On the Height Component for GNSS Positioning

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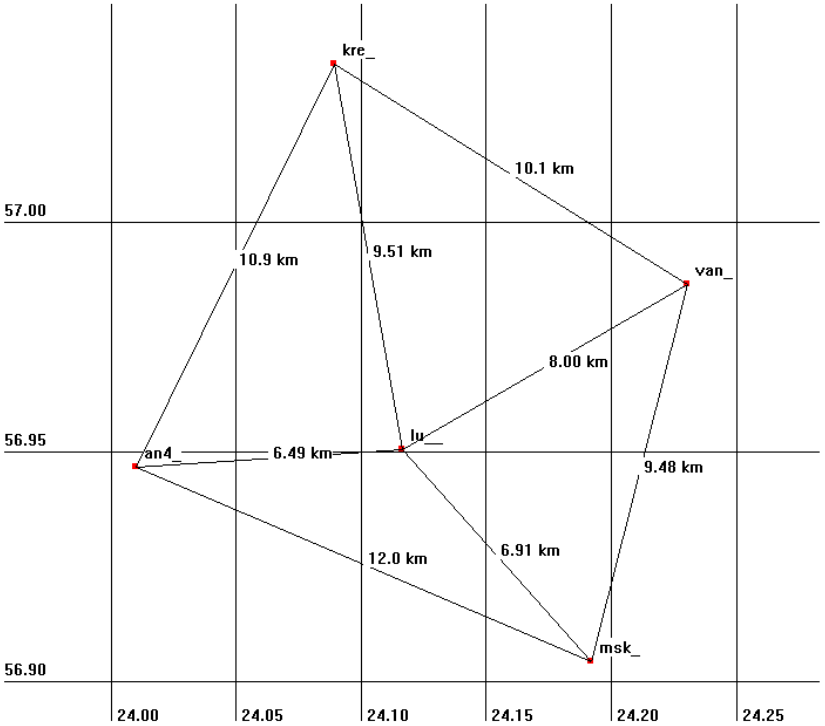
Overview

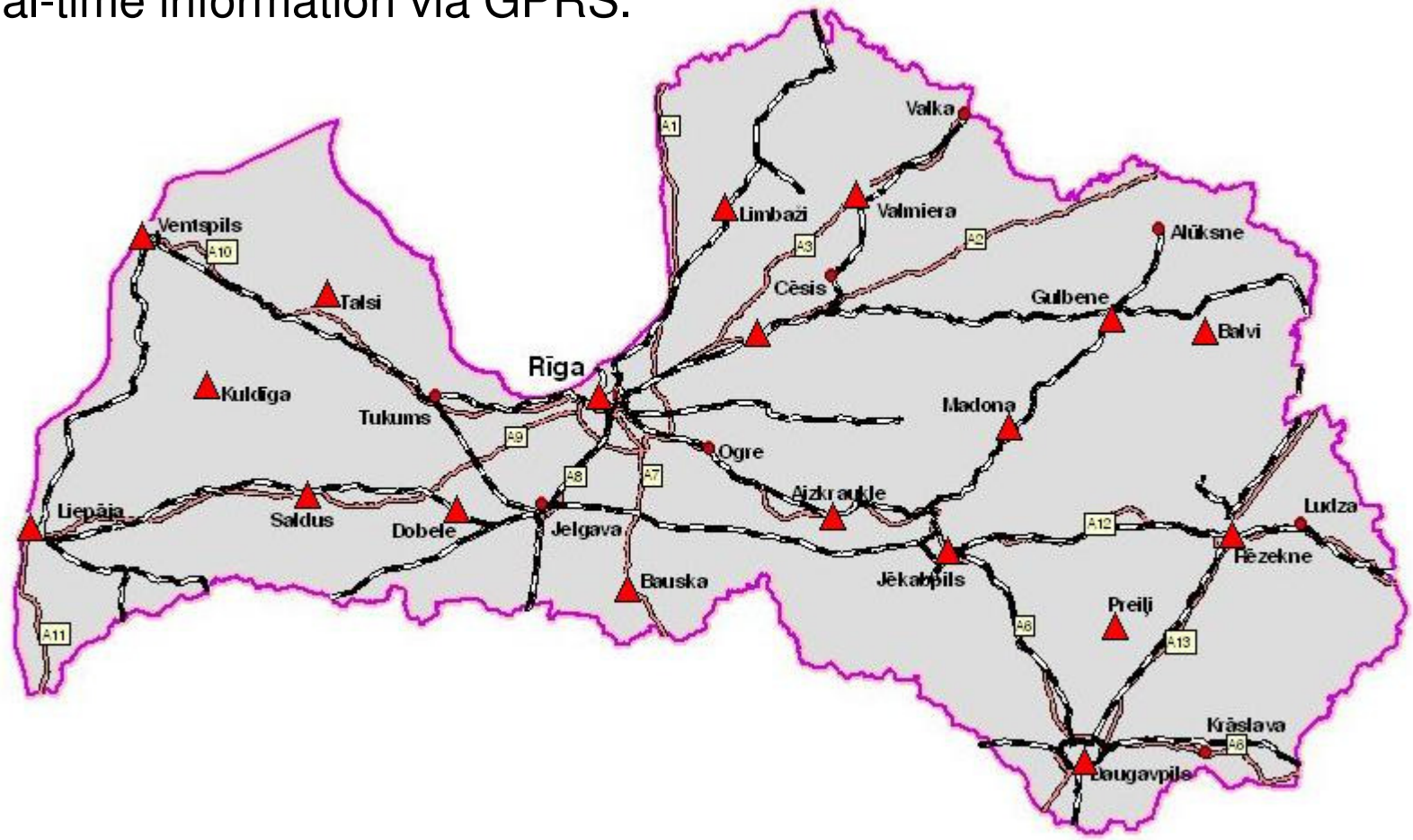
- **2 sets: Reference stations and “Rover” stations**
- **Station coordinate time series**
- **RTK measuring methods for height determination**
- **Conclusion**

GNSS stations in Riga: RIGA1884, OJAR (LATPOS) and EUPOS®-RIGA network

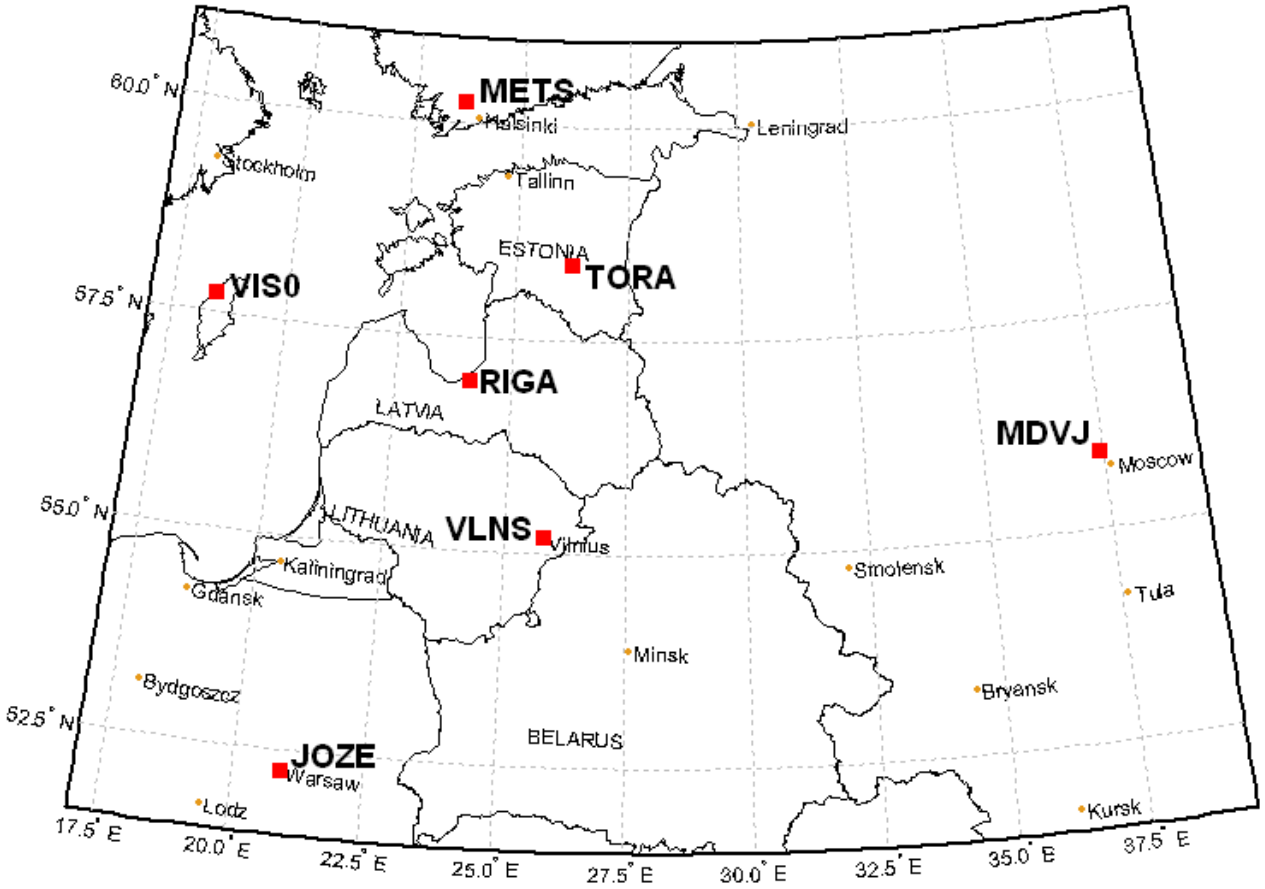


LATPOS

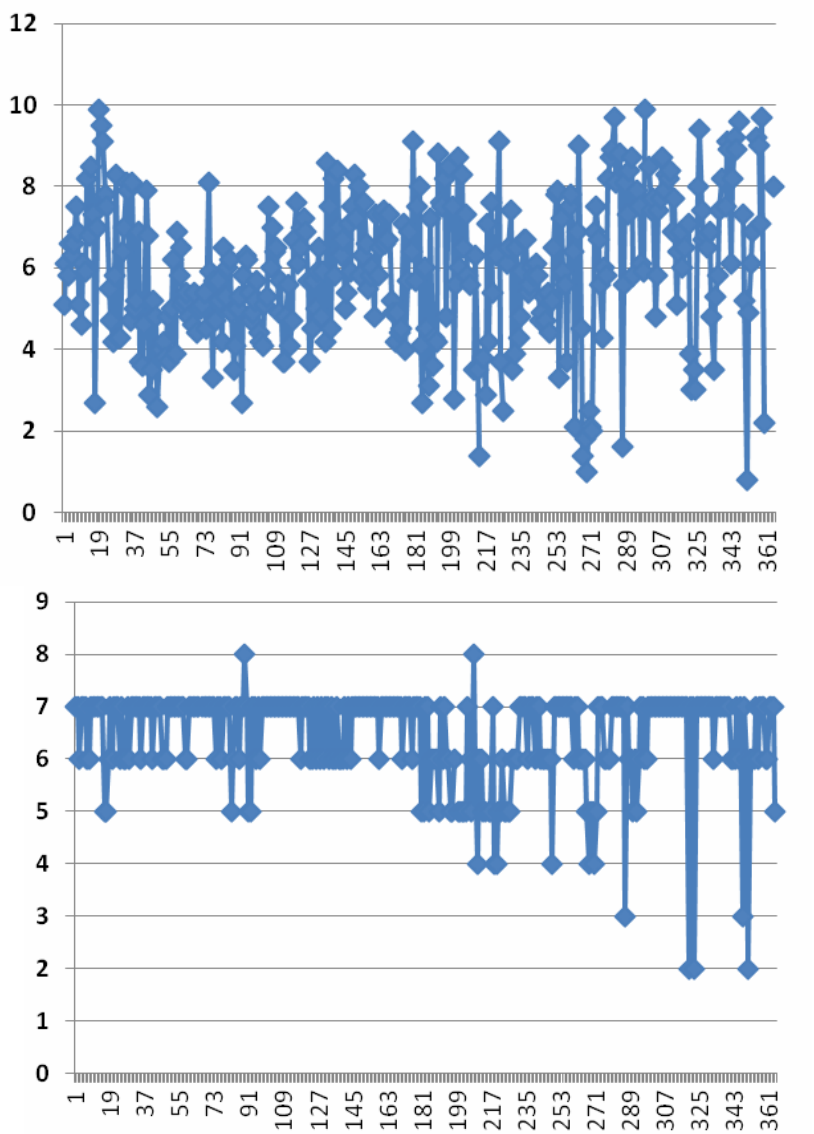
23 base stations within territory of Republic of Latvia. Base stations are sending information to service center in Riga. LATPOS users receive real-time information via GPRS.



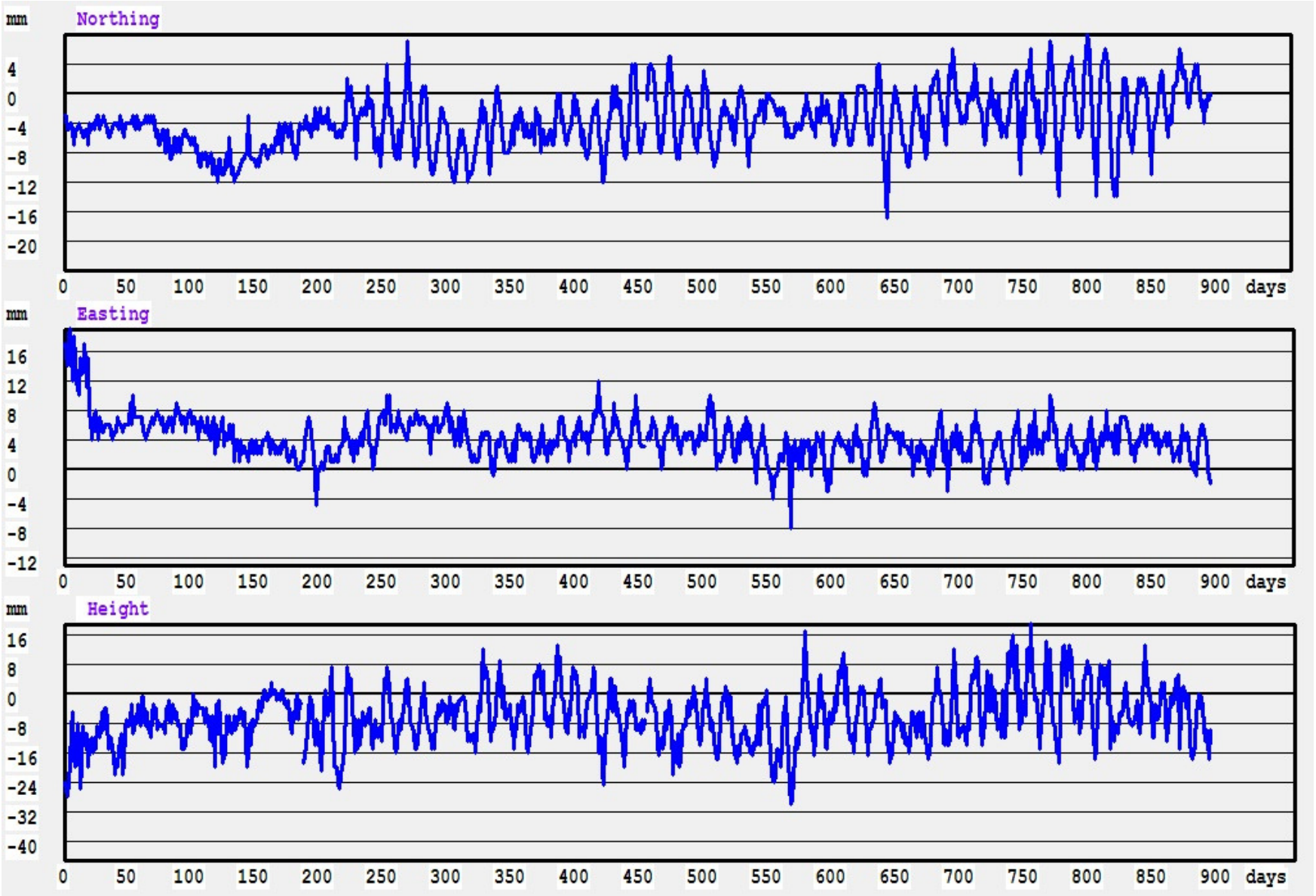
Reference stations



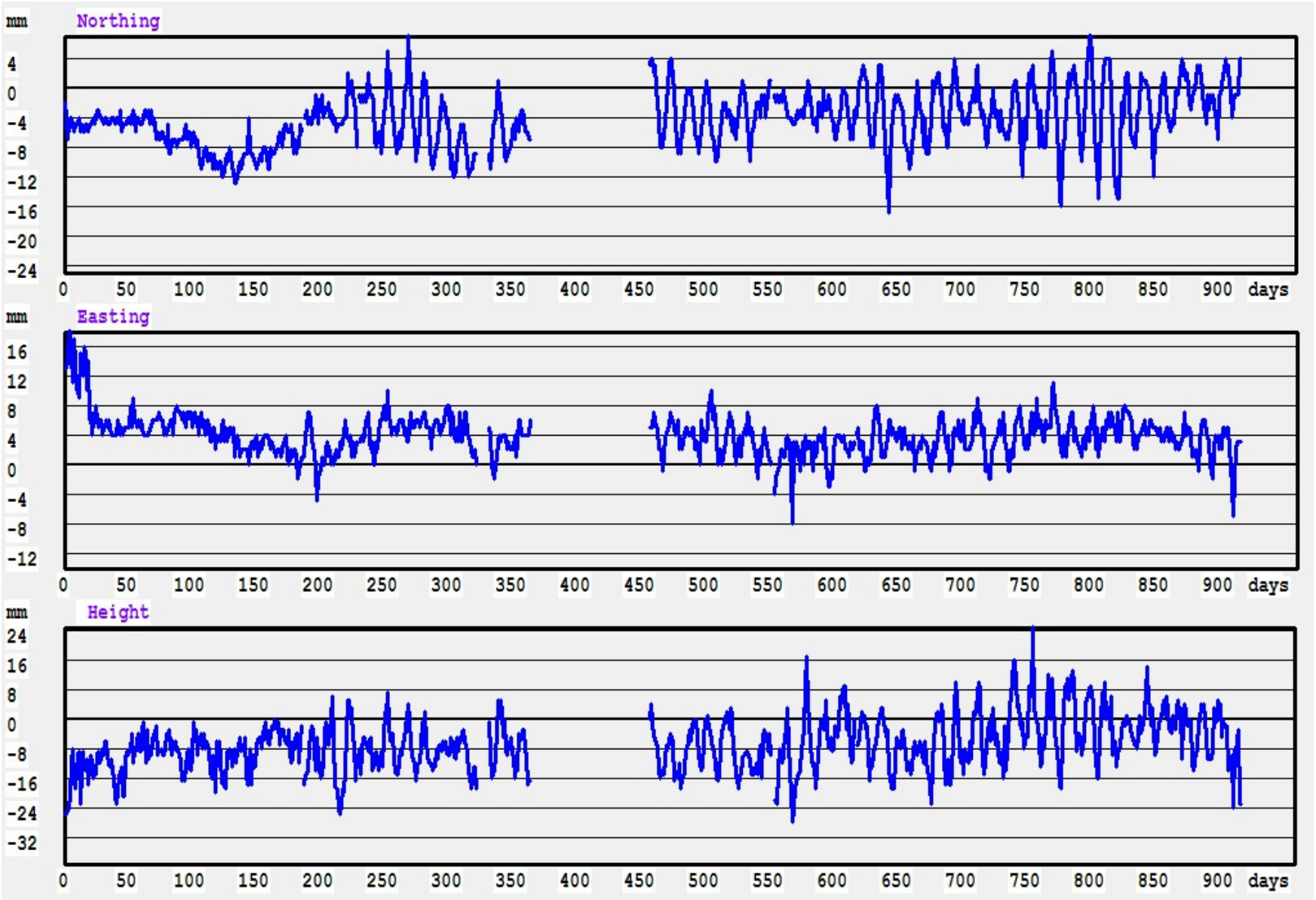
Transformation RMS and number of reference stations in Y2010 solutions



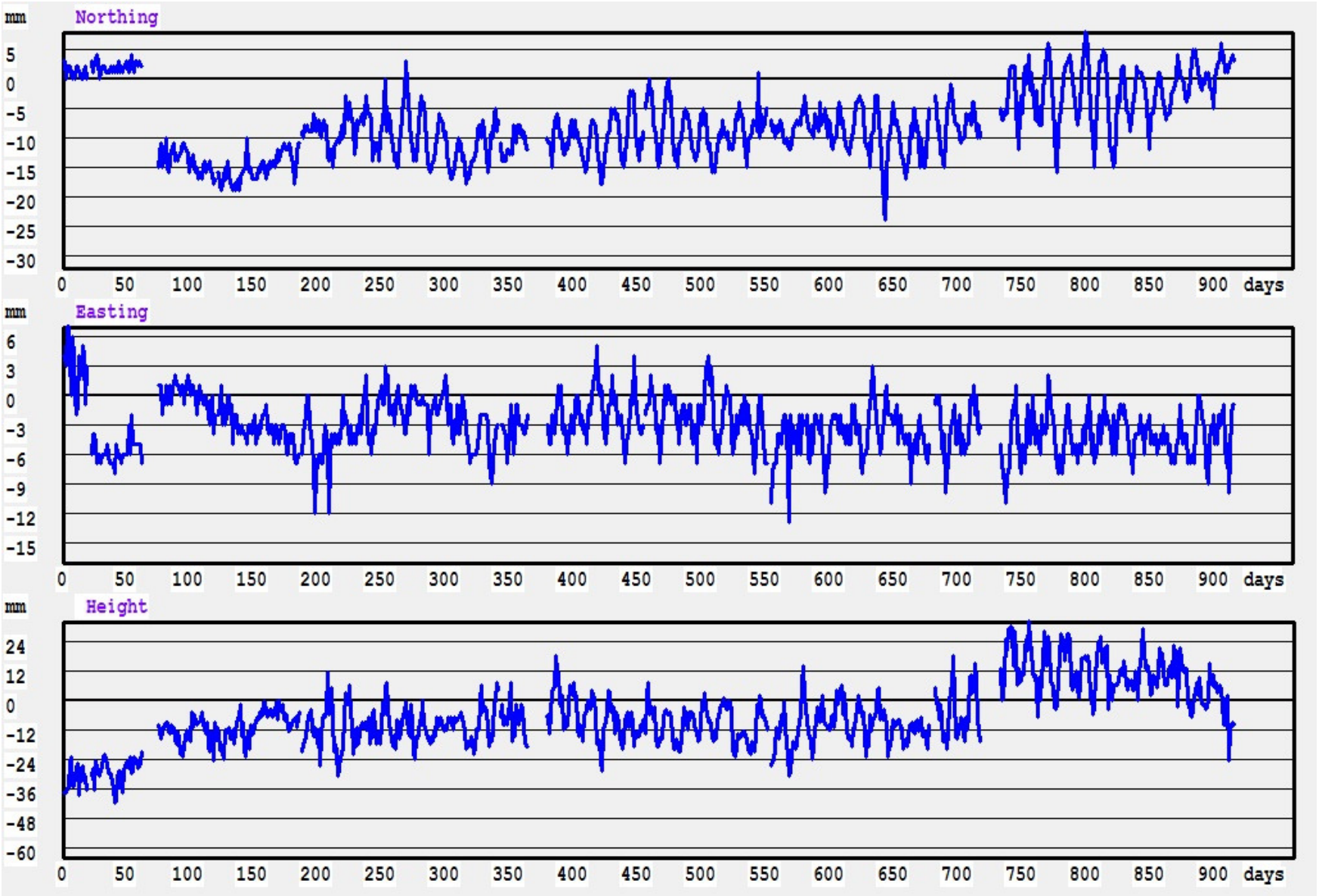
EPN/IGS STATION RIGA

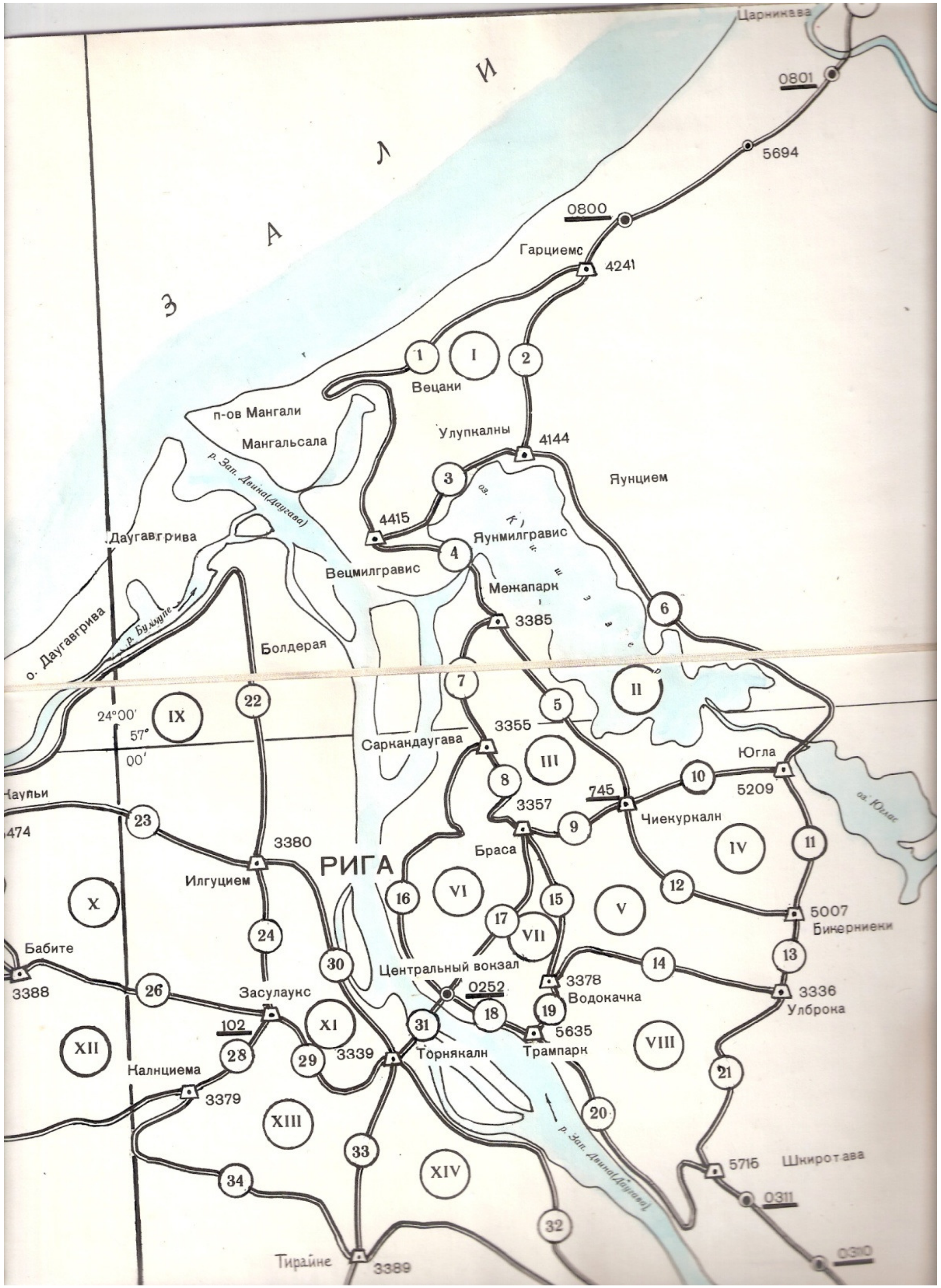


EUPOS-RIGA STATION LUNI



LATPOS STATION OJAR

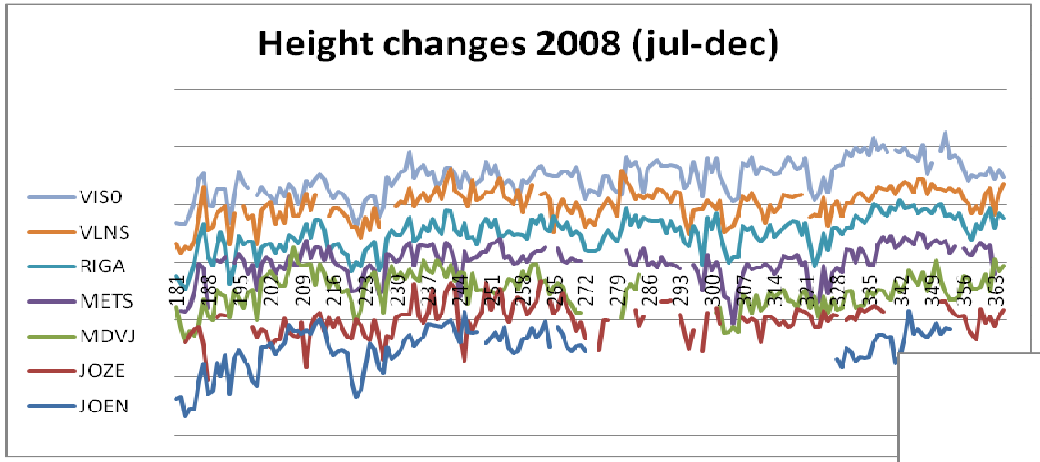


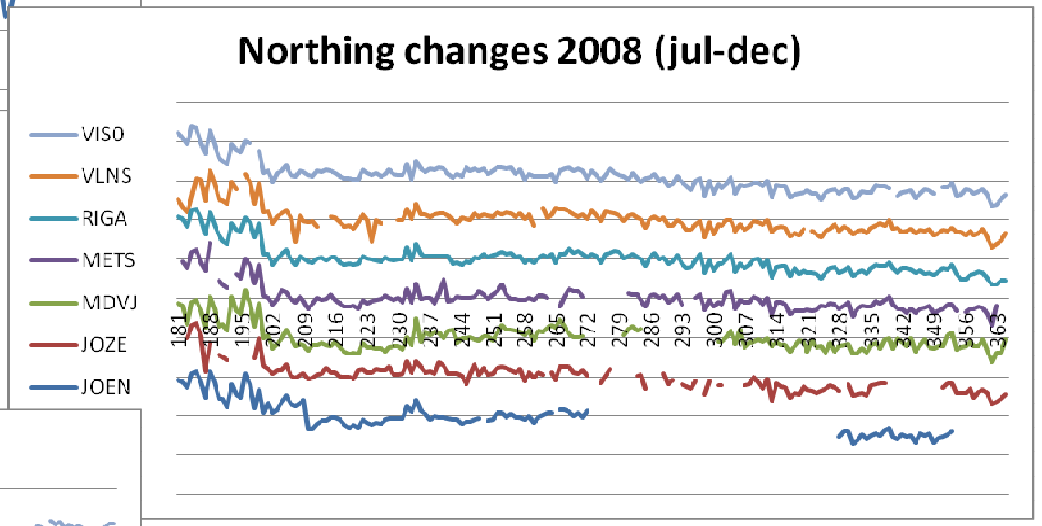


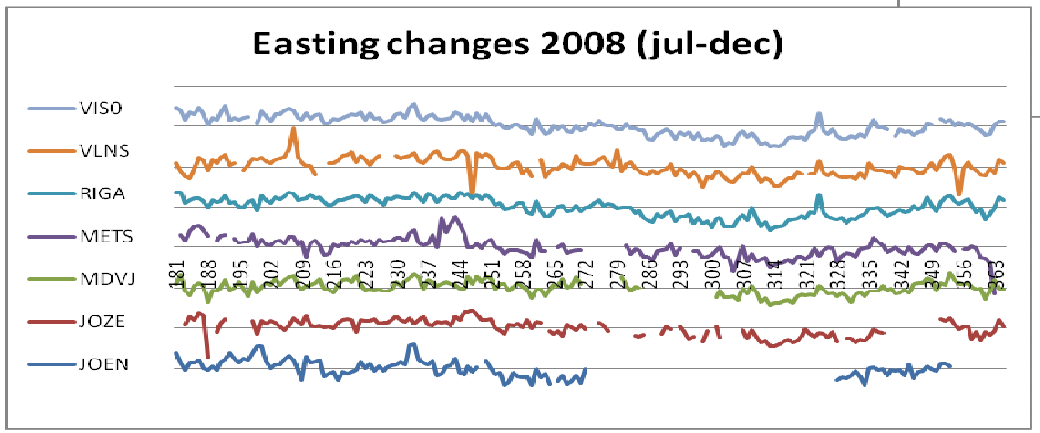
Царникава
0801
5694
0800
Гарциемс
4241
З А Л И
1
I
2
Вецаки
п-ов Мангали
Мангальсала
Улупкалны
4144
Яунцием
3
р. Зап. Двина (Даугава)
4415
Яунмилгравис
4
Даугавгрива
Вецмилгравис
Межапарк
о. Даугавгрива
р. Буллупе
6
3385
Болдерая
7
5
II
24°00′
57°
00′
IX
22
3355
Саркандаугава
III
Югла
10
5209
8
745
Чиекуркалн
оз. Югла
Чаупьи
3357
474
23
9
IV
11
3380
РИГА
Браса
Илгуцием
X
16
VI
12
15
V
17
VII
5007
Бикерниеки
24
Бабите
13
30
Центральный вокзал
14
3378
0252
Водокачка
3336
Улброка
3388
26
Засулаукс
XI
31
18
19
102
5635
XII
28
29
3339
Торнякалн
Трампарк
VIII
Калнциема
21
3379
XIII
20
33
XIV
5716
Шкиротава
34
0311
32
Тирайне
3389
0310

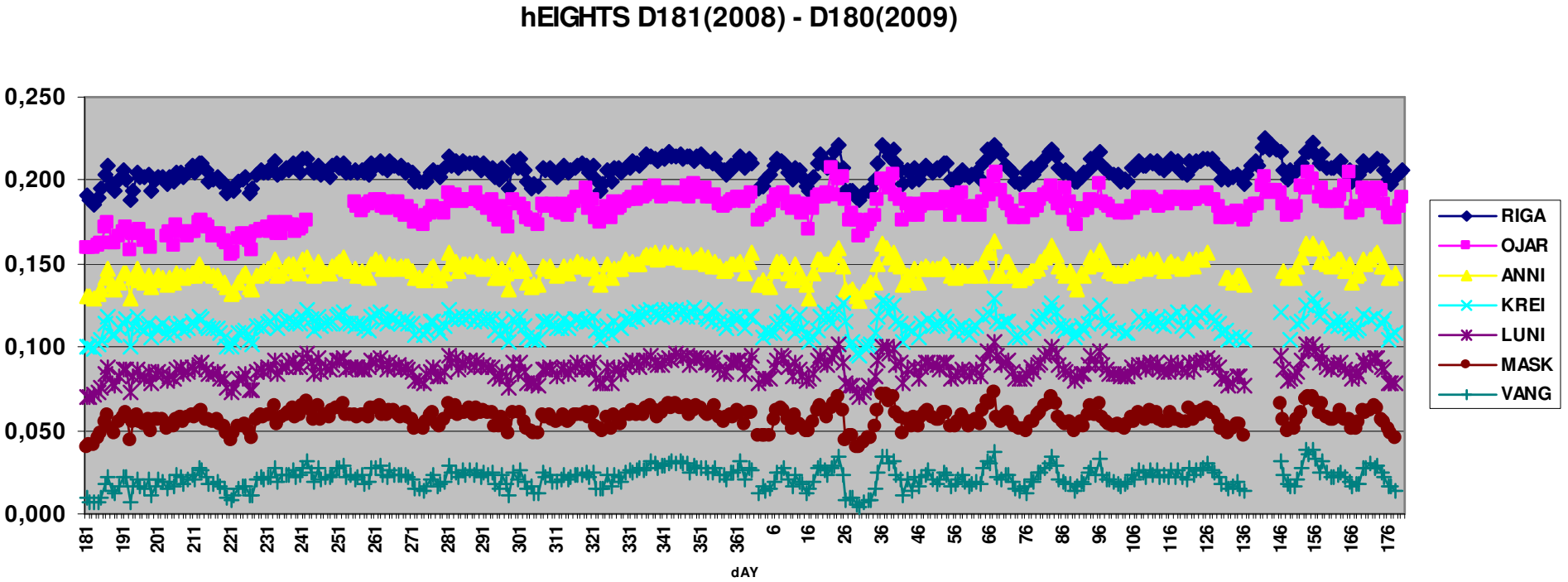
Reference station coordinate time series

(time series shifted in order to place in single figure)








hEIGHTS D181(2008) - D180(2009)
0,250
0,200
0,150
0,100
0,050
0,000
181
191
201
211
221
231
241
251
261
271
281
291
301
311
321
331
341
351
361
6
16
26
36
46
56
66
76
86
96
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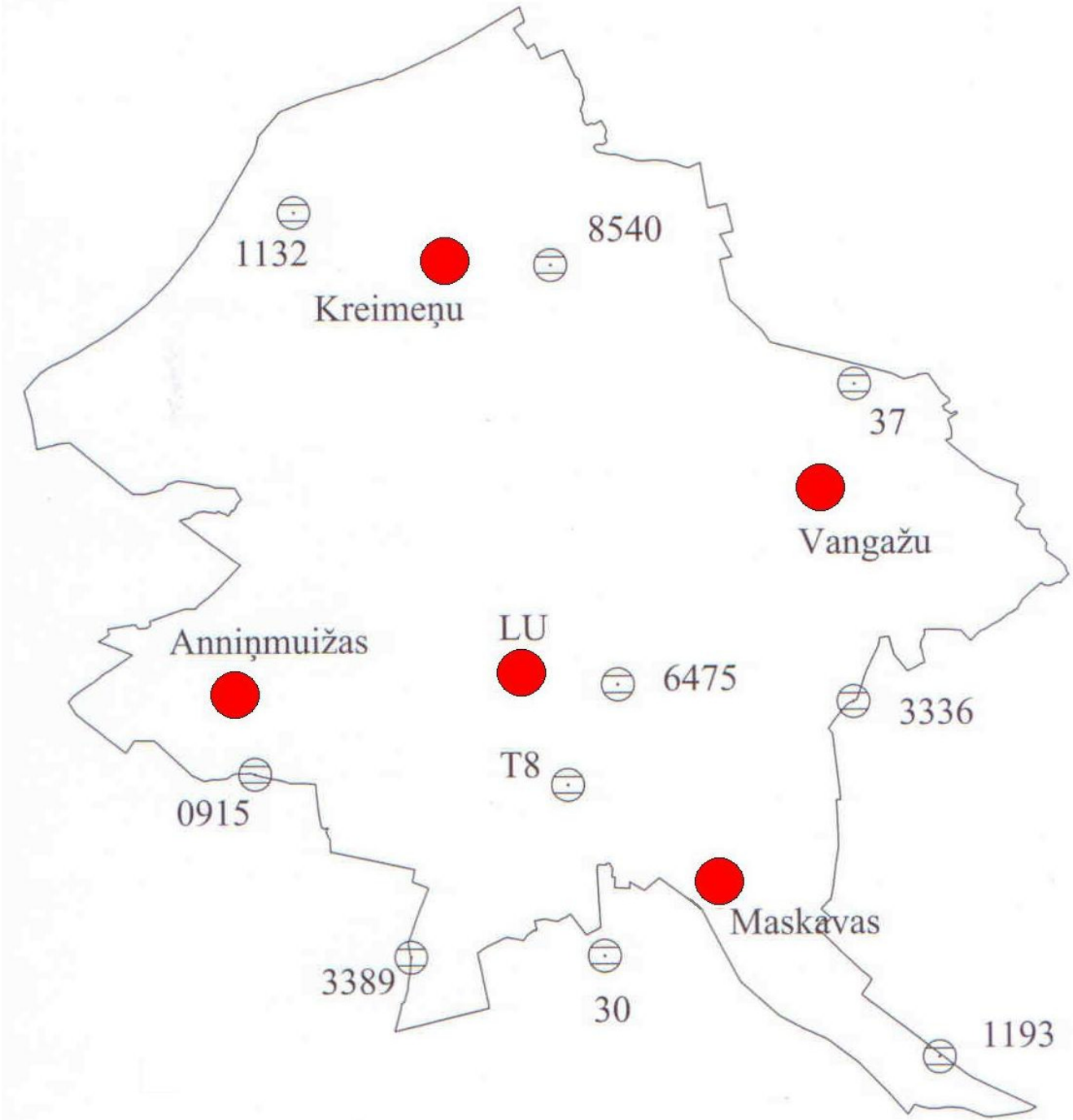
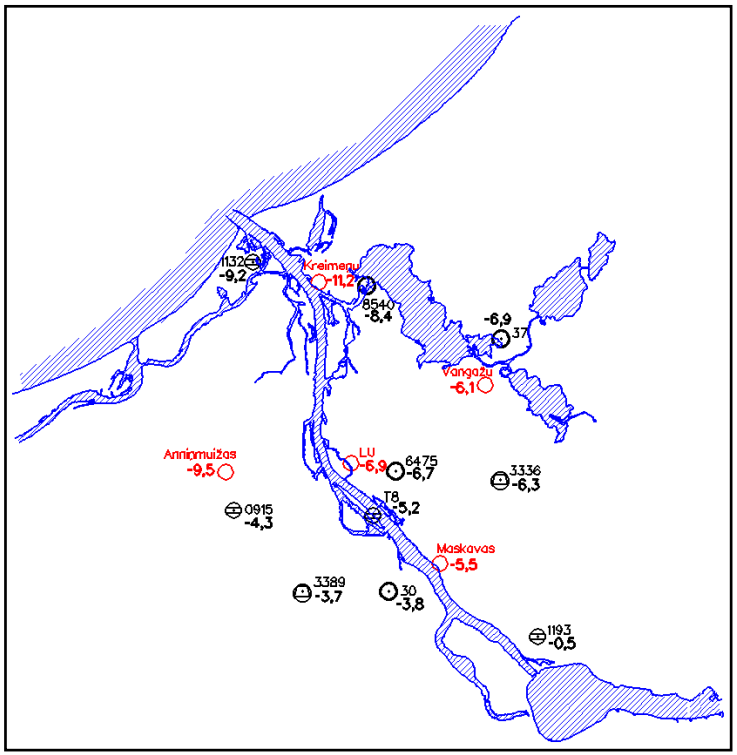
176
dAY
RIGA
OJAR
ANNI
KREI
LUNI
MASK
VANG


1132
8540
Kreimeņu
37
Vangažu
Anniņmuižas
LU
6475
3336
T8
0915
Maskavas
3389
30
1193

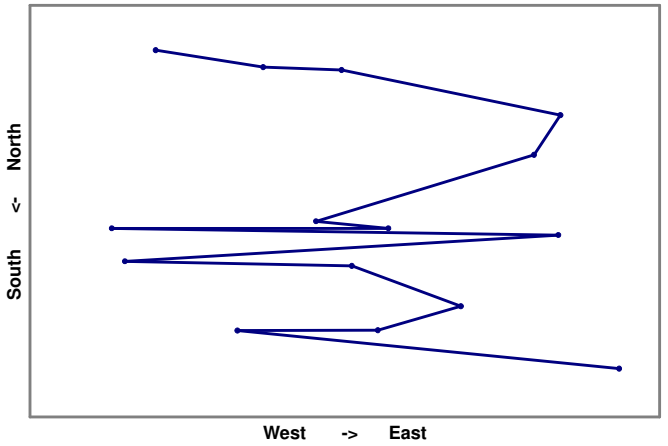
RTK Application for Levelling Network Deformation Control

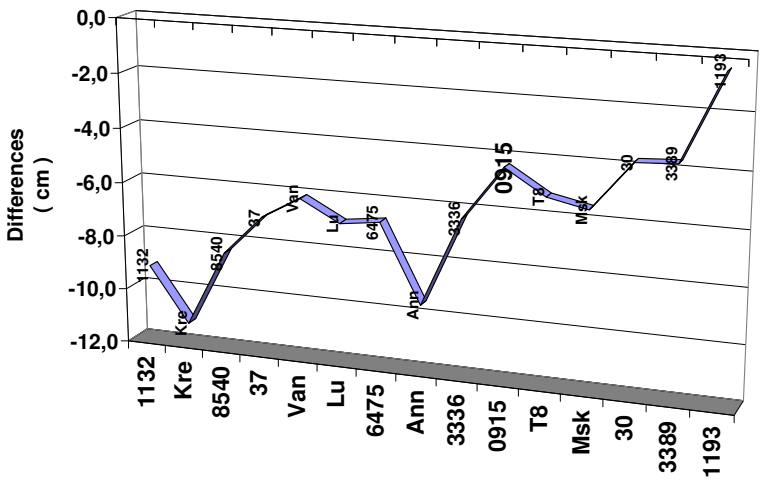


Epoch precision and reliability

Rp 0915 one measurement RMS=1,8 cm (62 measurements)
result RMS=2,3 mm

Arrangement N -> S





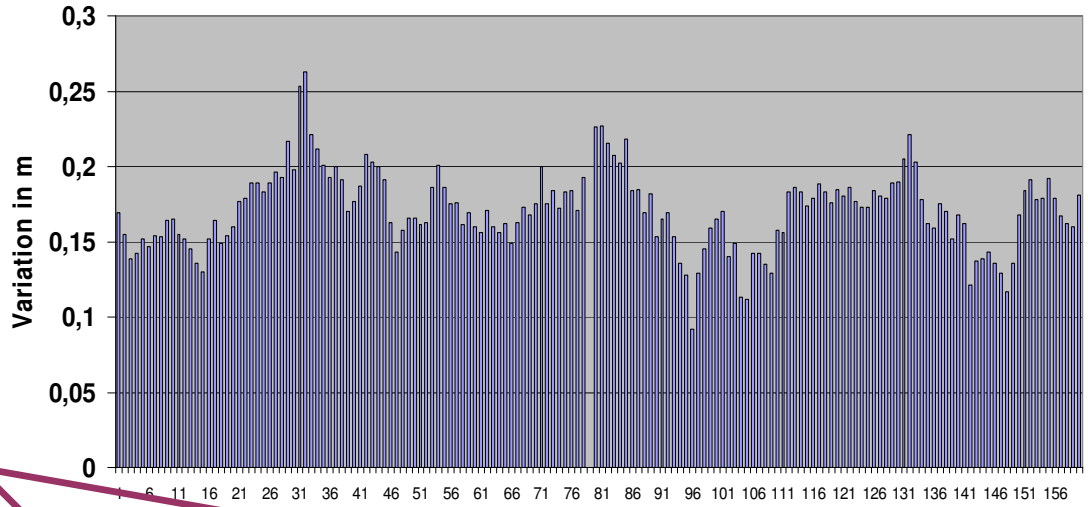
RTK measurements

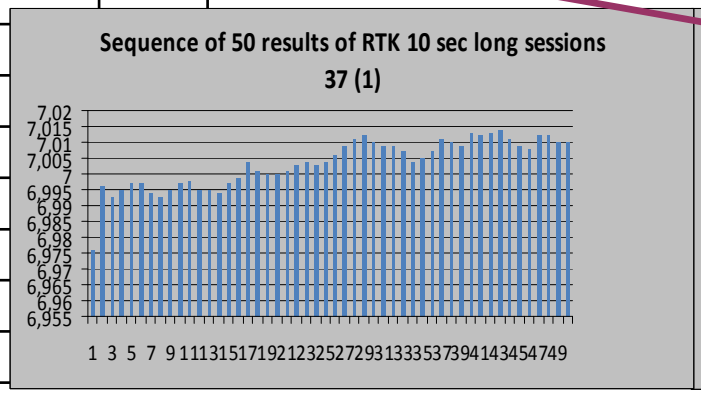
Evaluation of height network in Latvia

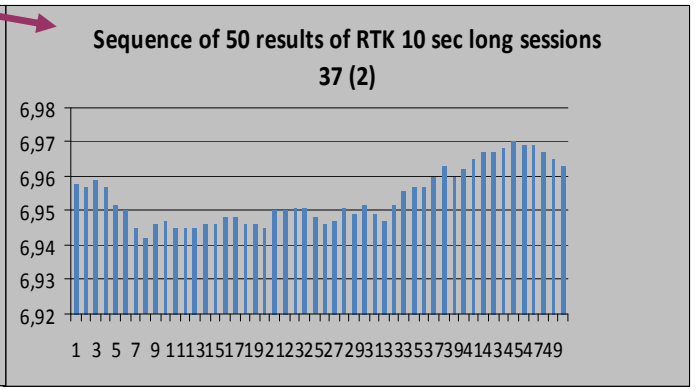
STDV= $\sqrt{\frac{\sum(x-\bar{x})^2}{(n-1)}}$ RMS= $\sqrt{\frac{\sum(x-\bar{x})^2}{n\,(n-1)}}$

	Results	STDV	RMS	STDV	RMS
#	H	mm	mm	mm	mm
5715	11,805	9,0	1,3	5,7	0,6
1193	10,590	7,2	1,0	11,6	1,3
915	11,792	3,0	0,4	7,2	0,7
173	9,011			5,4	0,5
1132	0,984			13,0	1,3
30	9,065	13,0	1,8	8,5	1,2
3389	12,292	10,0	1,4	10,9	1,3
8540	9,619	3,2	0,5	14,0	1,9
37	7,037	7,7	1,1	8,3	1,2
938	13,317	9,4	1,3		
140	6,226	24,7	3,5		
834	8,220	17,0	2,5		
6475	15,222	3,6	0,5		
3336	9,404	14,3	2,0		
SALA	10,503	11,6	1,6		
T8	4,719	6,0	0,9		
6551	4,135	31,5	3,1		

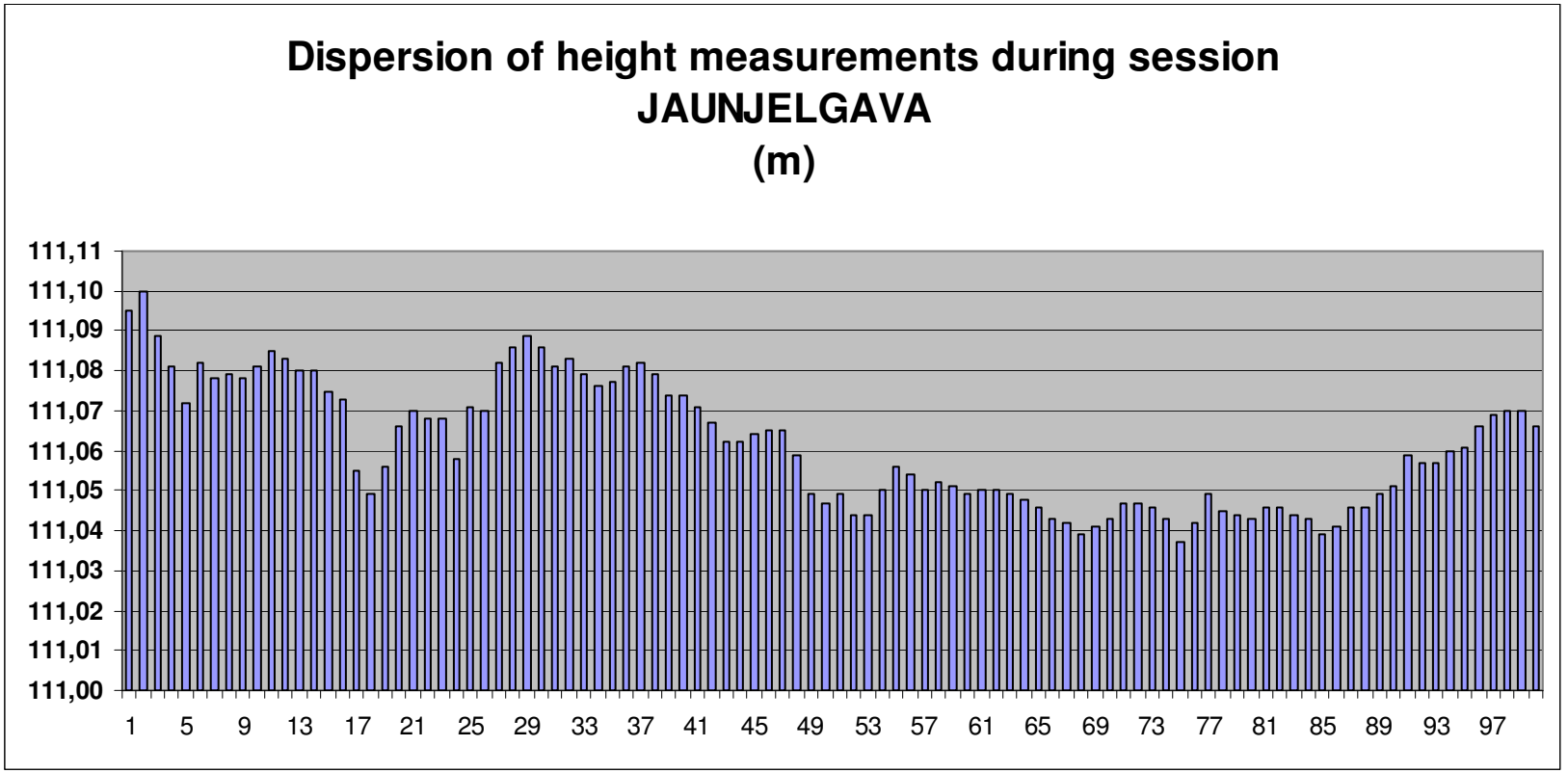
Sequence of 160 results of RTK 10 sec long sessions, probably influenced by ionosphere fluctuations





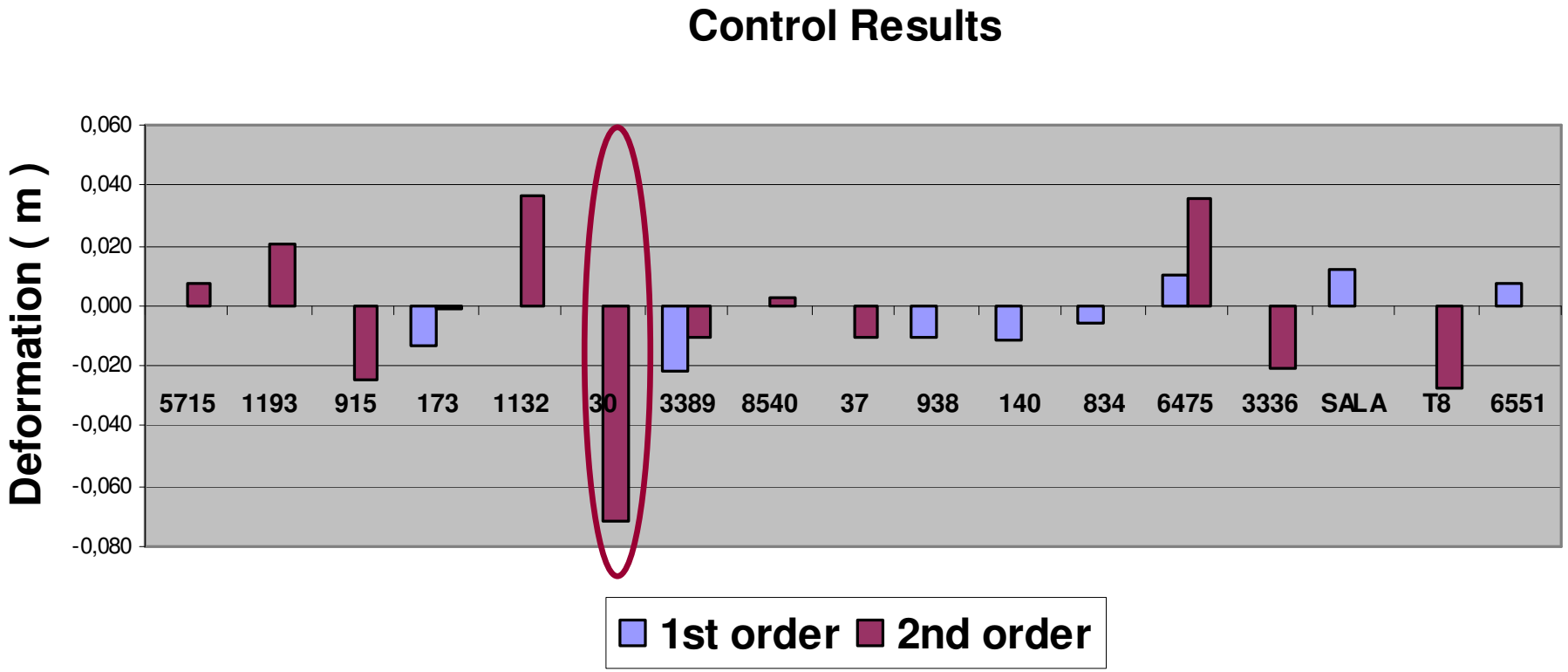


Evaluation of height network in Latvia



Ellipsoidal height = 111,062 m

Evaluation of height network in Latvia



Precision ?

Rp 0915 RMS of one measurement=	**1,8**	**cm**	**(62 measurements)**
resulting RMS=	**2,3**	**mm**	

Multipath ?

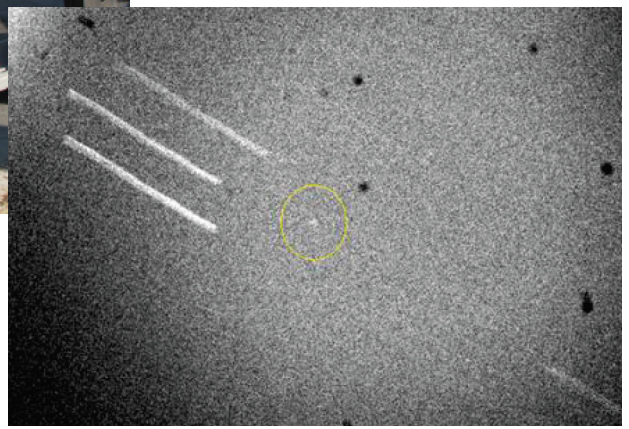
Average difference (2 times)	**5 mm**
Multipath STDV ?	20 mm

Satellite Laser Ranging system for LEO satellites

SLR for LEO ranging

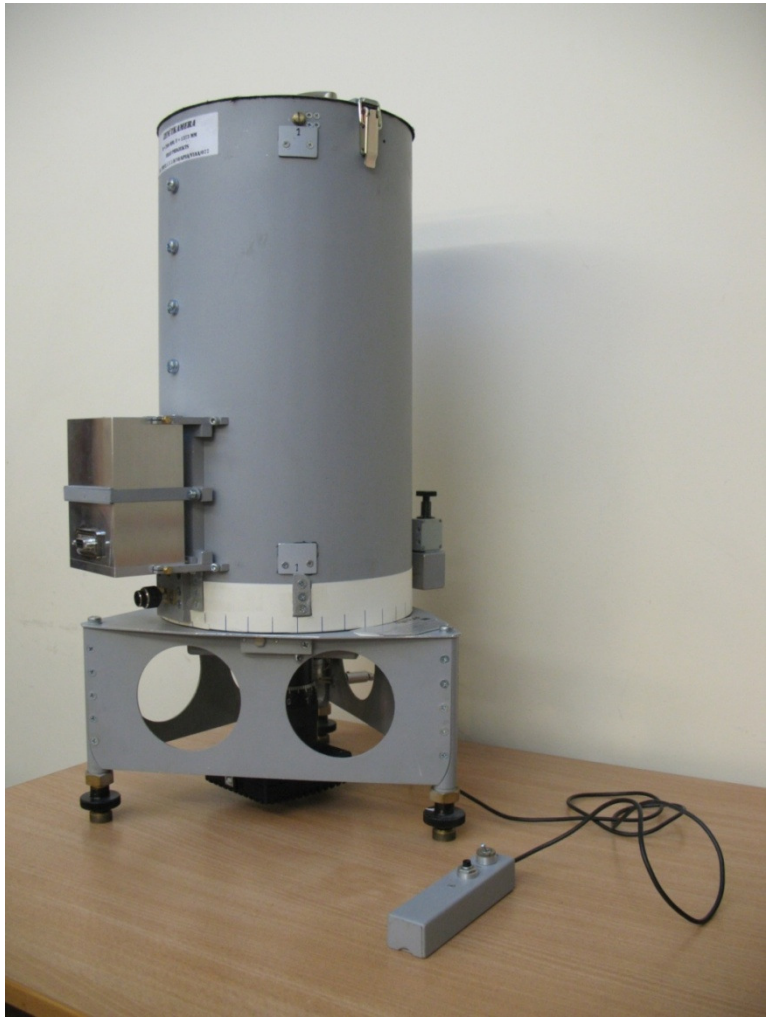
	Date	Satellite	Points	RMS (cm)	NP	RMS (cm)

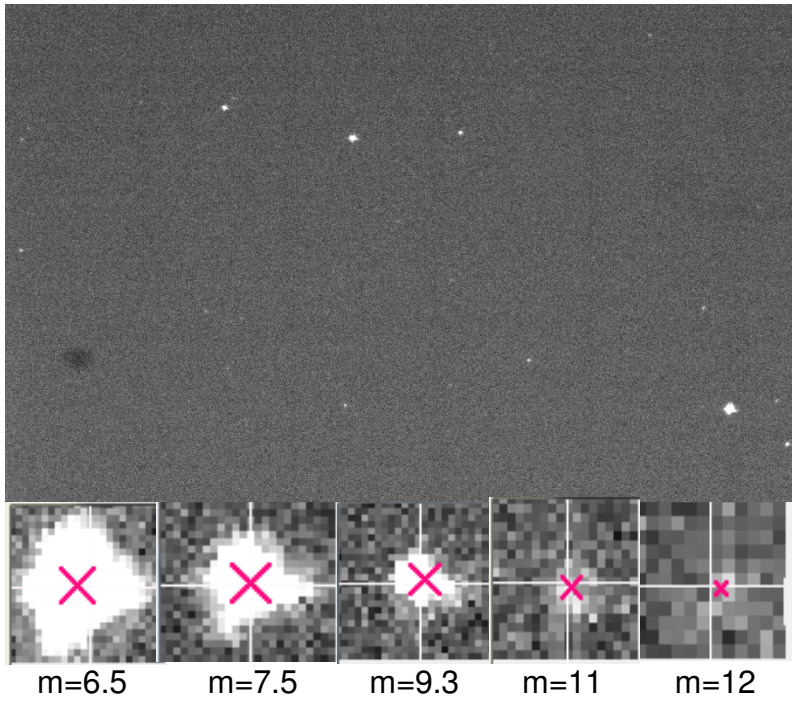
SLR test results



LAGEOS satellite observation using SLR

Digital zenith camera for studies of vertical deflection





Conclusions

- The hydro geologic conditions in upper layers of ground are additional sources of the movement of Earth surface.
- The value of Height component is corresponding to various systems.
- National levelling network, National geoid model and National RTK network are key elements in National height system determination.

Thank You!