8TH CZECH-POLISH WORKSHOP „ON RECENT GEODYNAMICS OF THE SUDETEN AND ADJACENT AREAS”
Klodzko-Boguszyn, March 29-31, 2007

Comparison of linear trend and periodic components of GPS time series for selected permanent stations of Central Europe.

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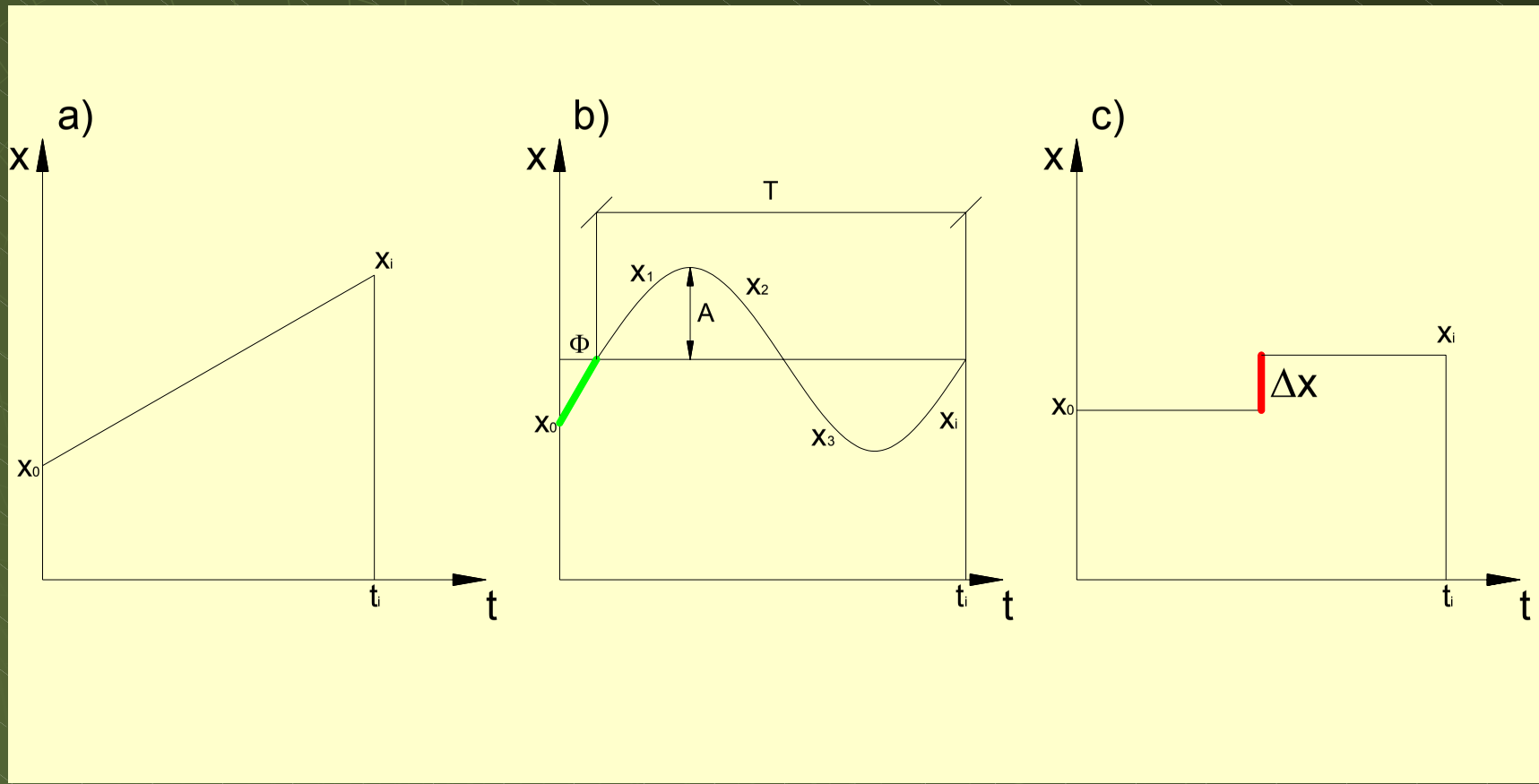
Models of GPS site movements



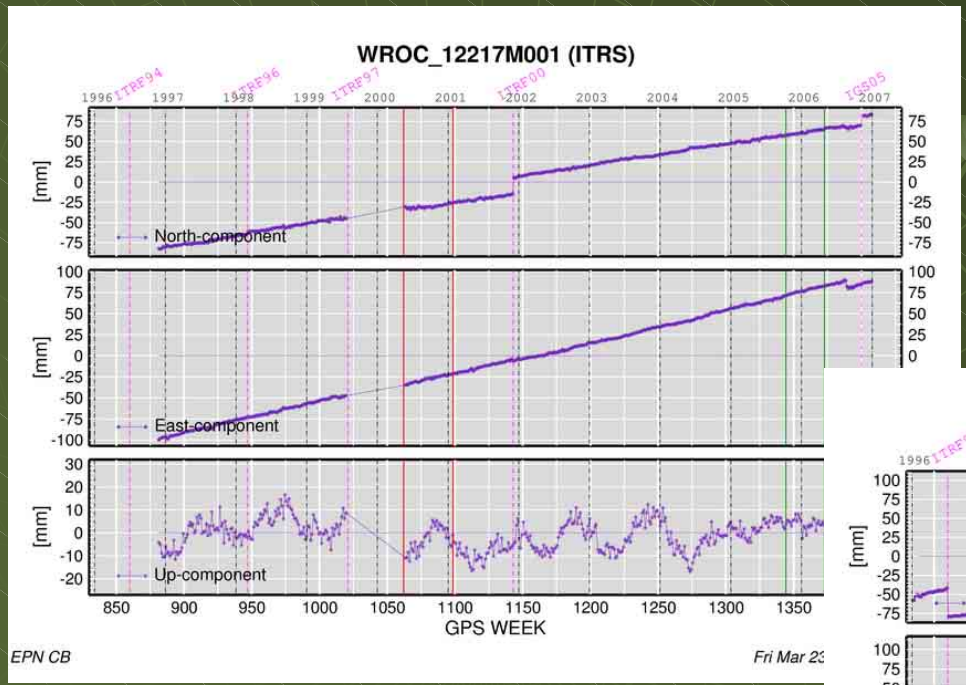
Linear

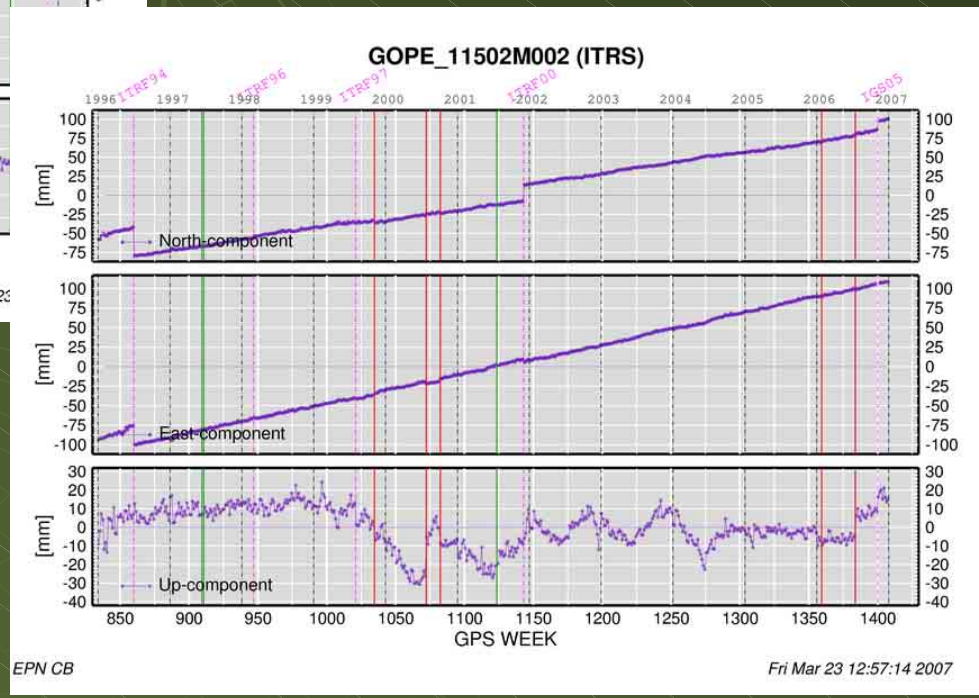
Periodic

Episodic displacement

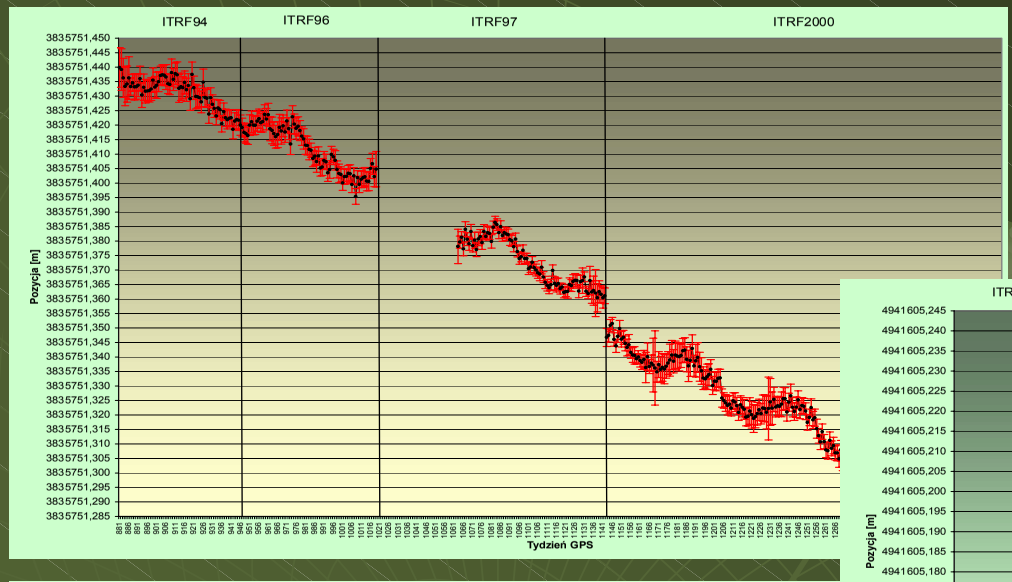
Input data

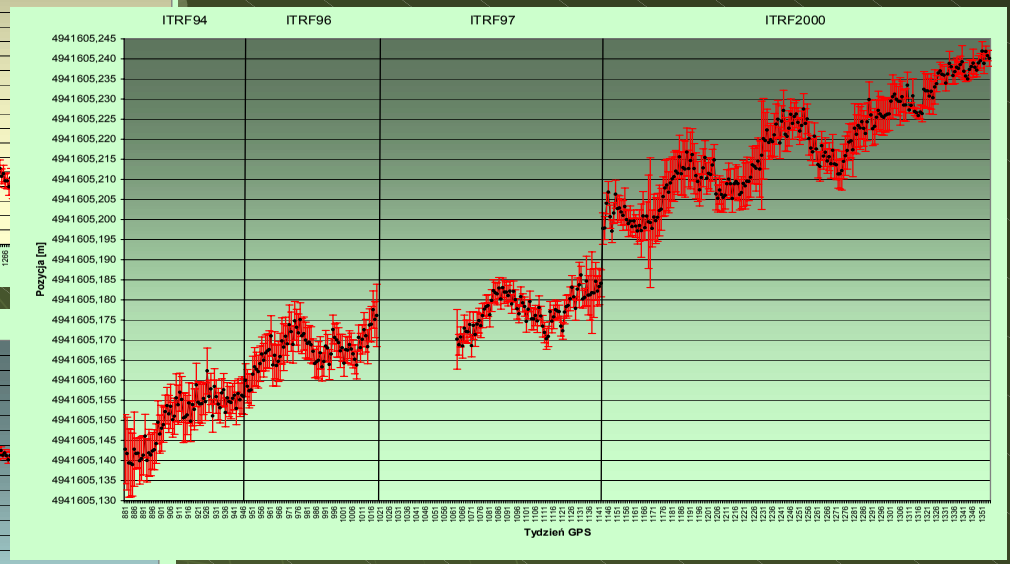
Coordinate Time Series in ITRS,
extracted from weekly EUREF combined solution (SINEX files).

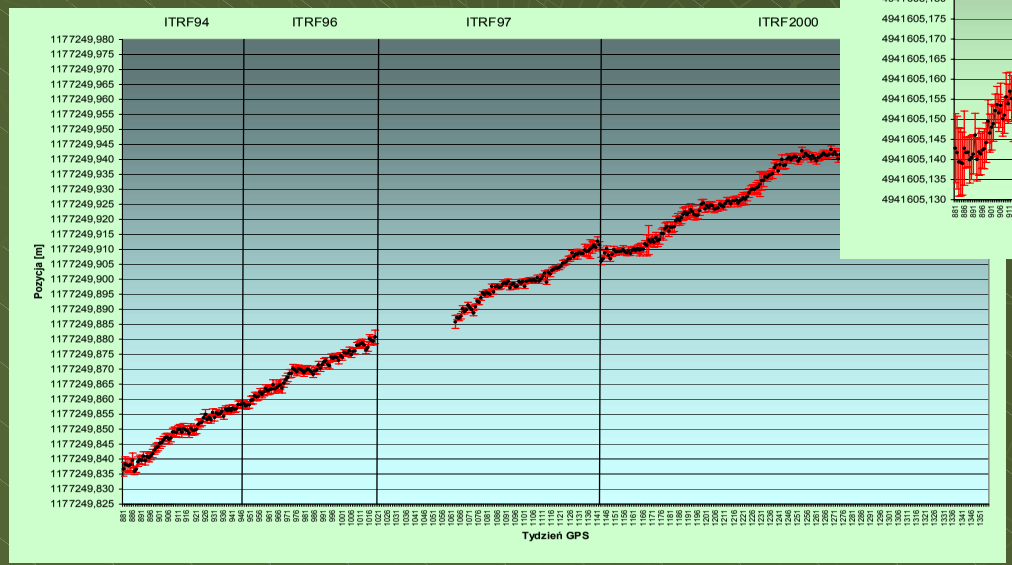




Input data - WROC





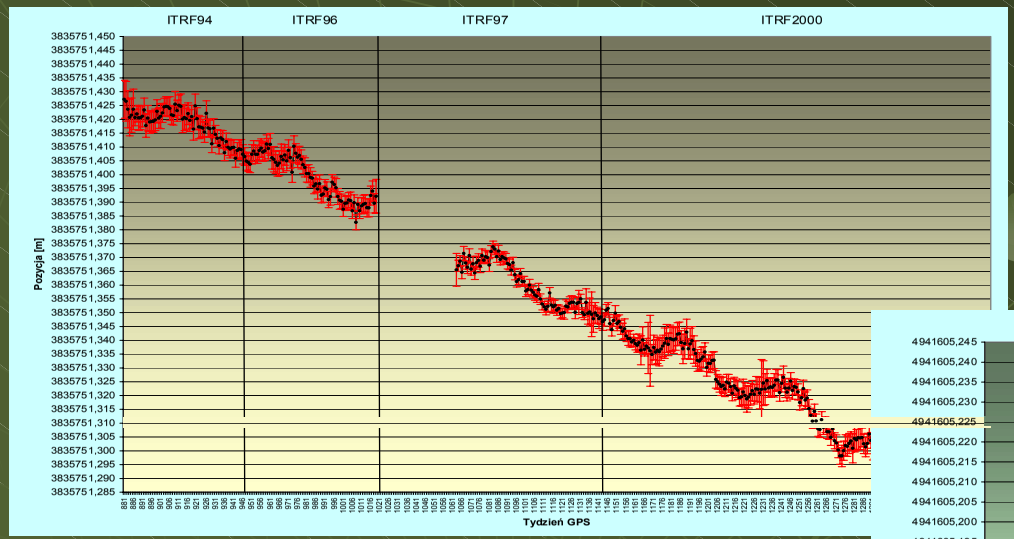


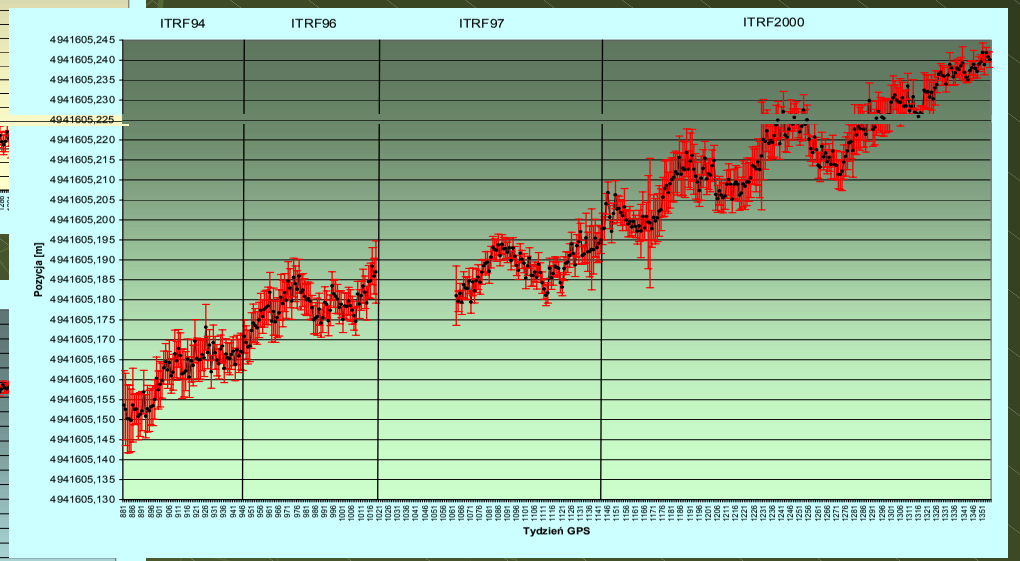
GPS Week	*Reference*
881 - 946	ITRF94
947 - 1020	ITRF96
1021 - 1142	ITRF97
1143 - 1355	ITRF2000

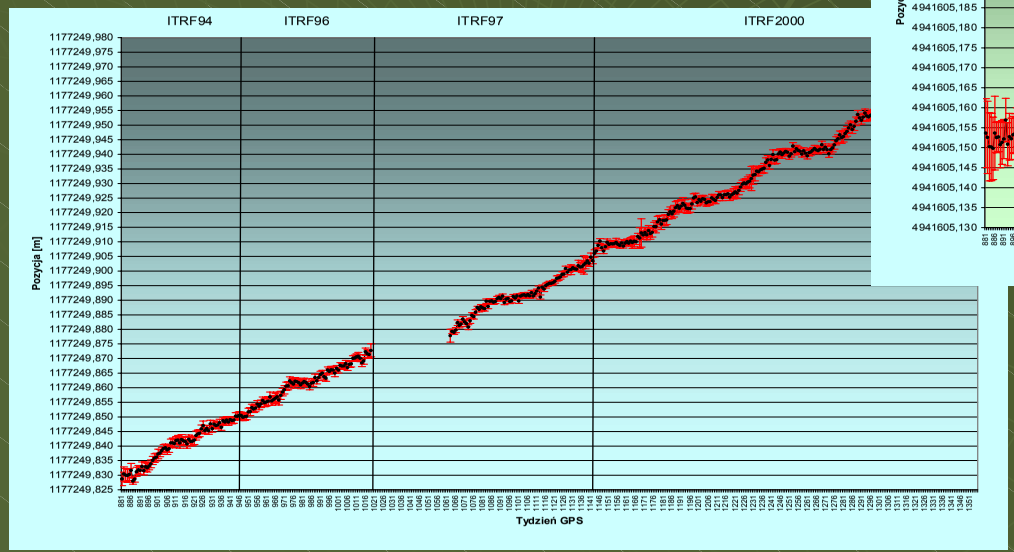
Data pre-processing (1)

$$X_{2000} = (I + R)^{-1} * (X_{XX} - T)$$

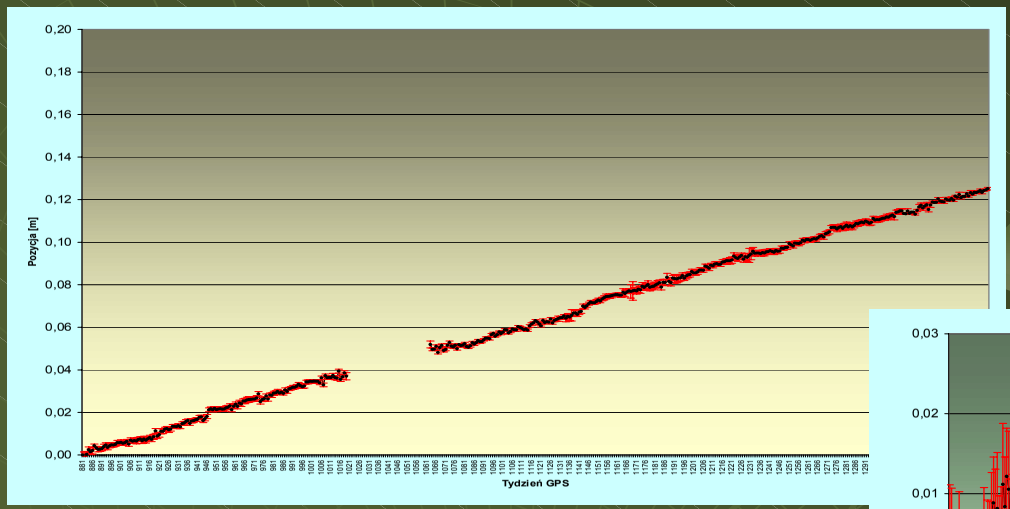
$$\begin{bmatrix} X_{2000} \\ Y_{2000} \\ Z_{2000} \end{bmatrix} = \left(I + \begin{bmatrix} D & -R3 & R2 \\ R3 & D & -R1 \\ -R2 & R1 & D \end{bmatrix} \right)^{-1} * \left(\begin{bmatrix} X_{XX} \\ Y_{XX} \\ Z_{XX} \end{bmatrix} - \begin{bmatrix} T1 \\ T2 \\ T3 \end{bmatrix} \right)$$





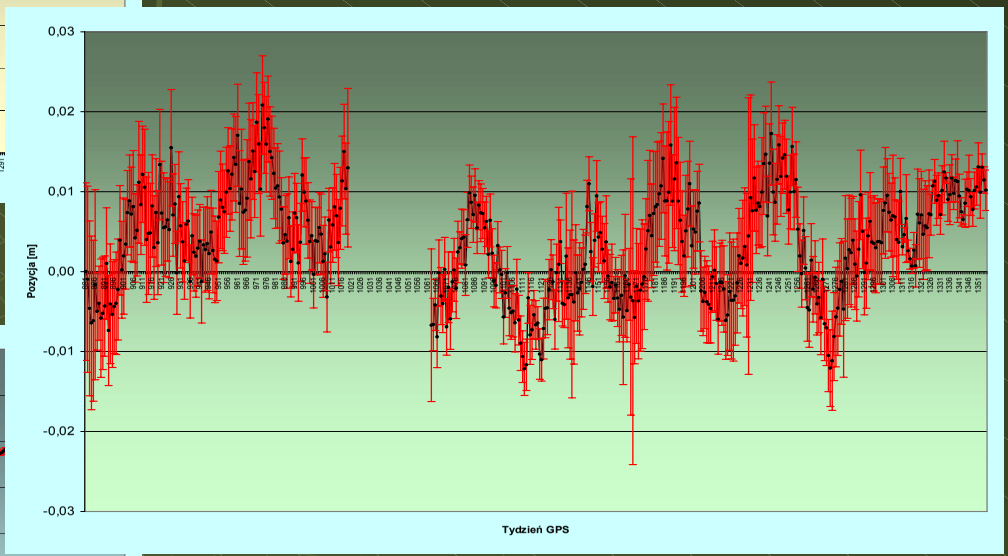


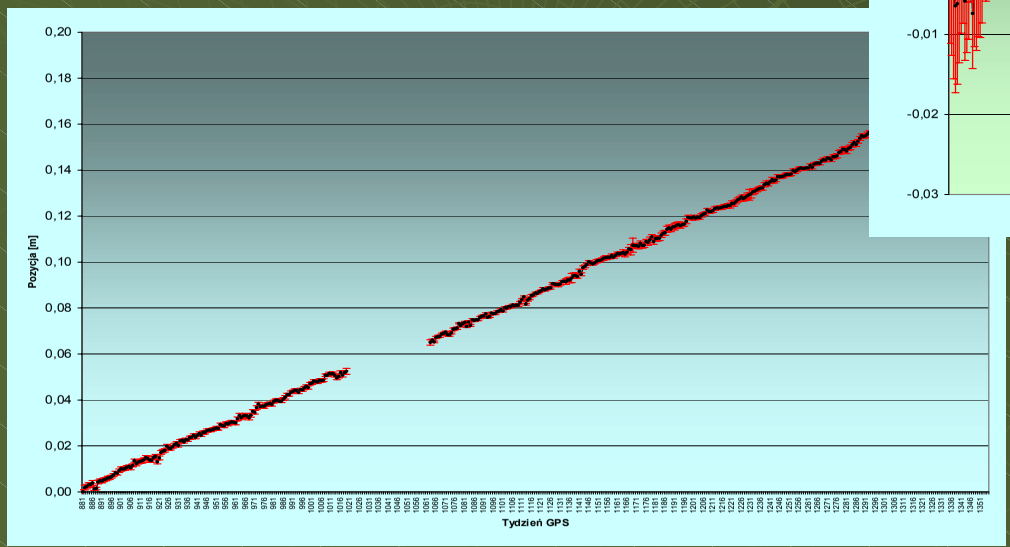
Data pre-processing (2)



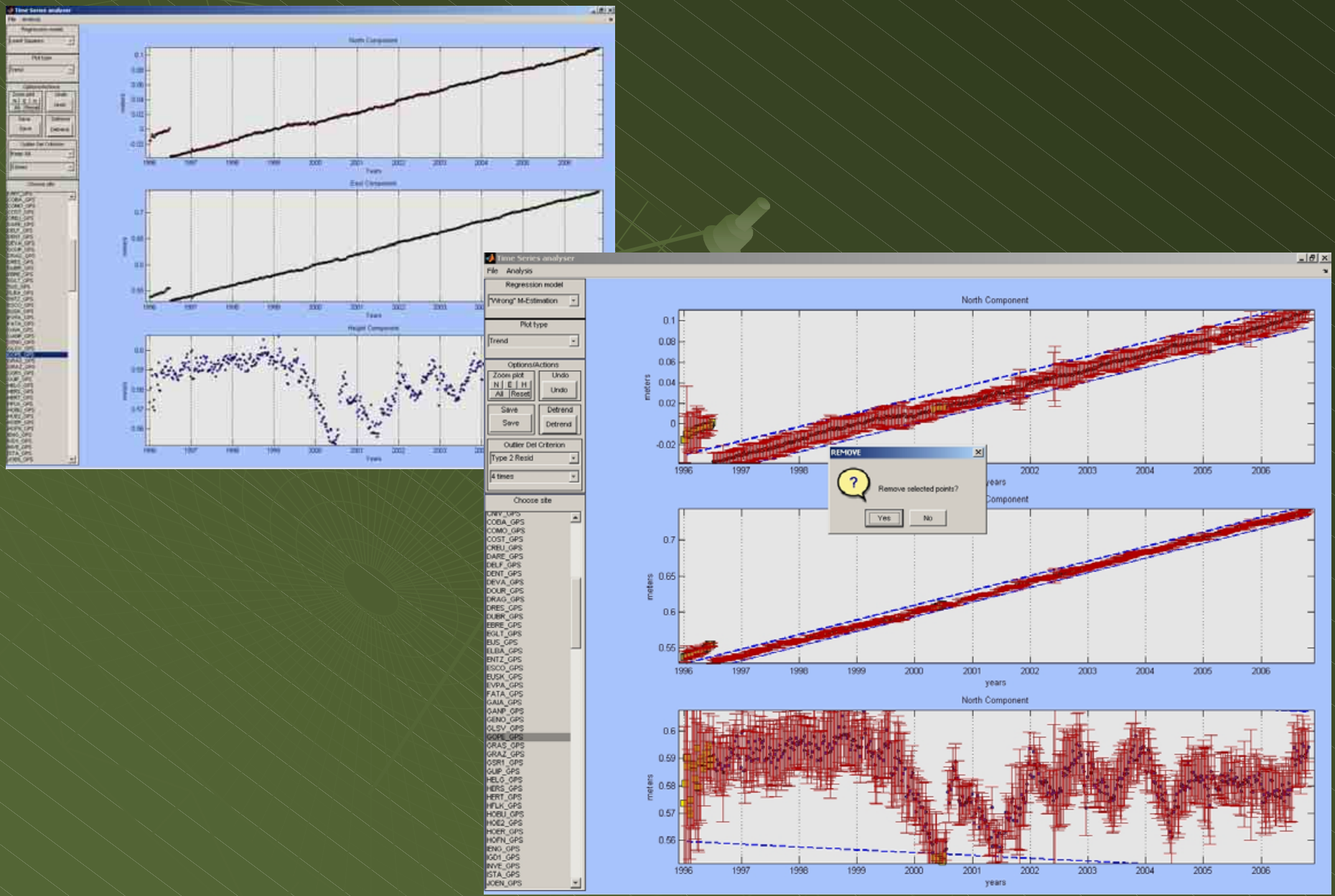
$$\begin{bmatrix} \Delta N_i \\ \Delta E_i \\ \Delta U_i \end{bmatrix} = \begin{bmatrix} -\sin B \cos L & -\sin B \sin L & \cos B \\ -\sin L & \cos L & 0 \\ \cos B \cos L & \cos B \sin L & \sin B \end{bmatrix} * \begin{bmatrix} \Delta X_{o-i} \\ \Delta Y_{0-i} \\ \Delta Z_{0-i} \end{bmatrix}$$

$$\begin{bmatrix} m^2 N \\ m^2 E \\ m^2 U \end{bmatrix} = \begin{bmatrix} -\sin B \cos L & -\sin B \sin L & \cos B \\ -\sin L & \cos L & 0 \\ \cos B \cos L & \cos B \sin L & \sin B \end{bmatrix} * \begin{bmatrix} \mathrm{var}\, X_i & \mathrm{cov}\, XY_i & \mathrm{cov}\, XZ_i \\ \mathrm{cov}\, XY_i & \mathrm{var}\, Y_i & \mathrm{cov}\, YZ_i \\ \mathrm{cov}\, XZ_i & \mathrm{cov}\, YZ_i & \mathrm{var}\, Z_i \end{bmatrix} * \begin{bmatrix} -\sin B \cos L & -\sin B \sin L & \cos B \\ -\sin L & \cos L & 0 \\ \cos B \cos L & \cos B \sin L & \sin B \end{bmatrix}^T$$





Data pre-processing (3)



Linear trend estimation (1)

M-Estimation, „Bisquare” weighting function

$$\begin{bmatrix} a \\ b \end{bmatrix}_i = \left(A^T P_i A\right)^{-1} A^T P_i Y$$

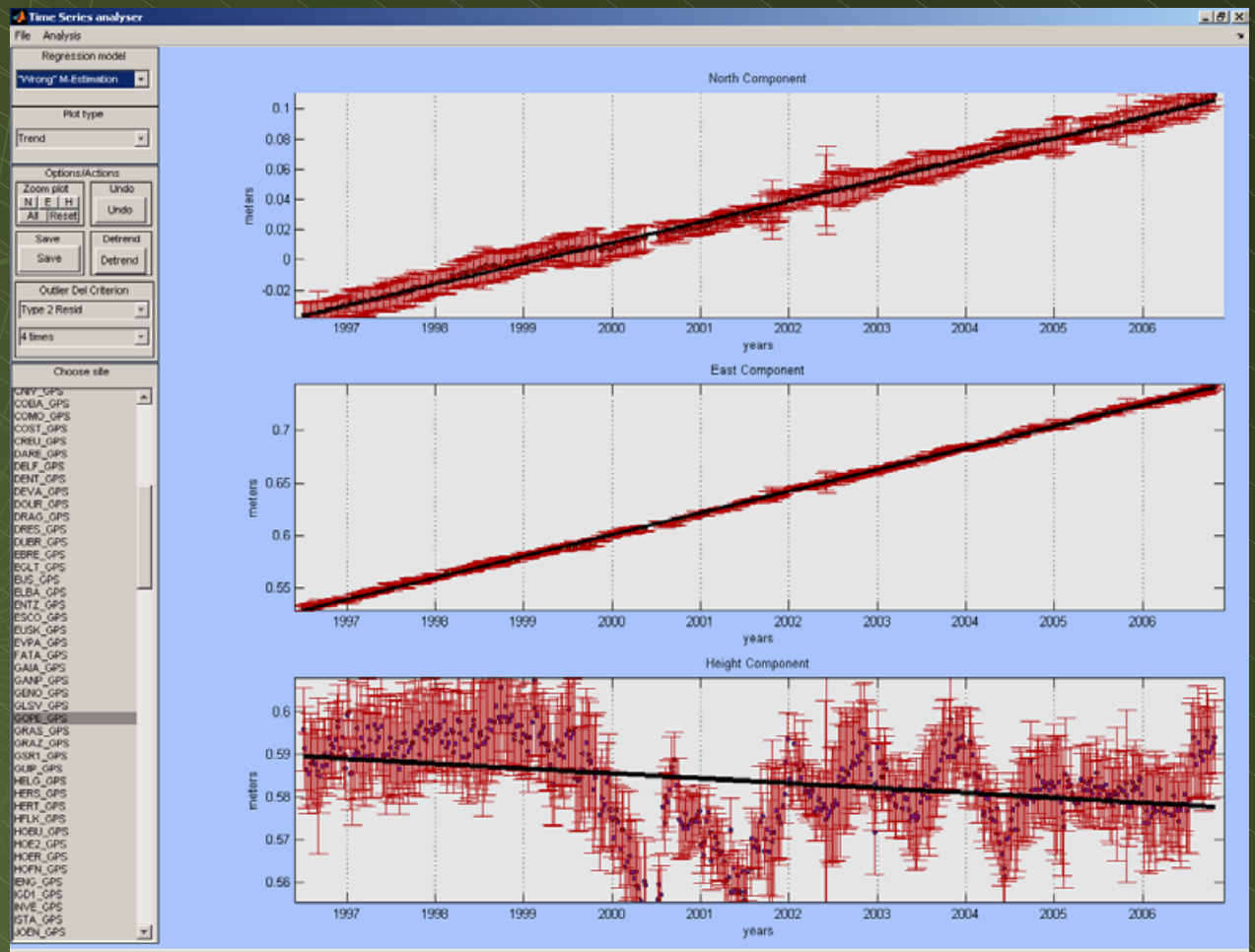
$$A = \begin{bmatrix} t_1 & 1 \\ t_2 & 1 \\ . & . \\ t_n & 1 \end{bmatrix}$$

$$p_i = \frac{1}{m_{yi}^{\,2}\,[mm]}$$

$$Ks = \frac{1}{0.6745} \cdot m$$

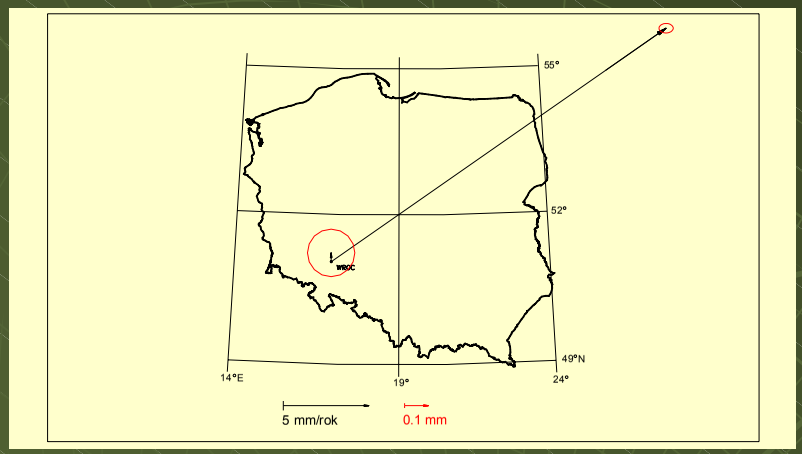
$$u = \frac{resid}{K_s}$$

$$P_i = \begin{cases} 0 & for \quad |u_i| > 1 \\ \left(1 - \left(\frac{u_i}{4.685}\right)^2\right)^2 & for \quad |u_i| \le 1 \end{cases}$$

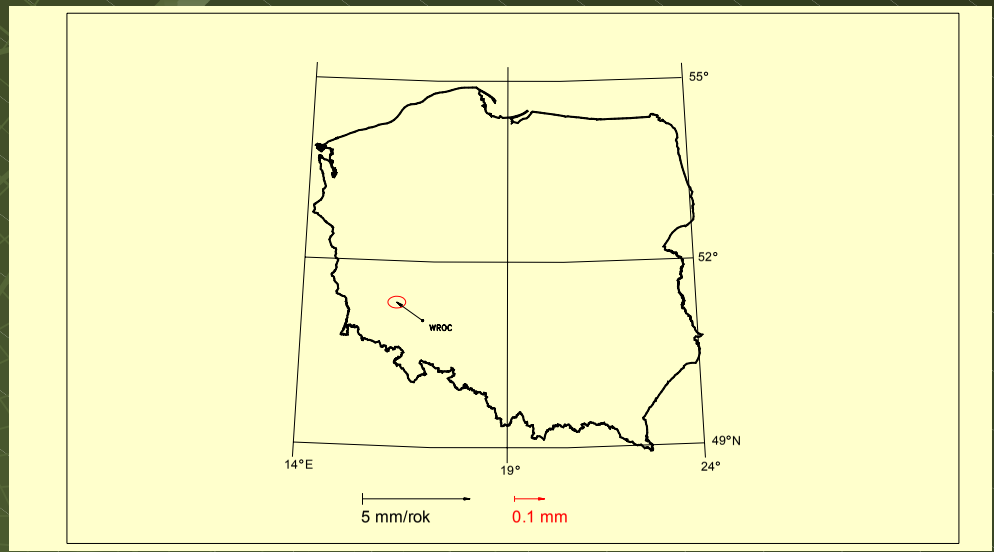


Linear trend estimation (2)

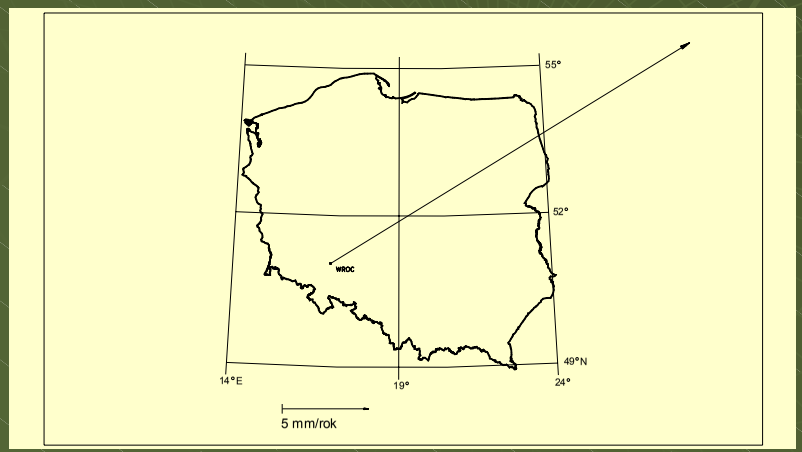
Estimated ITRF2000 velocity



Intraplate (local) velocity

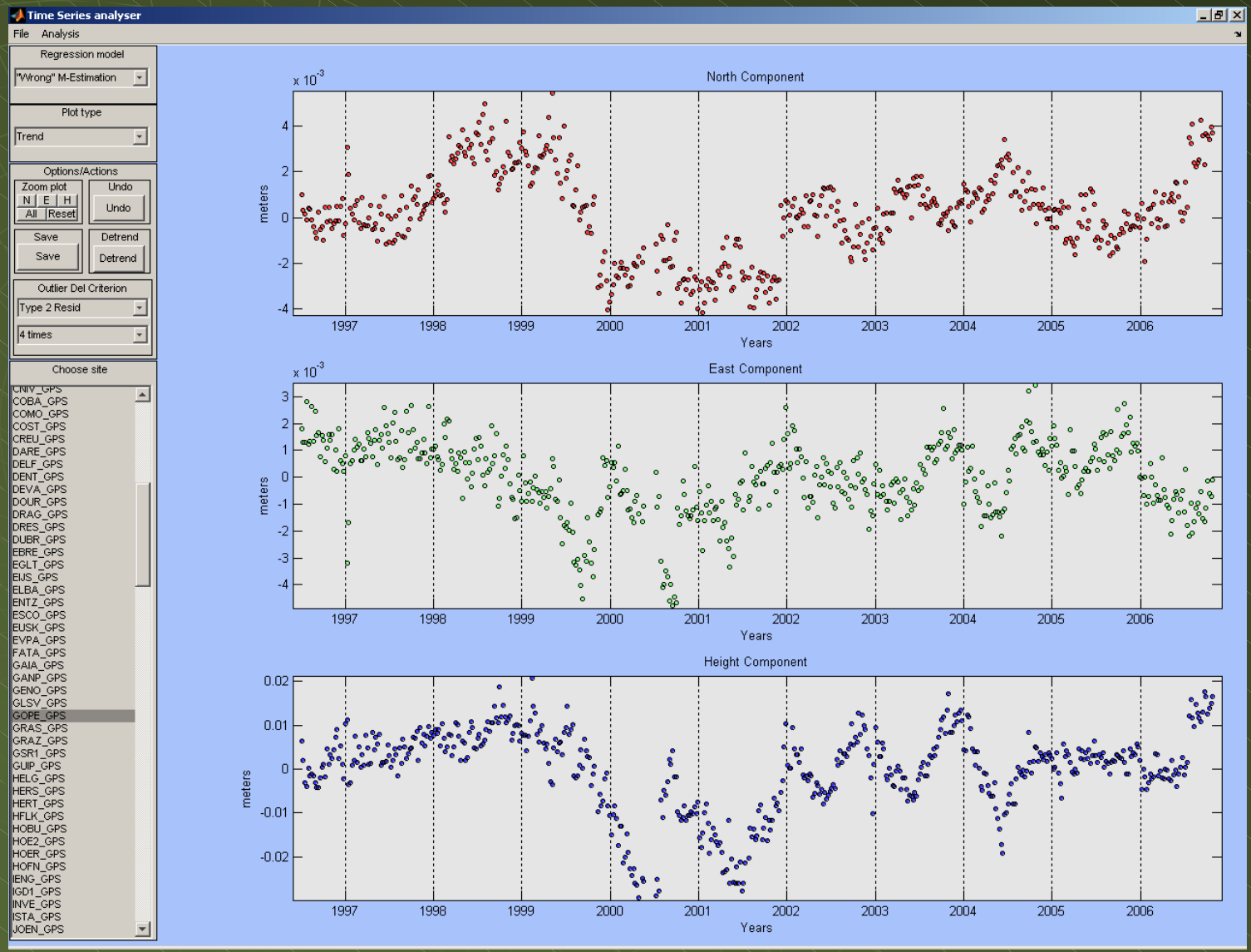


NNR-NUVEL 1A *[DeMets, 1994]*



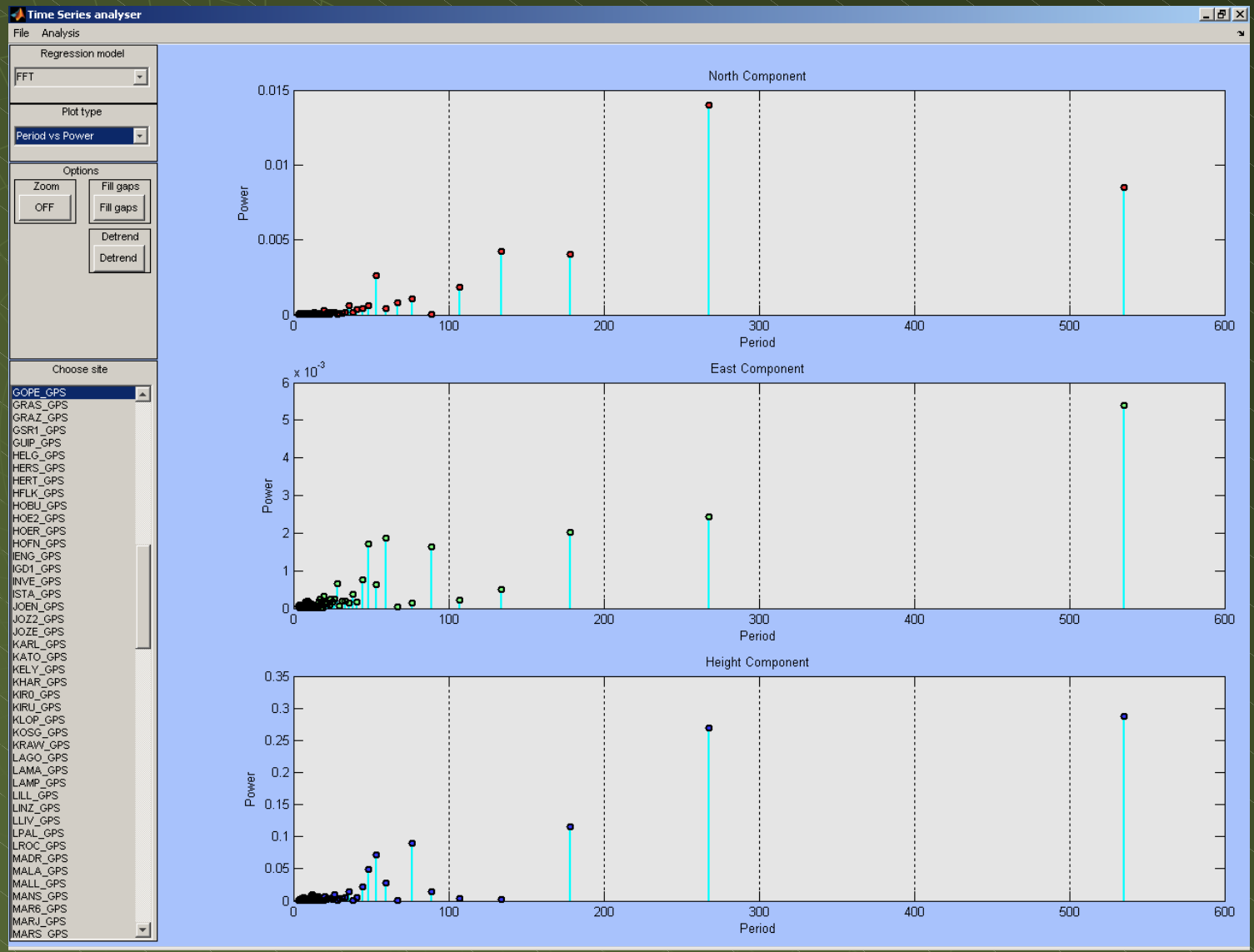
Determination of periodicity (1)

Residual (detrended) time series



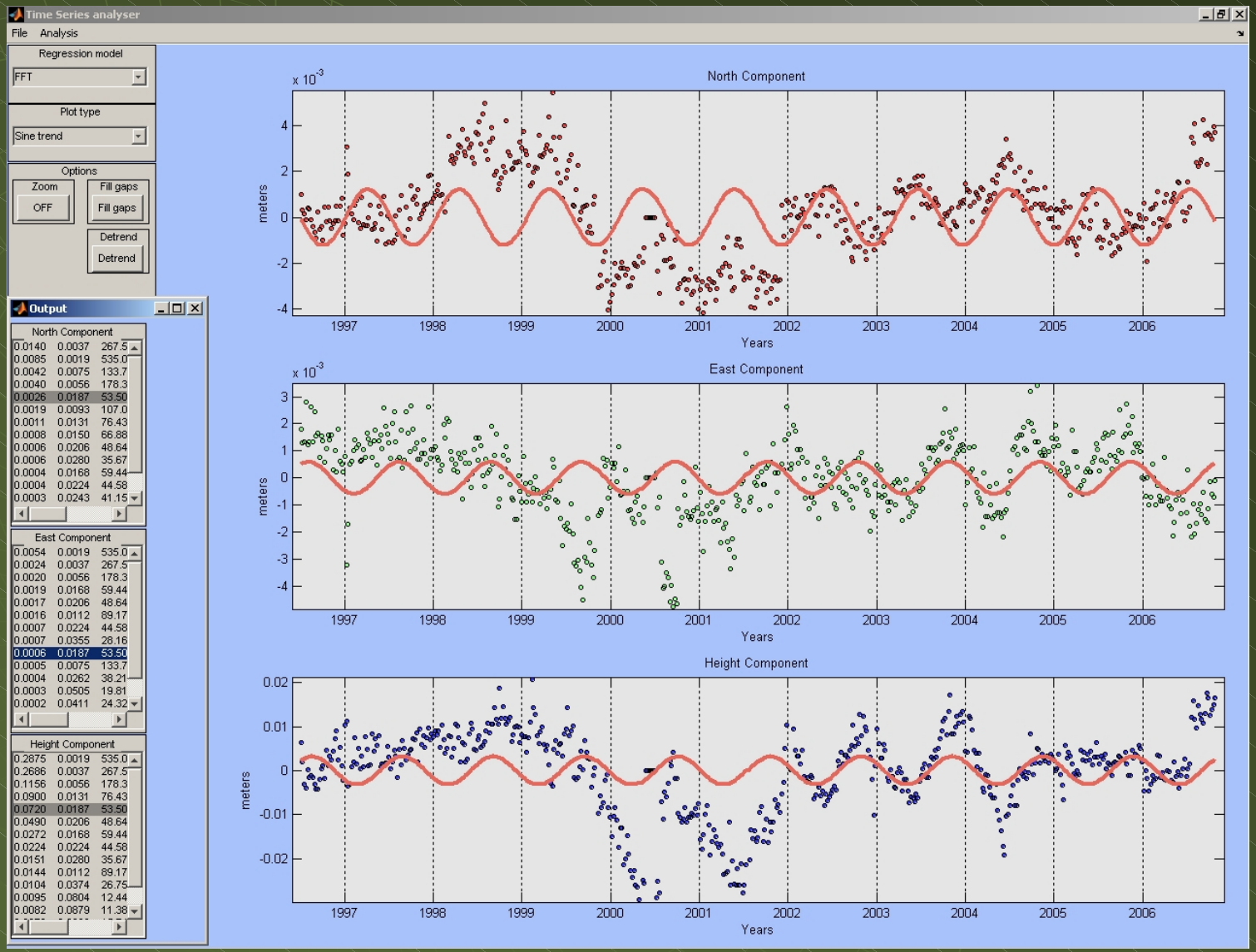
Determination of periodicity (2)

Periodogram (FFT)



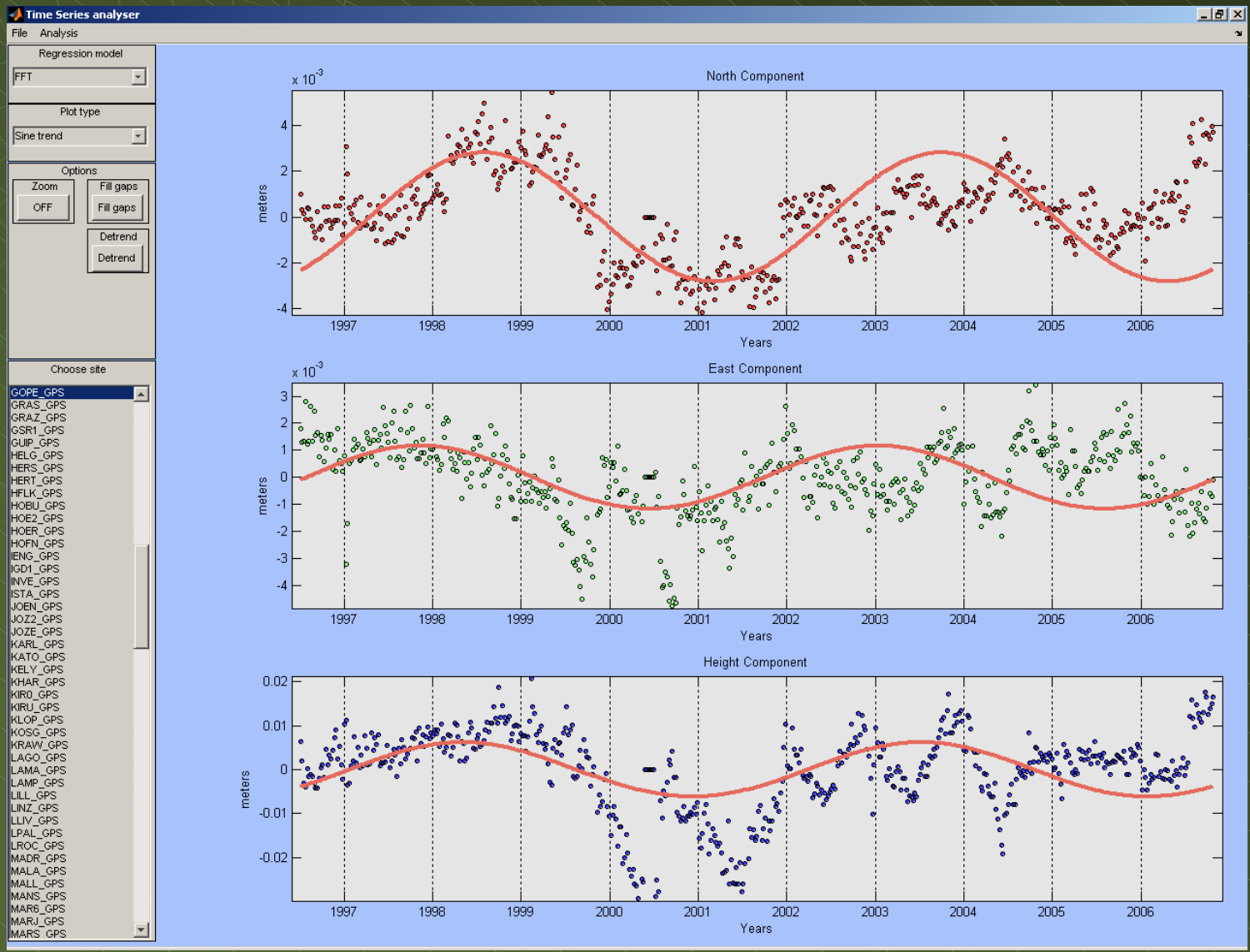
Determination of periodicity (3)

Annual signal



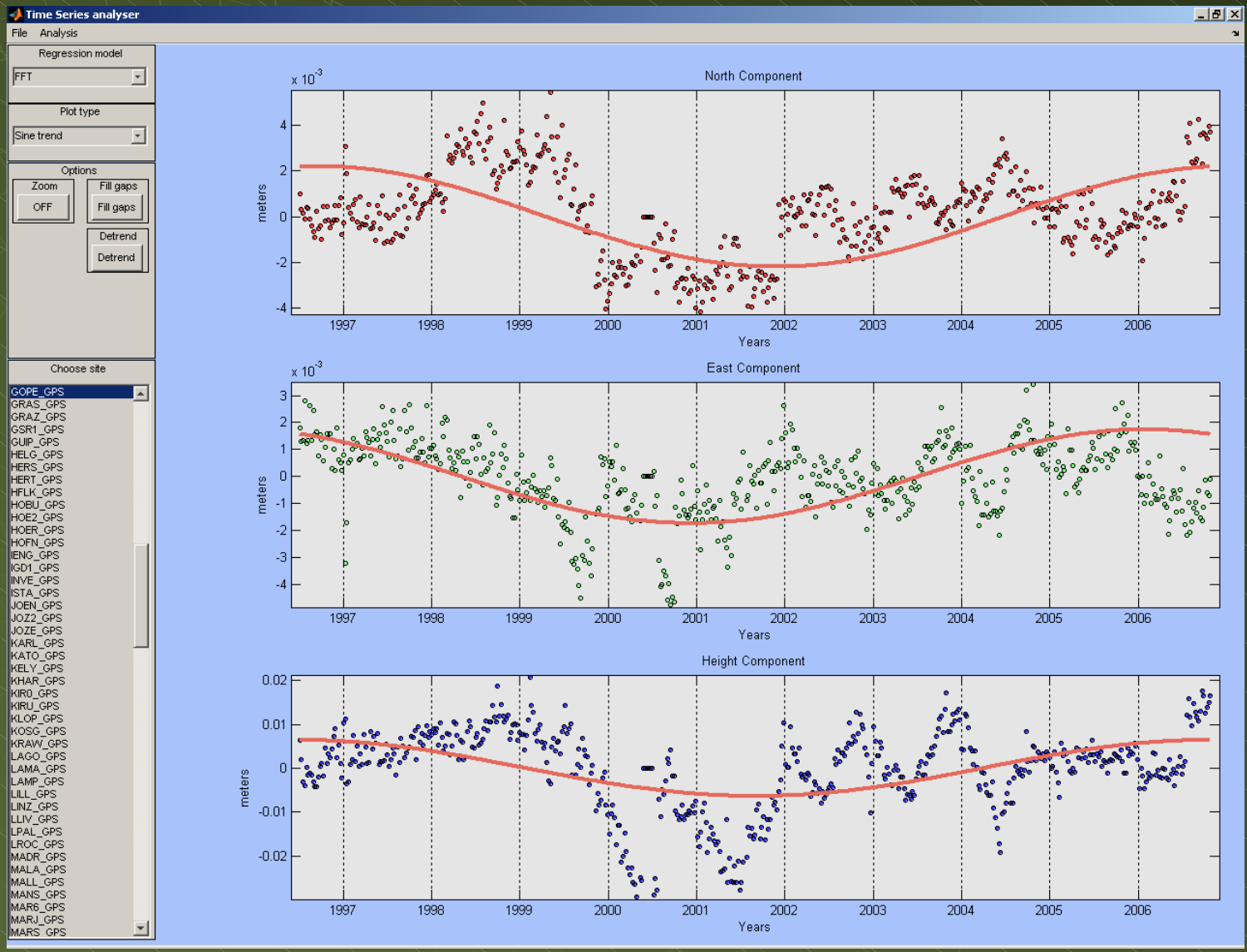
Determination of periodicity (4)

5-years signal

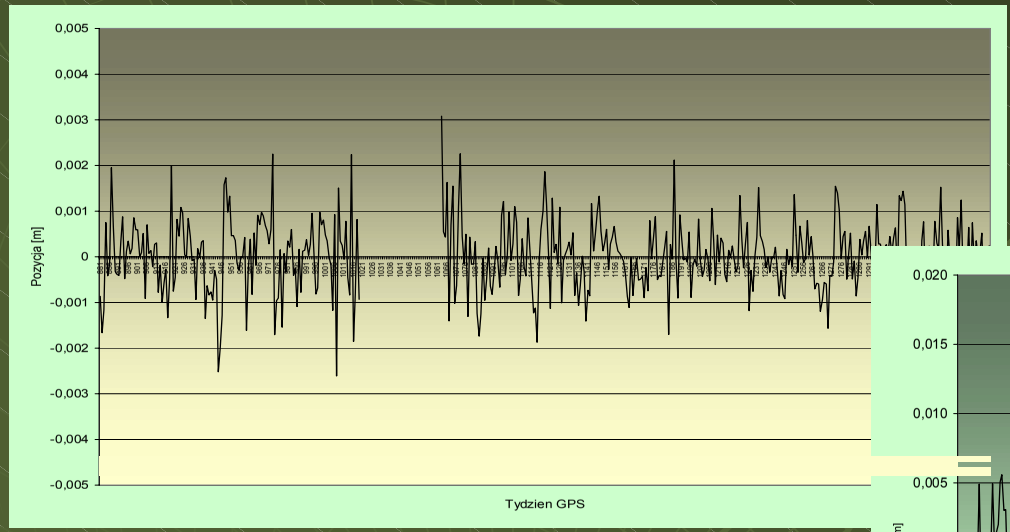


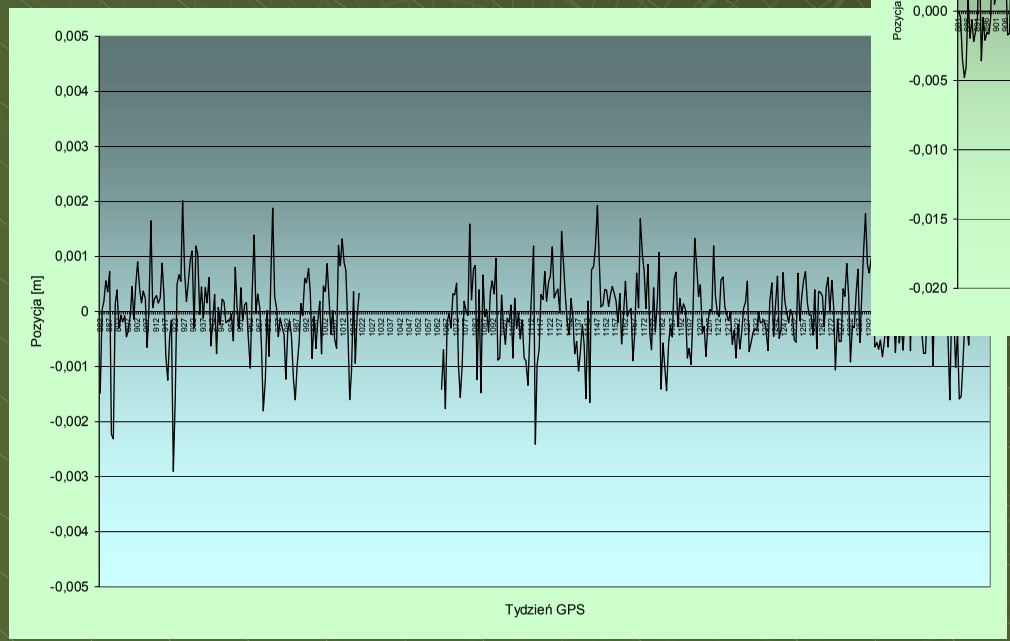
Determination of periodicity (5)

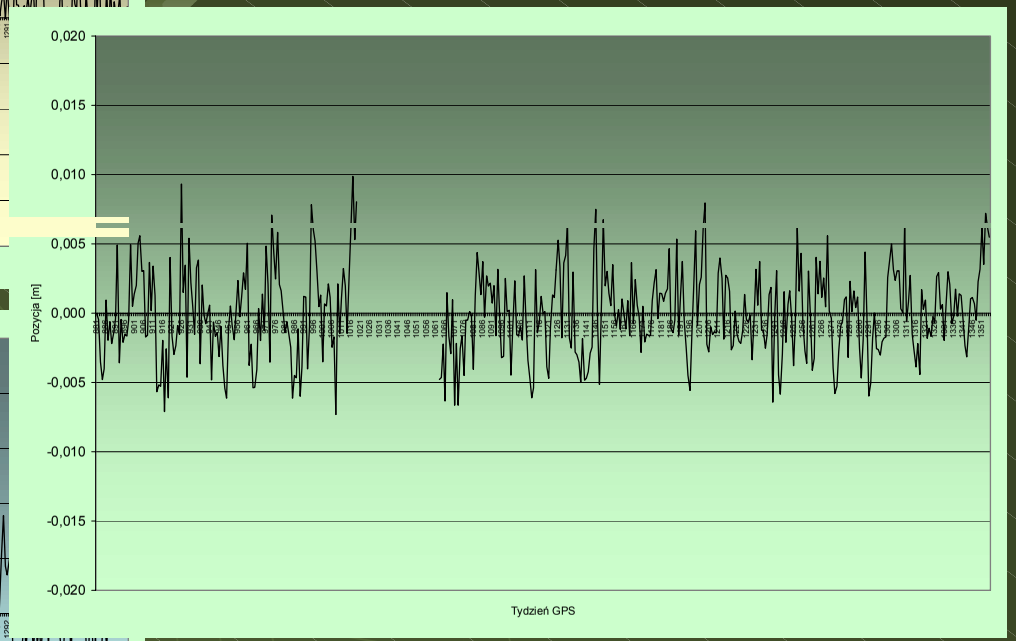
10-years signal



Determination of periodicity (6)







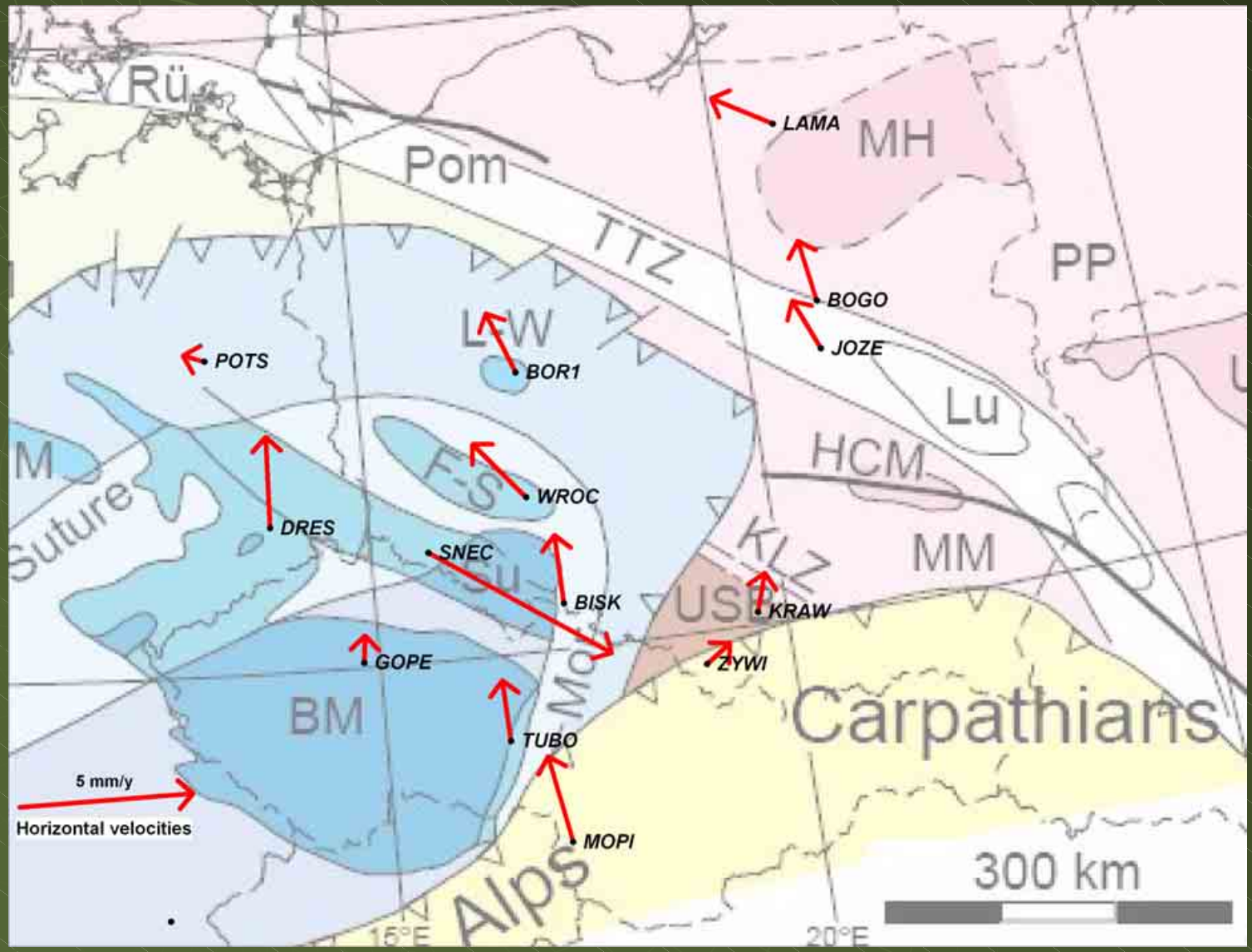
Comparison of the linear velocities

NUVEL1A-NNR

Comparison of the linear velocities

APKIM2000

Comparison of the linear velocities

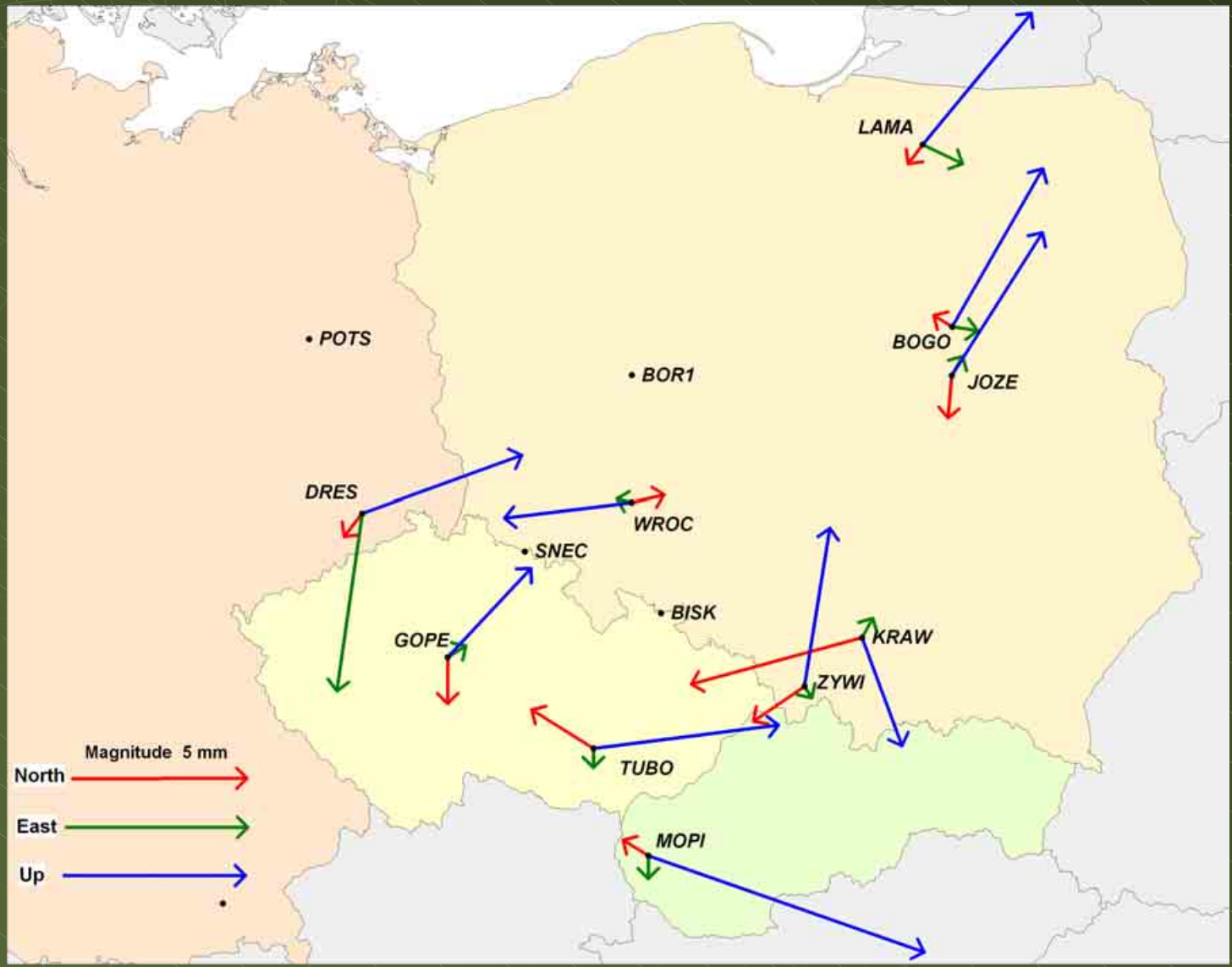


Comparison of the periodicity parameters

Site	0.5 year	1 year	3,5 years	5 years	10 years
BISK					
BOGO					
DRES					
GOPE					
JOZE					
KRAW					
LAMA					
MOPI					
SNEC					
TUBO					
WROC					
ZYWI					

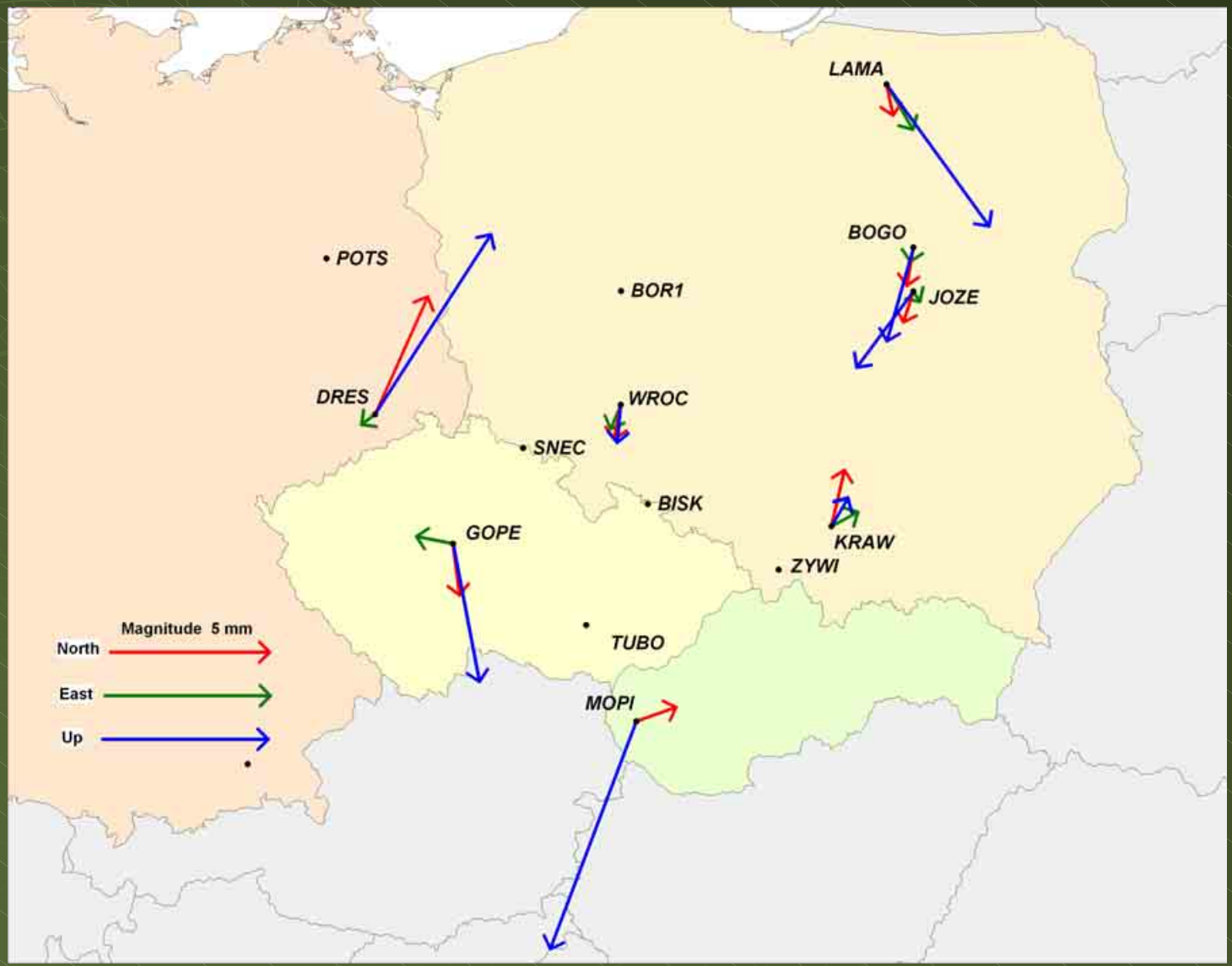
Comparison of the periodicity parameters

ANNUAL PERIODICITY



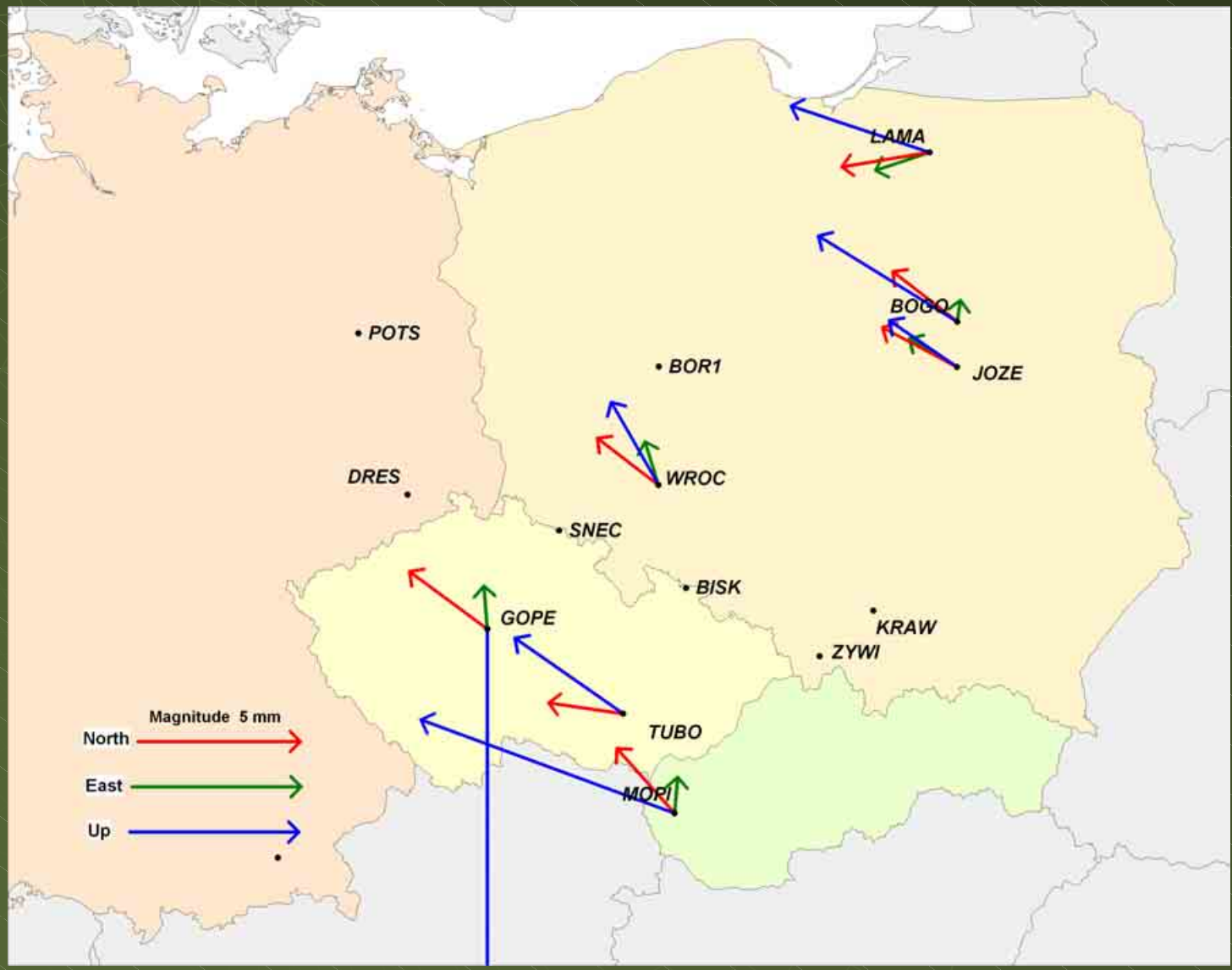
Comparison of the periodicity parameters

3.5 YEARS PERIODICITY



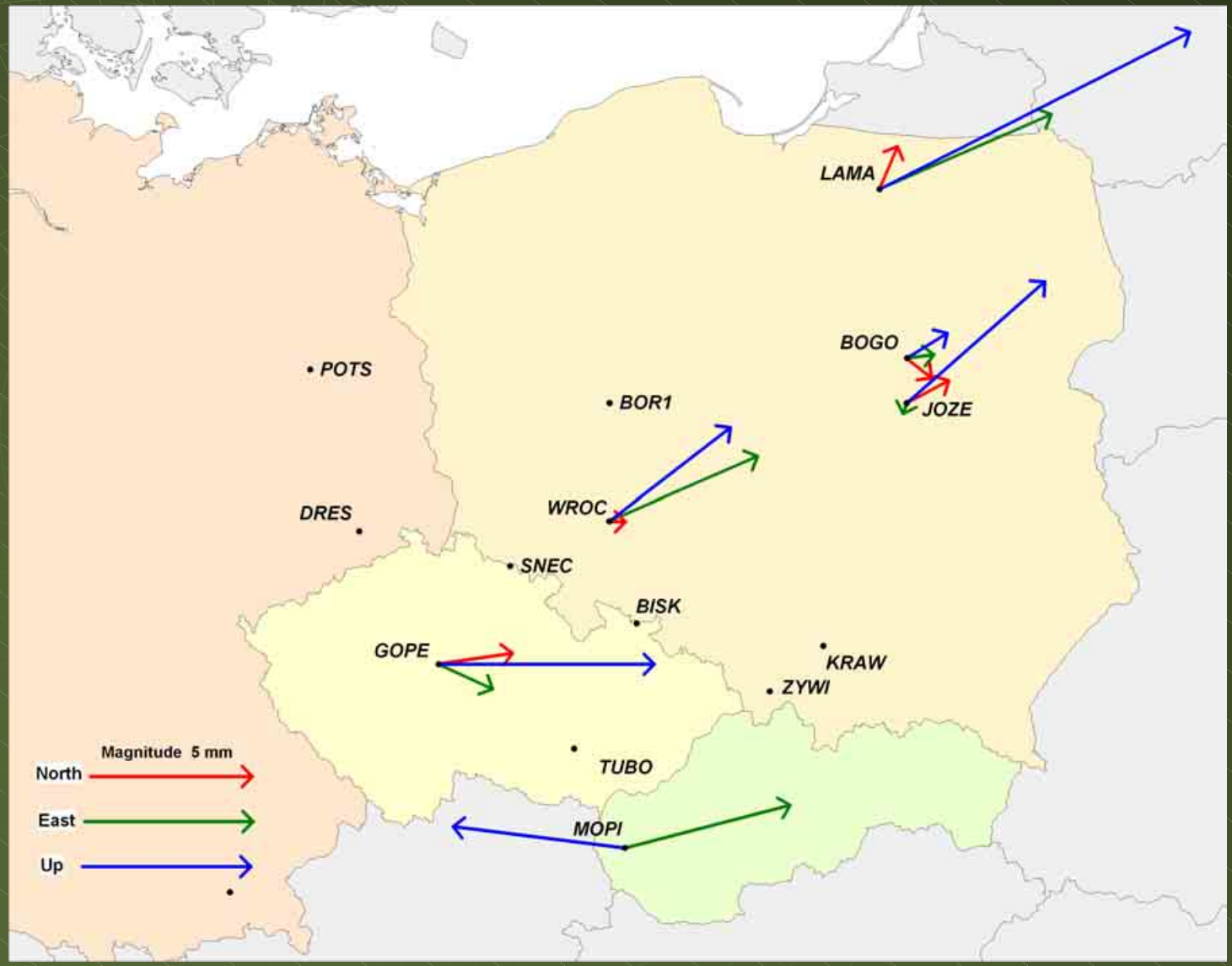
Comparison of the periodicity parameters

5 YEARS PERIODICITY



Comparison of the periodicity parameters

10 YEARS PERIODICITY



EPN Special Project „Time Series for Geodynamics”

CLEANED time series

Residuals of cummulative coordinate/velocity solution based on weeekly EUREF combined solution (outliers eliminated and discontinuities corrected) prepared for geokinematic interpretation.

Purpose :

Elimination of outliers and introduction of offsets indicated in the "RAW" time series.

Velocity estimation based on the cleaned time series.

The 'CLEANED' time series are computed using the CATREF software (developed by Z.Altamimi, IGN France).

The geodetic datum is defined by BOGO, BOR1, GRAZ, JOZE, KOSG, MATE, METS, ONSA, POTS, VILL and ZIMM stations.

Observations before GPSweek 860 are not taken into account, because of the apparent coordinate jump caused by the introduction of the ITRF96 reference frame.

The detected outliers are eliminated and the offsets related to equipment changes are introduced at the time series combination. Tables containing the dates, the estimated values and the possible explanation both of the outliers and offsets are published.

Three types of the CLEANED time series plots are created and published :

Type 1: the eliminated outliers and offsets are indicated.

Type 2: De-trended version of Type 1, linear velocity term is removed and additionaly the annual coordinate variation is estimated and plotted.

Type 3: same as Type 2, but the annual periodic term is removed.

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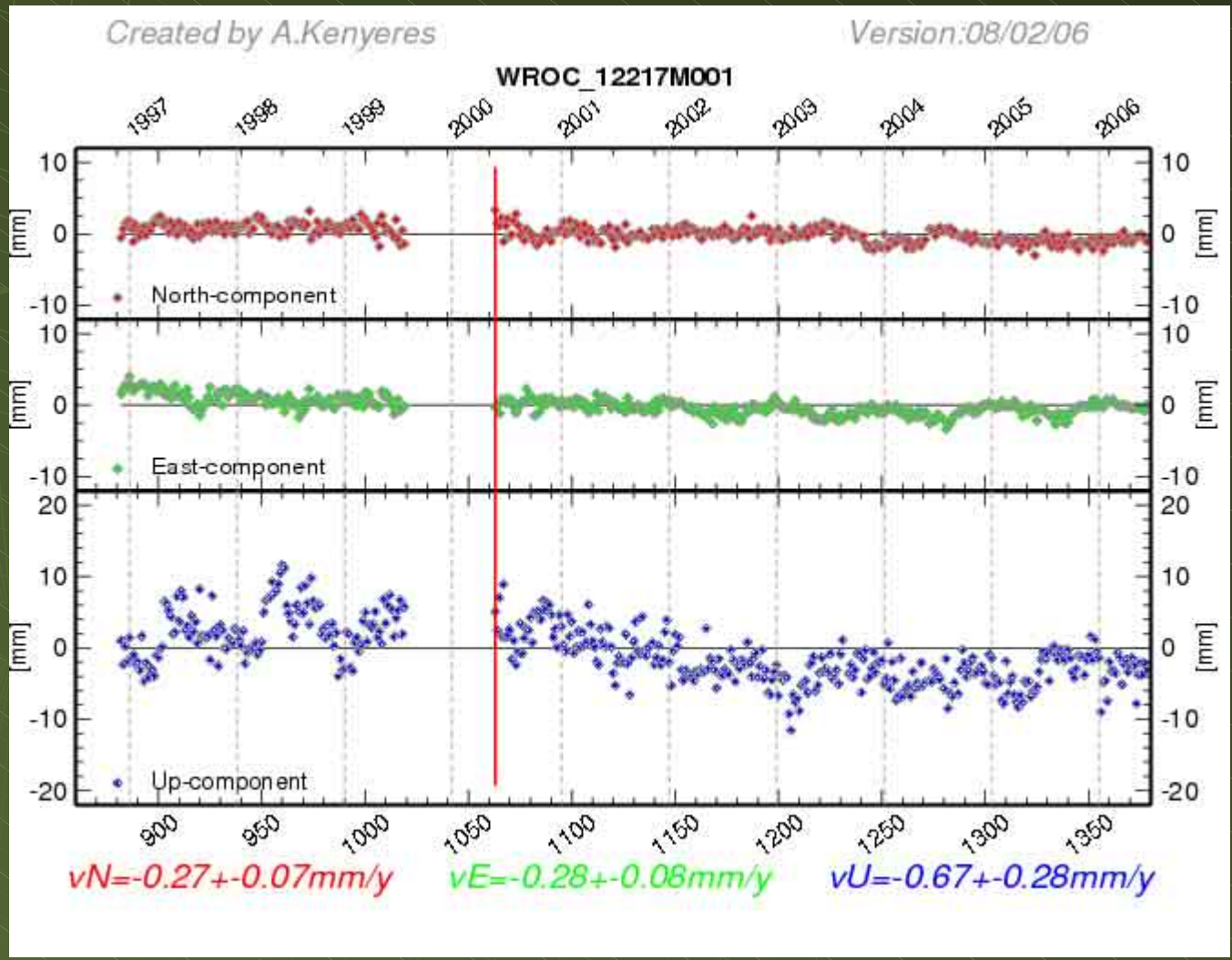
Type 1 Time series – WROC station



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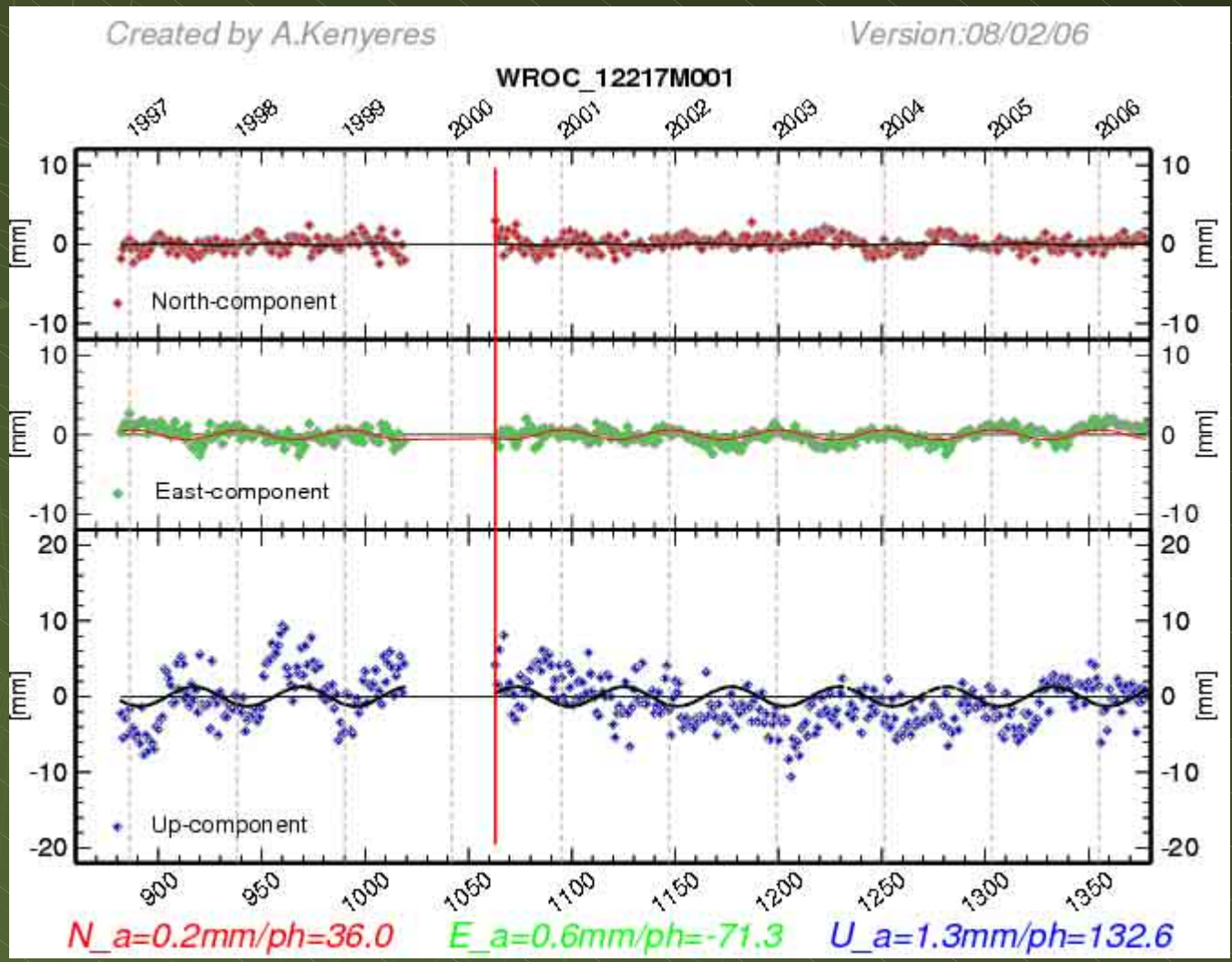
Type 2 Time series – WROC station



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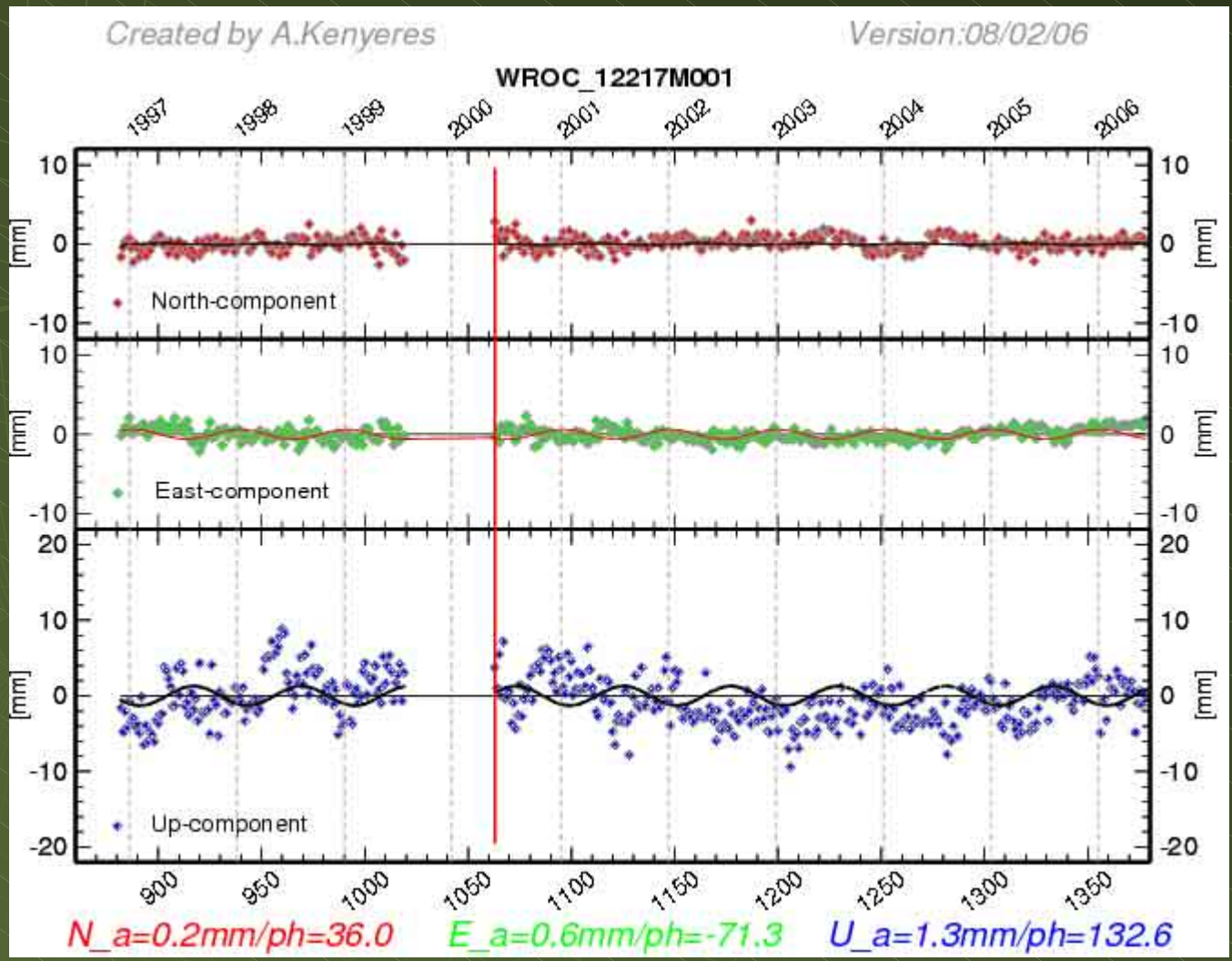
Type 3 Time series – WROC station



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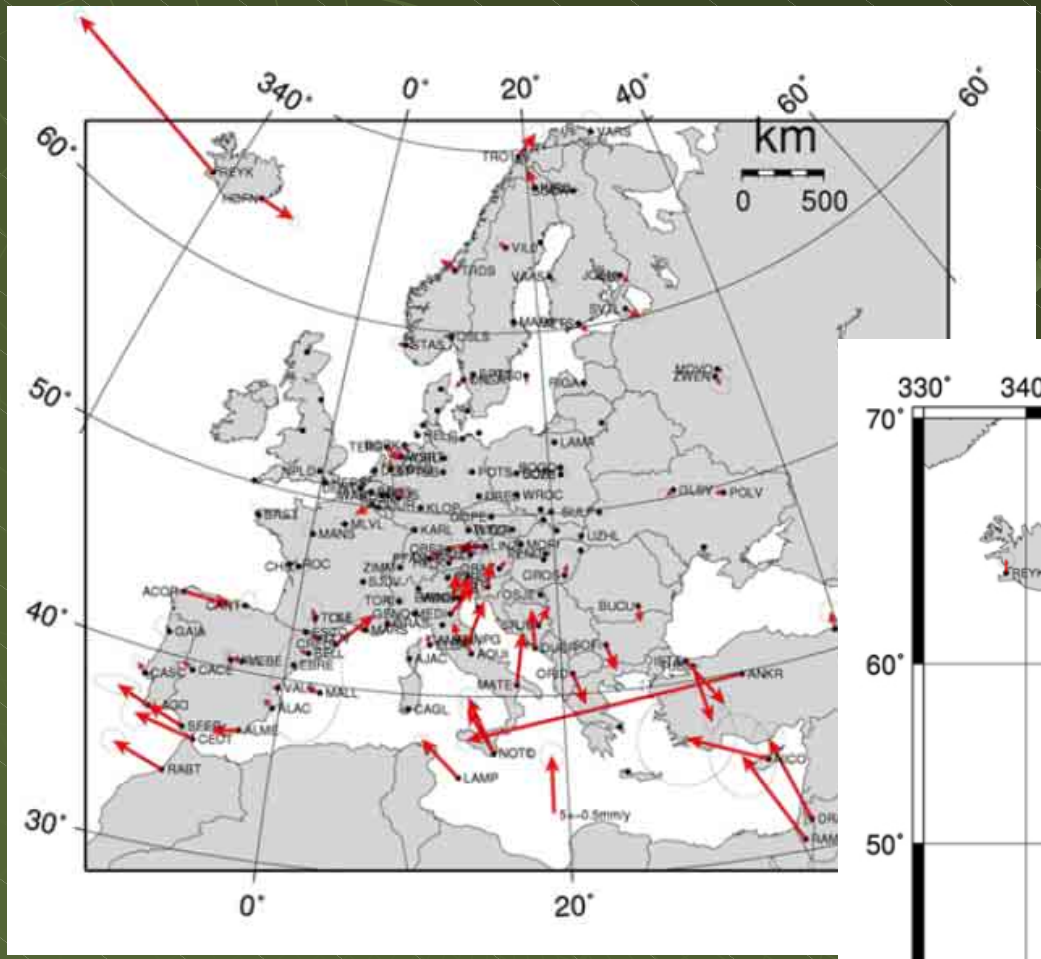
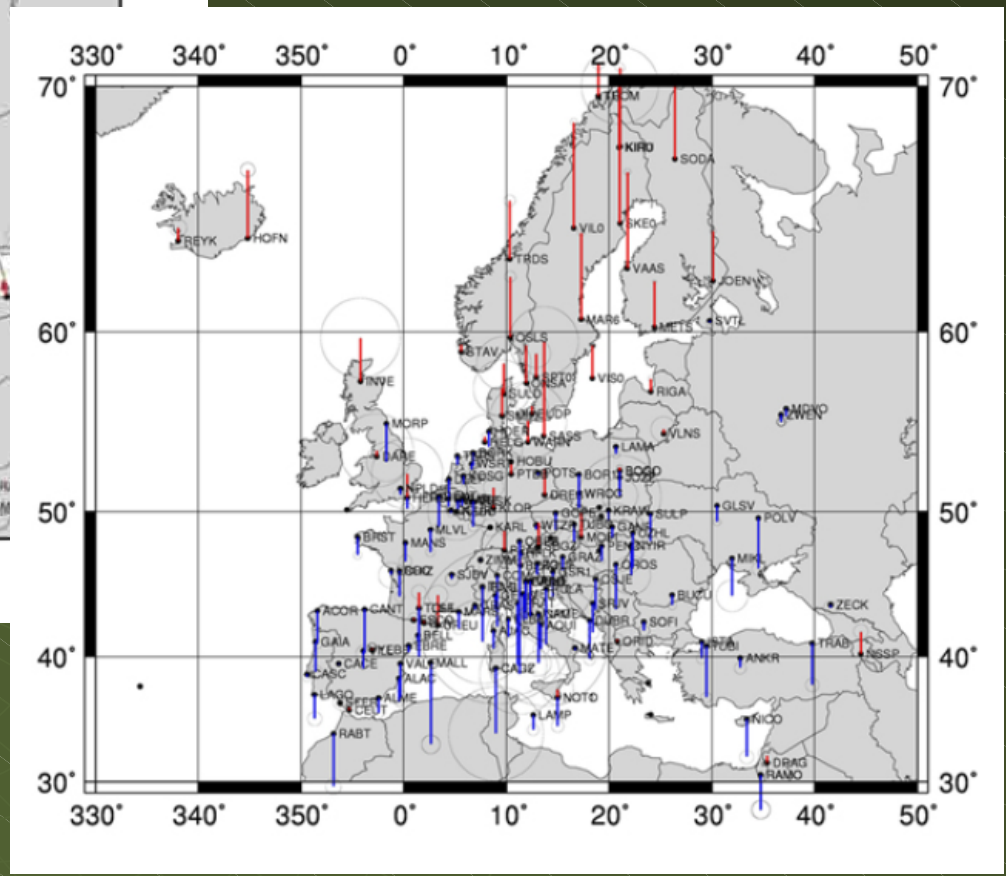


Horizontal velocities



Vertical velocities

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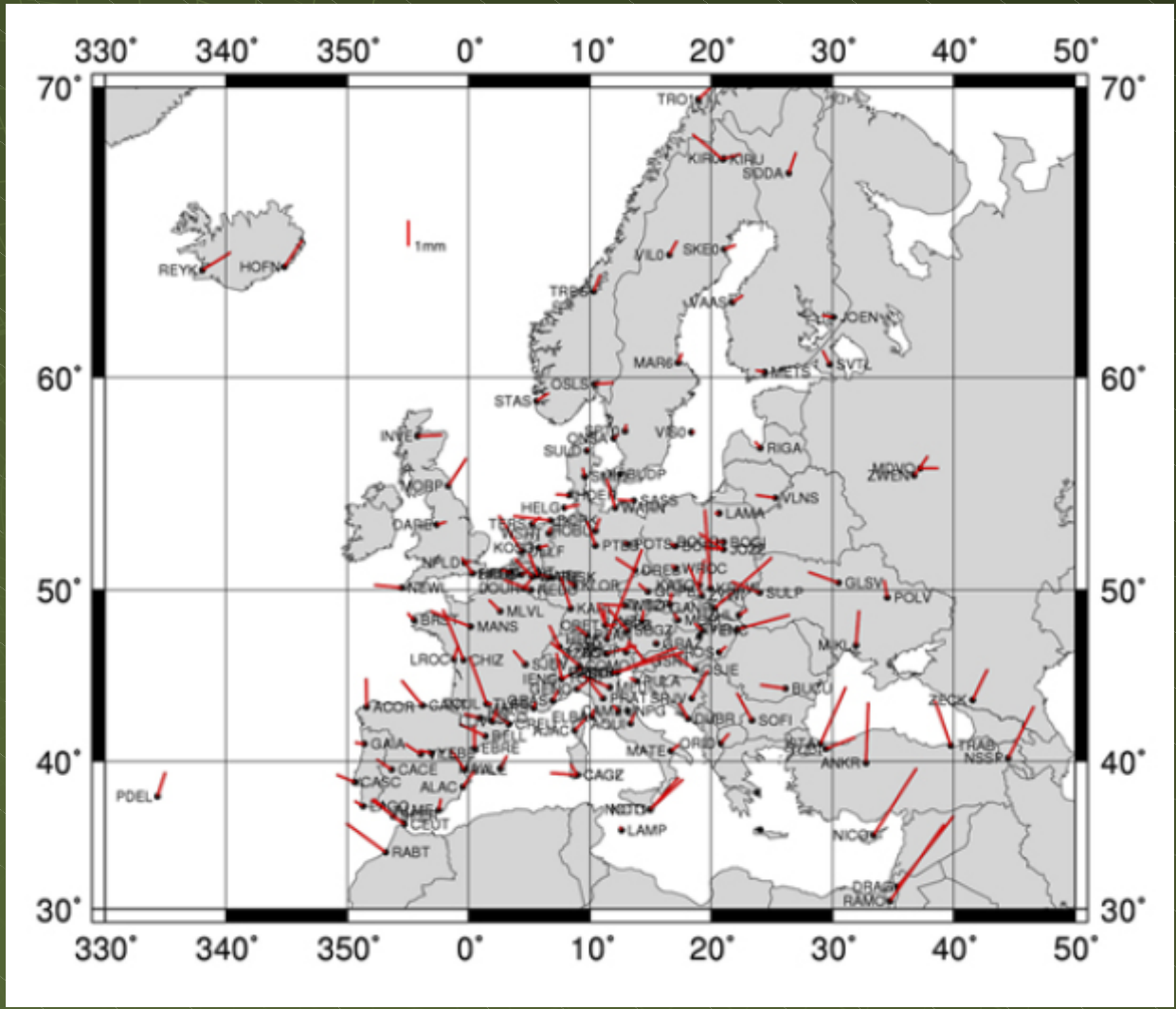
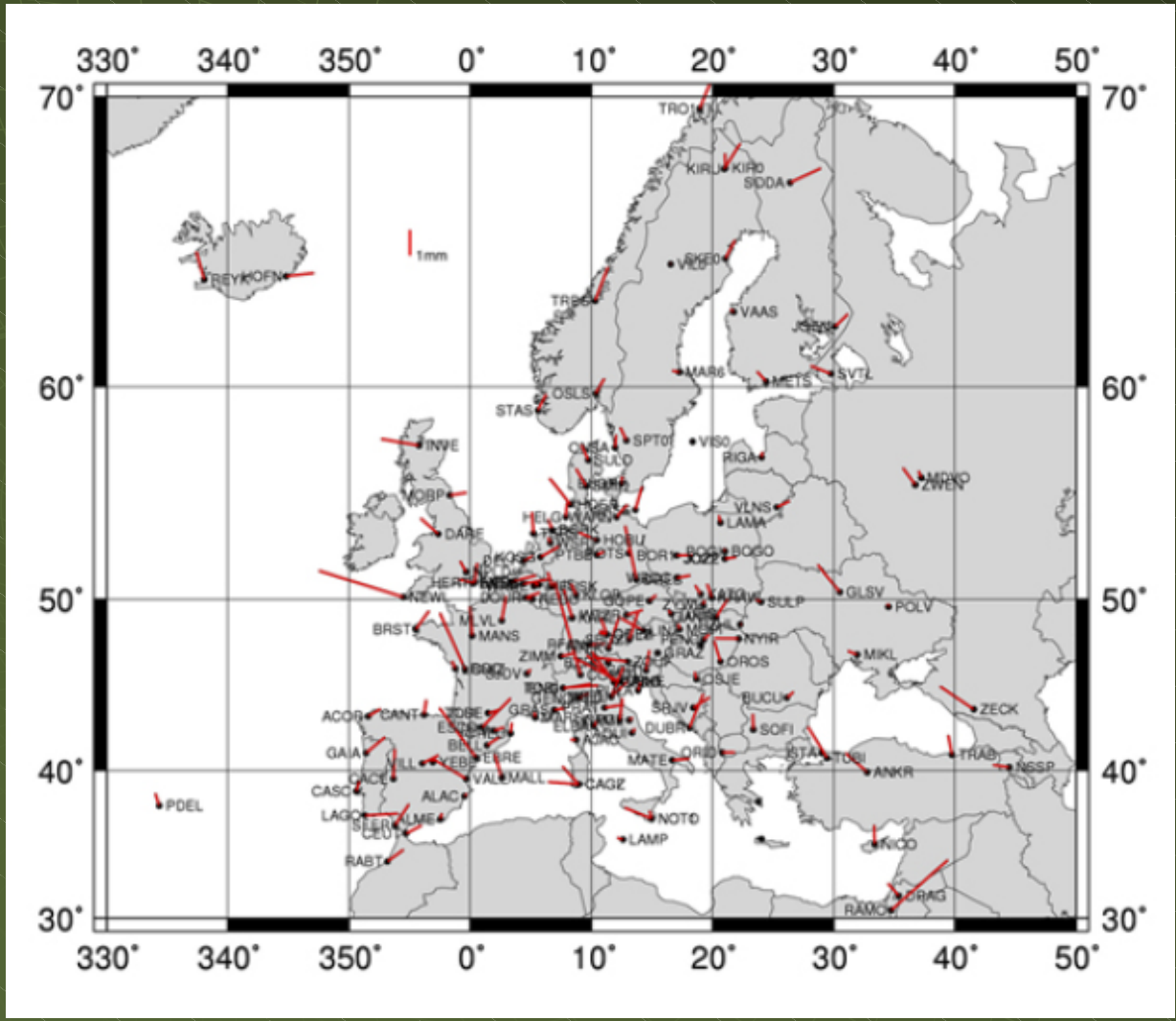
Magnitudes and phases of annual sigal - North component



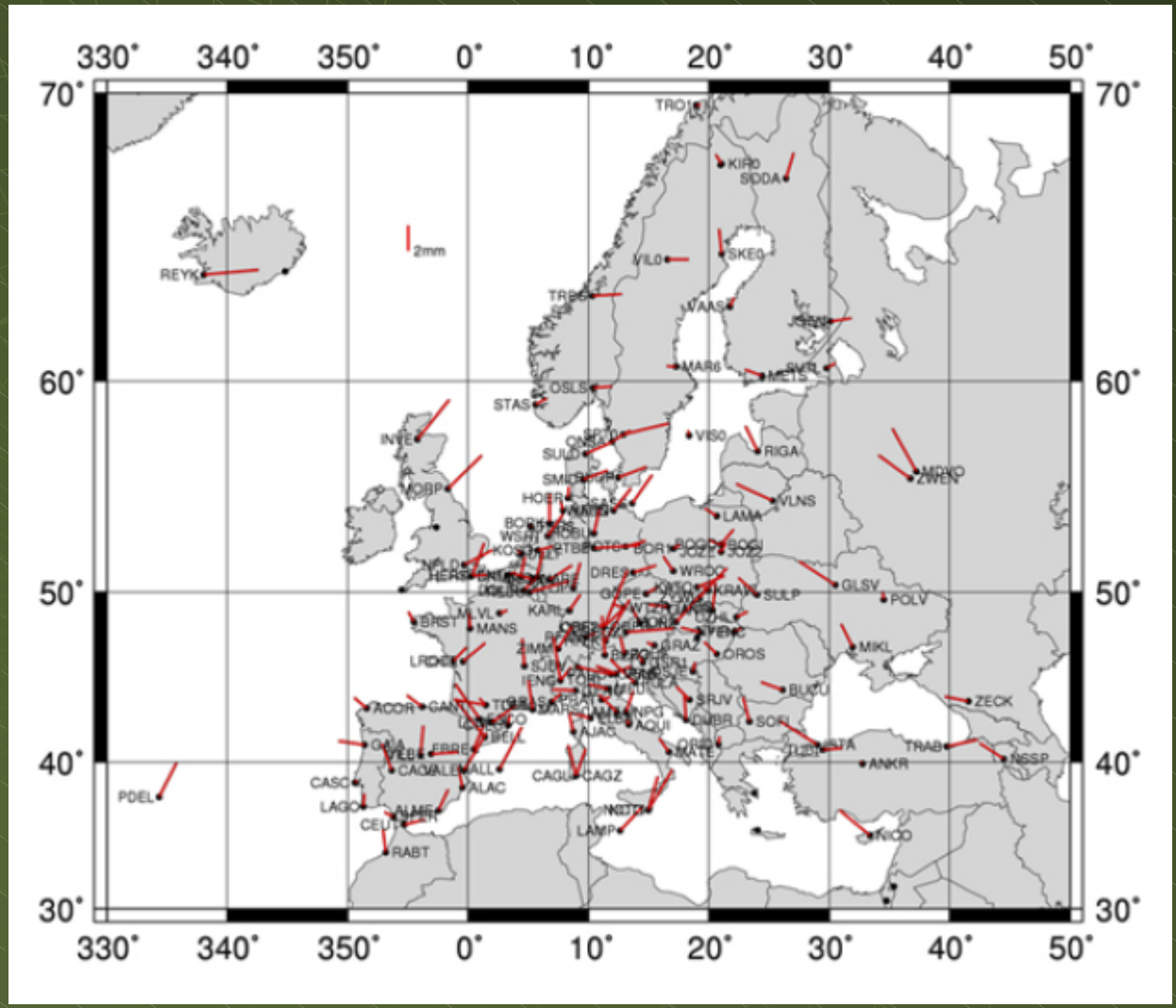
EPN Special Project „Time Series for Geodynamics”

Magnitudes and phases of annual sigal - East component



EPN Special Project „Time Series for Geodynamics”

Magnitudes and phases of annual sigal - Up component



Conclusions

- Linear velocities of analyzed EPN stations related to NUVEL1A-NNR are congruent with known models except SNEC station.
- There is no clear correlation between velocities and general tectonics of Europe.
- Annual, 3.5, 5 and 10 years periods are dominant in the coordinate time series of analyzed GPS stations.
- Vertical amplitudes presents much higher values than horizontal components.
- Periodicity parameters of individual components are not correlated for annual period but strongly correlated for longer periods.
- Presented results may be disturbed by influence of fixed station in EPN combined solutions.