DETERMINATION OF DEFORMATIONS OF THE CENTRAL EUROPE FROM CERGOP GPS OBSERVATIONS CAMPAIGNS

Magdalena Klek, Jerzy B. Rogowski

Warsaw University of Technology, Institute of Geodesy and Geodetic Astronomy

Determination of deformations parameters from CERGOP GPS observations campaigns are presented at the poster. The velocity vectors are determined for CERGOP stations participated in GPS observations campaigns in the period 1994-2005. In the period of 11 years, 7 GPS observation campaigns were executed. Good quality of observations and data processing create chance to determined precise value of velocity and deformations like main directions of deformations and elongation (distortion). Method used for computation of deformation was proposed by Altiner. Comparison of deformation parameter with a European stress model made by Jarosiński is also presented in the paper.

1. MAIN PRINCIPLES AND USED DATA

In the frame of the project CERGOP and CERGOP II 7 observations campaigns was performed in the period 1994-2005. Stations in the territory of CEI (Central European Initiative) countries create CEGRN network are the integral part of CERGOP project. Different number of the stations was participated in the successive GPS observations campaigns. In consequence different number of observations campaigns was performed at the stations participated in the project. The station where two or more observations campaigns were performed was used for determination of deformations parameters. List of the stations and GPS campaigns used for data processing are presented in the Table 1. Map of the stations, which was used for determination deformations parameters are presented in the Figure 1.

In the first step the stations coordinates was made in the reference frame be in force in the time when the observations were made for the mean epoch of observations. In the second step the coordination was transformed to the common epoch and reference frame. Velocity vectors are computed using linear regression method. For two stations there are presented changes of coordinates and their line of trend on the Fig. 3. The values of horizontal velocities and its rms are presented in the Table 2.

Algorithm proposed by Altiner (Altiner, 1999) used for computation deformation parameters. For determination of deformations parameters the network independent triangles was created. Network of 108 triangles used for determination of deformation parameters are presented in the Figure 2. Altiner methods assume that the value of velocities in the centre of the triangles is known. Determinations of the velocities in these points are executed using interpolation method. Cause the insufficient precision of the high value data processing was performed using only horizontal velocities.

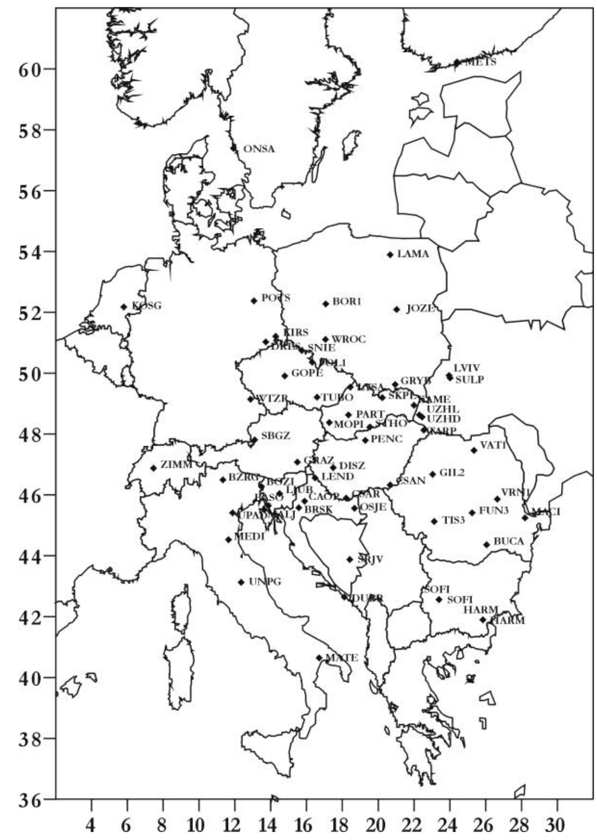

Fig. 1. Map of the station

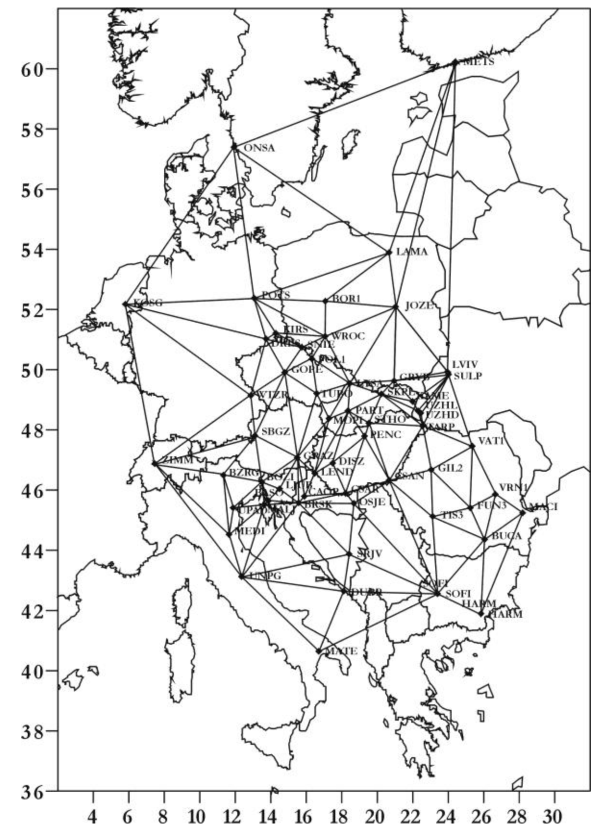

Fig. 2. Network of triangles

Table 1. List of the stations and GPS campaigns

	1994	1995	1996	1997	1999	2001	2003
BASO	x	x	x	x			
BOR1	x	x	x	x	x	x	x
BOZI					x	x	x
BRSK	x	x	x	x	x	x	x
BUCA		x	x	x	x		x
BUCU					x	x	x
BZRG					x	x	x
CAOP						x	x
CSAN					x	x	x
CSAR	x	x	x	x	x	x	x
DISZ	x	x	x	x	x	x	x
DRES					x	x	x
DUBR						x	x
FUN3					x	x	x
GIL2				x	x		
GOPE	x	x	x	x	x	x	x
GRAZ	x	x	x	x	x	x	x
GRYB	x	x	x	x	x	x	x
HARM			x	x			x
IAS3			x	x	x		
JOZE	x	x	x	x	x	x	x
KAME					x	x	x
KIRS	x	x	x	x	x		
KOSG	x	x	x	x	x	x	x
LAMA	x	x	x	x	x	x	x
LEND					x	x	
LJUB	X	x	x	x	x	x	x
LVIV		x	x	x	x	x	x
LYSA					x	x	x
MACI		x	x	x			
MALJ					x	x	x
MATE	x	x	x	x	x	x	x
MEDI					x	x	x
METS	x	x	x	x	x	x	x
MOPI	x	x	x	x	x	x	x
ONSA	x	x	x	x	x	x	x
OSJE						x	x
PART					x	x	x
PENC	x	x	x	x	x	x	x
POL1					x	x	x
POTS		x	x	x	x	x	x
SBGZ					x	x	x
SKPL	x	x	x	x	x	x	x
SNIE	x	x	x	x	x	x	x
SOFI			x	x	x	x	x
SRJV					x	x	x
STHO	x	x	x	x	x	x	x
SULP				x	x	x	x
TARP					x	x	x
TIS3			x	x	x		x
TUBO		x			x	x	x
UNPG						x	x
UPAD	x	x	x	x	x	x	
UZHD	x	x	x	x	x	x	x
UZHL						x	x
VAT1				x	x		
VRN1				x	x	x	x
WROC					x	x	x
WTZR			x	x	x	x	x
ZIMM	x	x	x	x		x	x

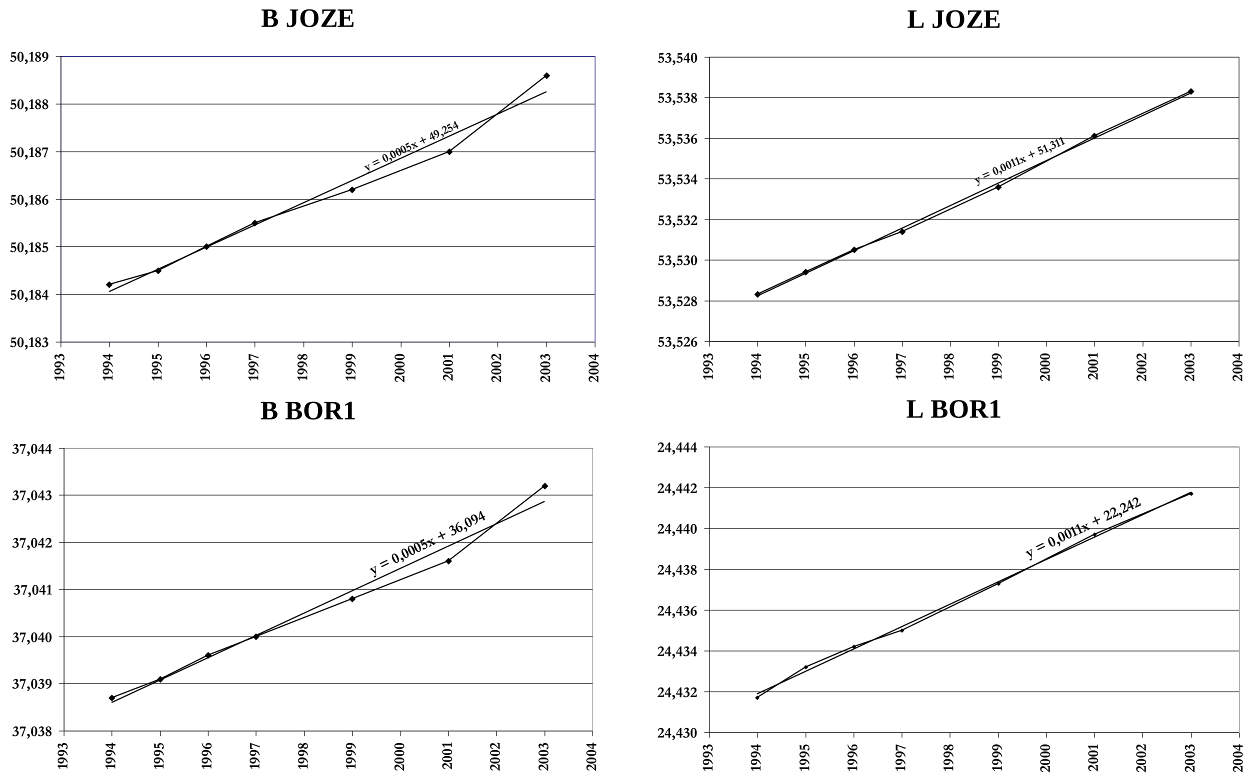

Fig. 4. Changes of coordinates and their trend

Table 2. Velocity vectors and their rms

	VB [mm]	σ [mm]	VL [mm]	σ [mm]		VB [mm]	σ [mm]	VL [mm]	σ [mm]
BASO	6,56	0,86	5,85	1,19	MALJ	7,78	1,57	4,71	2,17
BOR1	5,27	1,75	0,75	4,02	MATE	6,85	2,26	1,90	3,81
BOZI	8,06	1,67	0,82	2,12	MEDI	7,78	1,58	6,42	2,17
BRSK	5,88	1,95	1,89	4,04	METS	4,38	1,47	1,65	4,72
BUCA	4,67	1,48	0,86	3,87	MOPI	5,42	1,80	1,71	3,78
BUCU	5,56	1,14	4,32	2,50	ONSA	0,00	1,16	-2,91	3,00
BZRG	6,67	1,36	1,59	2,06	OSJE	8,90	1,26	4,84	1,57
CAOP	9,45	1,34	4,04	1,65	PART	8,06	1,67	3,23	2,40
CSAN	6,39	1,30	1,90	2,50	PENC	5,02	1,67	1,78	3,96
CSAR	5,51	1,83	1,76	3,73	POL1	7,23	1,46	2,38	2,00
DISZ	5,07	1,67	1,91	4,14	POTS	5,54	1,72	1,97	3,52
DRES	7,51	1,54	5,47	2,29	SBGZ	7,23	1,47	4,68	2,29
DUBR	0,00	1,26	4,10	1,42	SKPL	5,23	1,74	1,72	3,97
FUN3	4,45	0,95	4,78	2,51	SNIE	4,36	1,47	1,48	3,41
GIL2	3,34	0,47	2,93	1,81	SOFI	4,58	1,33	12,02	3,53
GOPE	5,36	1,78	1,70	3,86	SRJV	6,95	1,41	6,69	2,39
GRAZ	5,57	1,85	1,73	3,81	STHO	5,35	1,77	1,78	3,99
GRYB	5,26	1,74	1,74	3,96	SULP	5,28	1,41	9,36	3,29
HARM	4,49	1,70	6,46	4,61	TARP	6,39	1,31	7,05	2,39
IAS3	5,16	0,85	4,84	1,75	TIS3	5,49	1,71	7,12	3,64
JOZE	5,19	1,72	1,70	4,07	TUBO	5,94	2,05	6,22	3,96
KAME	6,39	1,30	4,84	2,56	UNPG	7,78	1,10	2,08	1,34
KIRS	5,12	0,99	2,60	2,24	UPAD	0,00	7,31	-4,82	2,97
KOSG	5,64	1,86	1,46	3,50	UZHD	4,76	1,60	1,81	4,02
LAMA	5,19	1,72	1,56	3,88	UZHL	9,45	1,34	4,73	1,73
LEND	5,00	0,71	3,53	0,71	VAT1	3,34	0,47	5,11	1,65
LJUB	6,06	2,01	1,62	3,52	VRN1	4,67	1,24	1,03	3,23
LVIV	5,11	1,59	5,42	3,71	WROC	6,95	1,42	5,26	2,34
LYSA	6,95	1,42	6,04	2,45	WTZR	5,72	1,66	1,20	3,24
MACI	5,56	0,57	3,10	1,17	ZIMM	5,86	2,10	2,09	3,80

2. MAIN PRINCIPLES OF DEFORMATION THEORY USED FOR DATA PROCESSING

Essential measure of deformation is the difference of the square of linear elements which is a function of the deformation tensor presented below:

$$d\bar{s}^2 - ds^2 = \left(\bar{f}_{\alpha\beta} - f_{\alpha\beta}\right)du^\alpha du^\beta = 2D_{\alpha\beta}du^\alpha du^\beta$$

Where:

$u^\alpha =$ coordinates P in t and $\bar{t}$

$f_{\alpha\beta} =$ metric tensor in t

$\bar{f}_{\alpha\beta} =$ metric tensor in $\bar{t}$

For the small displacement values with what we are in this case tensor of deformation is signify of $\varepsilon_{\alpha\beta}$.

Maximal values of extension and dilatation are determined:

$$D_{\alpha\beta} = \frac{\bar{f}_{\alpha\beta} - f_{\alpha\beta}}{2} = D_{\beta\alpha}$$

Where r^α principal direction of deformations.

In the frame of this project the values of maximal dilatation and extension as well as principal axis of ellipse named as a main direction strain was determined. In the Figure 3 principal direction of the strain are presented. Dilatation (negative value of deformation) is shown on the left, extension (positive value of deformation) on the right.

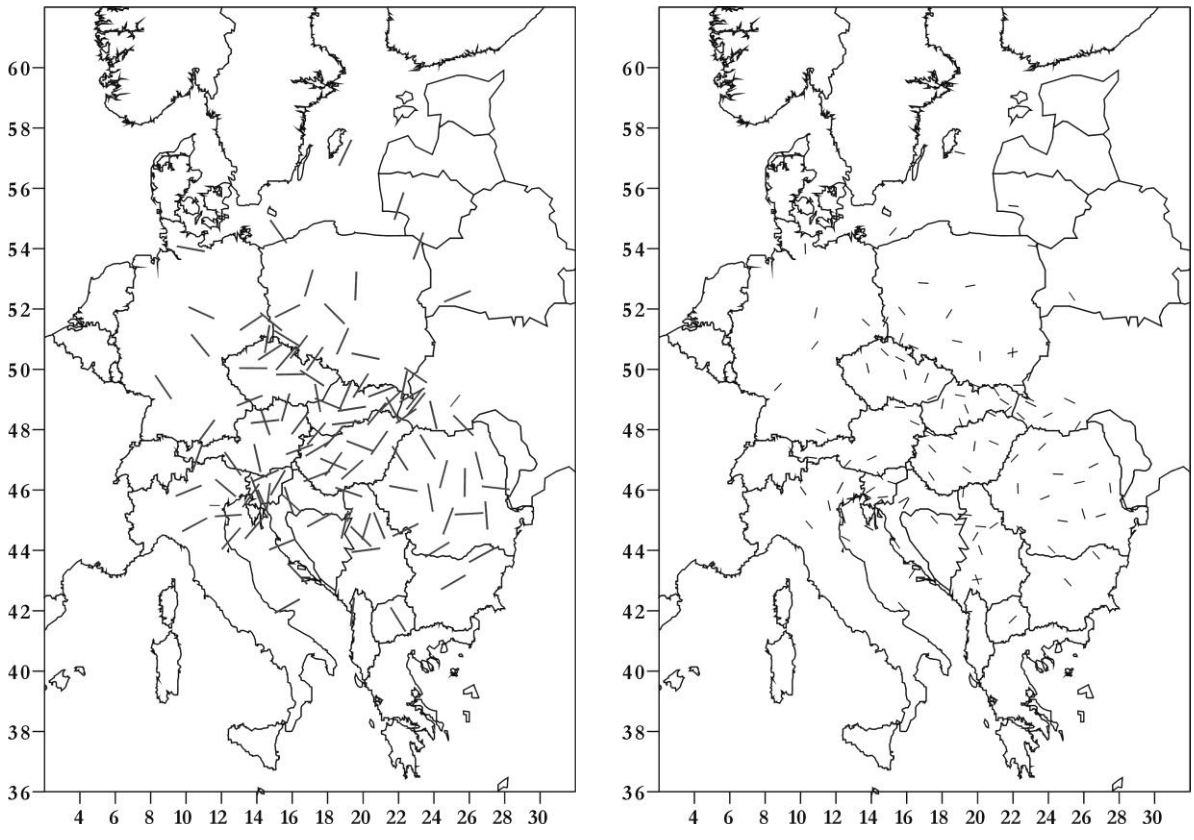

Fig. 3. Principal directions of the strain

Principal axis of deformations ellipse obtained from analysis of CERGOP campaigns are similar to model of stress elaborated by Jarosiński (Jarosiński, 1999) Figure 4.

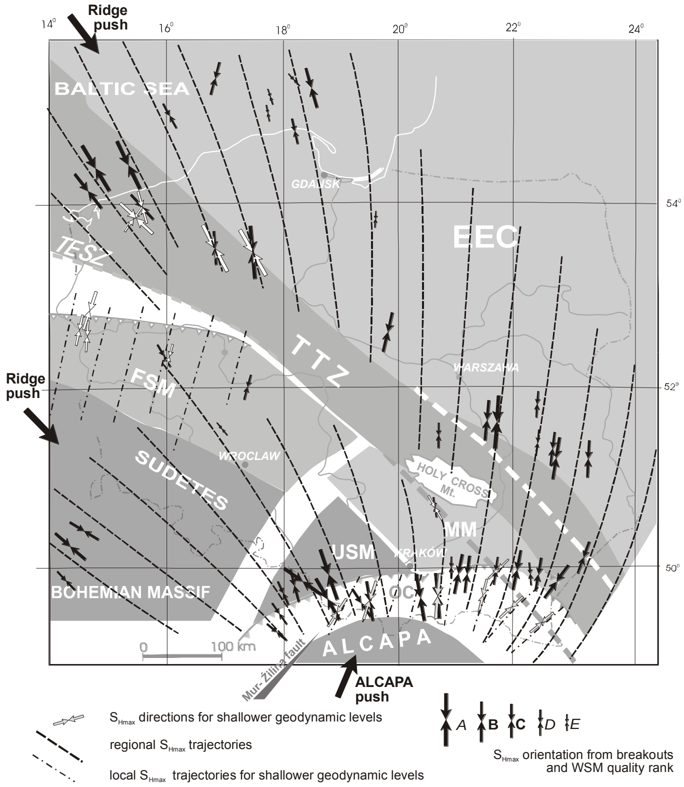

Fig. 4. A sketch map of the S_{Hmax} orientation from breakouts and hypothetical trajectories of S_{Hmax} for Poland

BIBLIOGRAPHY

Altiner Y., 1999. Analytical surface deformation theory, Springer, Berlin.

Jarosiński, M., 1999. Present-day tectonic stress directions in Poland and their relation to intra-plate motions as determined by mean of GPS. Paper presented at 2nd Euroconference on WSM Deformation and Stress in the Earth's Crust, Aspo Hard Rock Laboratory, Sweden.