EUPOS® for national and international research

j.Balodis(1), G.Silabriedis(2)
(1) Institute of Geodesy and Geoinformation< University of Latvia
(2) Riga Technical University

Applications of GNSS
Chisinau, Moldova
17-21 May, 2010

Overview

1. Introduction and short history
2. Statistical analyses of **EUPOS-RIGA** base station coordinate variations
3. Mapping control and RTK precision estimate
3. Project ESA Id 4307
4. Project ESA Id 433
5. Geoinformation and LBS

University of Latvia
Institute of Geodesy and Geoinformation
Janis Balodis
22.03.2010

EUPOS®

- ***EUPOS®*** community succesfully cooperating since 2002
- The national ***EUPOS®*** networks has been developed
- The INTERREG III C project has been succesfully completed on interregional co-operation
- New ideas and innovations has been exchanged

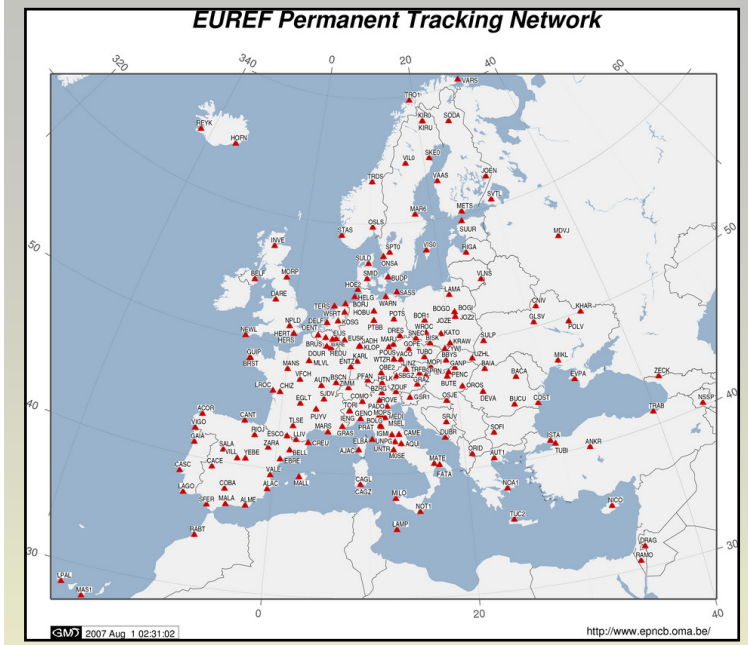
National research in EUPOS countries

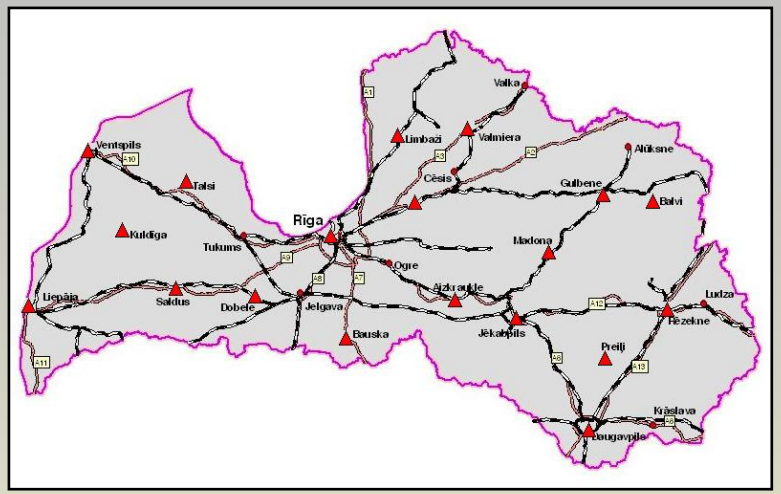
- Germany – Gep++, Positioning, navigation
- Estonia – Bernese solutions in NGK network
- Latvia – J,Zvirgzds on LATPOS
- Lithuania – managemet of LITPOS
- Poland – precision agriculture, suplement inf.for EGNOS
- Czech Rep.- long time experience in EUREF, EPN

National research in EUPOS countries

- Slovakia – Network analyses using Bernes
- Hungary – precision agriculture
- Bulgaria - flooding, lidar. Rail, RTCM
- Romania – cadastre
- Ukraine – GNSS, SLR

3. Project ESA Id 4307



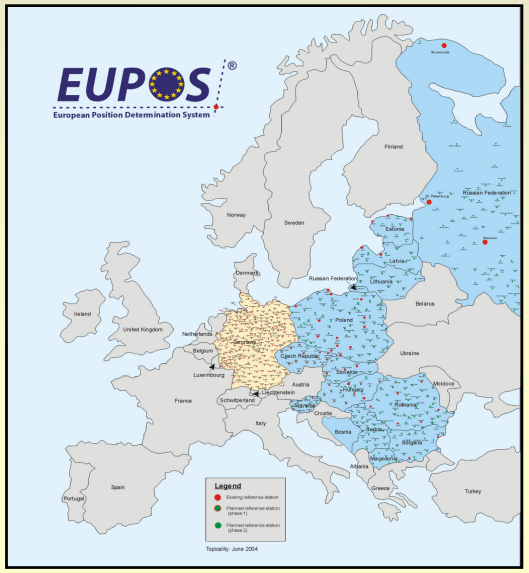


LATPOS

19 base stations

distance between stations ~70 km

Latvian Geospatial Information Agency

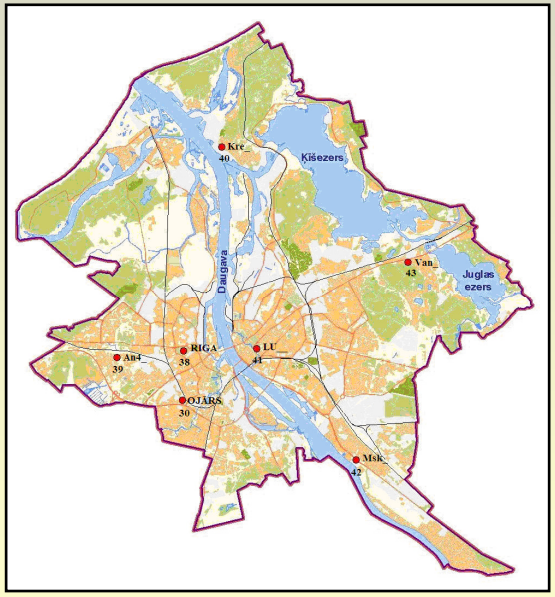


EUPOS®

about 900 reference stations

Distance between stations ~100 km

17 European countries



EUPOS®-RIGA multifunctional GNSS reference network

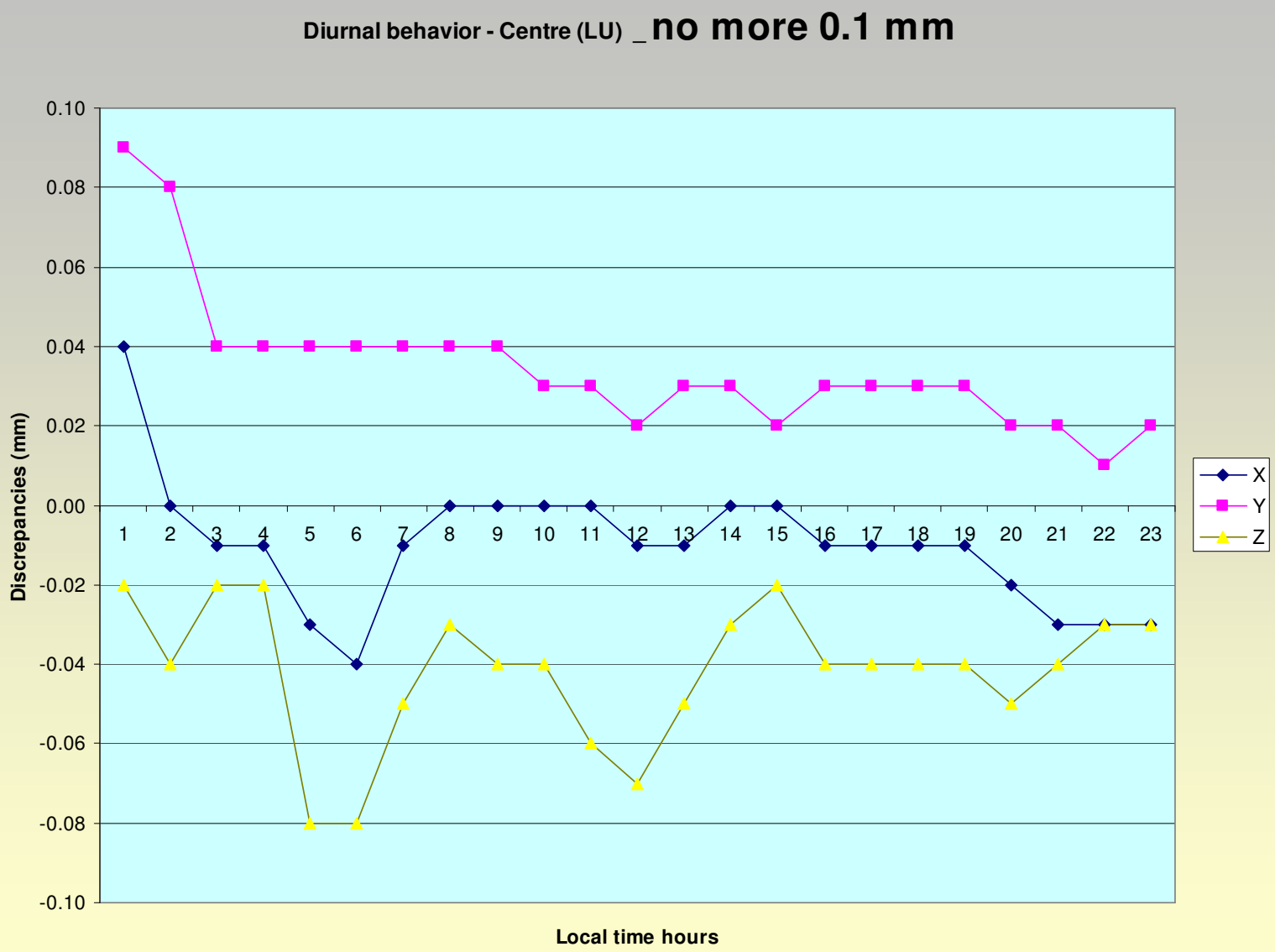
5 base stations

distance between stations ~12 km

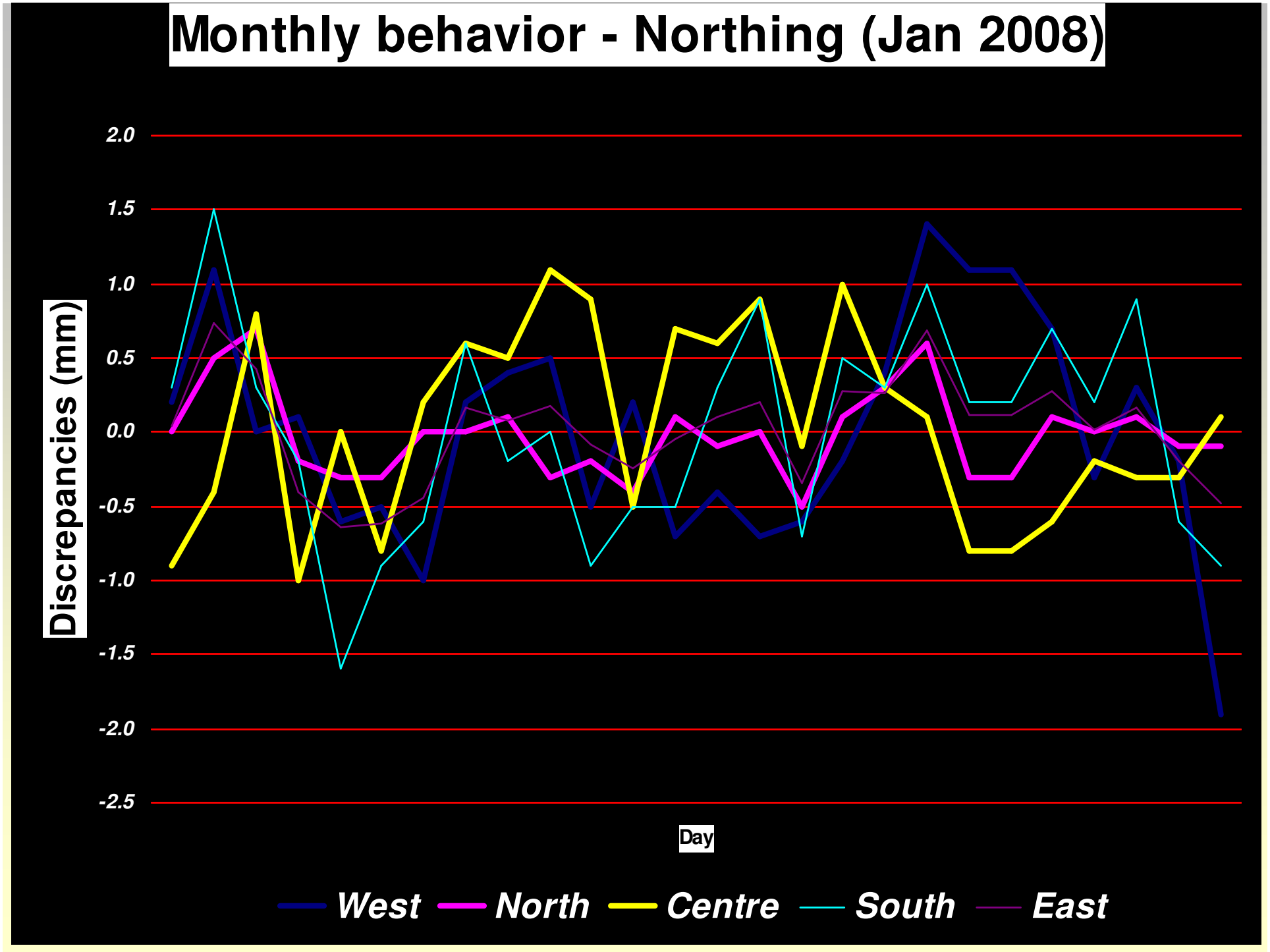
Riga's GeoMetrs Ltd. and Institute of Geodesy and Geoinformation /University of Latvia

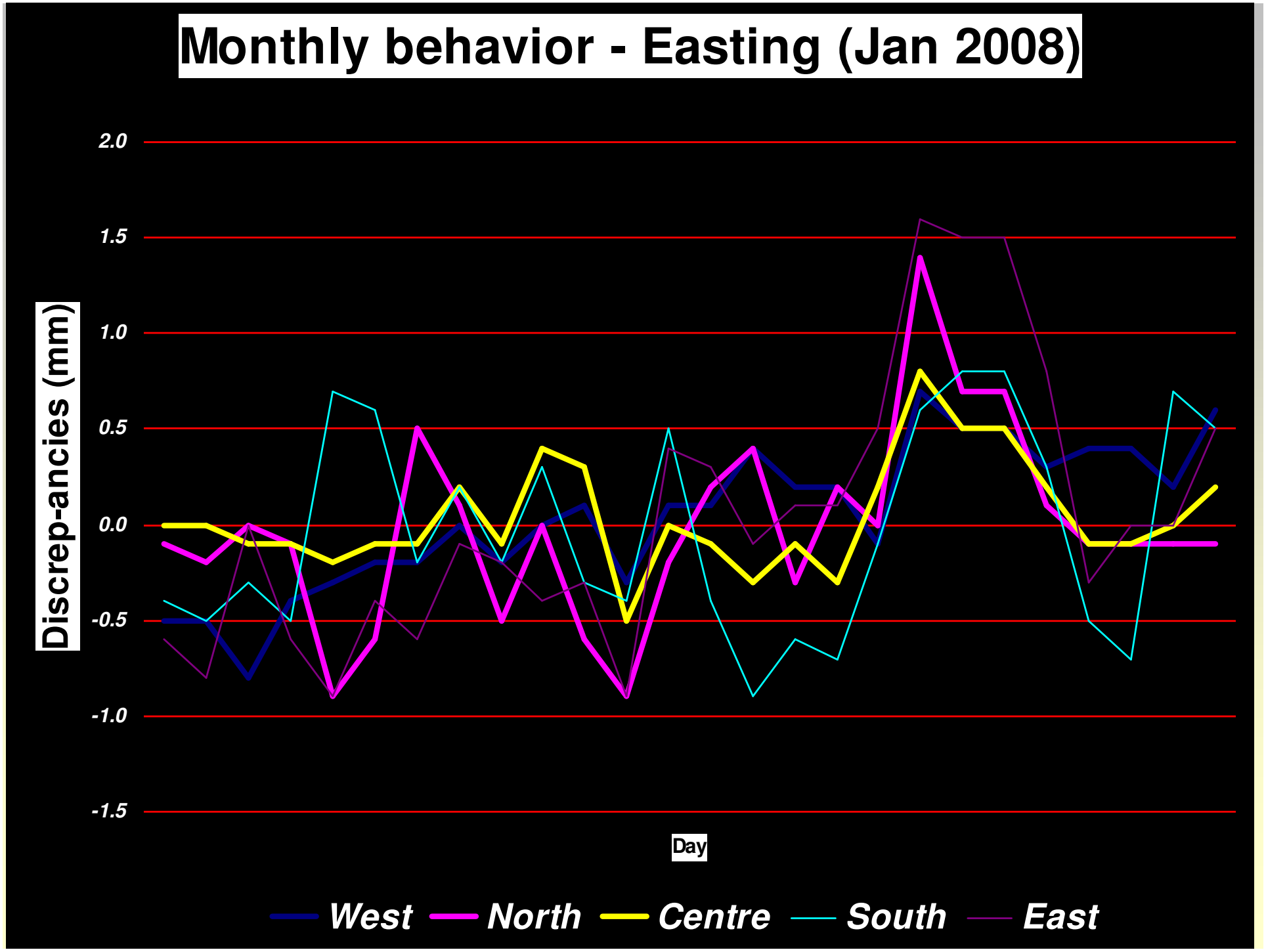
University of Latvia
Institute of Geodesy and Geoinformation
Janis Balodis
22.03.2010

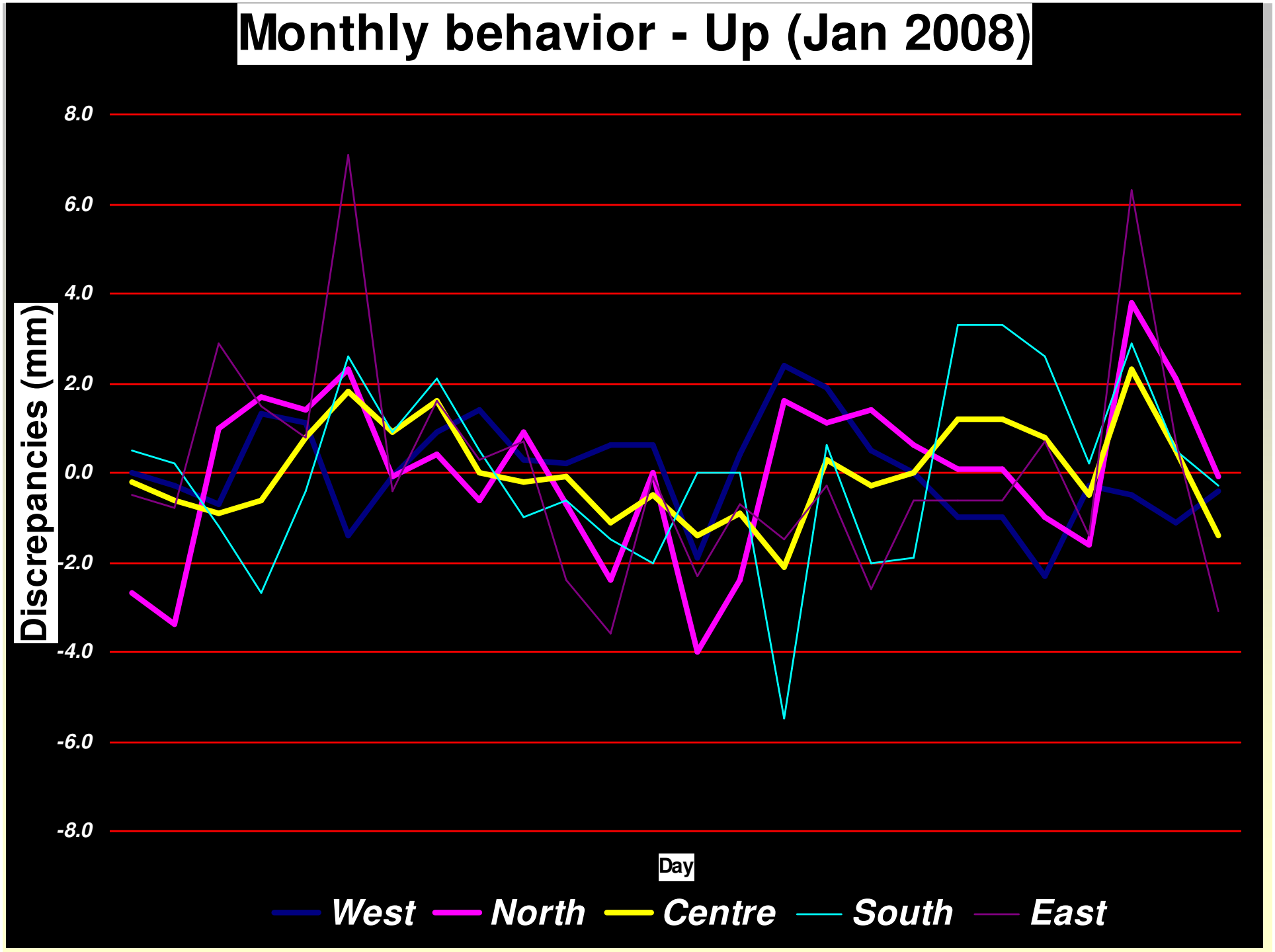
EUPOS-RIGA central station Lu


Diurnal behavior - Centre (LU) _ no more 0.1 mm
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
Discrepancies (mm)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Local time hours
X
Y
Z

Base station antena


Monthly behavior - Northing (Jan 2008)
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
Discrepancies (mm)
Day
West
North
Centre
South
East


Monthly behavior - Easting (Jan 2008)
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
Discrep-ancies (mm)
Day
West
North
Centre
South
East


Monthly behavior - Up (Jan 2008)
8.0
6.0
4.0
2.0
0.0
-2.0
-4.0
-6.0
-8.0
Discrepancies (mm)
Day
West
North
Centre
South
East

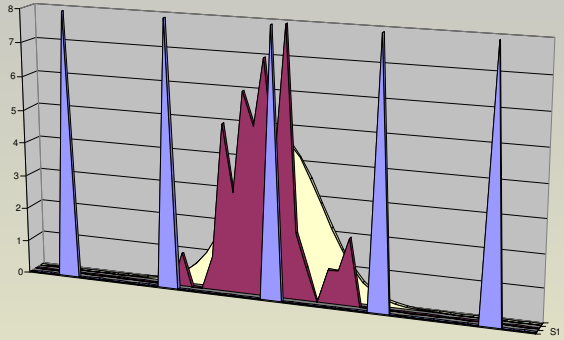
RMS (N,E,U) mm
2008,g, 1,janv,- 28,febr,

- Base station RIGA-1084 (IGS, EPN)

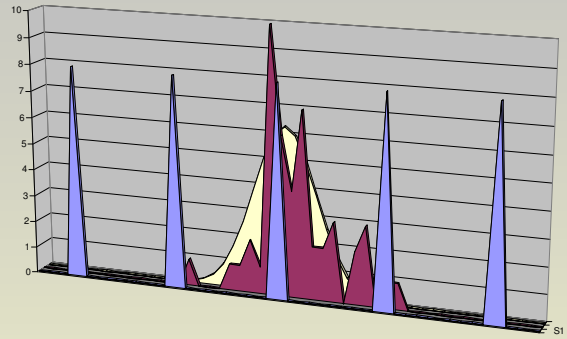
#	St,	X	Y	H
1	Ann	0,5	0,4	1.0
2	Kre	0,9	0,5	2.0
3	Lu	0,3	0,4	1.0
4	Msk	0,9	0,6	2.3
5	Van	0,8	0,8	2.2

Lu

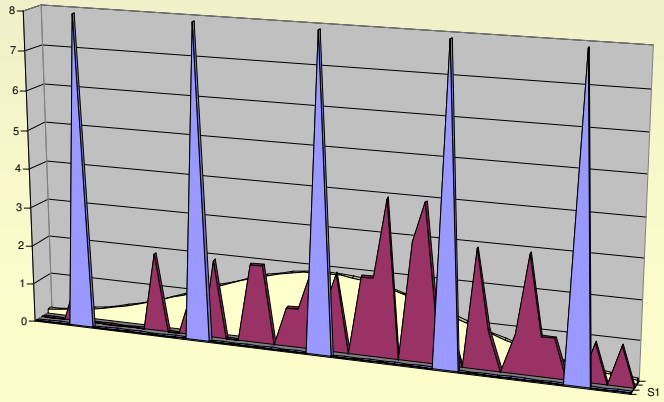
Lu (Northing) RMS= 0,3 mm



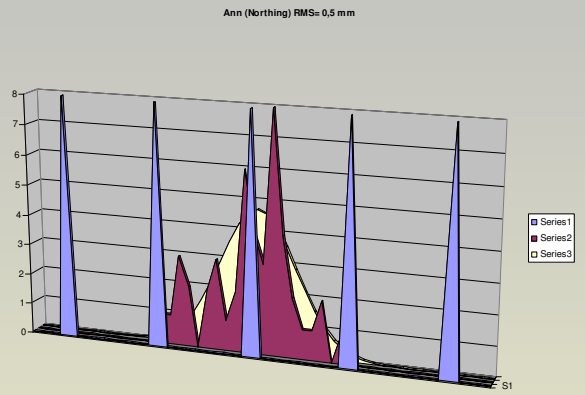
Lu (Easting) RMS= 0,4 mm

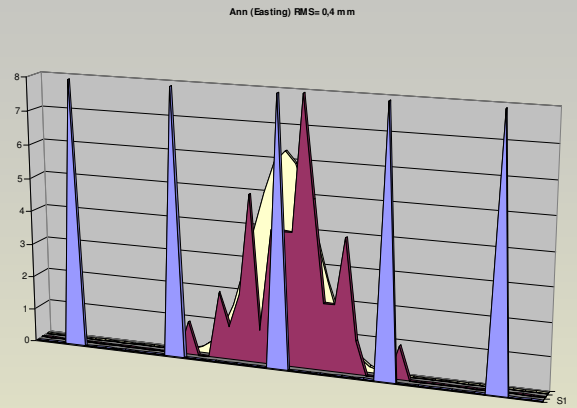


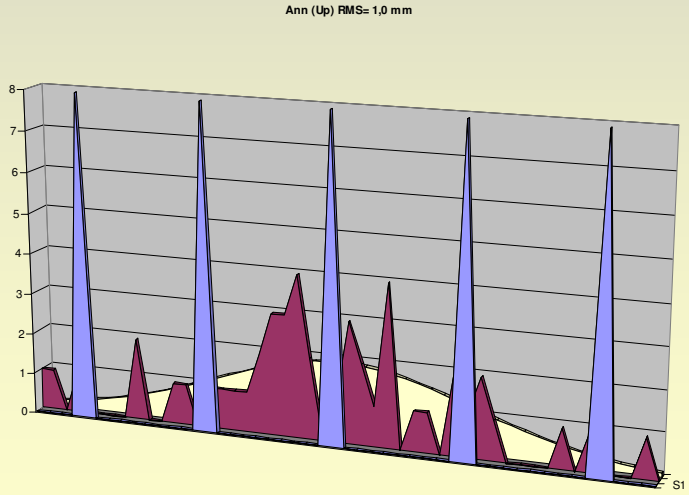
Lu (Up) RMS= 1,0 mm



Ann

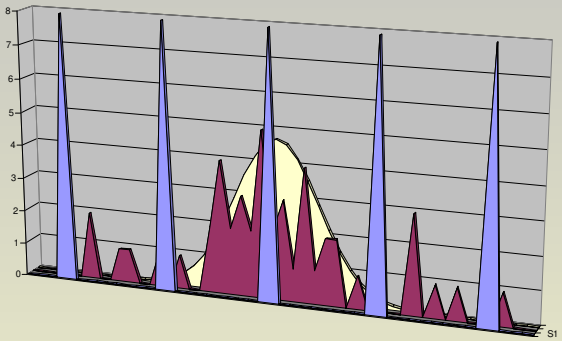

Ann (Northing) RMS= 0,5 mm
8
7
6
5
4
3
2
1
0
Series1
Series2
Series3
S1


Ann (Easting) RMS= 0,4 mm
8
7
6
5
4
3
2
1
0
S1

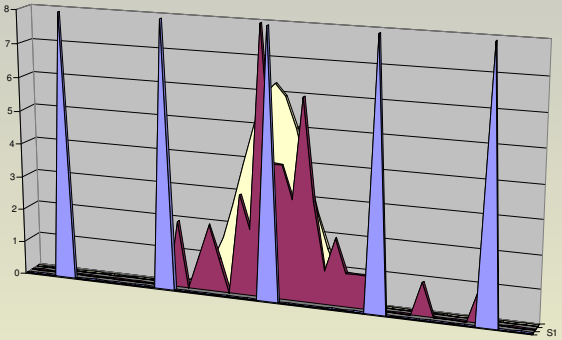

Ann (Up) RMS= 1,0 mm
8
7
6
5
4
3
2
1
0
S1

Kre

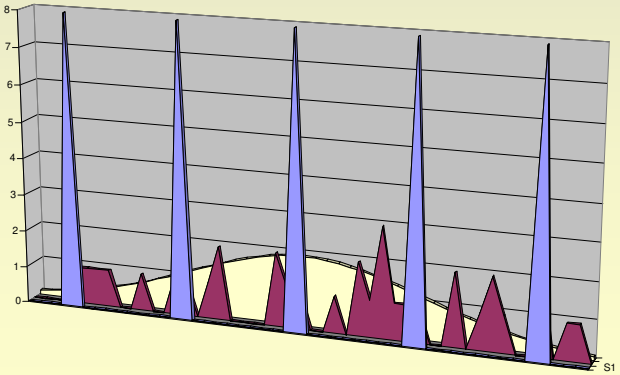
Kre (Northing) RMS= 0,9 mm



Kre (Easting) RMS= 0,5 MM

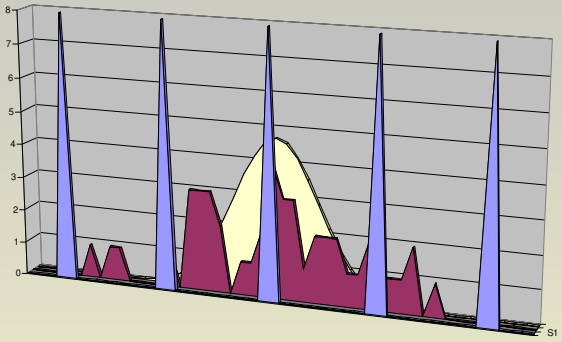


Kre (Up) RMS= 2,0 mm

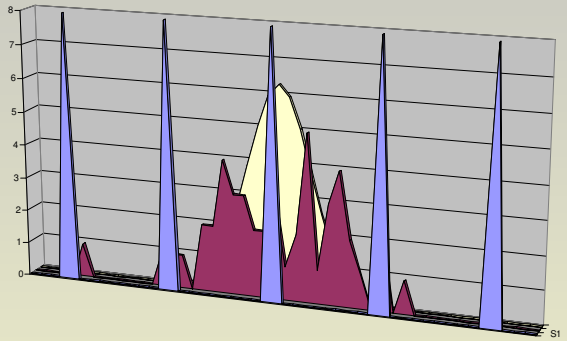


Msk

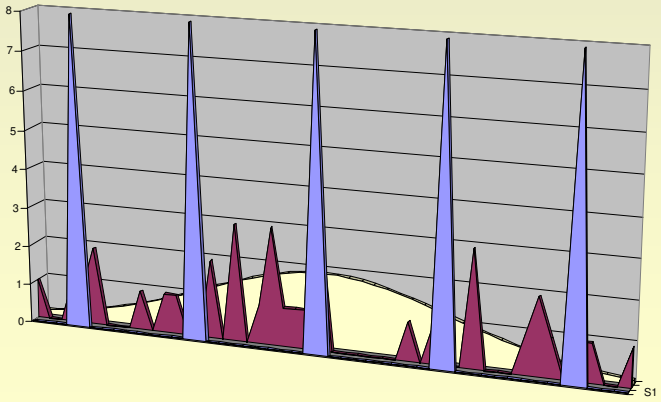
Msk (Northing) RMS= 0,9 mm



Msk (Easting) RMS= 0,6 mm

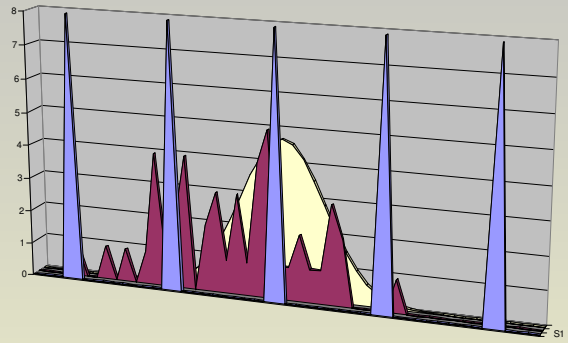


Msk (Up) RMS= 2,3 mm

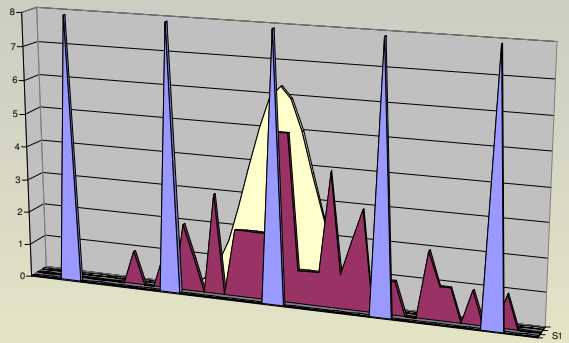


Van

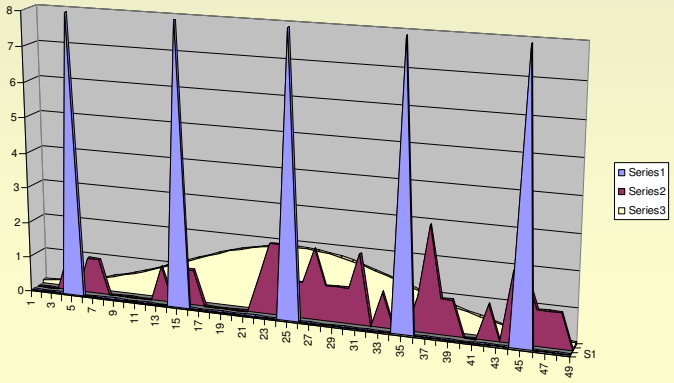
Van (Northing) RMS= 0,8 mm



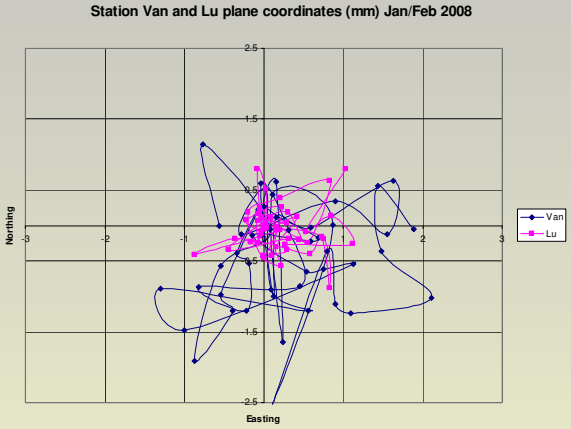
Van (Easting) RMS= 0,8 mm

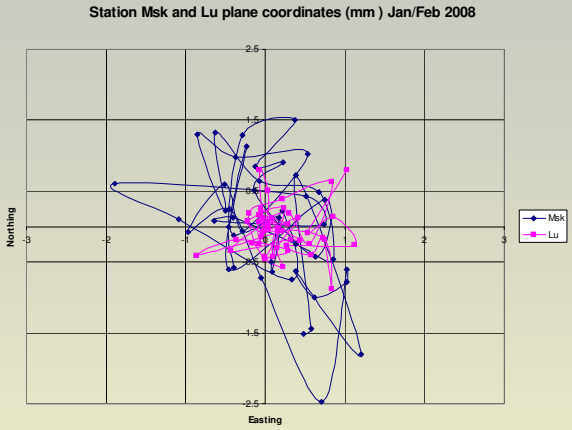


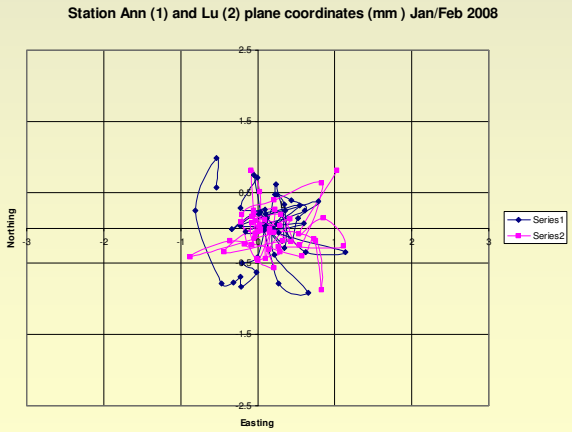
Van (Up) RMS= 2,2 mm

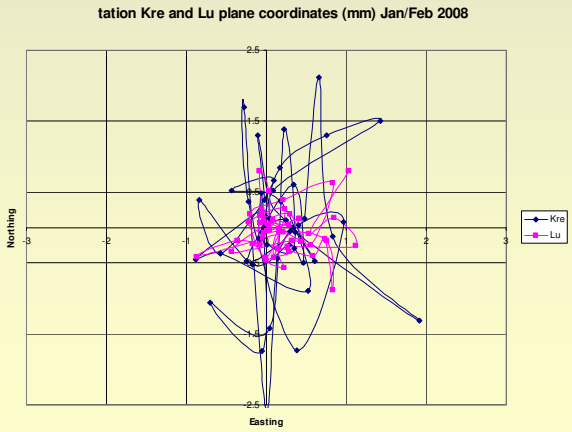


Ann, Kre, Msk, East vs. Lu





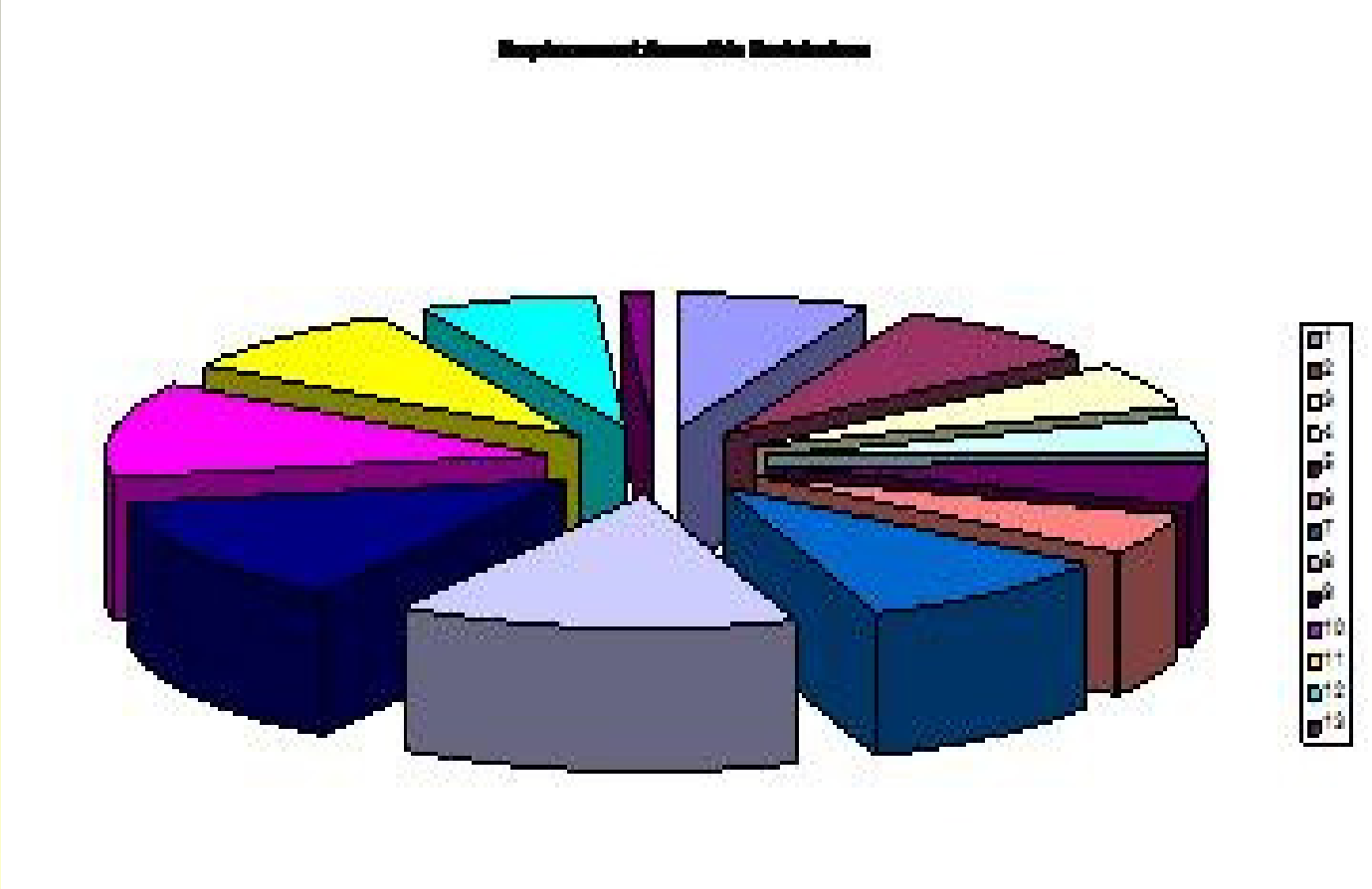




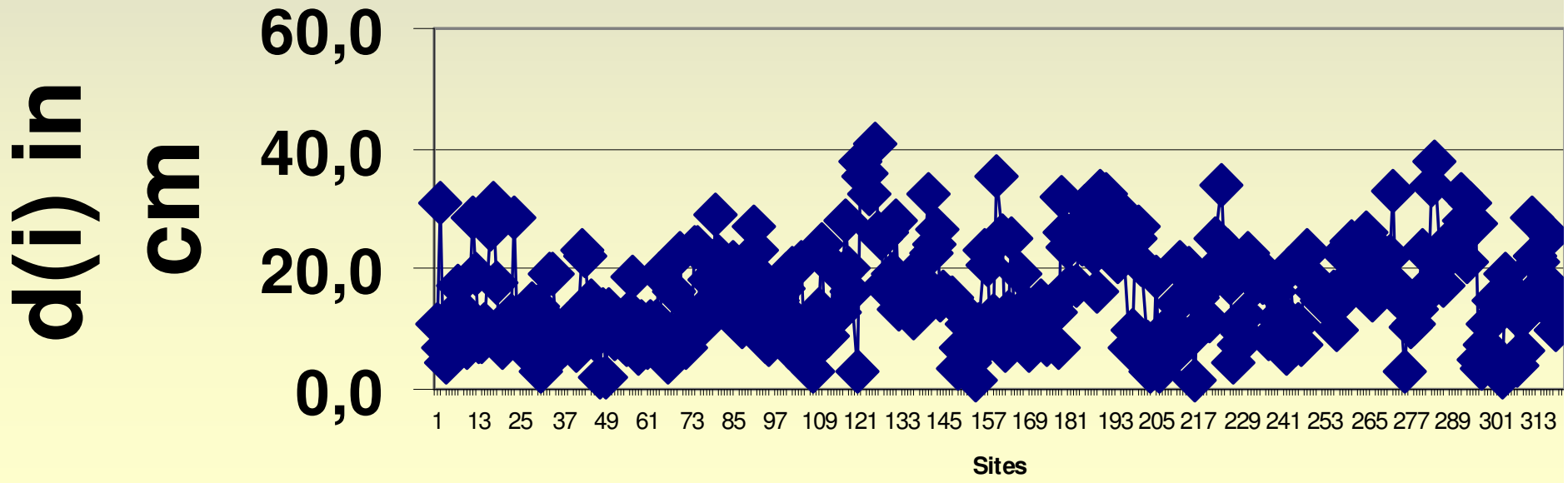
Mapping control

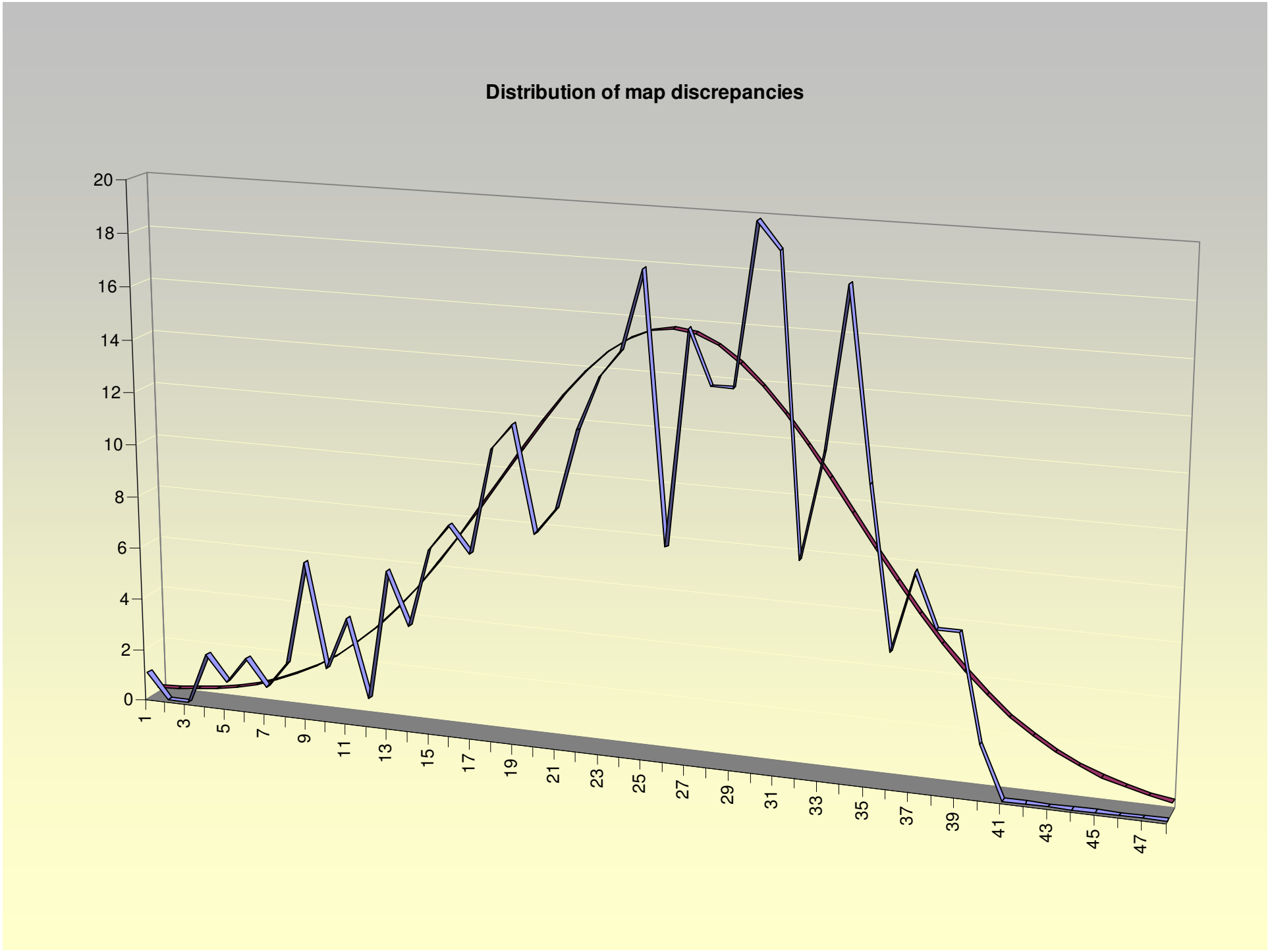
- Static survey in 337 sites with 3 ref.st.for each
- Trimble R8 (L1,L2,L2C.L5), static 7-10min, postprocessing, RMS HOR 0.80cm, ELEV 1.02cm
- Results of GNSS static survey - reliable
- Map discrepancies: Average 15.9 cm
- STDV 8.1 cm (excluded outliers)
- T-test for normal distribution of map discrepancies control 0.952

Azimuth 30° steps

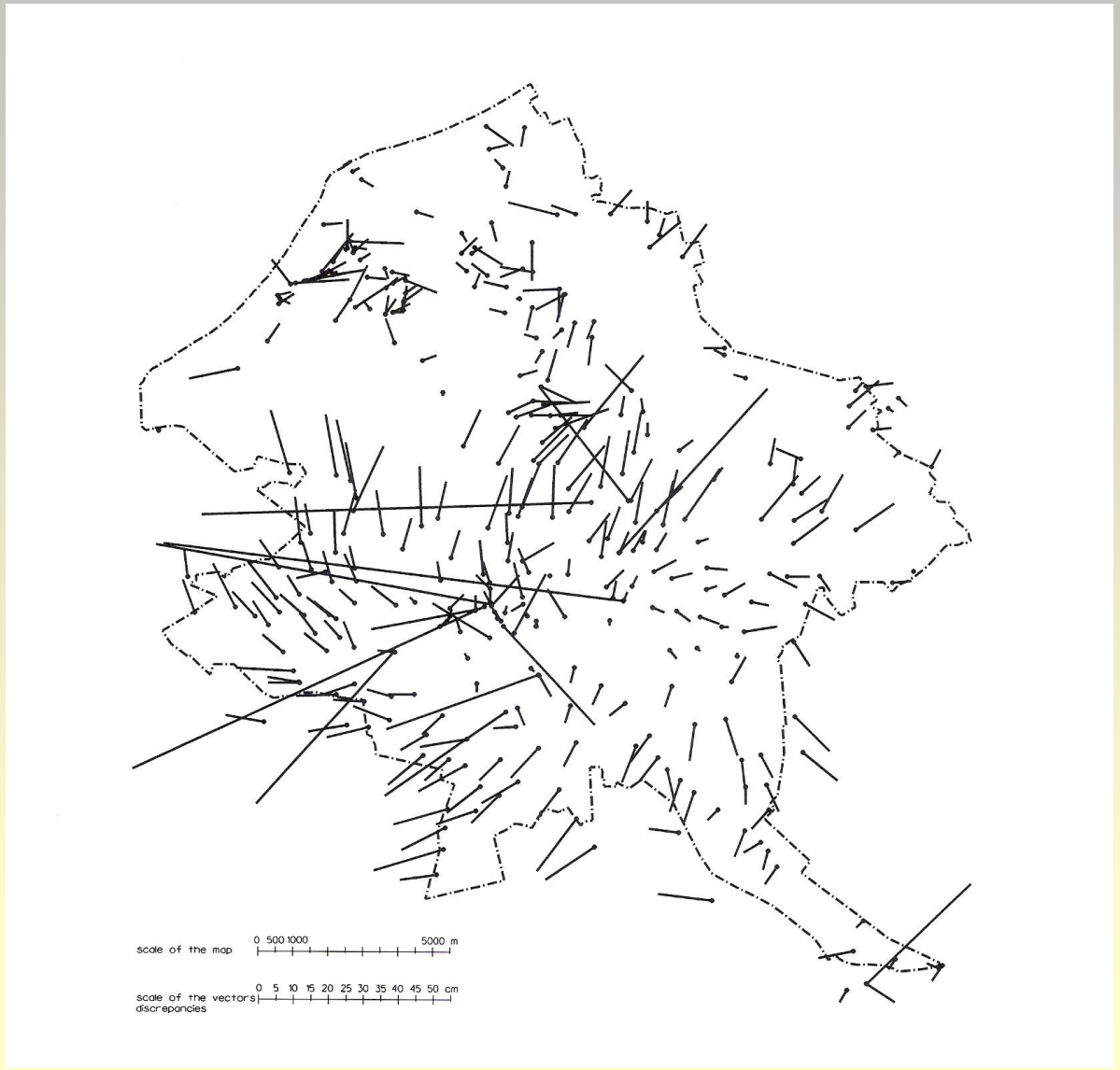


Distribution of discrepacy value d(i)




Distribution of map discrepancies
20
18
16
14
12
10
8
6
4
2
0
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
35
37
39
41
43
45
47

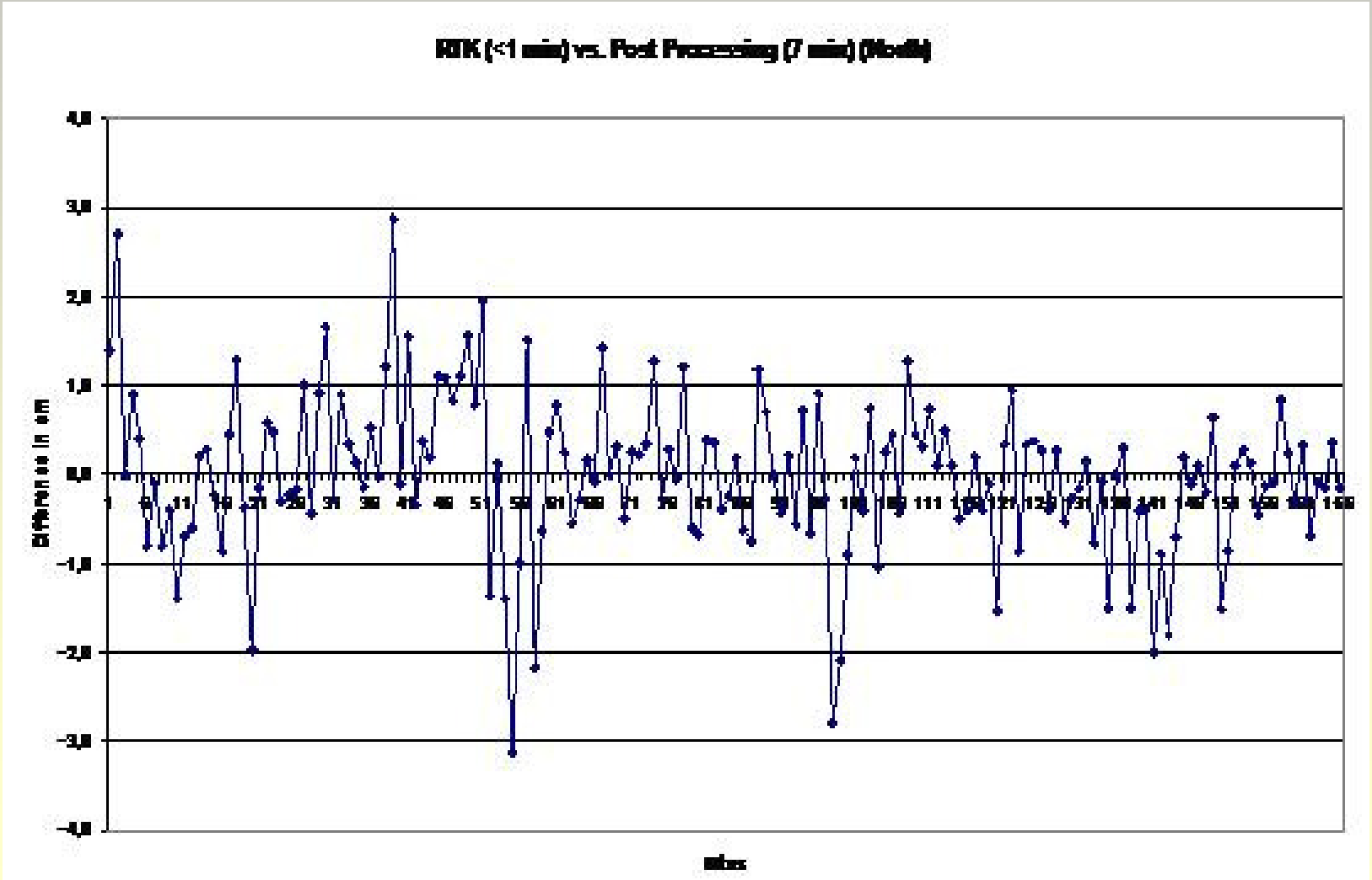
Discrepancies on the ortophoto map



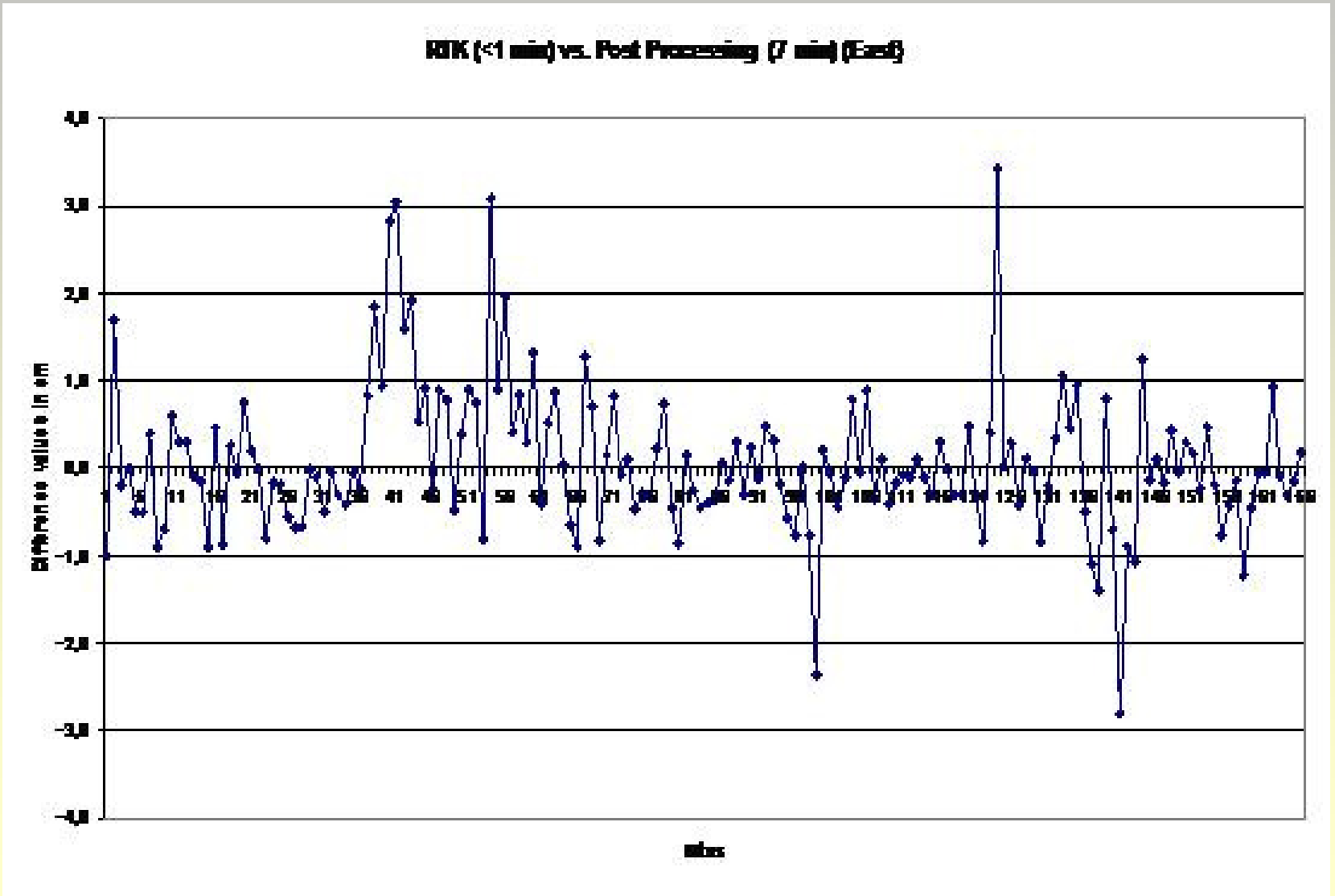
RTK precision control

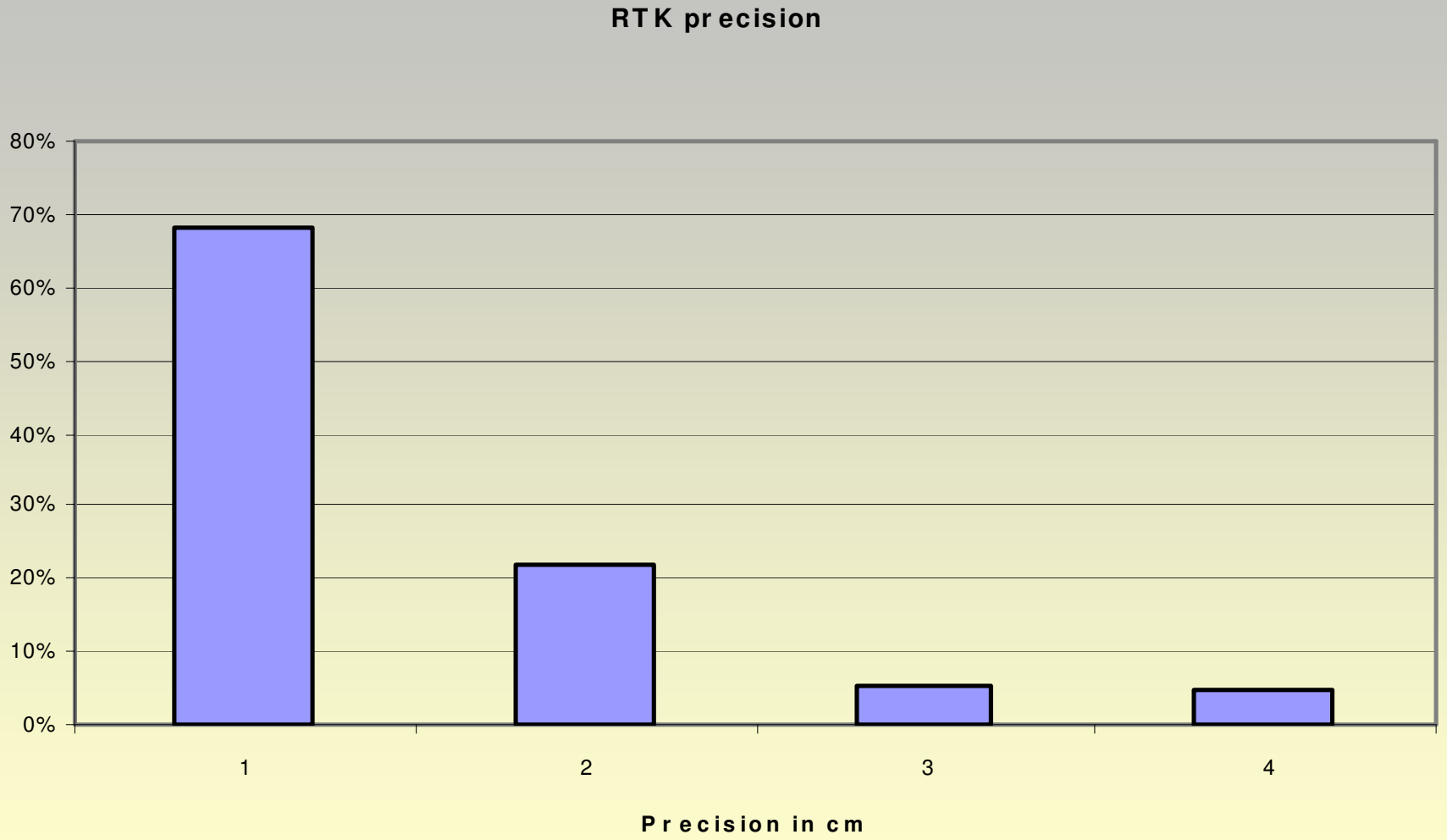
- RTK survey in 166 sites, Geo++ network solution, GPS and GLONASS
- Trimble R8 (L1,L2,L2C.L5), RTK 5-10 sec, average discrepancy vs. static 0.95cm, STDV 0.77cm
- EUPOS-RIGA and RTK survey are applicable for ortophoto map quality control

RTK (<**1min**) vs. static (>7min) (North)



RTK (<1min) vs. static (>7min) (East)




RTK precision
80%
70%
60%
50%
40%
30%
20%
10%
0%
1
2
3
4
Precision in cm

European Space Agency (ESA)

- **Project *"EUPOS® Contribution to GOCE Mission"* accepted**

  4 March 2007. Id 4307

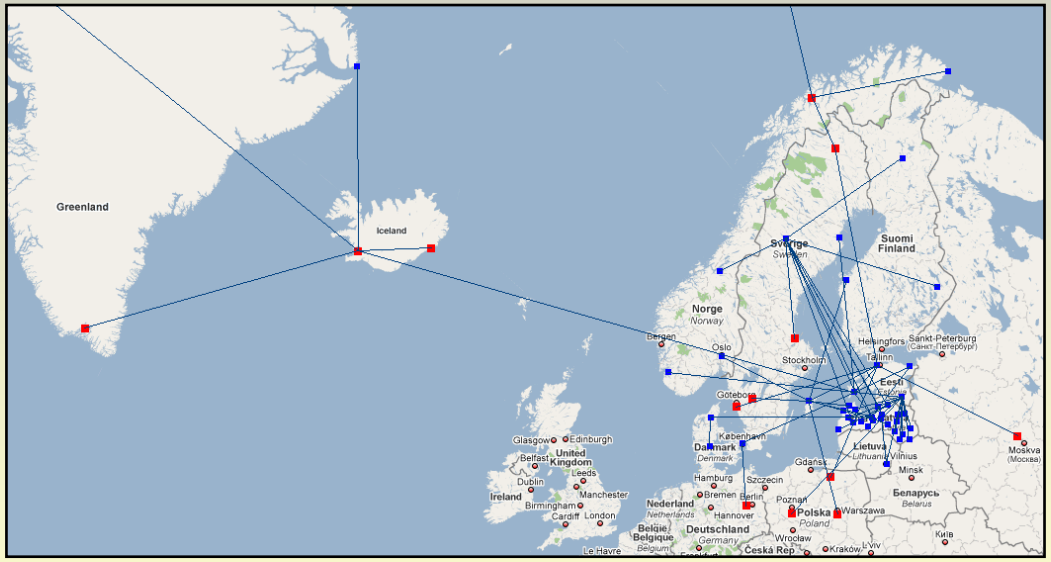
- **Partners: Berlin, Hungary, Czech Republic, Slovakia, Ukraine (GPS and SLR), Estonia, Latvia, Lithuania, Riga, Bosnia and Herzegovina, Bulgaria, Romania**

- **Principal Investigator: Janis Balodis (Latvia)**

University of Latvia
Institute of Geodesy and Geoinformation
Janis Balodis
22.03.2010

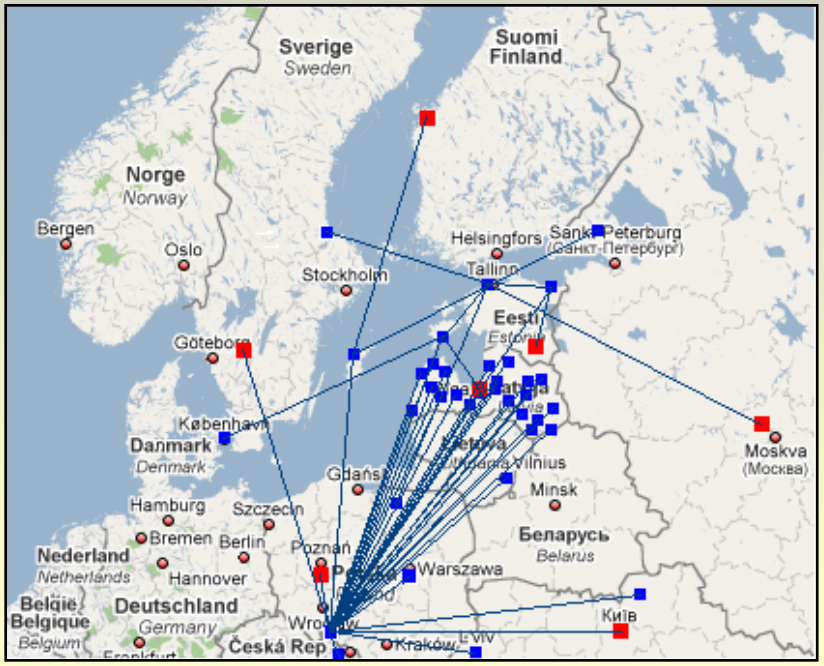
S_N
Nordic solution

Nordic NKG2008 solution with all required stations included
LATPOS and ***EUPOS®-RIGA*** has been calculated



S_M
Mid-Europe solution

Solution with evenly distributed base stations
LATPOS and ***EUPOS®-RIGA*** has been calculated

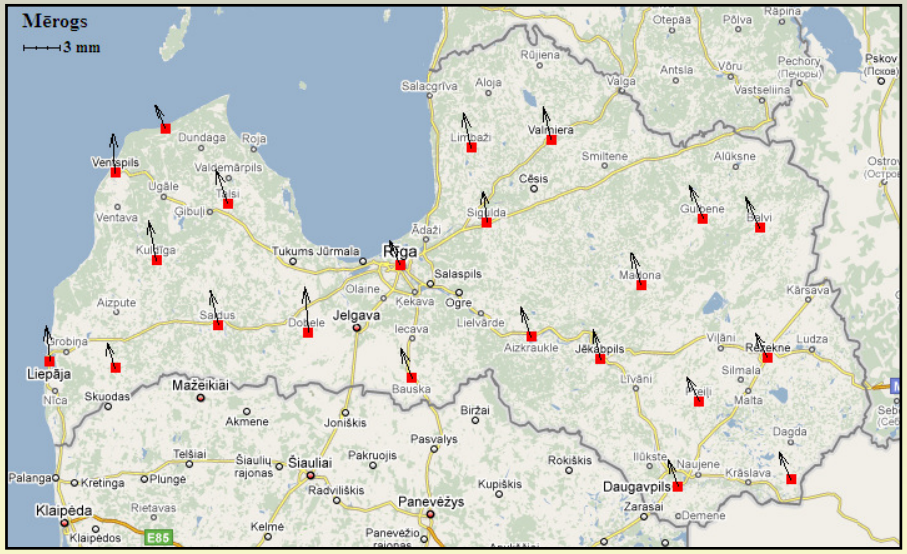


Red squares meaning the base stations
Blue lines show the baselines automatically selected by Bernese software
OBS-MAX baseline strategy for day 272 year 2008

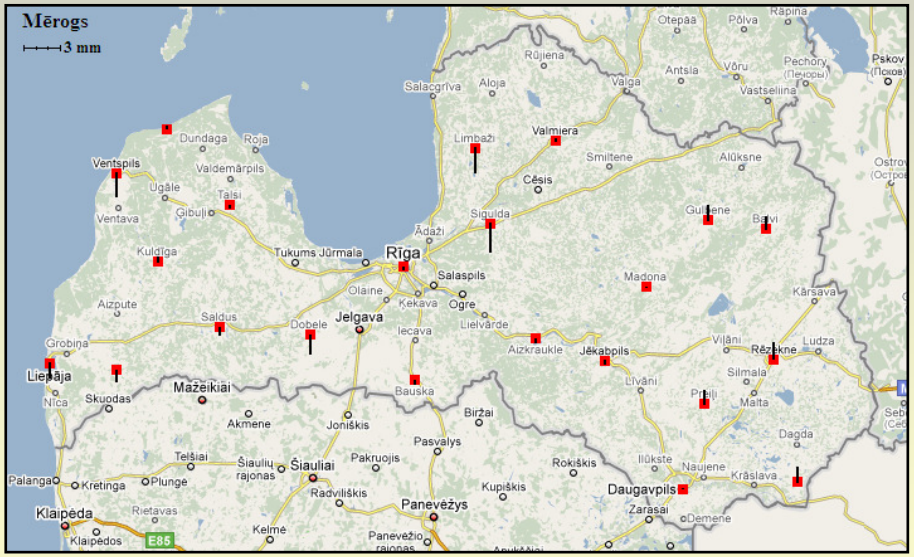
University of Latvia
Institute of Geodesy and Geoinformation
Janis Balodis
22.03.2010

Network effect

Horizontal position



Vertical position



University of Latvia
Institute of Geodesy and Geoinformation
Janis Balodis
22.03.2010

Levelling for EUPOS-RIGA antenna height contro

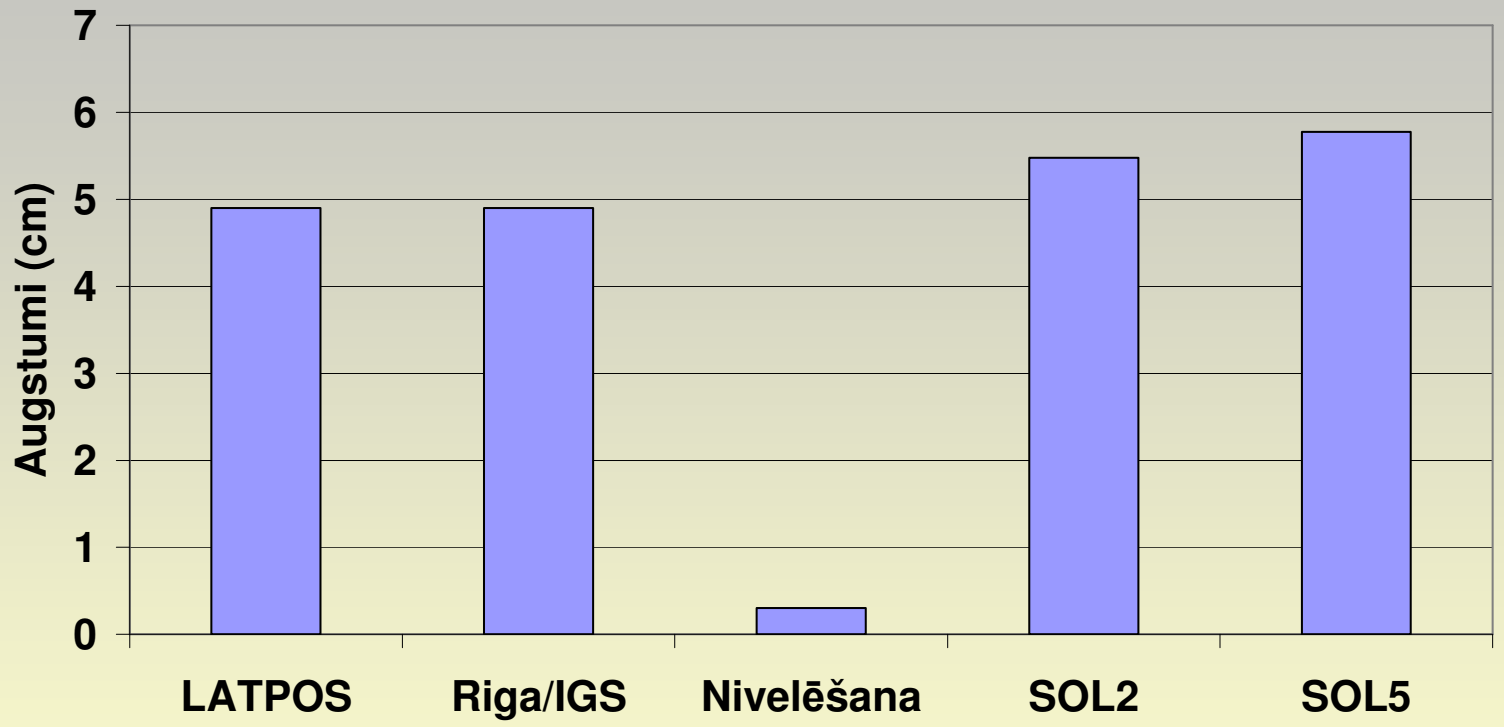
Levelled height trigonometric transfer to EUPOS-RIGA antenna

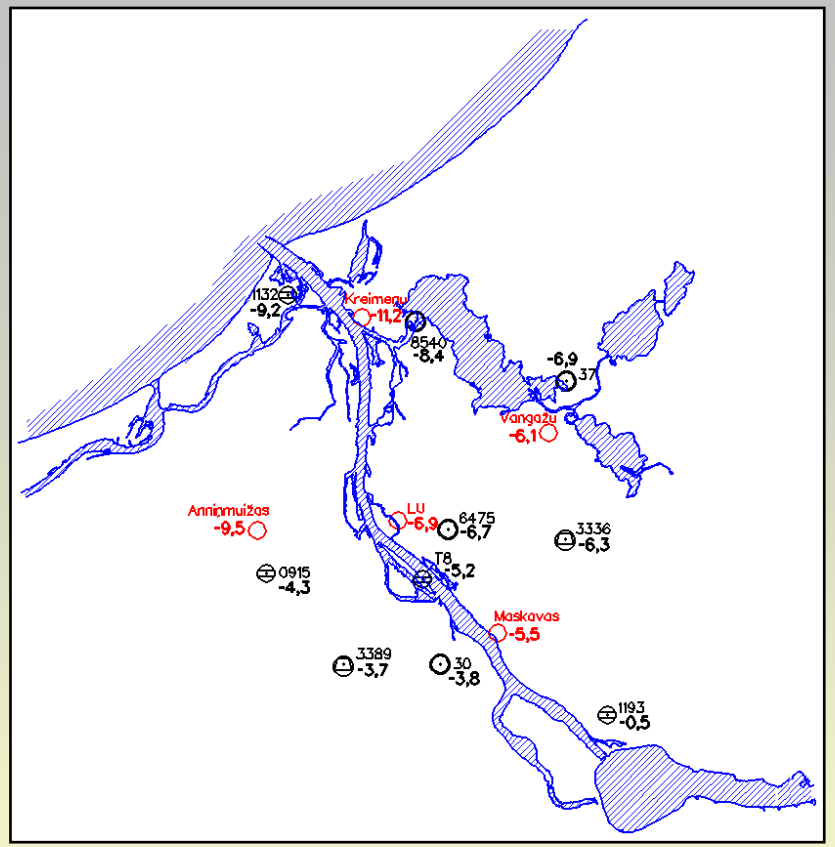
Augstumu no precīzi nivelētiem punktiem pārnesti ar trigonometrisko metodi uz jumta plakni

Augstums noteikts no vismaz 2 – 3 ģeometriski nivelētiem punktiem

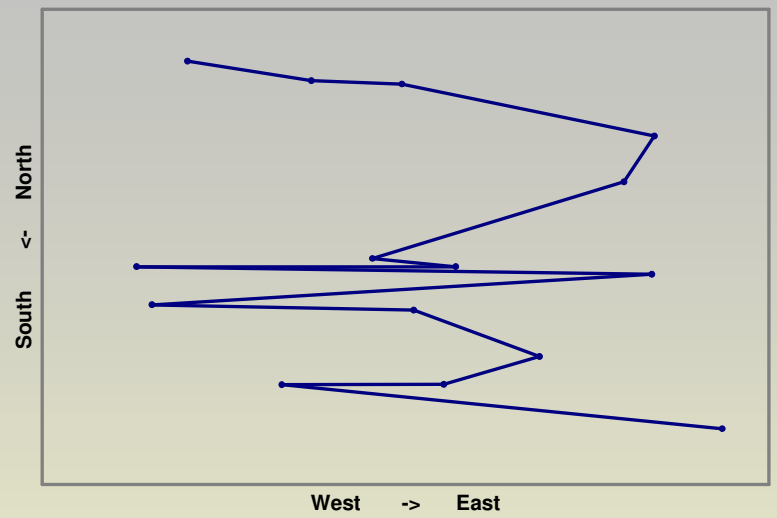
Mērījumi veikti ar atkārtotu pilna paņēmiena metodi

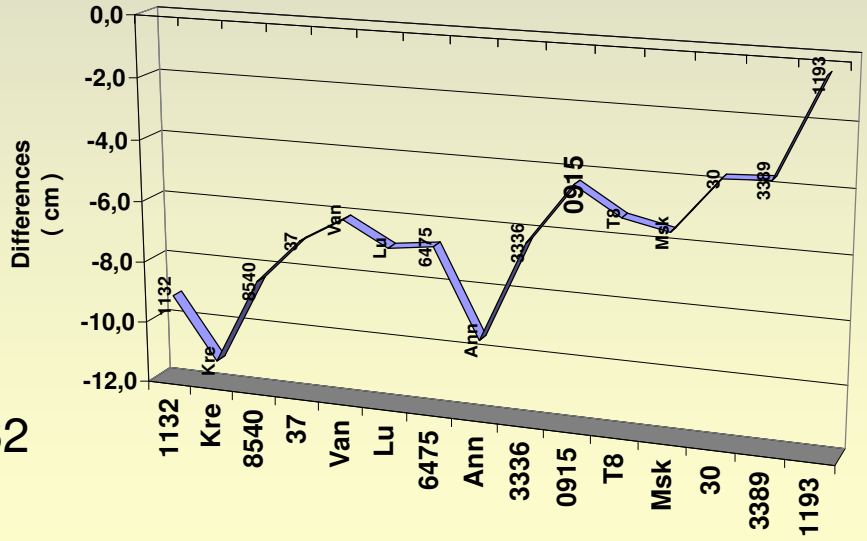
Lu (centrā)





Arrangement Z -> D





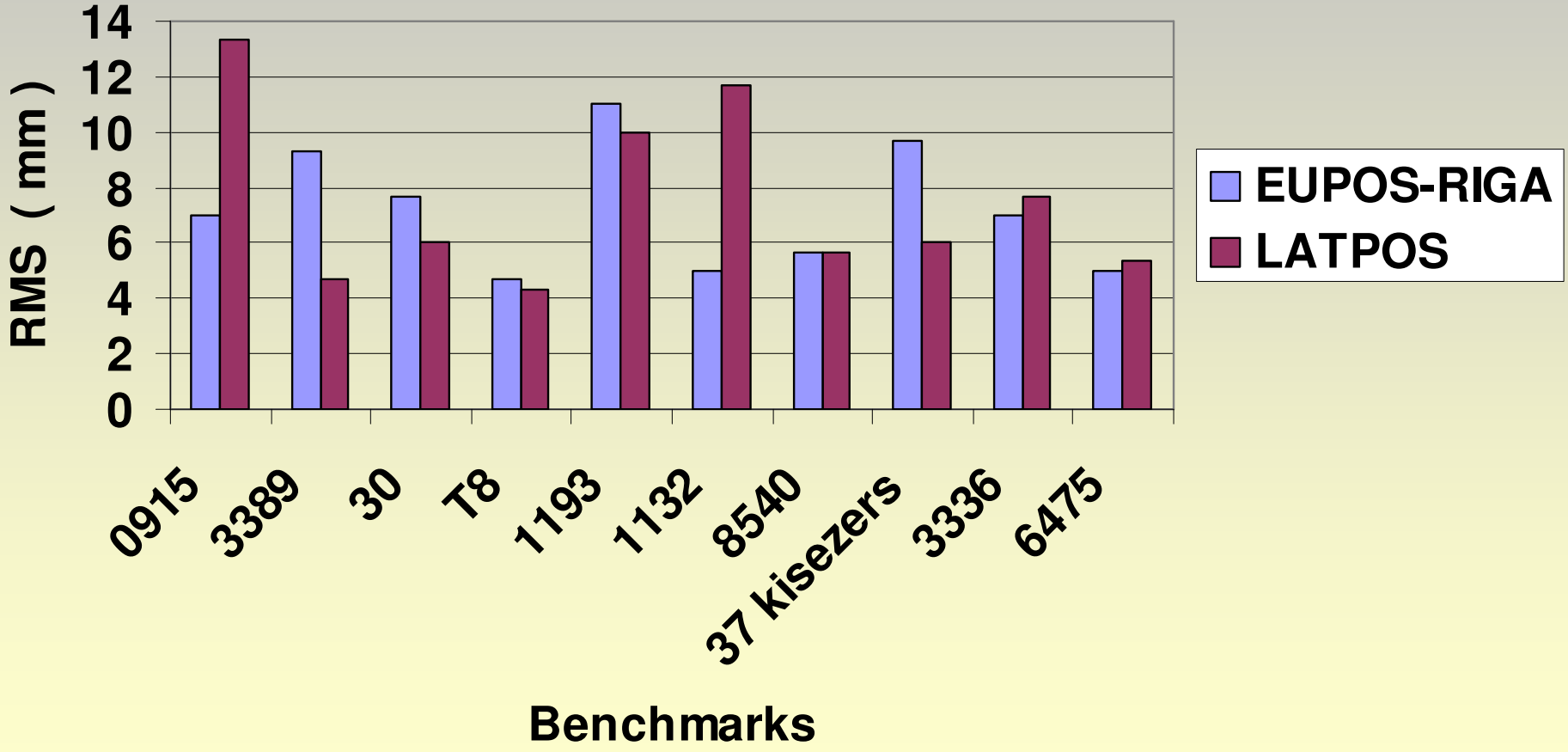
Epoch precision and reliability

Rp 0915 one measurement RMS=1,8 cm (62 measurements)

result RMS=2,3 mm

University of Latvia
Institute of Geodesy and Geoinformation
Janis Balodis
22.03.2010

RMS of height determination (mm)



EUPOS Combination Centre

The main task of the ECC is the combination of the weekly national ***EUPOS®*** SINEX solutions into a single weekly EUPOS solution (Ambrus Kenyeres, 2009)

This activity is analogous to the EPN data analysis and combination approach, and the ***EUPOS®*** **combined solution may be regarded as the densification of the EPN, namely the further densification of the actual ETRS89 realization.**

The EPN analysis standards should also be followed, therefore ECC can only handle SINEX solutions computed by a scientific, post-processing software package.

University of Latvia
Institute of Geodesy and Geoinformation
Janis Balodis
22.03.2010

European Space Agency (ESA)

GOCE Observations Using SLR for LEO Satellites

ID: 4333

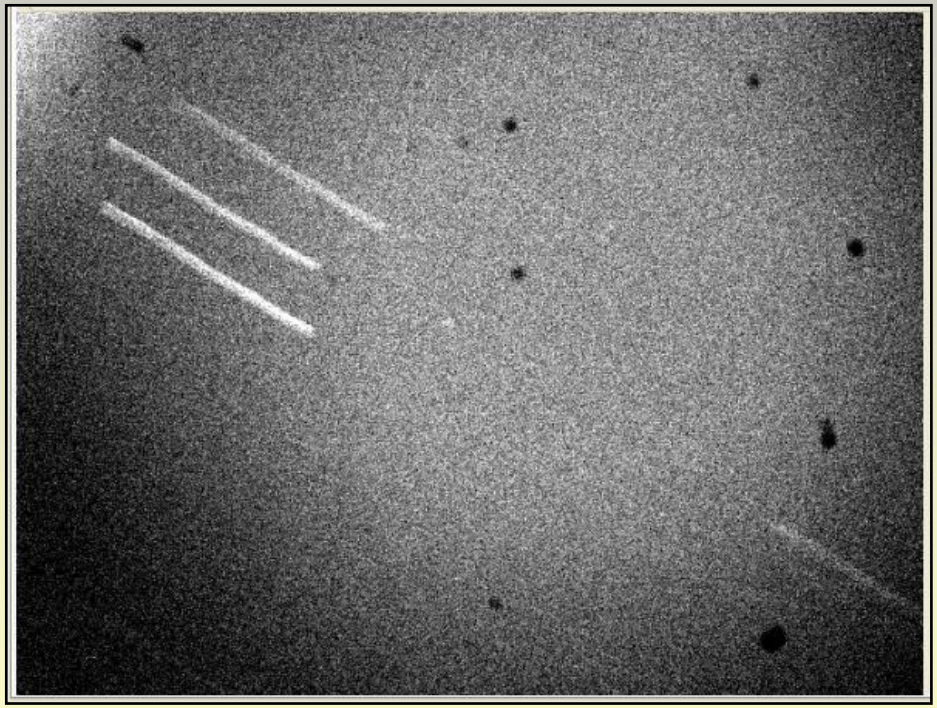
University of Latvia
Institute of Geodesy and Geoinformation
Janis Balodis
22.03.2010

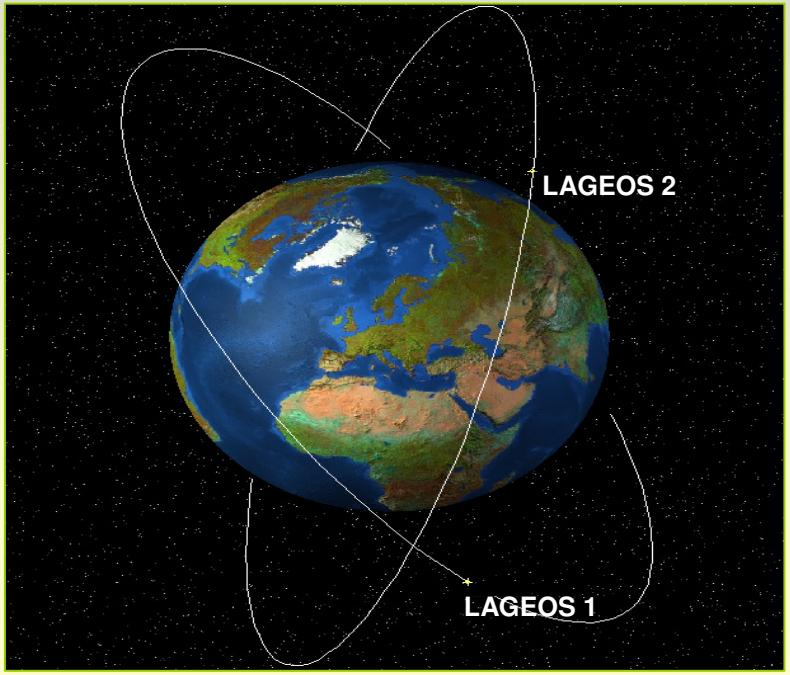
2. Project ESA Id 4333

University of Latvia
Institute of Geodesy and Geoinformation
Janis Balodis
22.03.2010

2. Project ESA Id 4333

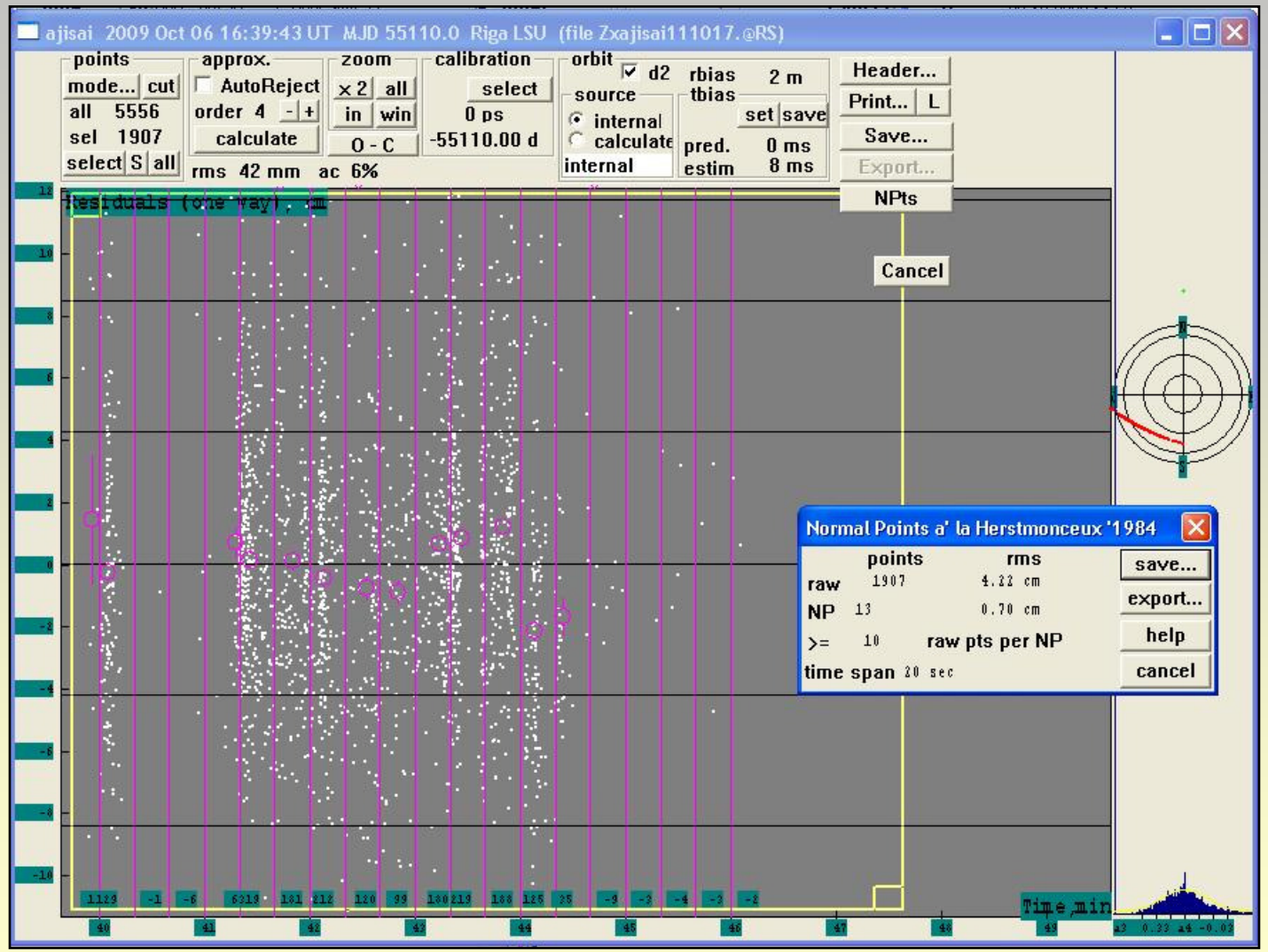
LAGEOS visible in SLR telescope guide
at a distance of 7000 km





University of Latvia
Institute of Geodesy and Geoinformation
Janis Balodis
22.03.2010

2. Project ESA Id 4333



University of Latvia
Institute of Geodesy and Geoinformation
Janis Balodis

22.03.2010

Geoinformation

2D geographical databases

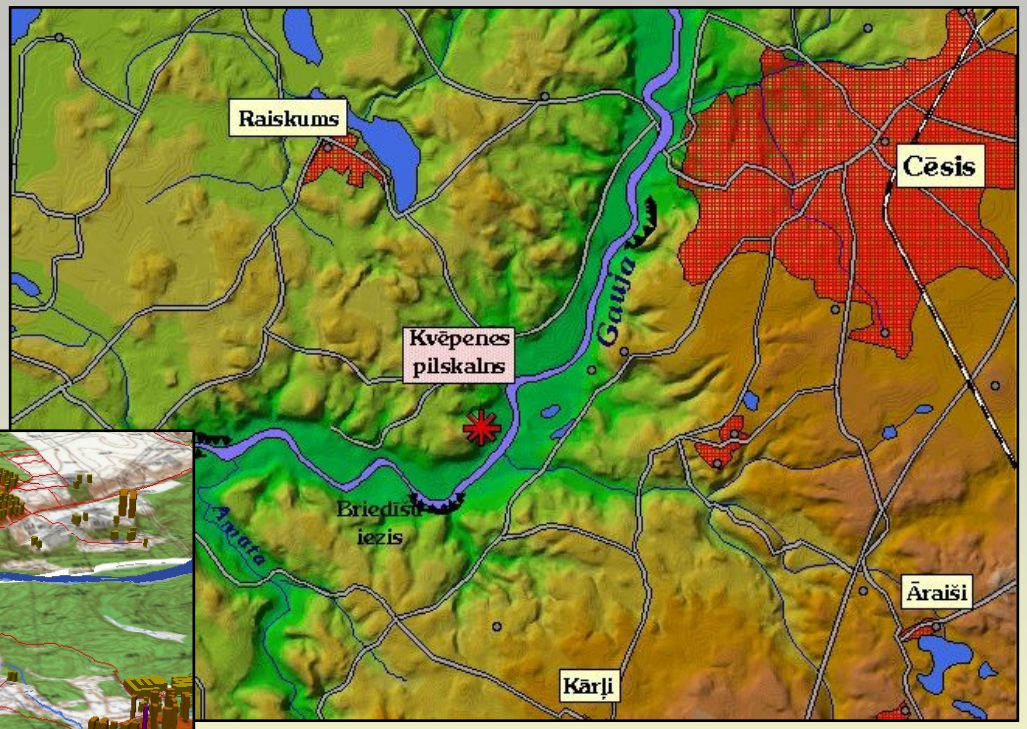
digital overview map of Latvia – database with 11 thematic layers, scale 1: 200 000

geographical database of Riga city – database with 6 thematic layers, scale 1: 5 000

University of Latvia
Institute of Geodesy and Geoinformation
Janis Balodis
22.03.2010

3D geographical databases

digital terrain model of Latvia
(raster size – 500 m, 200 m, 100m, 50m, 25m)
digital elevation models of Riga and other cities: terrain,
buildings, vegetation
(raster size – 10m or 5m)



University of Latvia
Institute of Geodesy and Geoinformation
Janis Balodis
22.03.2010

CONCLUSION

- **GNSS and its use for positioning, navigation and timing has optimised a lot of applications in many sectors of industry:**
- **Transport and logistics, geodesy and land surveying, high precision agriculture, GIS, security (GMES), limitless field of location based services (LBS)**
- ***EUPOS®* discovers a capability to reach the highest accuracy in GNSS innovations and applications**
- **Convergence of communication, navigation and geo-information is a wide field for research and innovations in national and international level**

THANK YOU

University of Latvia
Institute of Geodesy and Geoinformation
Janis Balodis
22.03.2010