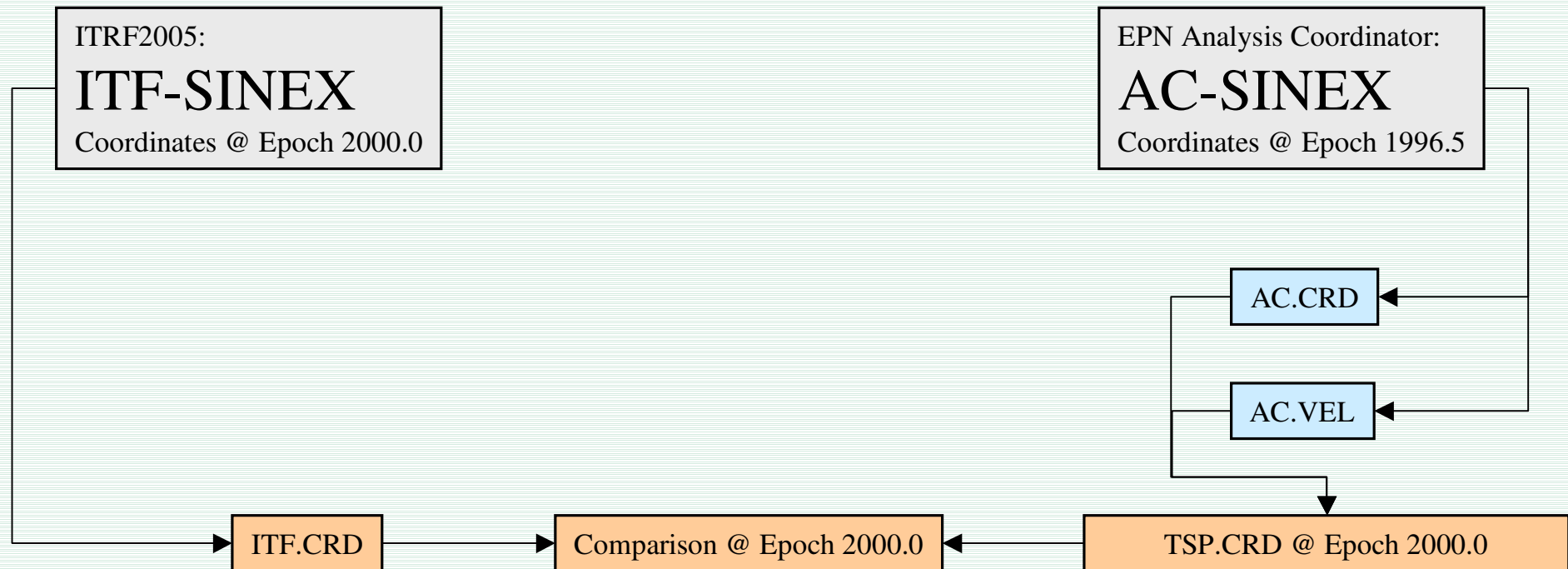
ACCEPTED STATIONS : 124

REJECTED STATIONS : 7

LIST OF REJECTED STATIONS

STATION	RESIDUALS (MILLIMETERS)		
	N	E	U
KELY 43005M001	-1.8	2.8	24.5
HOFN 10204M002A	0.6	-1.4	21.7
QAQ1 43007M001A	0.4	-0.8	-22.8
REDU 13102M001	2.1	-2.2	-20.6
SFER 13402M004	2.4	10.4	1.3
OBET 14208M004	3.0	-1.3	-26.3
QAQ1 43007M001	1.4	-1.4	-34.2

threshold outlier rejection 10 mm horizontal, 20 mm vertical



Helmert Transformation ITF – AC @ Epoch 2000.0

NUMBER OF PARAMETERS : 3
NUMBER OF COORDINATES : 360
RMS OF TRANSFORMATION : 4.1 MM

PARAMETERS:

TRANSLATION IN X	:	1.0	+-	0.4	MM
TRANSLATION IN Y	:	-0.8	+-	0.4	MM
TRANSLATION IN Z	:	1.7	+-	0.4	MM

NUMBER OF ITERATIONS : 2

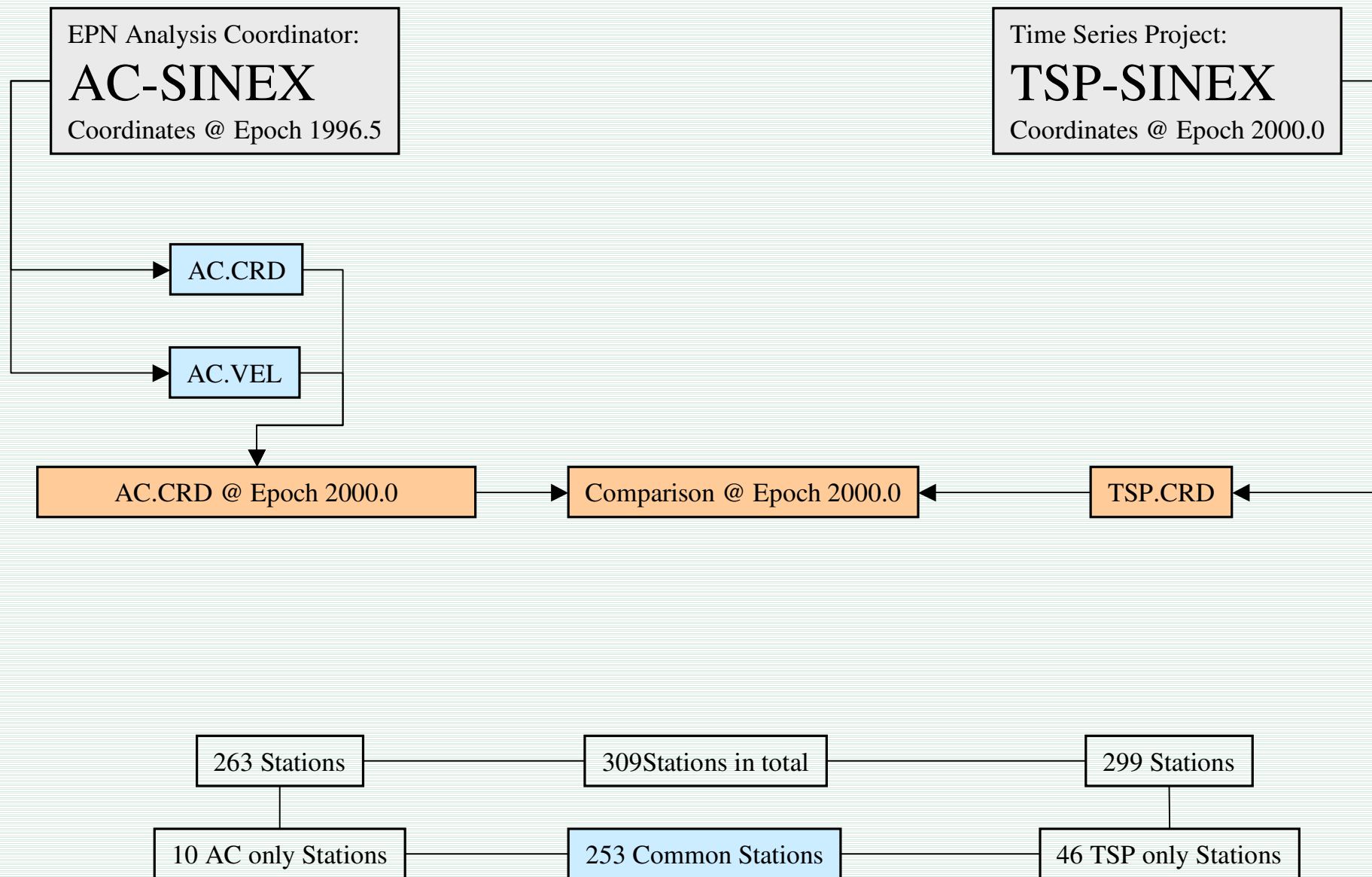
ACCEPTED STATIONS : 120

REJECTED STATIONS : 5

LIST OF REJECTED STATIONS

STATION	RESIDUALS (MILLIMETERS)		
	N	E	U
THU1 43001M001	-0.4	-5.7	-22.0
SFER 13402M004B	-3.3	11.3	-2.5
REDU 13102M001	3.5	-2.0	-20.6
OBET 14208M004	1.5	-0.3	-33.5
TRO1 10302M006	1.8	12.3	1.5

threshold outlier rejection 10 mm horizontal, 20 mm vertical



Helmert Transformation AC – TSP @ Epoch 2000.0

NUMBER OF PARAMETERS : 3
 NUMBER OF COORDINATES : 747
RMS OF TRANSFORMATION : 3.6 MM

PARAMETERS:

TRANSLATION IN X	:	-0.3	+-	0.2	MM
TRANSLATION IN Y	:	0.1	+-	0.2	MM
TRANSLATION IN Z	:	-1.1	+-	0.2	MM

NUMBER OF ITERATIONS : 2

ACCEPTED STATIONS : 249

REJECTED STATIONS : **4**

LIST OF REJECTED STATIONS

STATION	RESIDUALS (MILLIMETERS)		
	N	E	U
NEWL 13273M103	-0.0	1.9	-21.2
QAQ1 43007M001A	3.0	5.4	-23.2
QAQ1 43007M001	5.9	7.5	-45.3
THU1 43001M001	-6.4	3.6	20.8

threshold outlier rejection 10 mm horizontal, 20 mm vertical

Datum Issue: Minimum Constraint *versus* Heavily Constraint AC @ Epoch 2000.0

NUMBER OF PARAMETERS : 3
NUMBER OF COORDINATES : 789
RMS OF TRANSFORMATION : 1.4 MM

PARAMETERS:

TRANSLATION IN X	:	4.6	+-	0.1	MM
TRANSLATION IN Y	:	0.6	+-	0.1	MM
TRANSLATION IN Z	:	-9.0	+-	0.1	MM

NUMBER OF ITERATIONS : 2

NO OUTLIER DETECTED

→ No change of network geometry but common shift of about +/- 1 cm

threshold outlier rejection 10 mm horizontal, 20 mm vertical

Datum Issue: Free Network *versus* Heavily Constraint AC @ Epoch 2000.0

NUMBER OF PARAMETERS : 3
NUMBER OF COORDINATES : 789
RMS OF TRANSFORMATION : 1.7 MM

PARAMETERS:

TRANSLATION IN X	:	-0.8	+-	0.1	MM
TRANSLATION IN Y	:	1.6	+-	0.1	MM
TRANSLATION IN Z	:	-21.4	+-	0.1	MM

NUMBER OF ITERATIONS : 2

NO OUTLIER DETECTED

→ No change of network geometry but common shift of about +/- 2 cm

threshold outlier rejection 10 mm horizontal, 20 mm vertical

Datum Issue: Minimum Constraint AC *versus* TSP @ Epoch 2000.0

NUMBER OF PARAMETERS : 3
NUMBER OF COORDINATES : 747
RMS OF TRANSFORMATION : 3.6 MM

PARAMETERS:

TRANSLATION IN X	:	4.3	+-	0.2	MM
TRANSLATION IN Y	:	0.8	+-	0.2	MM
TRANSLATION IN Z	:	-10.2	+-	0.2	MM

NUMBER OF ITERATIONS : 2

ACCEPTED STATIONS : 249

REJECTED STATIONS : 4

LIST OF REJECTED STATIONS

STATION	RESIDUALS (MILLIMETERS)		
	N	E	U
NEWL 13273M103	-0.7	2.1	-23.6
QAQ1 43007M001A	2.5	6.2	-21.2
QAQ1 43007M001	5.5	8.6	-42.9
THU1 43001M001	-6.5	4.5	20.8

→ No change of network geometry but common shift of about +/- 1 cm

threshold outlier rejection 10 mm horizontal, 20 mm vertical

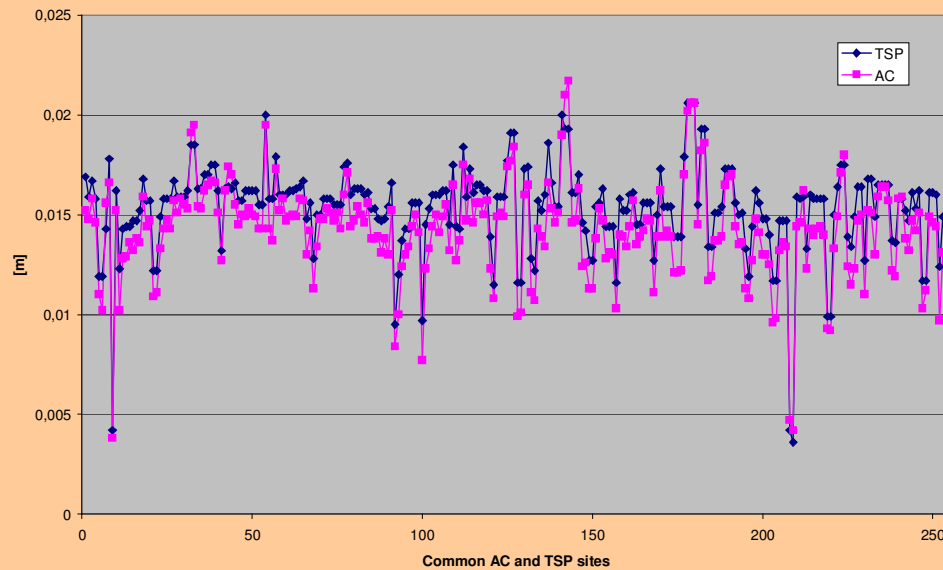


**40 sites
(49 solutions)**

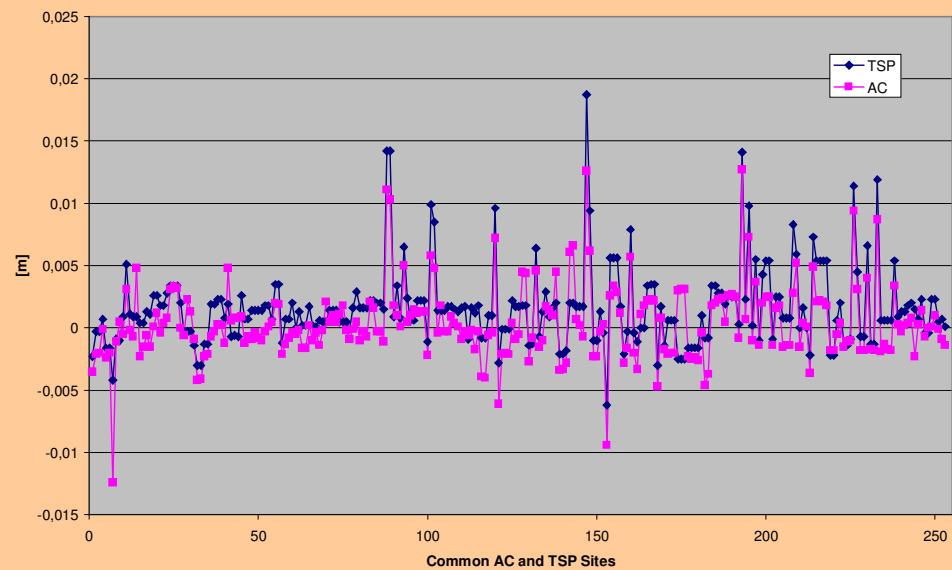


Comparison of Velocities

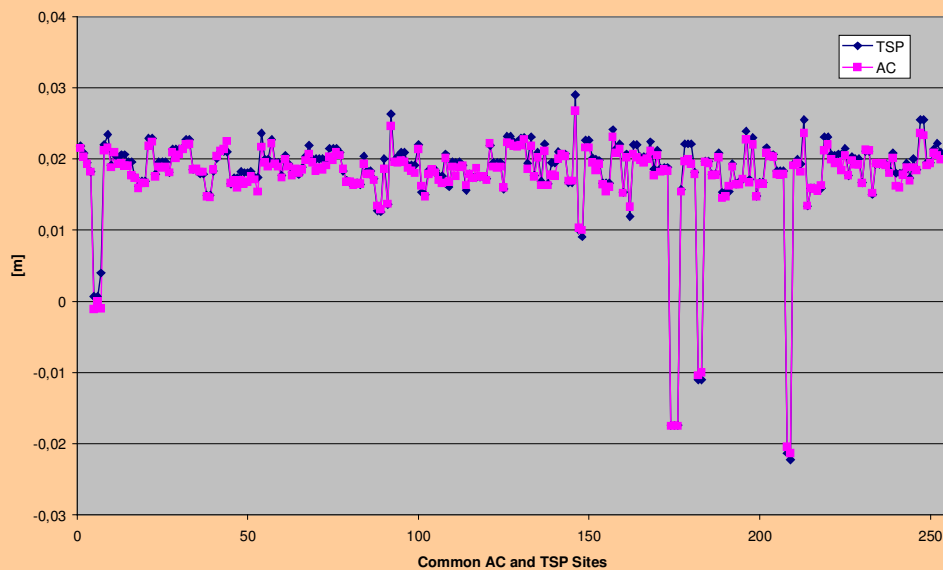
Velocity North



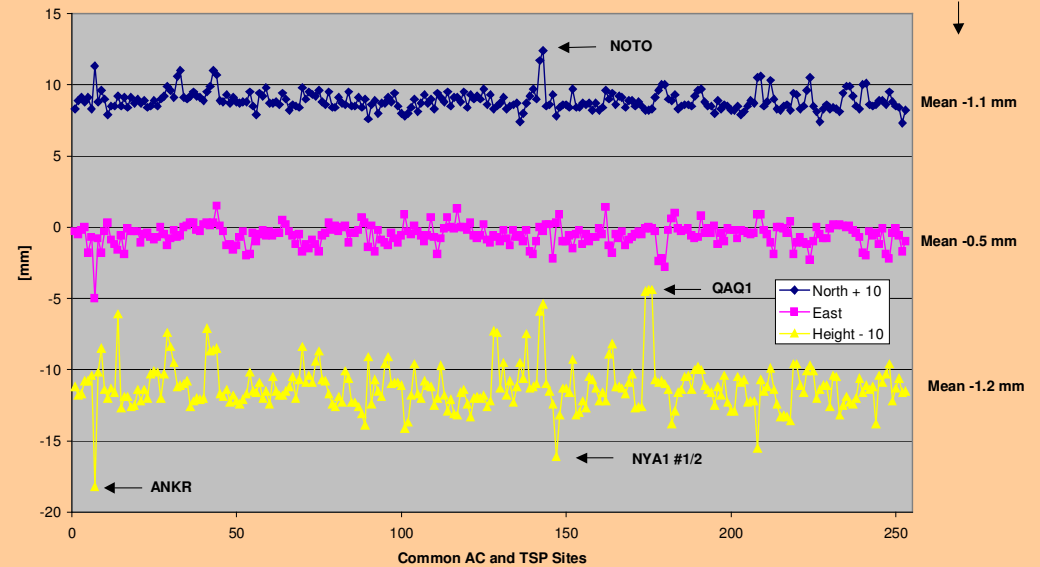
Velocity Height



Velocity East



Velocity Differences (AC-TSP)



Changing Helmert Parameter for Datum Definition and Coordinate Comparison

- Number of Helmert parameters has been varied between „0“ and „7/14“ for
 - Coordinate comparison
 - Definition of minimum constraint condition
- Coordinate changes of about ± 1 cm observed $\rightarrow$ this reflects the absolute accuracy
- No real improvement from parameter change found

- The AC and TSP solutions are equivalent → 3.6 mm RMS of transformed coordinates
- Minimum constraint and heavily constraint AC solutions are equivalent w.r.t. network geometry, but differ by common shift
- Heavily constraint AC solution is proposed as ITRF2005 densification, due to optimal alignment to ITRF2005 → Product files: SINEX, coordinates and velocities