

Local Ties of the Fundamental Station Wettzell (Analysis and SINEX)

Rudolf Zerneck¹

Wolfgang Schlüter²

¹Forschungseinrichtung Satellitengeodäsie

²Bundessamt für Kartographie und Geodäsie



What do we have? What do we need?

■ We have:

- ◆ Local Measurements as
 - ☞ Directions (Kern DKM2, Leica)
 - Horizontal
 - (Vertical)
 - ☞ Distances (Mekometer, Leica)
 - Auxilliary Parameters
 - ☞ Height differences (Leica)
 - Leveling,
 - (Gravity)
- ◆ With reference to the local vertical and horizon (plumbline)
- ◆ Special procedures for Determination of RTW- and WLRs- reference points

■ We need to have:

- ◆ Local ties between the reference points and monuments as
 - ☞ $\Delta X, \Delta Y, \Delta Z$
 - ☞ < Millimeter precise
- ◆ Variance – Co-Variance Matrix **Q**
- ◆ With reference to ITRF

■ Orientation via GPS (identical points)

Steps to reach the goal

- Local Networks Observation and Adjustments
 - ◆ 2D Adjustment (Gauss-Krüger: R, H)
 - ◆ 1D Adjustment for the Height
- Orientation via identical points from the local system to ITRF via GPS observations
- Transformation of Coordinates from Gauss Krüger (R, H) and heights to X, Y, Z in ITRF
- Transformation of Q 's from Q_{RH} , Q_{Height} of the local system to Q_{xyz} of ITRF
- Combination of classical local Network with GPS local Network employing the Q 's

Adjustment: 2D - Network Summary (Gauss-Krüger Coordinates)

- **Two Software Packages employed**
 - PANDA Software
 - Cremer Software
- **Two Solutions (free network adjustment)**
 - 2d coordinates (R=East, H=North)
 - Variance Co-Variance Matrix: $\mathbf{Q}_{RH}$

Summary:

- Number of Observations 972
 - Directions 422
 - Distances 550
- Number of Points
 - Total 57
 - Datum Points 30
- Number of Unknowns
 - Coordinates (R, H) : 114
 - Orientation 39
- Standard Deviations
 - Standard Deviation Position (0.13... 0.23mm)
 - Standard Deviation Orientation (0.08... 0.25 mgon)

Adjustment: 1D - Leveling Summary

- Height Measurements
 - ◆ Leveling with LEICA DNA 03 (no gravity)
- Analysis Software
 - ◆ PANDA
 - ◆ CREMER
- 2 comparable 1D Solutions
 - ◆ Heights for all points with
 - ◆ Variance Covariance Matrix: Q_H

Summary of the free network adjustment

◆ Number of Observations:	317
◆ Number of Points	
☞ Total	115
☞ Datum Points	64
◆ Standard Deviations Heights	
☞ Stand. Dev. Average	0.05mm
☞ Min.-max Stand. Dev.	0.02-0.08mm

Differences between PANDA and CREMER

- 2D Solutions (R = East, H = North)
 - ◆ Differences in R,
 ☞ -0.30mm + 0.45mm
 - ◆ Differences in H
 ☞ -0.53mm +0.28mm
- 1D Solution (Heights)
 - ◆ Differences in Heights
 ☞ -0.10mm +0.05mm
- Reason
 - ◆ different strategies
 - ◆ different reduction procedures (refraction)
- Nevertheless reasonable good agreement

List of Coordinates (Gauss-Krüger)-Extract

EPOCHE 2002					Bemerkungen
Gauß- Krüger- Koordinaten und Höhen über NN					
Pkt.Nr.	Rechtswert [m]	Hochwert [m]	Höhe ü. NN. [m]		
1	4564128,97968	5445706,51044	612,21413	UK	Main Marker
21	4564054,69102	5445693,84218	610,69932	UK	Marker with inclinometer
21-LS	-	-	610,71421	-	
21-OK	-	-	610,74992	-	
100	4564137,24954	5445625,51430	610,82725	OZ	TIGO-VLBI
200	4564110,93105	5445601,47416	610,55224	US	TIGO-SLR
1201	4564234,12432	5445596,85541	619,27493	MOK	WTZT
1202	4564231,89839	5445593,42718	619,36509	OK Strich	WTZR
1203	4564233,57264	5445593,75678	619,26632	MOK	WTZJ
1204	4564231,37532	5445596,44286	619,25275	MOK	WTZA
1205	4564231,46165	5445594,95866	619,23383	MOK	WTZZ
1206	4564232,74917	5445596,65912	619,25683	MOK	free
7224	4564124,54099	5445682,33930	622,46617	SSK	RTW (VLBI)
7595	4564210,59873	5445632,60425	611,46312	BP	Mob. Pad

[illegible]

Transformation from the local Network to ITRF

Helmert Transformation:

- ◆ Identical Network Points observed with GPS
 - X, Y, Z in ITRF available (Variance Co-Variance not available)
- ◆ Conversion of R=East, H=North, Height to X', Y', Z'
 - Conversion of Gauss-Krüger Coordinates to Latitude, Longitude
 - applying conversion formulas, Ellipsoid
 - Conversion of Heights to ellips. Heights
 - $\text{Height}_{\text{ell}} = \text{Height} + \text{Geoidundulation}$
 - Conversion of Latitude, Longitude, ell. Height to X', Y', Z'
 - Applying conversion formulas; Ellipsoid



Local Ties in ITRF

- Reference of the ties to the main reference point (main ground marker)
 - ☞ $\Delta X(i) = X(i) - X(1)$
 - ☞ $\Delta Y(i) = Y(i) - Y(1)$
 - ☞ $\Delta Z(i) = Z(i) - Z(1)$
- Provision of this invariant information should be in the responsibility of the stations!!!

Ties from Wettzell - Extract

No	Point No.	X(i)-X(1)	Y(i)-Y(1)	Z(i)-Z(1)	Remarks
1	1201	63,09768	120,9814	-67,18196	GPS WTZT (Trimble SSI 4000)
2	1204	63,97814	118,35798	-67,44774	GPS WTZA (ASHTech Z12T)
3	7597	87,38725	92,24275	-89,59306	DORIS
4	1205	65,04577	118,67301	-68,43351	GPS/GLONASS WTZZ (JAVAD LEGACY)
5	1202	66,10522	119,3451	-69,41489	GPS WTZR (AOA SNR 8000)
6	7224	25,23457	0,93013	-8,18668	RTW VLBI
7	8834	62,34649	51,15807	-53,82354	WLRS SLR/LLR
8	1	0	0	0	Main Marker
9	21	24,34102	-70,78837	-8,85961	Marker with Inclinator
10	1206	63,52619	119,66645	-67,31362	free
11	1203	65,5032	120,92875	-69,21107	GPS WTZJ (JAVD LEGACY RT)

Transformation of the Variance Co-Variance Matrix from Q_{RH} and Q_{Height} to Q_{XYZ}

- ◆ Combination of Q_{RH} , Q_{Height}
- ◆ Determination of the Transformation Parameters from local system to TRF (XYZ)
- ◆ Transformation

Variance Co-Variance Matrix - Extract (Converted to TRF for X, Y, Z)

	1201			1204			7597	
1201X	1,15E-08	1,48E-09	3,41E-09	8,98E-09	1,29E-09	5,63E-09	9,01E-10	-2,12E-09
Y	1,48E-09	5,32E-08	-7,61E-09	-2,57E-09	8,86E-09	-3,48E-09	2,89E-10	1,94E-09
Z	3,41E-09	-7,61E-09	1,14E-08	6,37E-09	-2,30E-10	7,44E-09	3,23E-10	-2,08E-09
1204	.			1,14E-08	1,77E-09	3,28E-09	8,65E-10	-1,97E-09
	.			1,77E-09	1,82E-08	-6,30E-10	1,25E-10	2,23E-09
	.			3,28E-09	-6,30E-10	9,98E-09	3,24E-10	-2,01E-09
7597	.						2,95E-09	-1,38E-10
	.						-1,38E-10	7,19E-09
	.						1,80E-09	-1,33E-09
1205	.							
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1202	.							
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7224	.							
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8834	.							
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21	.							
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Further Improvements

- Combining of local survey with GPS observations via identical points observed

- ☞ with GPS : X, Y, Z and Q_{GPS}

- ☞ from local survey : X, Y, Z and Q_{XYZ}



best $\Delta X, \Delta Y$ and ΔZ

Requirements:

- ◆ Archiving results for further survey activities!!!
- ◆ Documentation!
- ◆ Standards and Formats?

Responsibility of Station?