PROBLEM OF INTRAPLATE VELOCITY DETERMINATION FOR GEOKINEMATIC INTERPRETATIONS

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1. INTRODUCTION

This paper presents regional velocity field determined using time series from Polish Ground-Based Augmentation System (ASG-EUPOS). The system has been operating since mid-2008, so the velocities obtained through the processing of 3-year time series are supposed to be reliable from statistical point of view. The paper presents intraplate velocities (IPV) determined using geological model NUVEL-1A NNR and geological-geodetic APKIM2005 in comparison to geodetic determination (ITRF global velocities and ETRF frame).

Multifunctional precise satellite positioning system ASG-EUPOS was established by the Head Office of Geodesy and Cartography in 2008 (Bosy et al., 2007). In 2012 it became a basic control network for Poland. According to the agreement between Military University of Technology and the Head Office Centre of Applied Geomatics makes independent processing of the data aimed at monitoring of the reference frame stability. From geodetic point of view proper determination of the intraplate velocities will show how the Polish reference network would be deformed by station velocities for the next decade. From the other side the geokinematic situation of the Central Europe is able to be described. In 2010 the project aimed at improving the system started (Figurski et al., 2011).

The region of Central Europe, Adriatic region and Balkan Peninsula were subjects of geo-kinematical monitoring in several projects performed since 1992 described by Hefty (2007). He analysed independent GPS epoch-wise observing campaigns and discussed the intraplate GPS velocities in Central and South-East Europe and their reliability, mainly focusing on Adria and East Balkan region. Hefty (2005) determined the intraplate velocity field from observations conducted within the CERGOP (Central European Regional Geodynamic Project) which was realised in 1994-1997 and its follow-up CERGOP-2 using the data from annual and bi-annual epoch GPS campaigns. He evaluated new velocity field which was based on the data set enlarged by inclusion of 2003 CEGRN campaign in relation to the previous determinations (Becker et al., 2002). Haslinger et al. (2007) derived intraplate velocities from coordinate time series of permanent stations in Austria, by taking into account offsets and detecting outliers. The estimated velocities had a precision of 1 mm/y laterally and 1-3 mm/y vertically. These velocities were reduced by the rotational velocity of the Eurasian Plate, derived from ITRF2000 (International Terrestrial Reference Frame), in order to investigate intraplate movements. Apart from some local movements they obtained velocities in the range of 0-3 mm/y.

2. COVERAGE

We have considered observations from over 300 EPN (EUREF Permanent Network) and ASG-EUPOS sites. The layout on the Polish area is presented in Fig. 1.

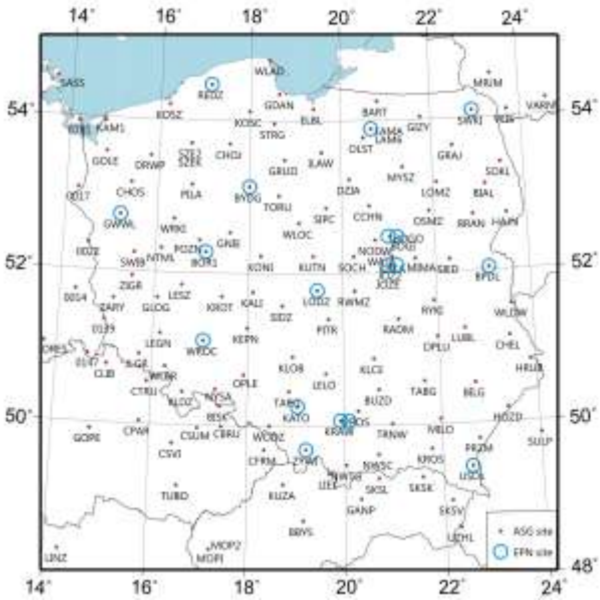

Fig. 1. Layout of the permanent GNSS sites in Poland.

The velocities were determined from daily solutions in ITRF2005 reference frame (Altamimi et al., 2007), performed in the Military University of Technology EPN Local Analysis Centre (MUT LAC). Time span covered data from 2008 (start of ASG-EUPOS) to 2011. Then outliers, offsets and periodic effects were defined (Bogusz et al., 2012a). Finally the robust method (Huber, 1964) of linear trend determination was applied (Bogusz et al., 2012b).

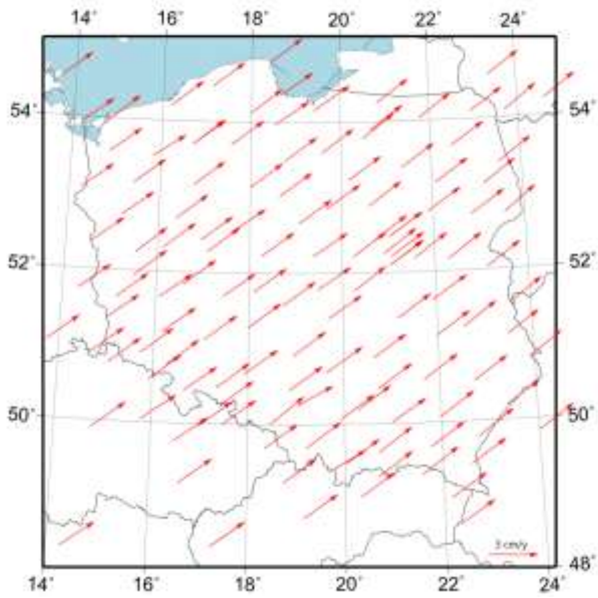

Fig 2. Absolute velocities in ITRF2005 reference frame.

3. INTRAPLATE VELOCITIES

The determination of intraplate velocities was based on 3 models. We have used:

- NUVEL-1A NNR (De Mets et al., 1990);
- APKIM2005 (Drewes, 2009);
- ITRF2005 (plate velocity, Altamimi et al., 2007)

and compared to the velocities described in the ETRF2000 (R05) reference frame calculated using Memo (Boucher and Altamimi, 2011). The parameters (Fig. 3) taken for Eurasia plate were:

	□$_E$ [°]	□$_E$ [°]	□ [°/Ma]
APKIM2005 (IGN)	53.400	264.300	0.259
APKIM2005 (DGFI)	54.500	262.900	0.258
NUVEL-1A NNR	50.600	247.700	0.234
ITRF2005	56.330	264.021	0.261

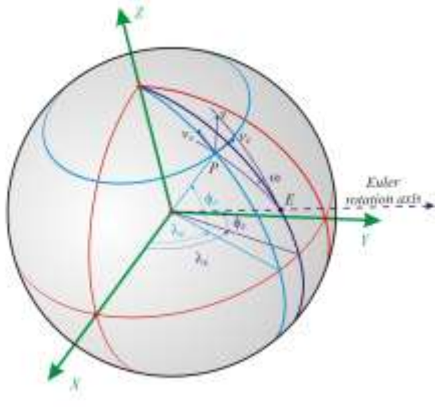

Fig. 3. Idea of the modelled velocity determination.

Figures 4-6 presents intraplate velocities determined for the territory of Poland.

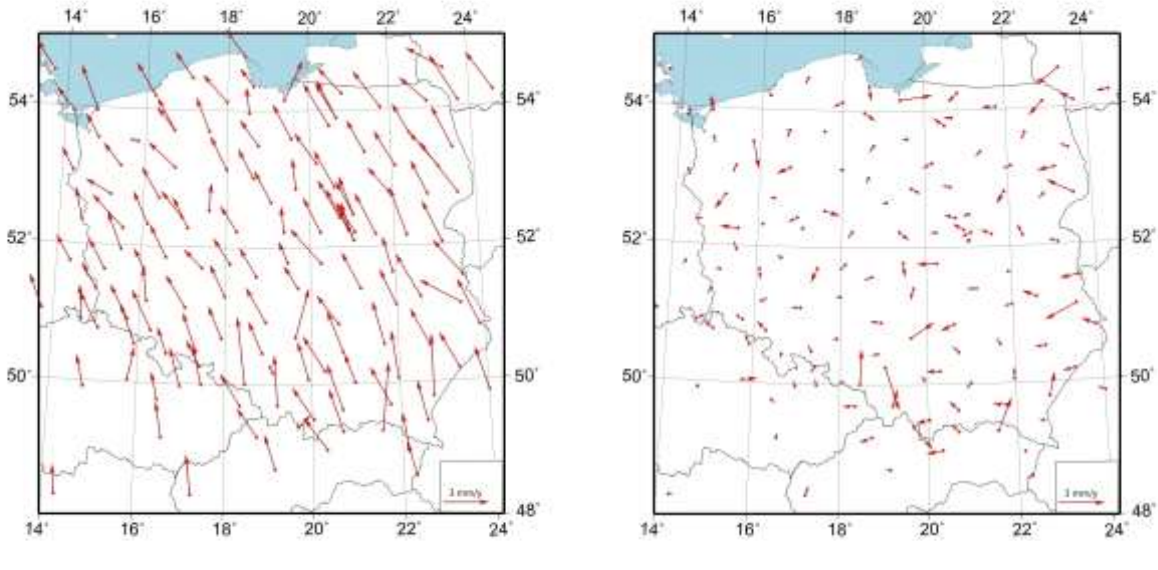

Fig. 4. Residuals from NUVEL-1A NNR (left) and ITRF2005 velocity models.

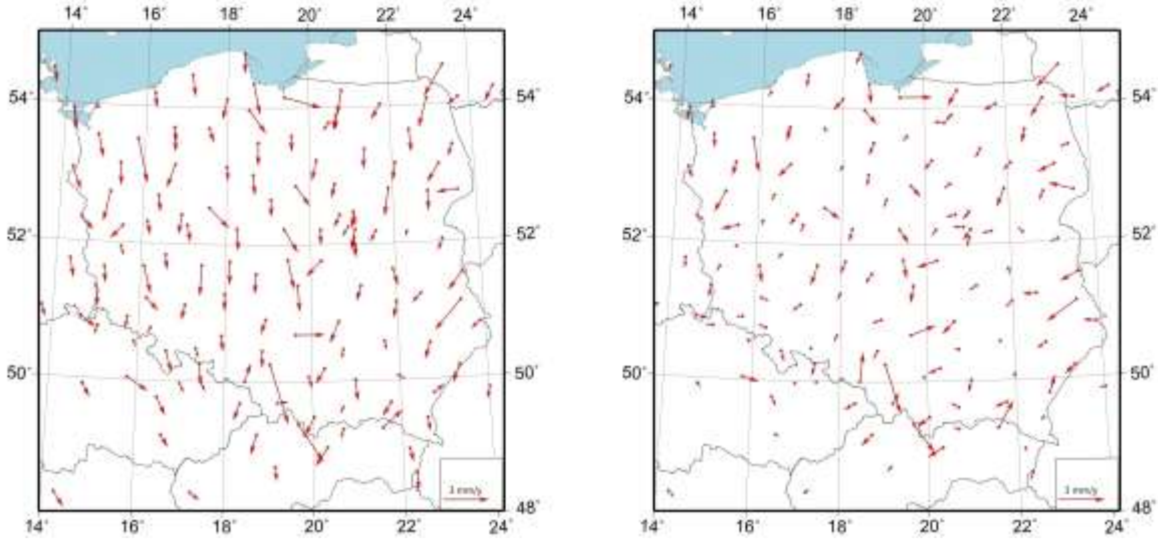

Fig. 5. Residuals from APKIM2005 (IGN) (left) and APKIM2005 (DGFI) models.

Fig. 6. Intraplate velocities in ETRF2000 reference frame.

From geodetic point of view determination of the velocity vector is very precise, with standard deviations at the level of 0.1 mm/y when applying white noise (Bogusz et al., 2012a). But according to the geological information several stations were assumed to be non reliable and excluded from further investigations (Fig. 7).

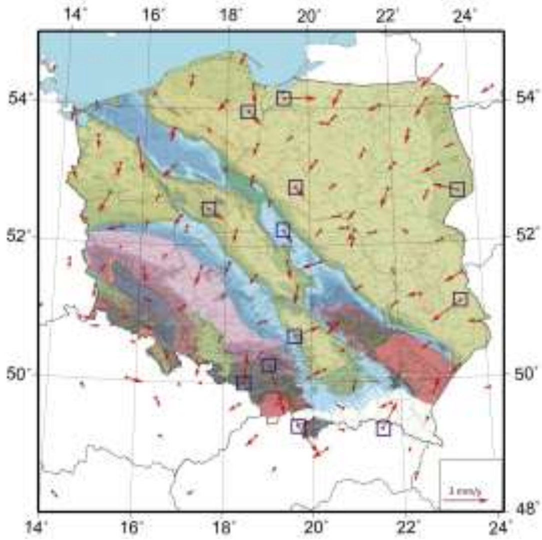

Fig. 7. Sites excluded from further analyses.

Table 1 presents statistics (minimum, maximum and average values) of each model for more than 130 stations on Polish territory.

Table 1.

	NUVEL		ITRF2005 (Red.)		ETRF2000 (R05)		APKIM2005 (IGN)		APKIM2005 (DGFI)	
	V_E	V_N	V_E	V_N	V_E	V_N	V_E	V_N	V_E	V_N
MIN	-2.6	-0.6	-2.1	-2.8	-2.5	-2.8	-1.8	-3.9	-2.0	-3.2
MAX	1.2	4.4	2.1	2.3	1.6	2.3	2.4	1.2	2.1	1.9
AV.	-1.0	2.2	-0.3	0.0	-0.7	0.1	0.1	-1.1	-0.2	-0.4

6. SUMMARY

Proper determination of the intraplate velocities is doubtful from using different models of plate motion. In our studies we have used two different models (NUVEL and APKIM2005) in comparison with the velocities determined in the ETRF2000 reference frame and reduced using ITRF2005 global velocities. Maximum difference between particular IPV was 3.5 mm/y (NUVEL and APKIM). If we exclude NUVEL model which seems to be least fit, the differences reach 1.3 mm/y (average 1.1). For further analyses (strain rates) APKIM2005 (IGN) model will be adopted.

ACKNOWLEDGMENTS

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Maps and charts were drawn using the Generic Mapping Tool (Wessel and Smith, 1998).

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