Military University of Technology
Faculty of Land Engineering & Geodesy

GPS station coordinates dynamics monitoring by CGS WAT

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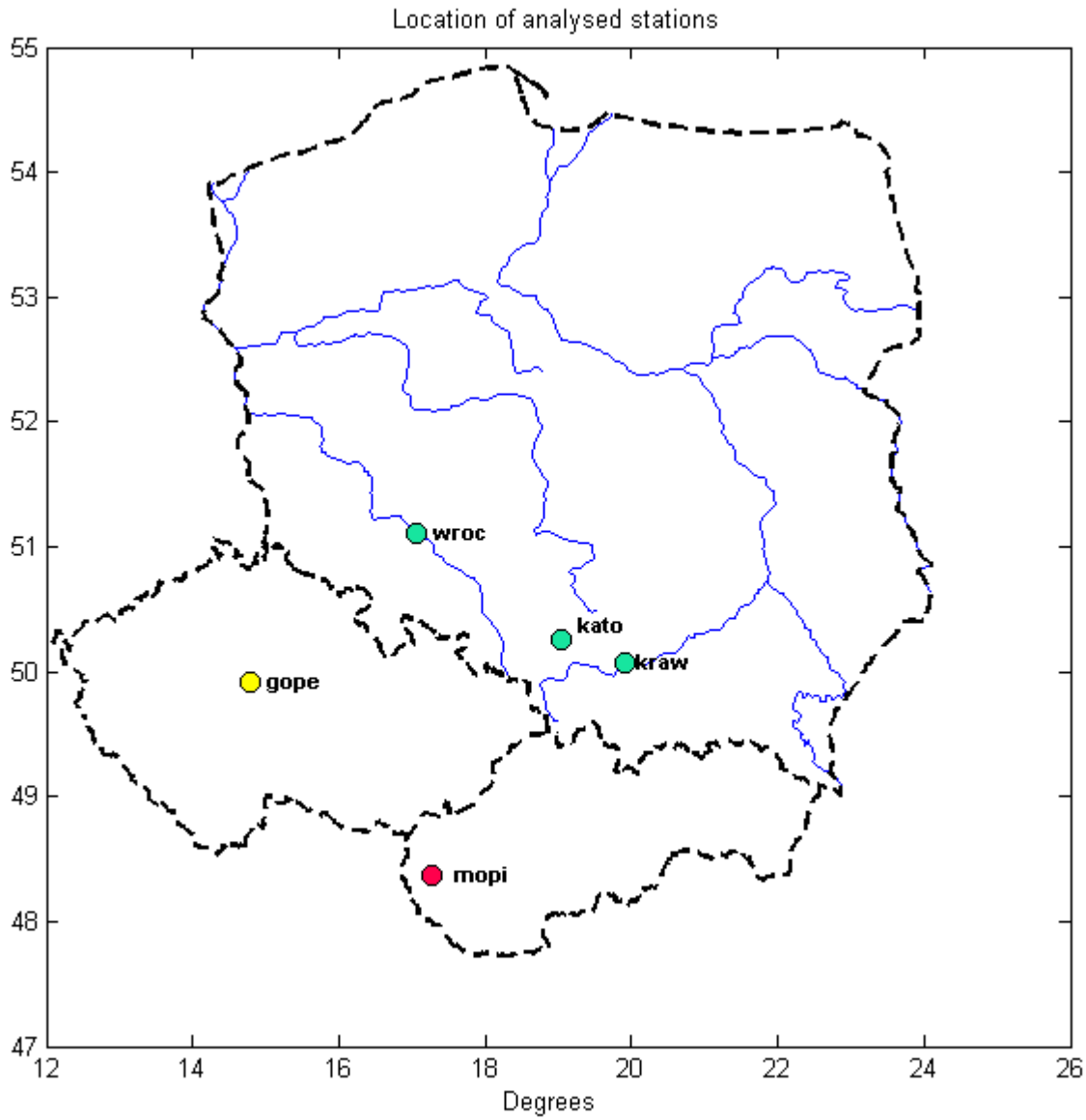
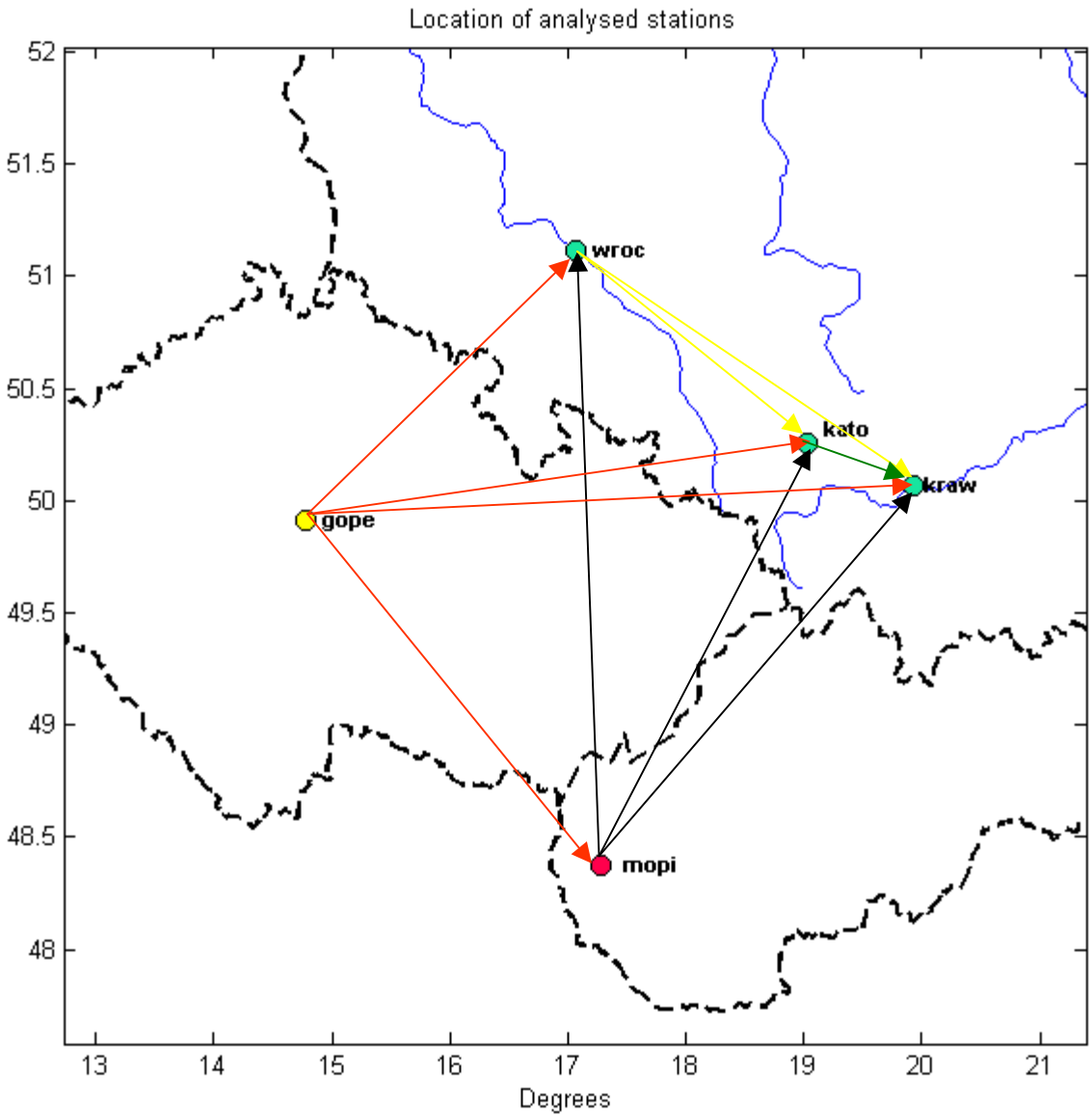

Location of analysed stations
55
54
53
52
51
50
49
48
47
12
14
16
18
20
22
24
26
Degrees
wroc
kato
kraw
gope
mopi


Location of analysed stations
52
51.5
51
50.5
50
49.5
49
48.5
48
13
14
15
16
17
18
19
20
21
Degrees
wroc
kato
kraw
gope
mopi

DATA EPN

Software Used : Bernese 5.0, developed at AIUB

MEASUREMENT MODELS

Basic observations : GPS carrier phase. Code measurements are only used for synchronized receiver clock. The elevation cut-off angle used for the official solution is 3 degrees. The data sampling rate is 30 and 180 seconds, respectively.

Ground antenna: Absolute antenna phase center corrections based on IGS05 model (exceptions for stations with indiv. absol. calibrations listed in epnc_05.atx) considering antenna radome codes. If antenna/radome pair has no available calibrations, the corresponding values for the radome code "NONE" are used.

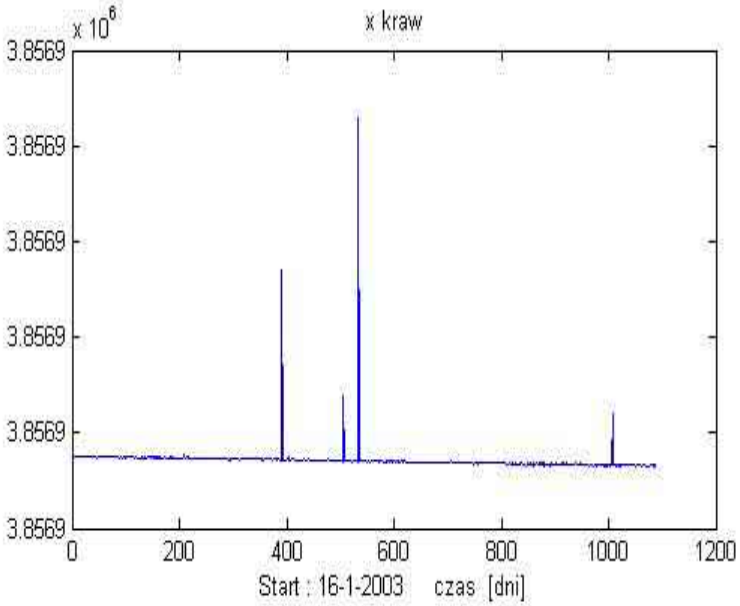
Satellite antenna: Absolute antenna phase centre corrections based on IGS05 model

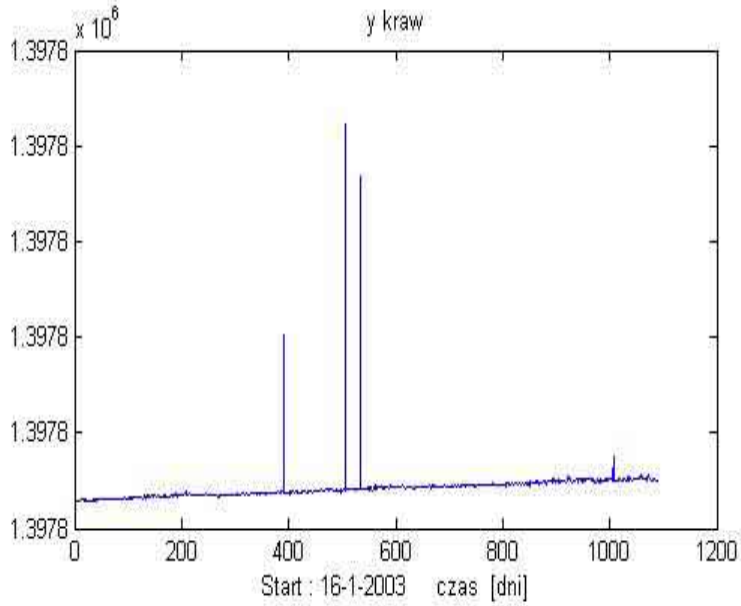
Troposphere : Dry-GMF as a priori model, estimation of zenith delay corrections at 1-hour intervals for each station, using the wet-GMF MF, no apriori sigmas. Horizontal gradient parameter estimated/day/station (TILTING), no apriori constraints.

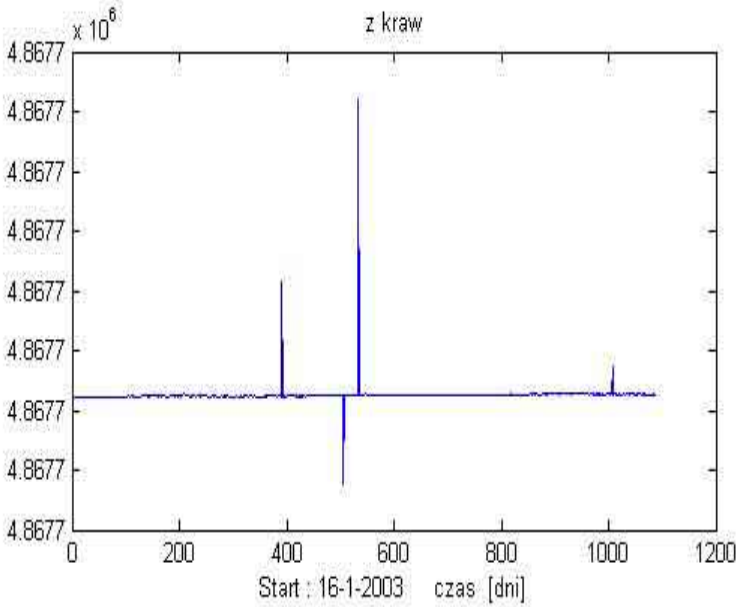
ESTIMATED PARAMETERS (APRIORI VALUES & SIGMAS)

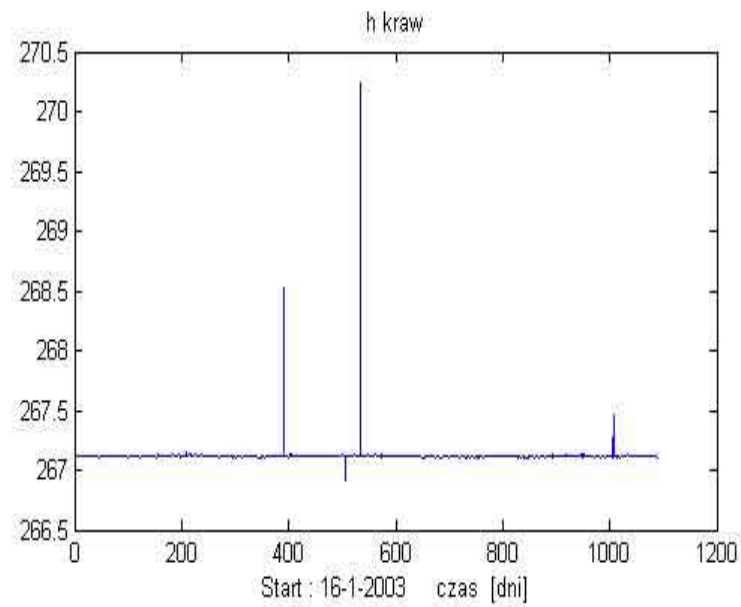
Datum definition : A 3-translation condition with respect to IGS05, the IGS realization of ITRF2000, is imposed (see also "orbits and ERPs"). The list of stations defining the datum currently includes the following IGS05 core stations:

ONSA	BOR1	WTZR
GRAZ	BRUS	MATE
ZIMM		


x kraw
x 10^6
3.8569
3.8569
3.8569
3.8569
3.8569
3.8569
0
200
400
600
800
1000
1200
Start : 16-1-2003 czas [dni]


y kraw
x 10^6
1.3978
1.3978
1.3978
1.3978
1.3978
1.3978
0
200
400
600
800
1000
1200
Start : 16-1-2003 czas [dni]


z kraw
x 10^6
4.8677
4.8677
4.8677
4.8677
4.8677
4.8677
4.8677
0
200
400
600
800
1000
1200
Start : 16-1-2003 czas [dni]

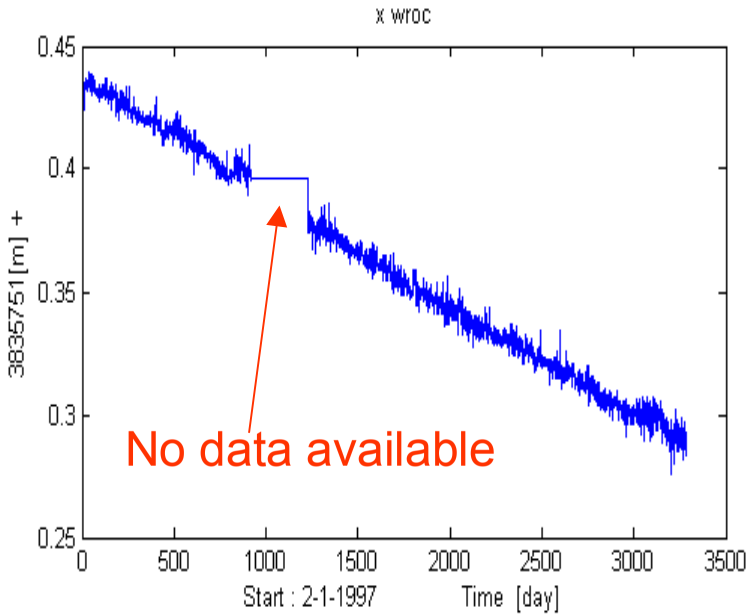

h kraw
270.5
270
269.5
269
268.5
268
267.5
267
266.5
0
200
400
600
800
1000
1200
Start : 16-1-2003 czas [dni]

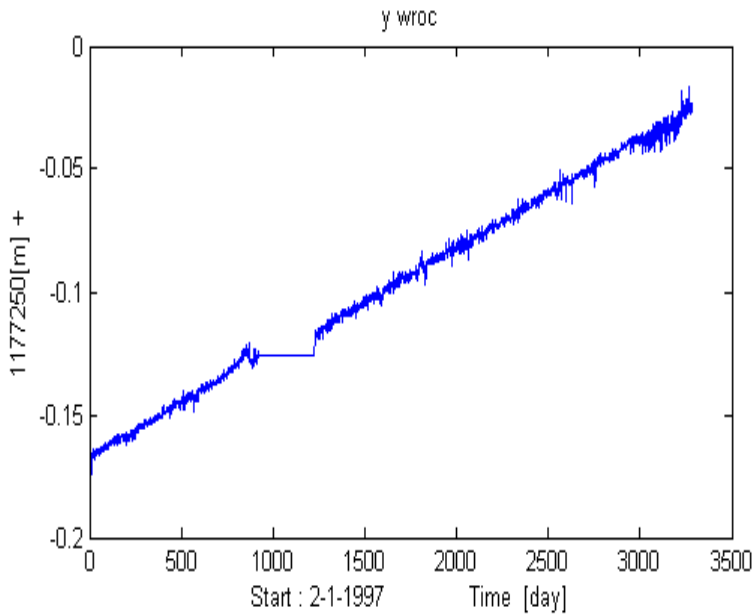
1. Various number of data (Different working time of certain stations)

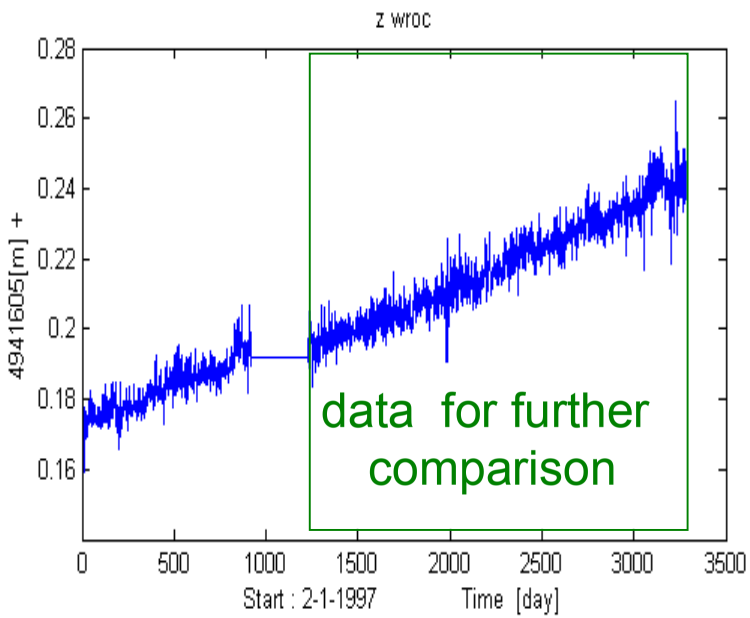
2. Measurements with significant errors (errors origin was not examined)

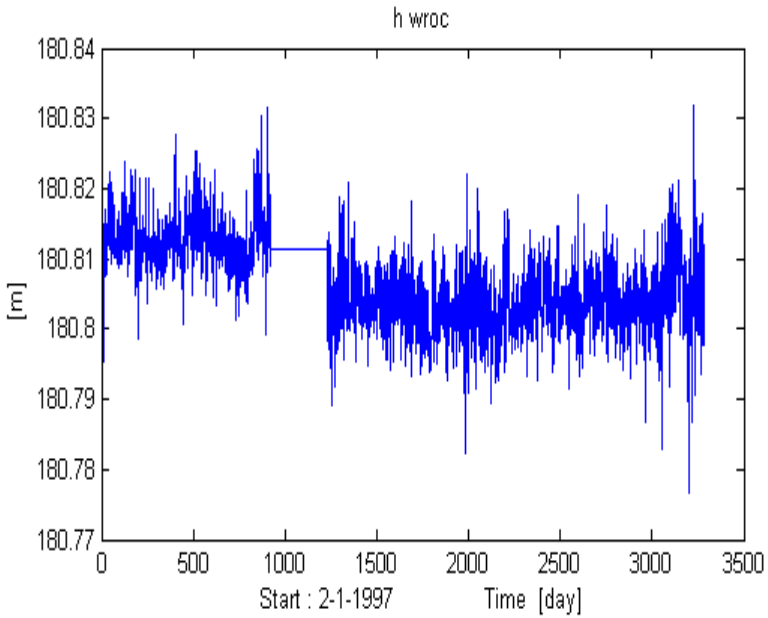
3. Data with significant measurement errors was estimated by taking average data from the previous and next day

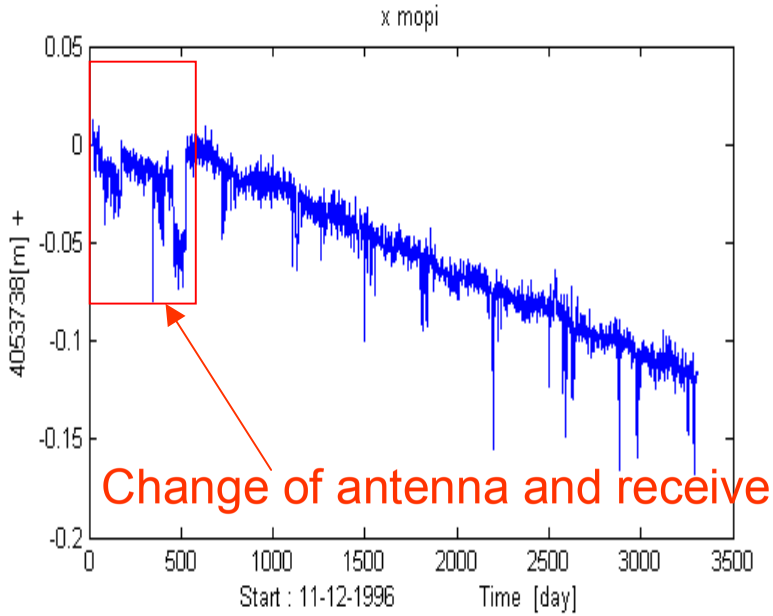
4. Data visualization without significant errors

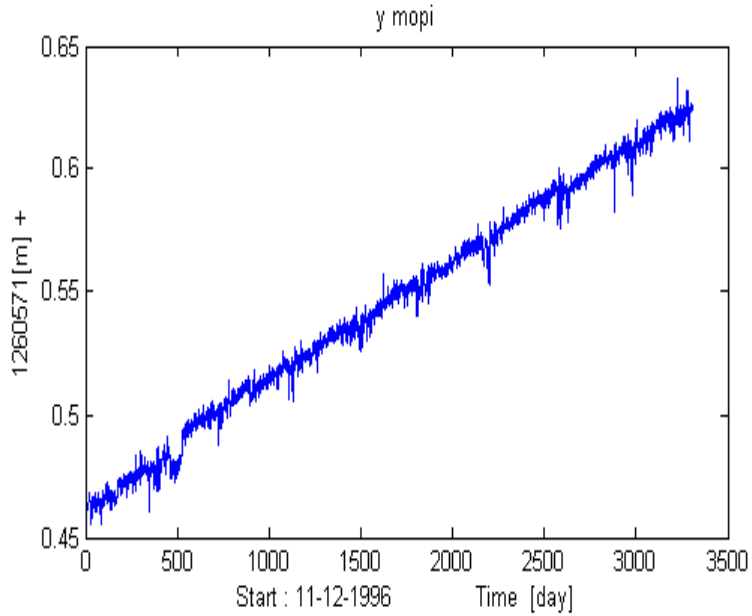

x wroc
3835751[m] +
No data available
Start : 2-1-1997
Time [day]

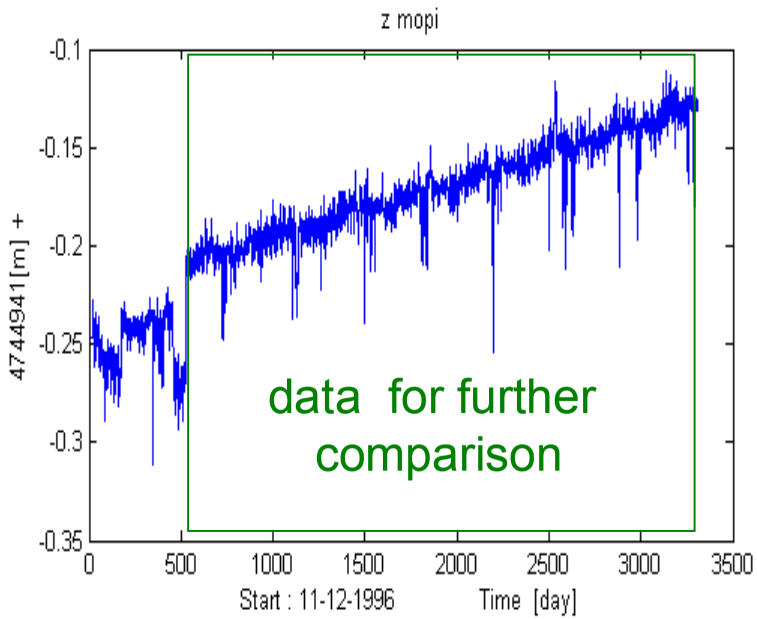

y wroc
1177250[m] +
Start : 2-1-1997
Time [day]

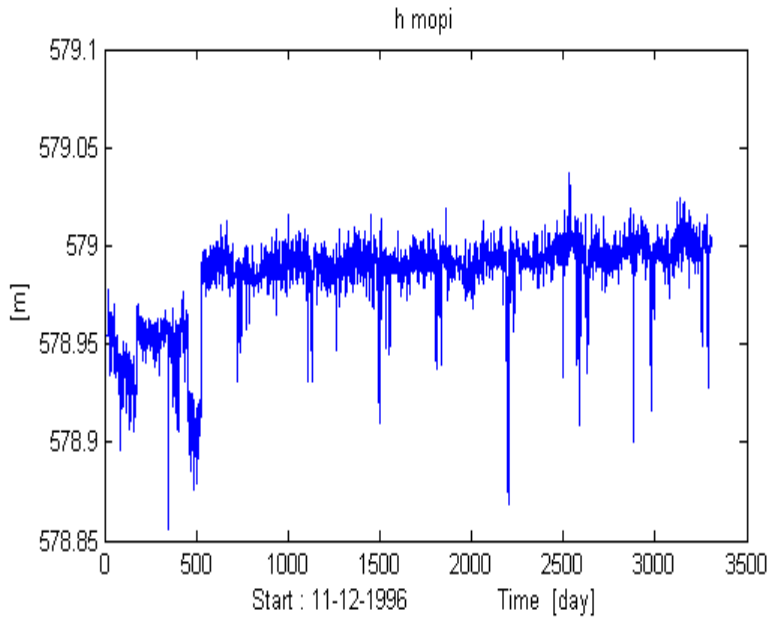

z wroc
4941605[m] +
data for further comparison
Start : 2-1-1997
Time [day]

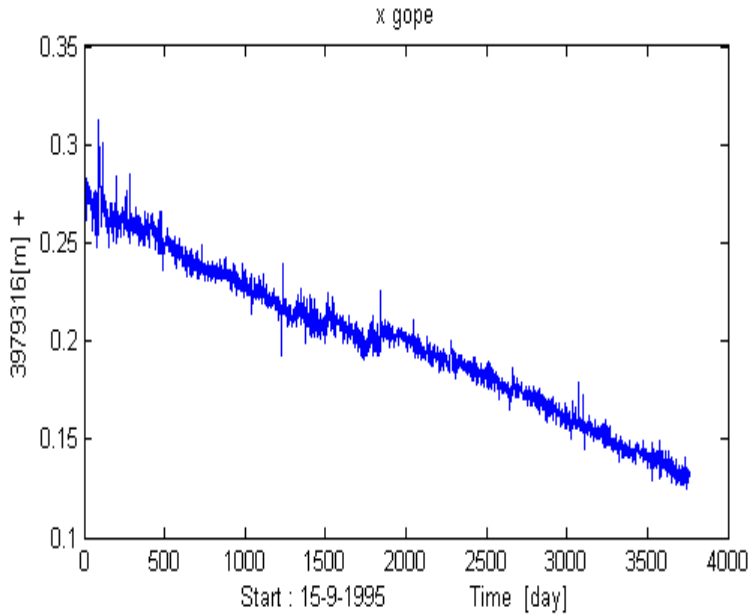

h wroc
[m]
Start : 2-1-1997
Time [day]

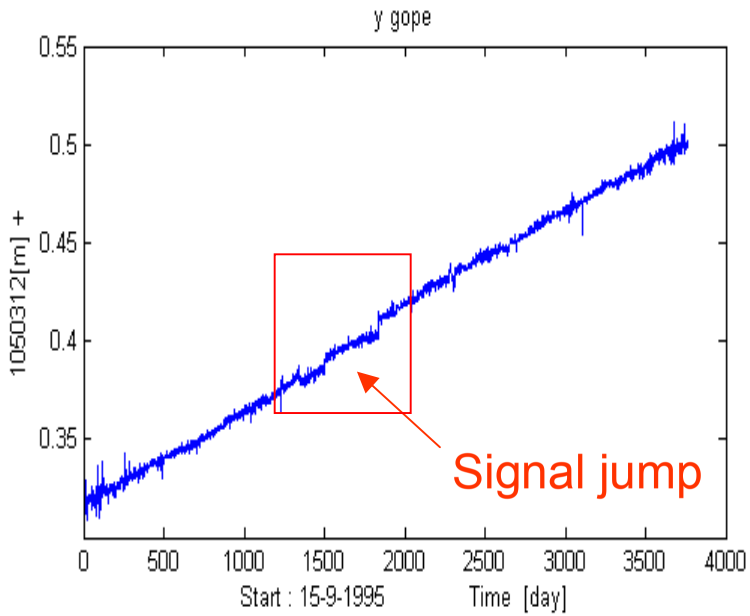

x mopi
4053738[m] +
0.05
0
-0.05
-0.1
-0.15
-0.2
0
500
1000
1500
2000
2500
3000
3500
Start : 11-12-1996
Time [day]
Change of antenna and receiver

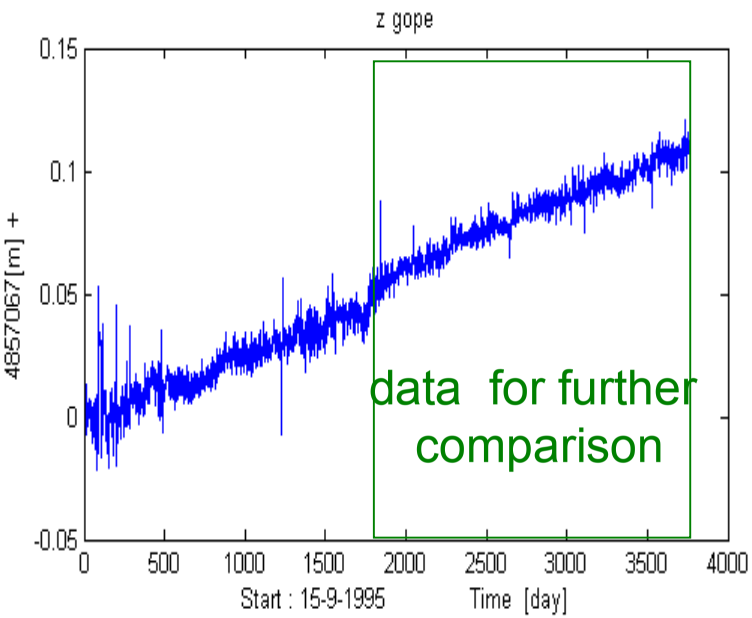

y mopi
1260571[m] +
0.65
0.6
0.55
0.5
0.45
0
500
1000
1500
2000
2500
3000
3500
Start : 11-12-1996
Time [day]

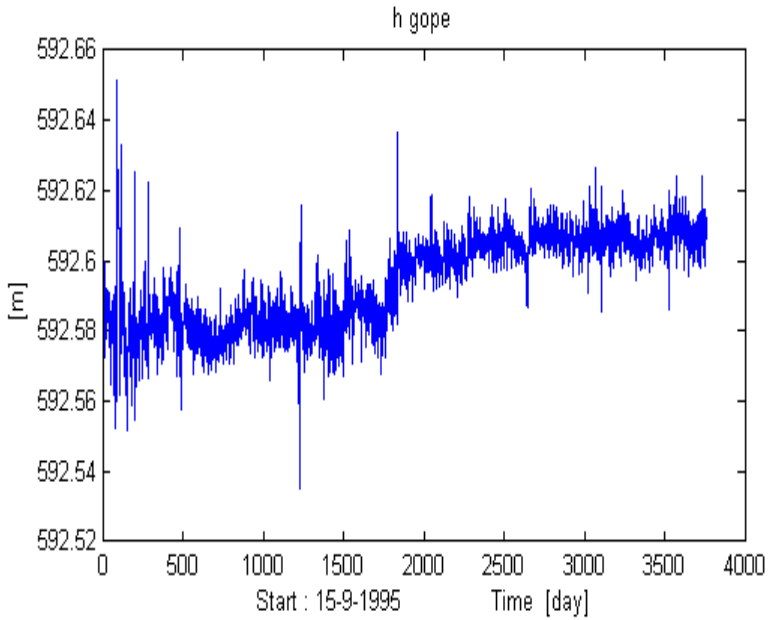

z mopi
4744941[m] +
-0.1
-0.15
-0.2
-0.25
-0.3
-0.35
0
500
1000
1500
2000
2500
3000
3500
Start : 11-12-1996
Time [day]
data for further comparison

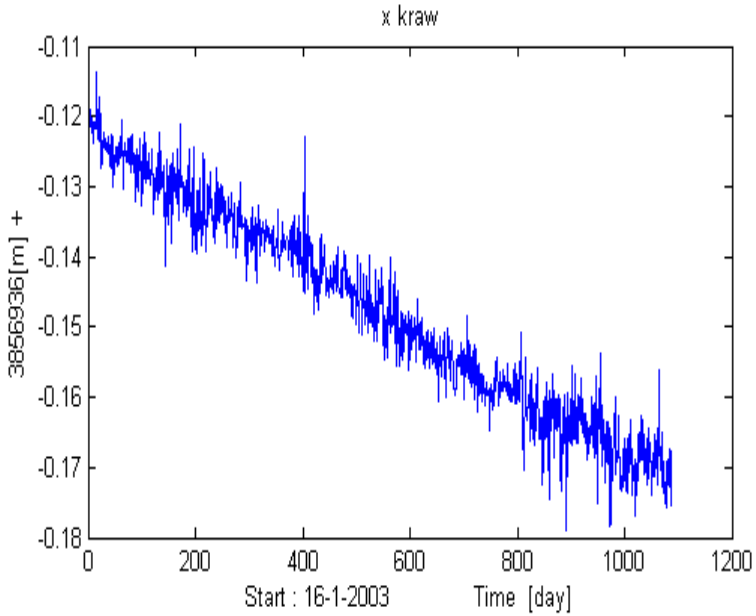

h mopi
[m]
579.1
579.05
579
578.95
578.9
578.85
0
500
1000
1500
2000
2500
3000
3500
Start : 11-12-1996
Time [day]

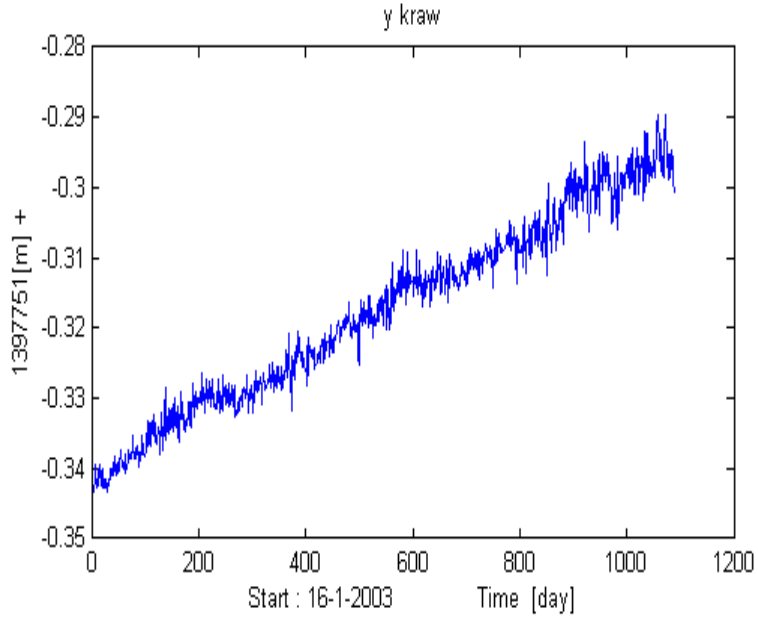

x gope
3979316[m] +
0.35
0.3
0.25
0.2
0.15
0.1
0
500
1000
1500
2000
2500
3000
3500
4000
Start : 15-9-1995
Time [day]

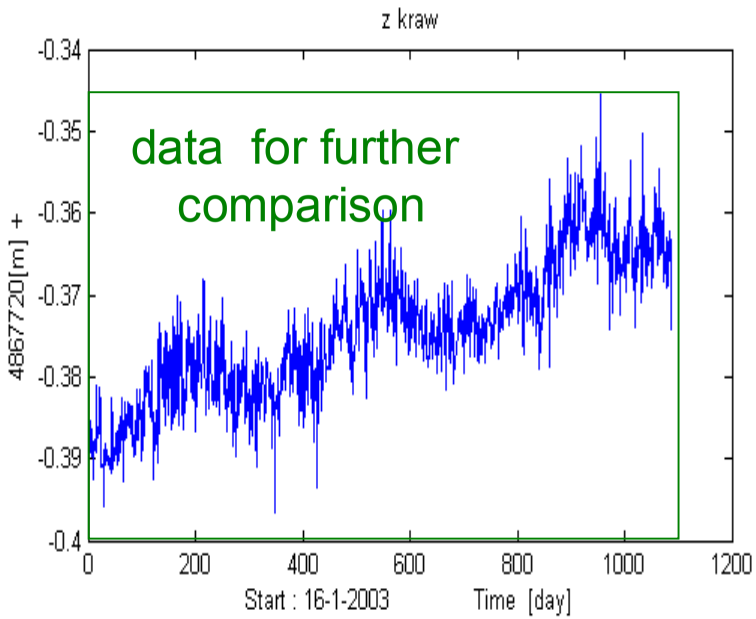

y gope
1050312[m] +
0.55
0.5
0.45
0.4
0.35
Signal jump
0
500
1000
1500
2000
2500
3000
3500
4000
Start : 15-9-1995
Time [day]

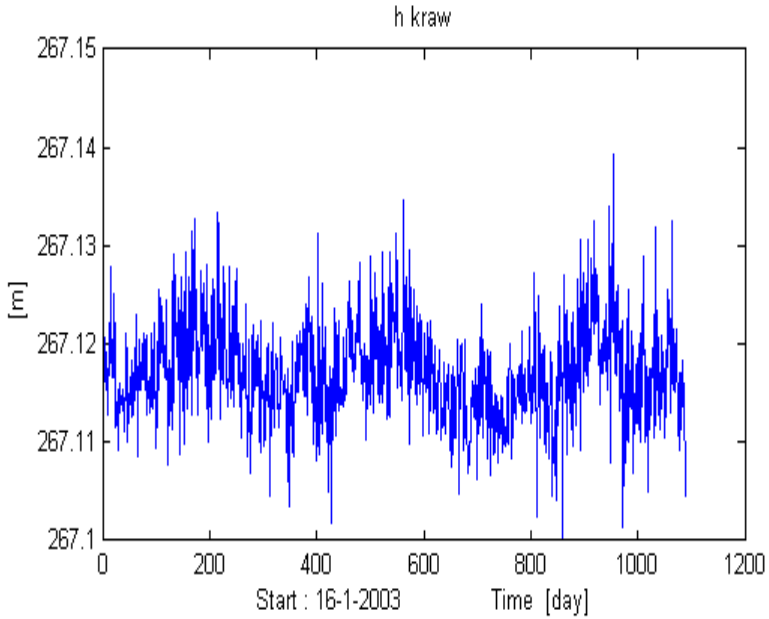

z gope
4857067[m] +
0.15
0.1
0.05
0
-0.05
data for further comparison
0
500
1000
1500
2000
2500
3000
3500
4000
Start : 15-9-1995
Time [day]

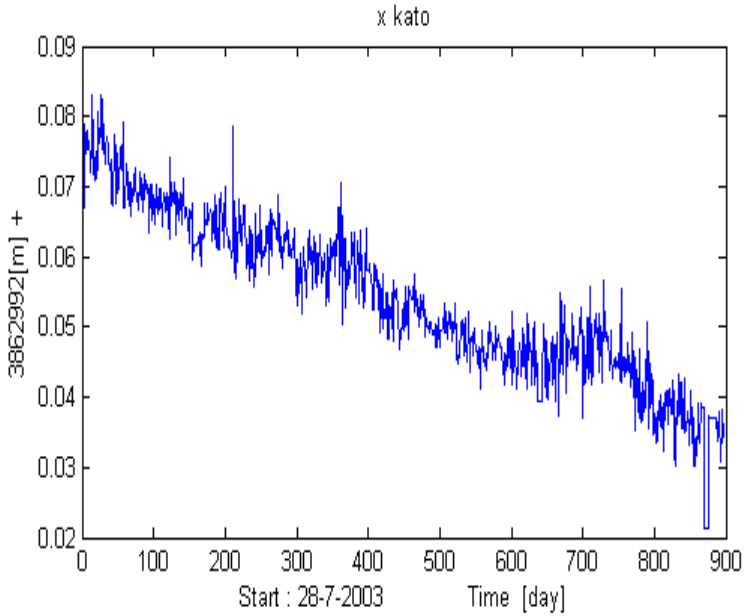

h gope
[m]
592.66
592.64
592.62
592.6
592.58
592.56
592.54
592.52
0
500
1000
1500
2000
2500
3000
3500
4000
Start : 15-9-1995
Time [day]

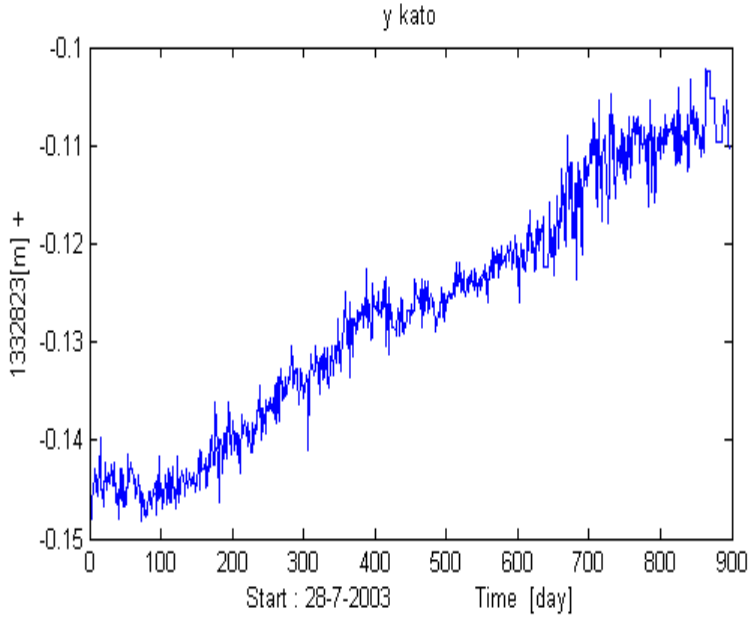

x kraw
-0.11
-0.12
-0.13
-0.14
-0.15
-0.16
-0.17
-0.18
3856936[m] +
0
200
400
600
800
1000
1200
Start : 16-1-2003
Time [day]

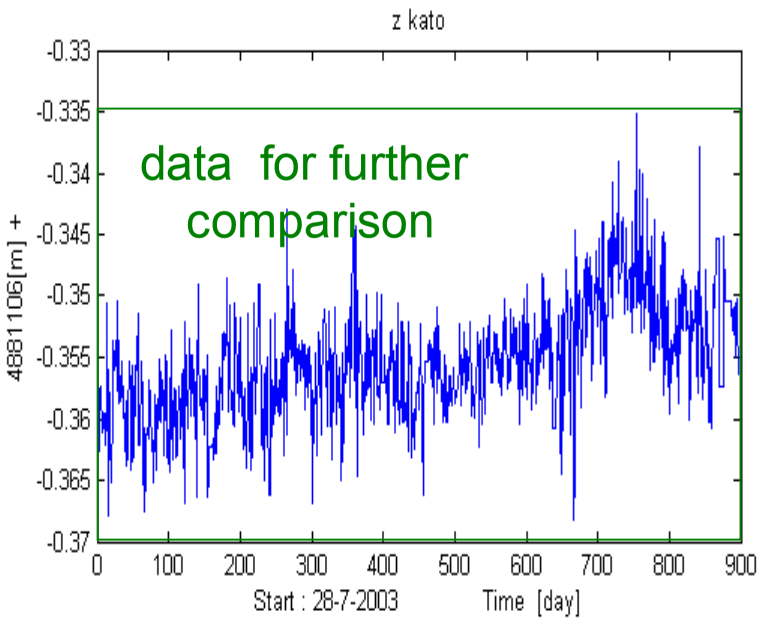

y kraw
-0.28
-0.29
-0.3
-0.31
-0.32
-0.33
-0.34
-0.35
1397751[m] +
0
200
400
600
800
1000
1200
Start : 16-1-2003
Time [day]

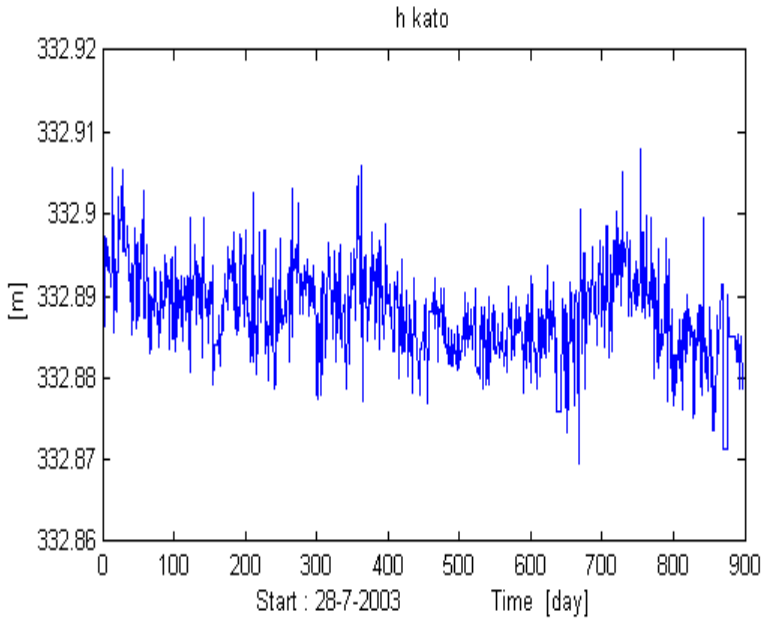

z kraw
-0.34
-0.35
-0.36
-0.37
-0.38
-0.39
-0.4
4867720[m] +
data for further comparison
0
200
400
600
800
1000
1200
Start : 16-1-2003
Time [day]


h kraw
267.15
267.14
267.13
267.12
267.11
267.1
[m]
0
200
400
600
800
1000
1200
Start : 16-1-2003
Time [day]


x kato
3862992[m] +
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0
100
200
300
400
500
600
700
800
900
Start : 28-7-2003
Time [day]


y kato
1332823[m] +
-0.1
-0.11
-0.12
-0.13
-0.14
-0.15
0
100
200
300
400
500
600
700
800
900
Start : 28-7-2003
Time [day]

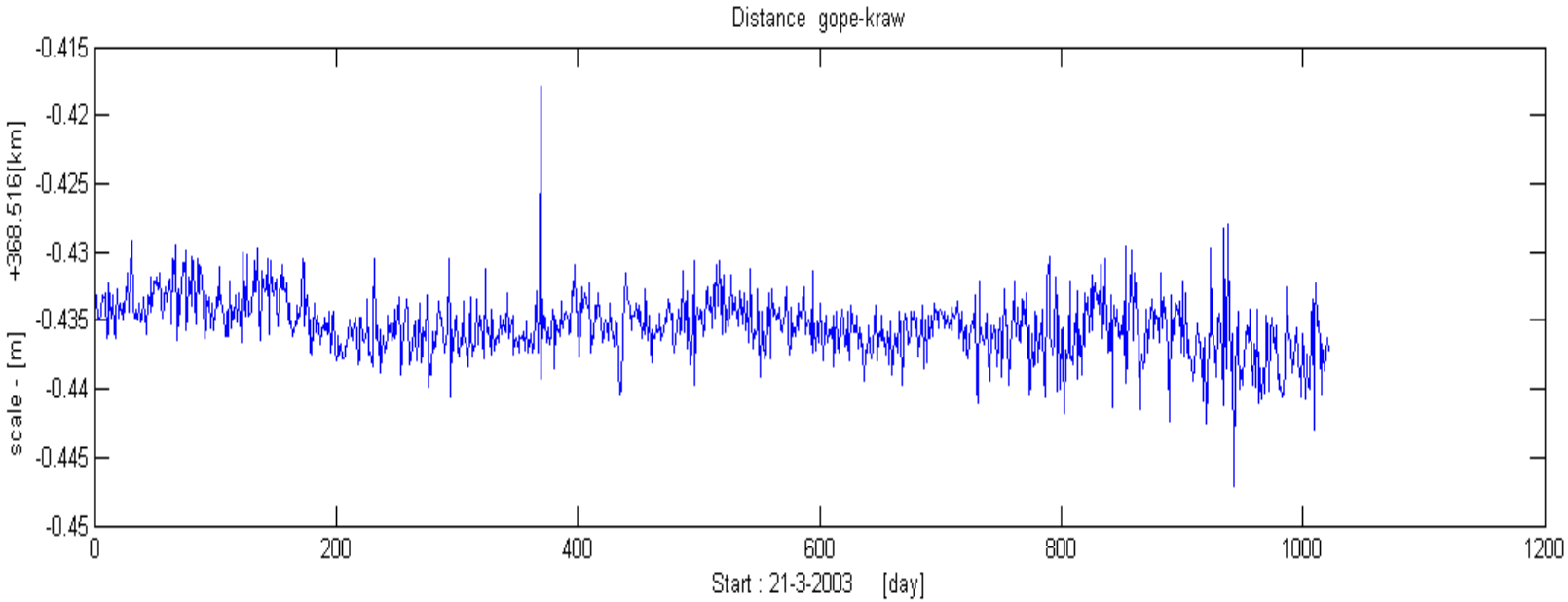

z kato
4881106[m] +
-0.33
-0.335
-0.34
-0.345
-0.35
-0.355
-0.36
-0.365
-0.37
data for further comparison
0
100
200
300
400
500
600
700
800
900
Start : 28-7-2003
Time [day]

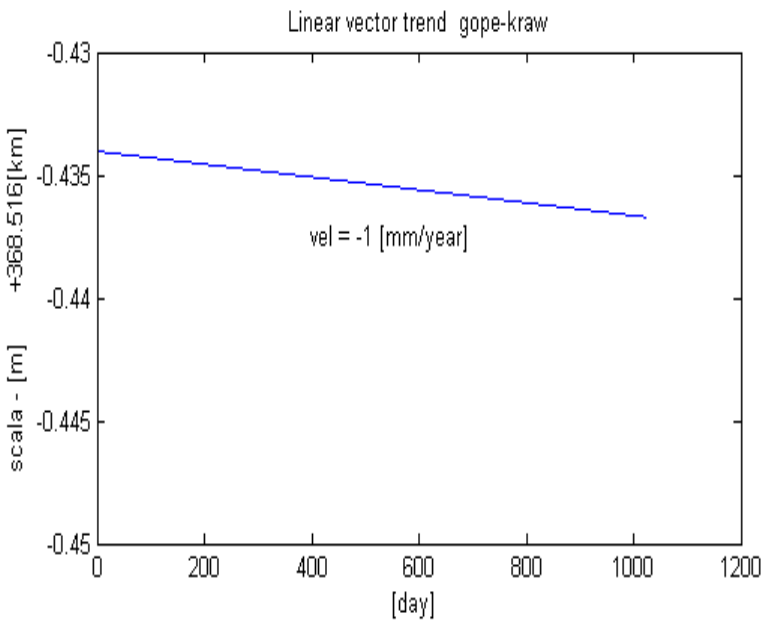

h kato
[m]
332.92
332.91
332.9
332.89
332.88
332.87
332.86
0
100
200
300
400
500
600
700
800
900
Start : 28-7-2003
Time [day]

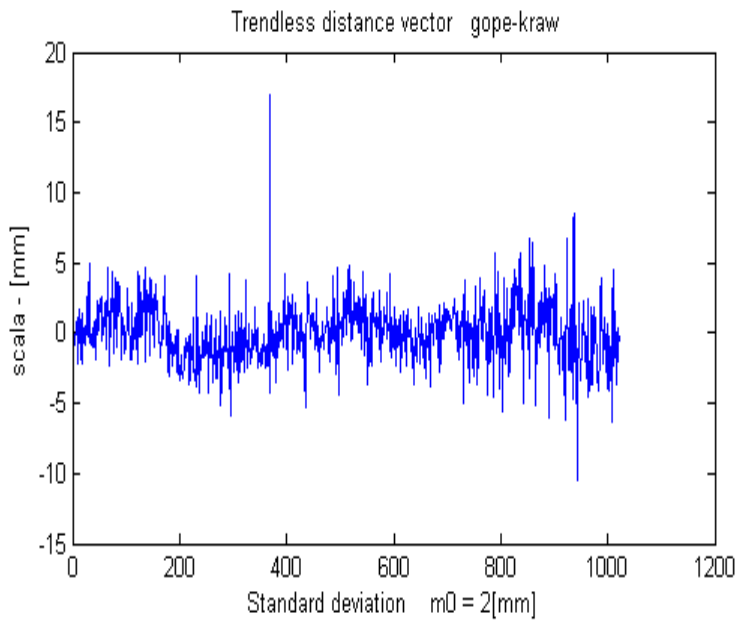
After indicating the same time interval, vector length between the stations for every day was delivered using this formula:

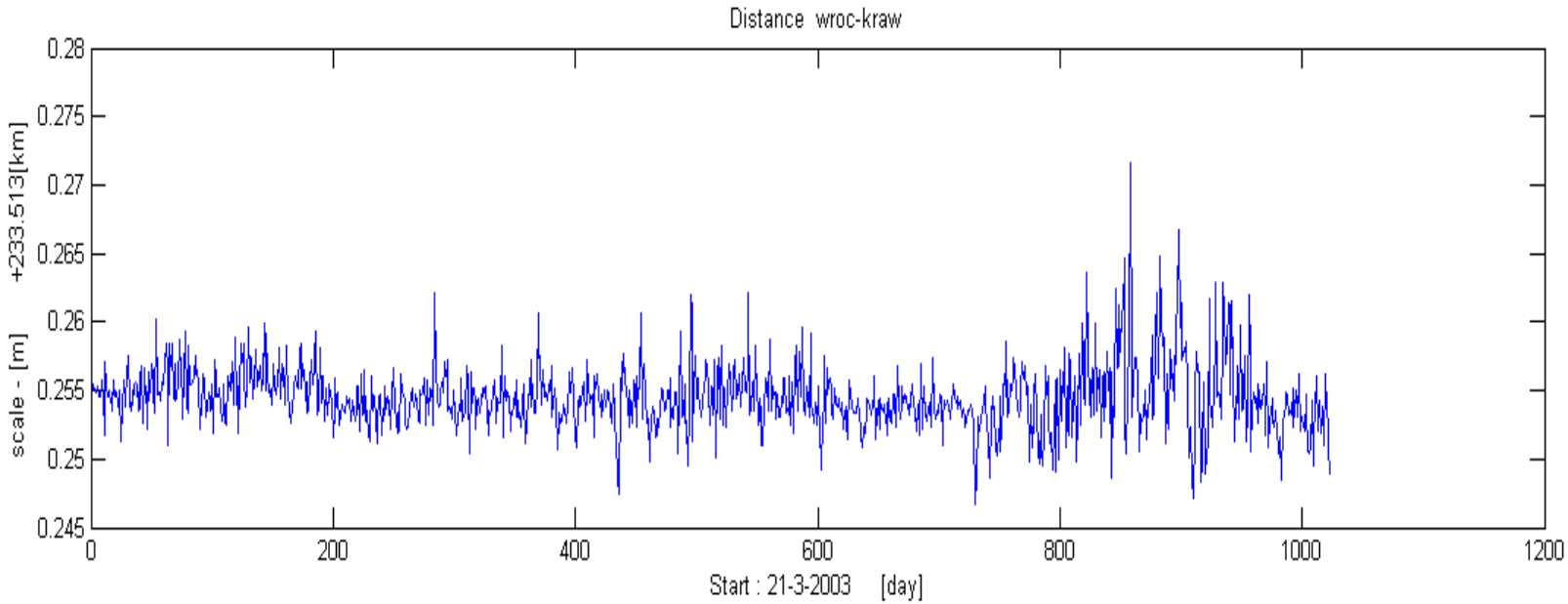
$$d_{AB} = \sqrt{(x_B - x_A)^2 + (y_B - y_A)^2 + (z_B - z_A)^2}$$

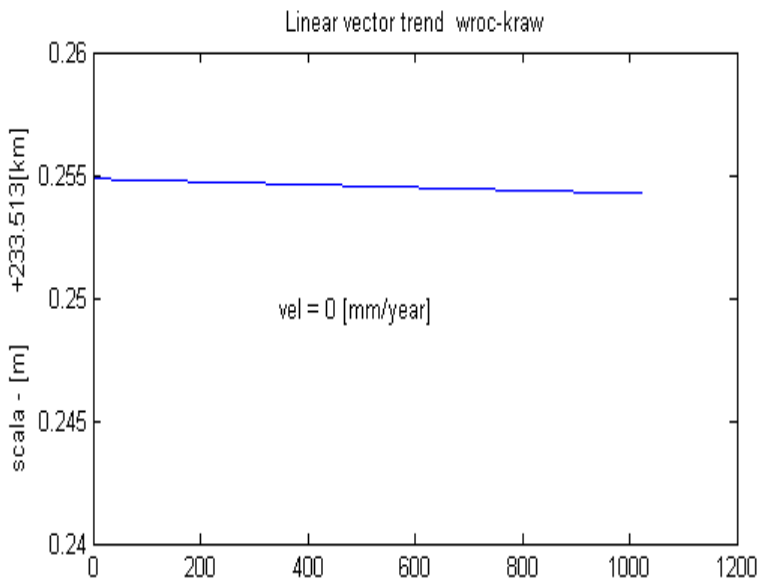
- After indicating vector length, linear trend can be established for all 10 vectors.
- Using trend data the speed between the stations can be established
- Standard diversion was also created. The results are in graphic form.

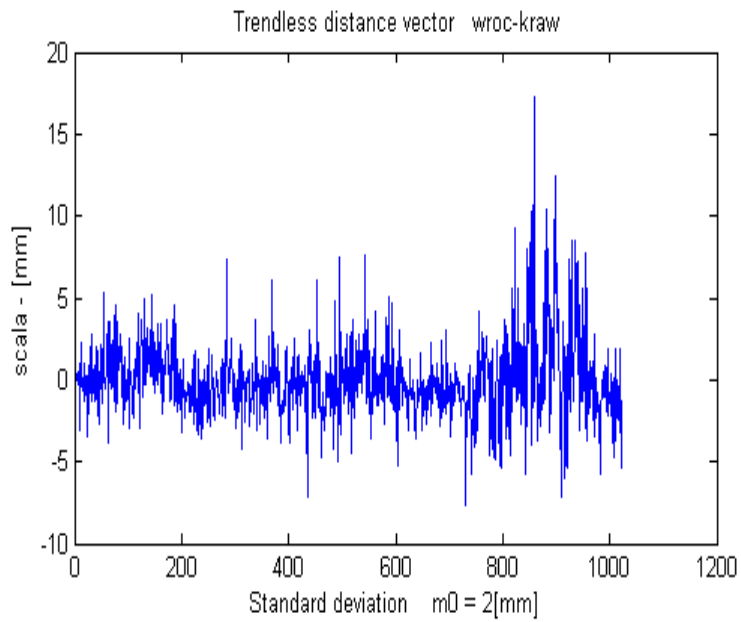

Distance gope-kraw
-0.415
-0.42
-0.425
-0.43
-0.435
-0.44
-0.445
-0.45
scale - [m] +368.516[km]
0
200
400
600
800
1000
1200
Start : 21-3-2003 [day]

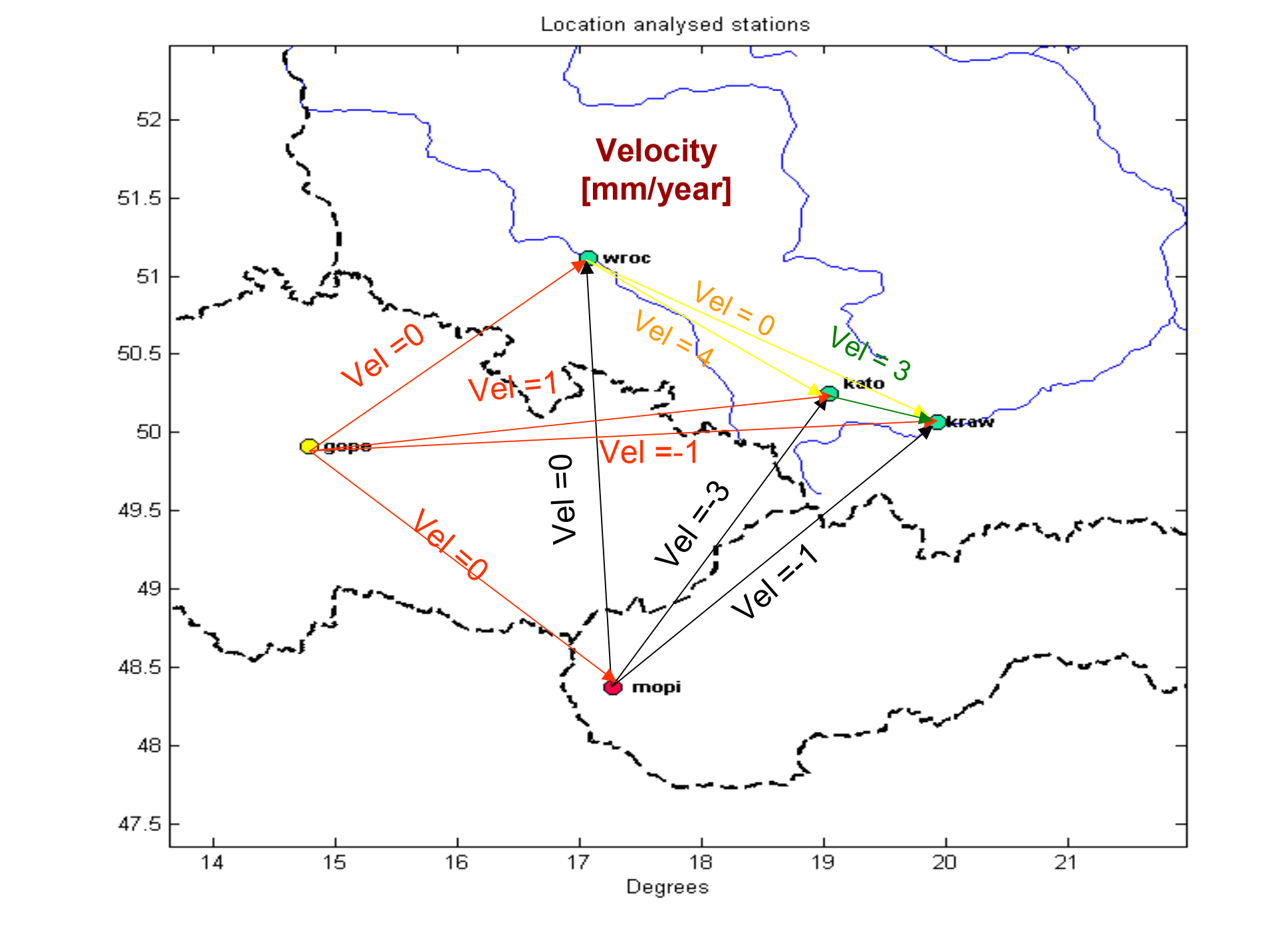

Linear vector trend gope-kraw
-0.43
-0.435
-0.44
-0.445
-0.45
scala - [m] +368.516[km]
vel = -1 [mm/year]
0
200
400
600
800
1000
1200
[day]


Trendless distance vector gope-kraw
20
15
10
5
0
-5
-10
-15
scala - [mm]
0
200
400
600
800
1000
1200
Standard deviation m0 = 2[mm]


Distance wroc-kraw
scale - [m] +233.513[km]
0.28
0.275
0.27
0.265
0.26
0.255
0.25
0.245
0
200
400
600
800
1000
1200
Start : 21-3-2003 [day]


Linear vector trend wroc-kraw
scala - [m] +233.513[km]
0.26
0.255
0.25
0.245
0.24
vel = 0 [mm/year]
0
200
400
600
800
1000
1200


Trendless distance vector wroc-kraw
scala - [mm]
20
15
10
5
0
-5
-10
0
200
400
600
800
1000
1200
Standard deviation m0 = 2[mm]

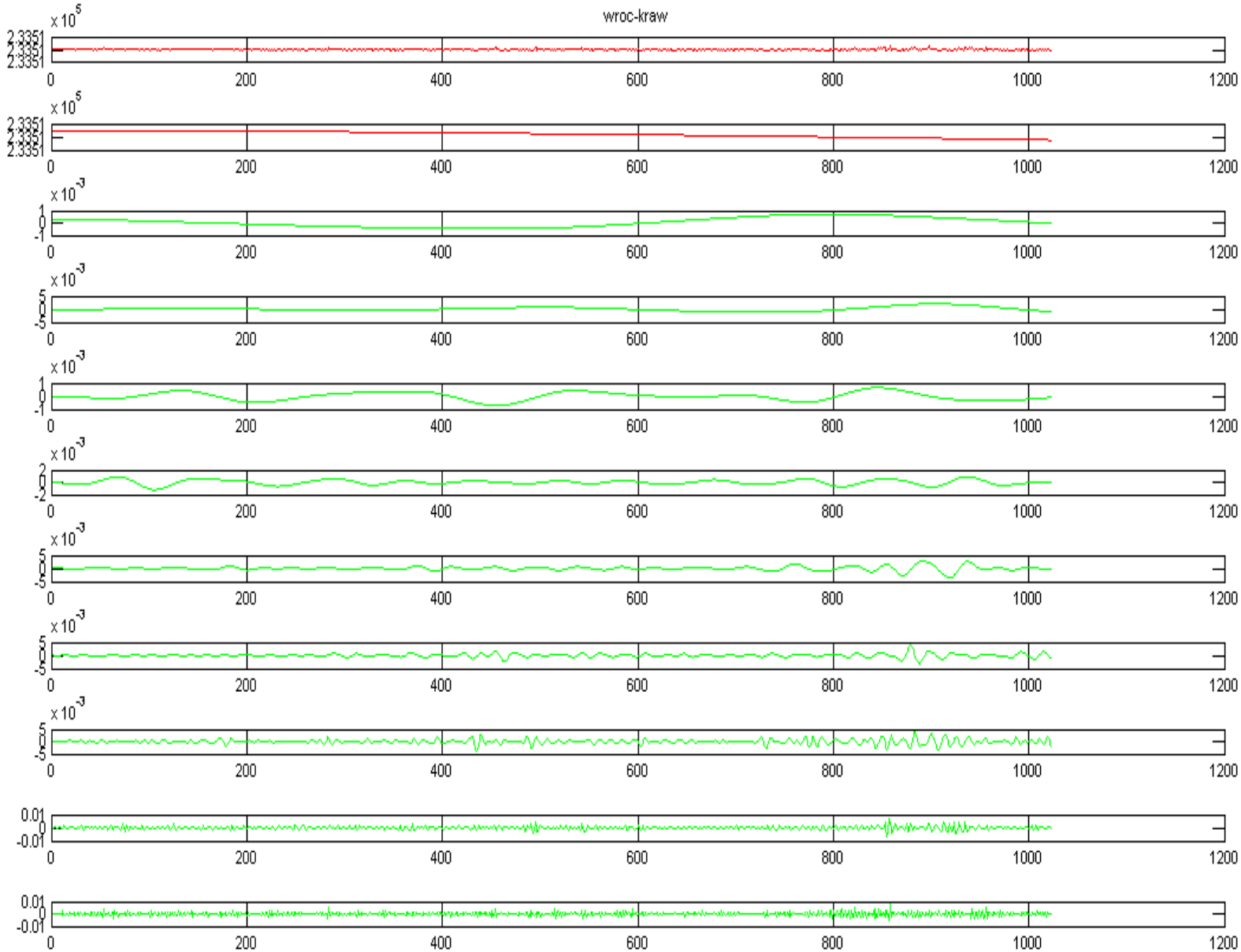

Location analysed stations
Velocity
[mm/year]
wroc
kato
kraw
gope
mopi
Vel =0
Vel =1
Vel =4
Vel = 0
Vel = 3
Vel =-1
Vel =0
Vel =0
Vel =-3
Vel =-1
52
51.5
51
50.5
50
49.5
49
48.5
48
47.5
14
15
16
17
18
19
20
21
Degrees

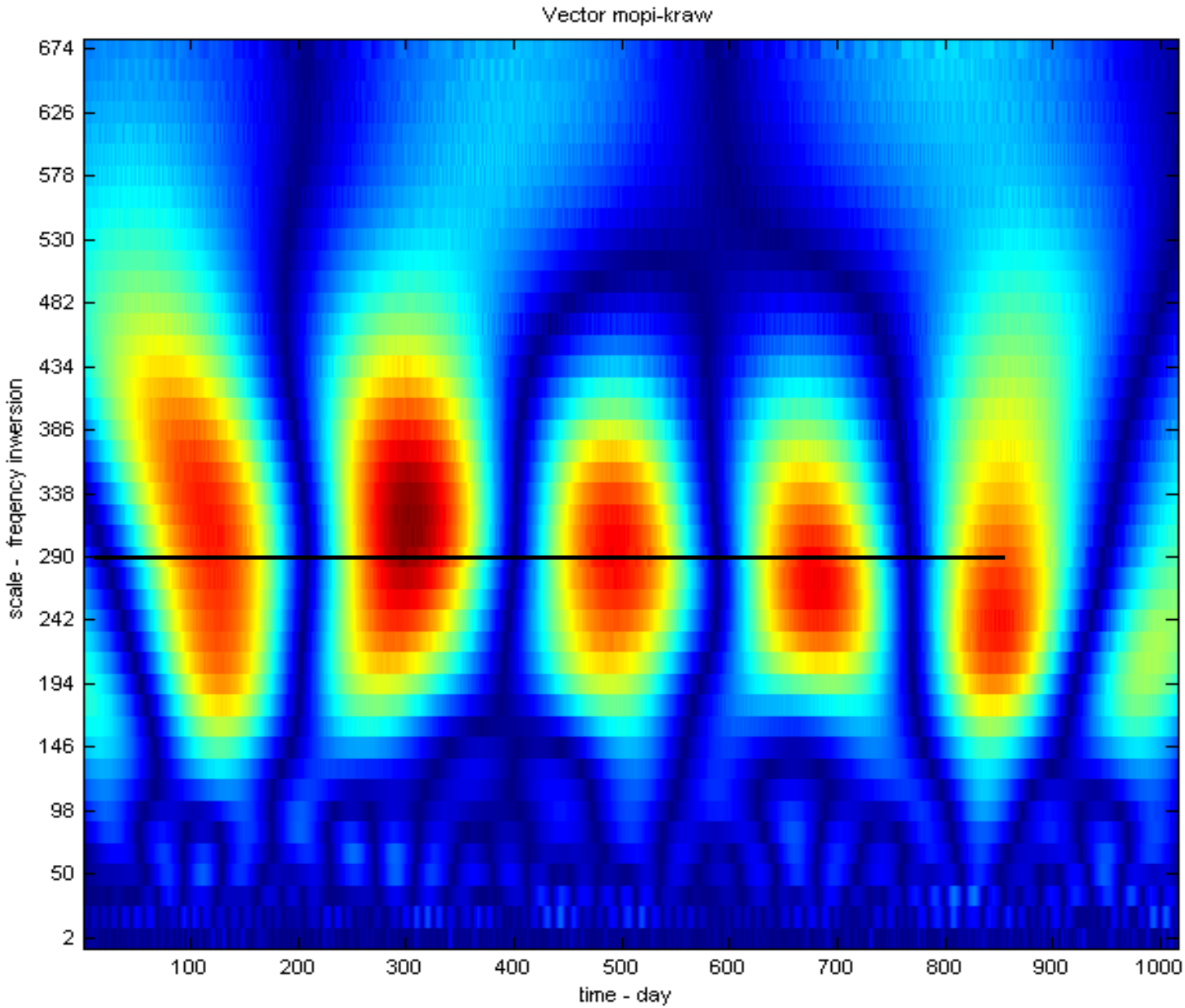
- Most of speed vectors distance is nearly zero
- Vectors regarding kato station are different than zero

Results from vector distance of linear trend

1. Distance between the stations do not show linear tendency change
2. Kato station is problematic (additional analysis is needed)
3. Cyclic changes are easy to observe in trendless signals and in signals without constant value
4. In order to know more of vectors distance wavelet analysis was undertaken

N=10


wroc-kraw
x 10^5
2.3351
2.3352
2.3352
2.3351
x 10^5
2.3351
2.3352
2.3352
2.3351
x 10^-3
1
0
-1
x 10^-3
5
0
-5
x 10^-3
1
0
-1
x 10^-3
2
0
-2
x 10^-3
5
0
-5
x 10^-3
5
0
-5
x 10^-3
5
0
-5
0.01
0
-0.01
0.01
0
-0.01
0
200
400
600
800
1000
1200


Vector mopi-kraw
674
626
578
530
482
434
386
338
290
242
194
146
98
50
2
scale - freqency inwersion
100
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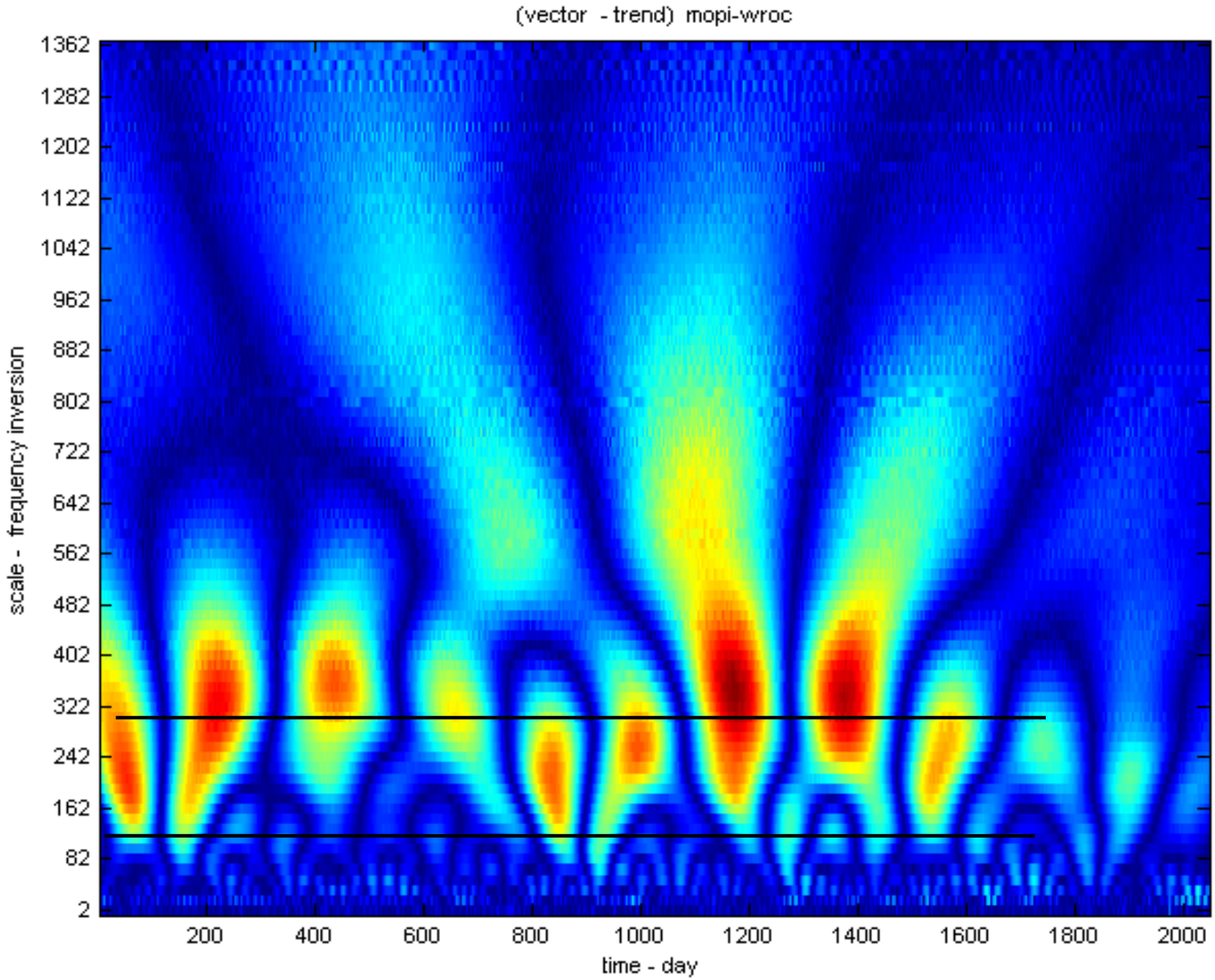
1000
time - day


(vector - trend) mopi-wroc
scale - frequency inversion
1362
1282
1202
1122
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962
882
802
722
642
562
482
402
322
242
162
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2
200
400
600
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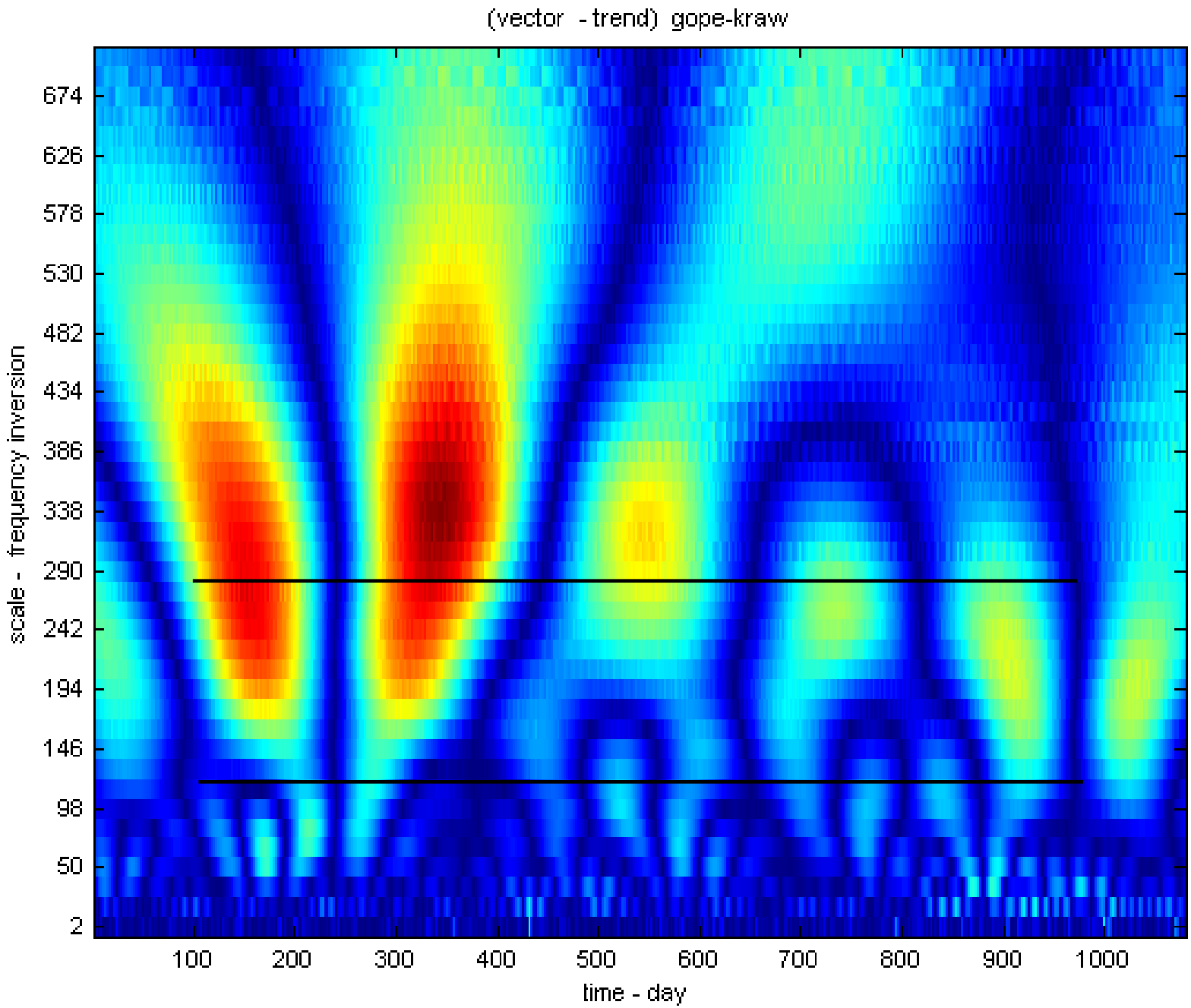
1200
1400
1600
1800
2000
time - day


(vector - trend) gope-kraw
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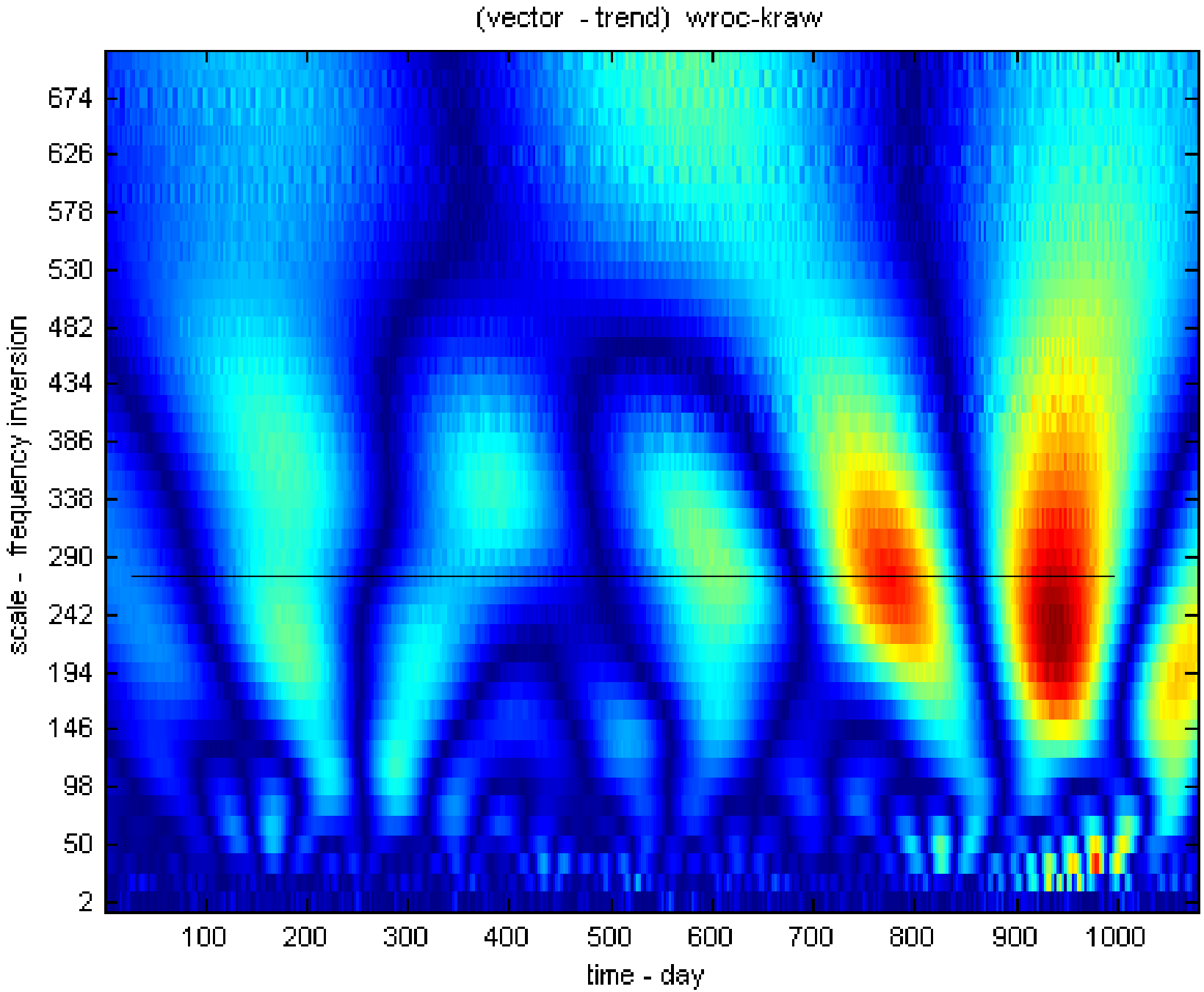
time - day


(vector - trend) wroc-kraw
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scale - frequency inversion
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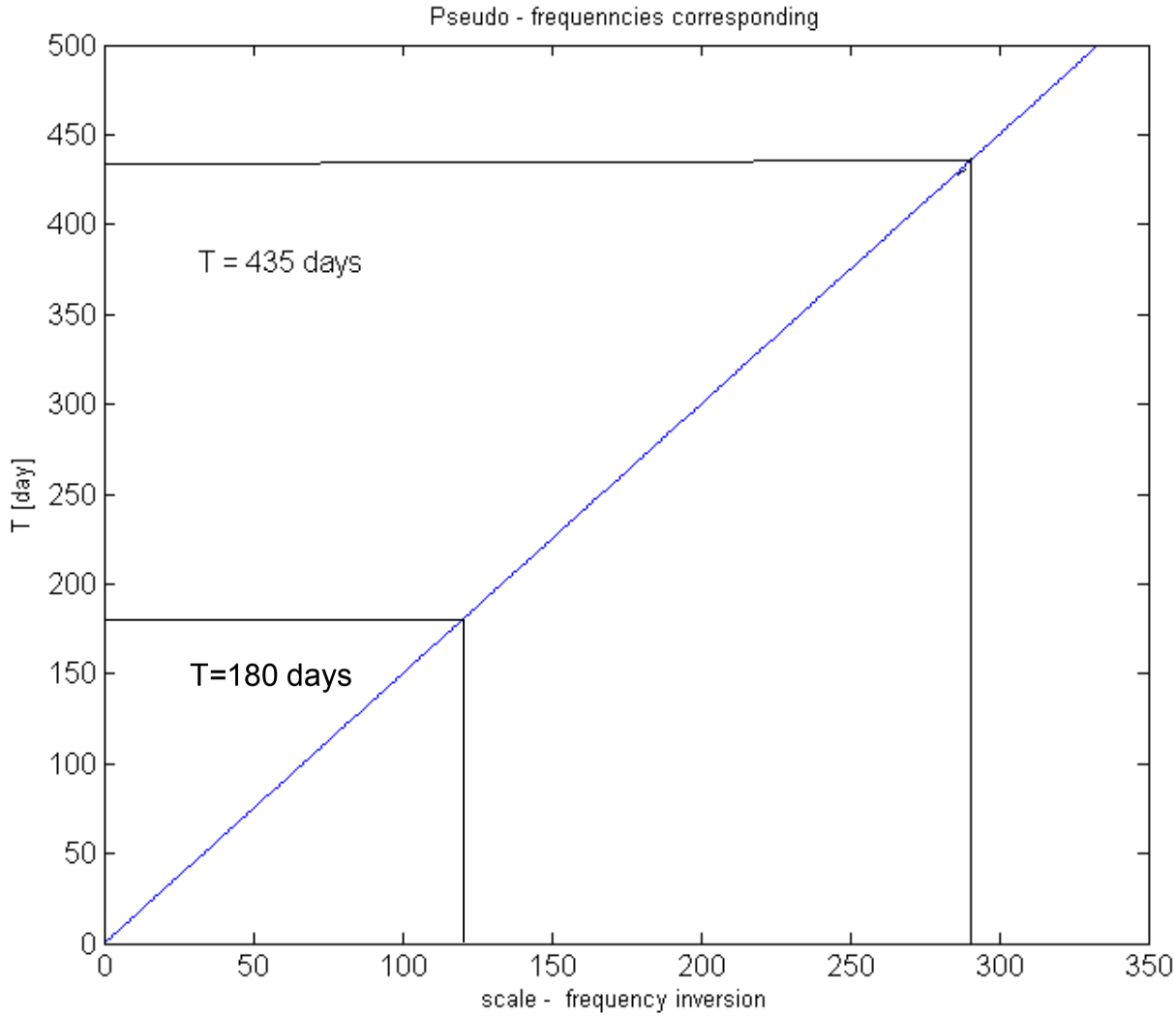
Pseudo - frequenncies corresponding
T = 435 days
T=180 days
T [day]
scale - frequency inversion
0
50
100
150
200
250
300
350
400
450
500

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