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Contribution of GGI – EPN Densification Analysis Centre

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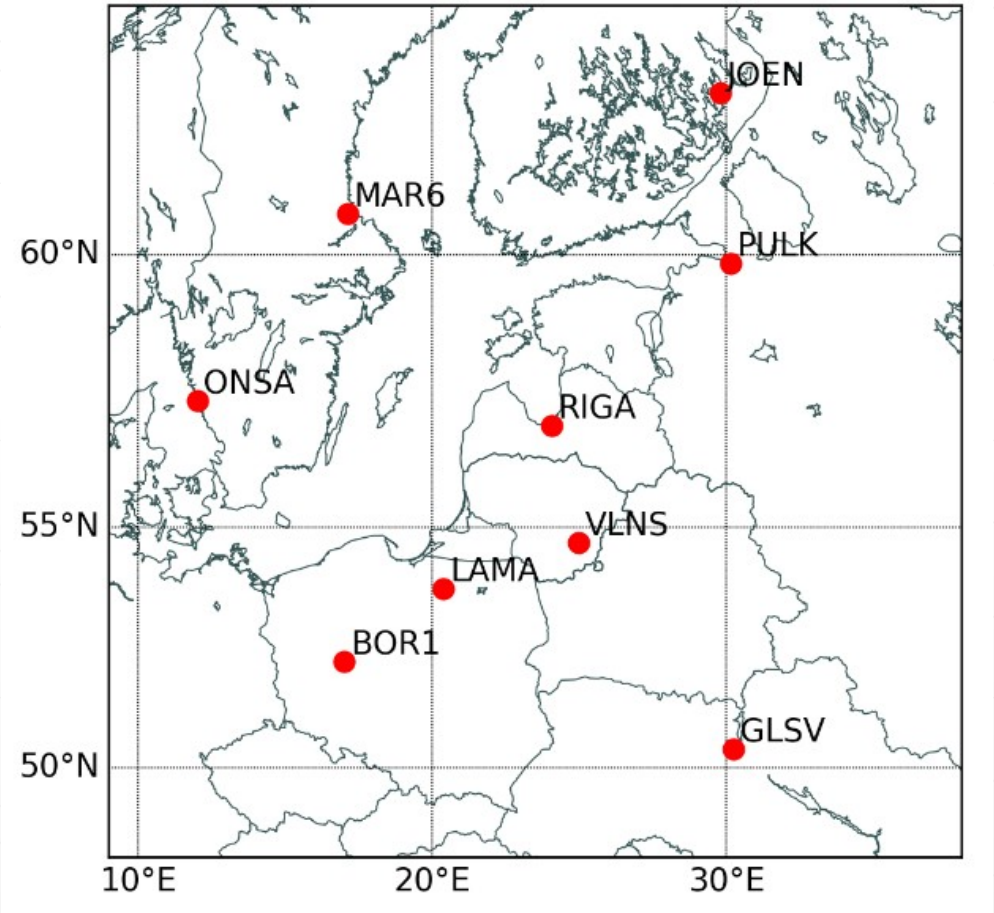
Introduction

- Institute of Geodesy and Geoinformatics, University of Latvia (GGI);
- Contribution to EUPOS Combination Centre since 2010;
- Currently EPN Densification analysis centre - regularly transferring weekly SINEX solutions to EPN.

Bernese 5.2 processing

- Double-difference mode;
- Final CODE precise orbits, Earth orientation, clock and final ionosphere product used;
- Dry Global Mapping Function as the a priori troposphere model, zenith path delay parameters estimated using the wet Global Mapping Function;
- Cut-off elevation angle: 3°;
- Positions of all stations corrected for solid Earth tide effect and ocean tide loading (FES2004);
- Minimum constrained solution;
- Only GPS observations were used before 2015.

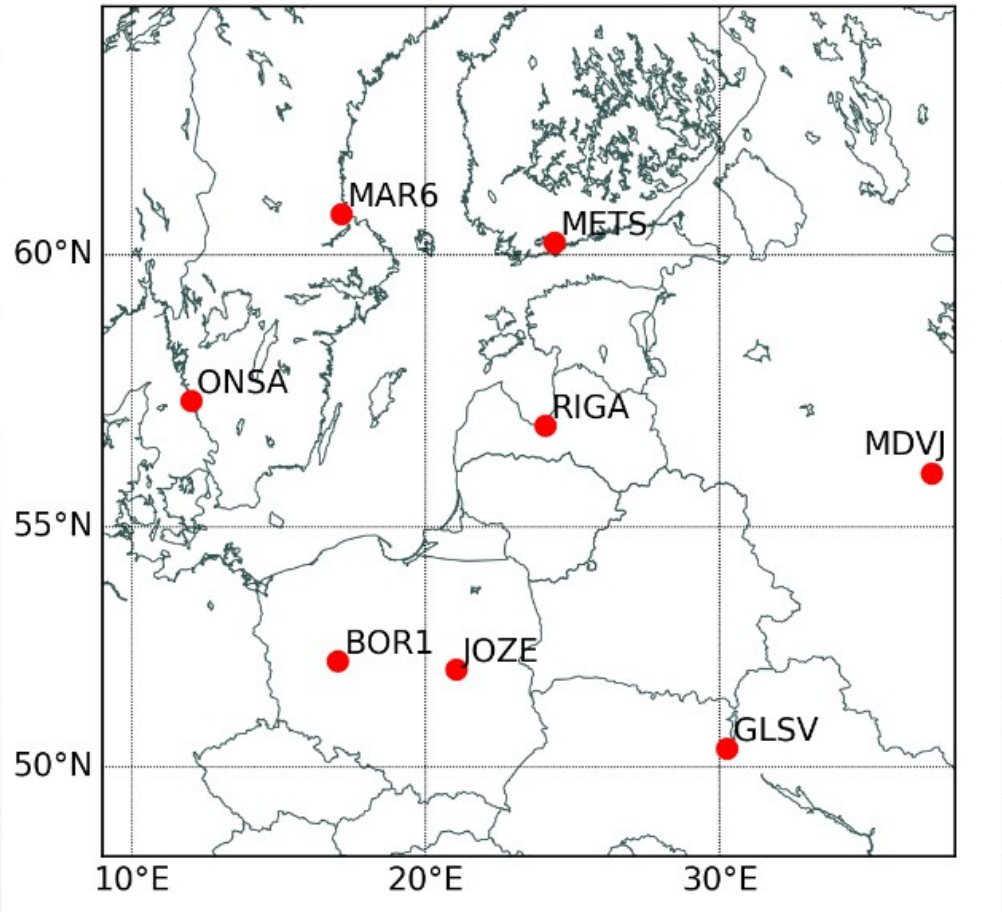
Fiducial stations (IGb08)



Fiducial stations from EPN/IGS networks:

- BOR1 (Borowiec, Poland),
- GLSV (Kiev, Ukraine),
- JOEN (Joensuu, Finland),
- LAMA (Olzstyn, Poland),
- MAR6 (Gavle, Sweden),
- ONSA (Onsala, Sweden),
- PULK (St.Petersburg, Russia),
- RIGA (Riga, Latvia),
- VLNS (Vilnius, Lithuania)

Fiducial stations (IGS14)

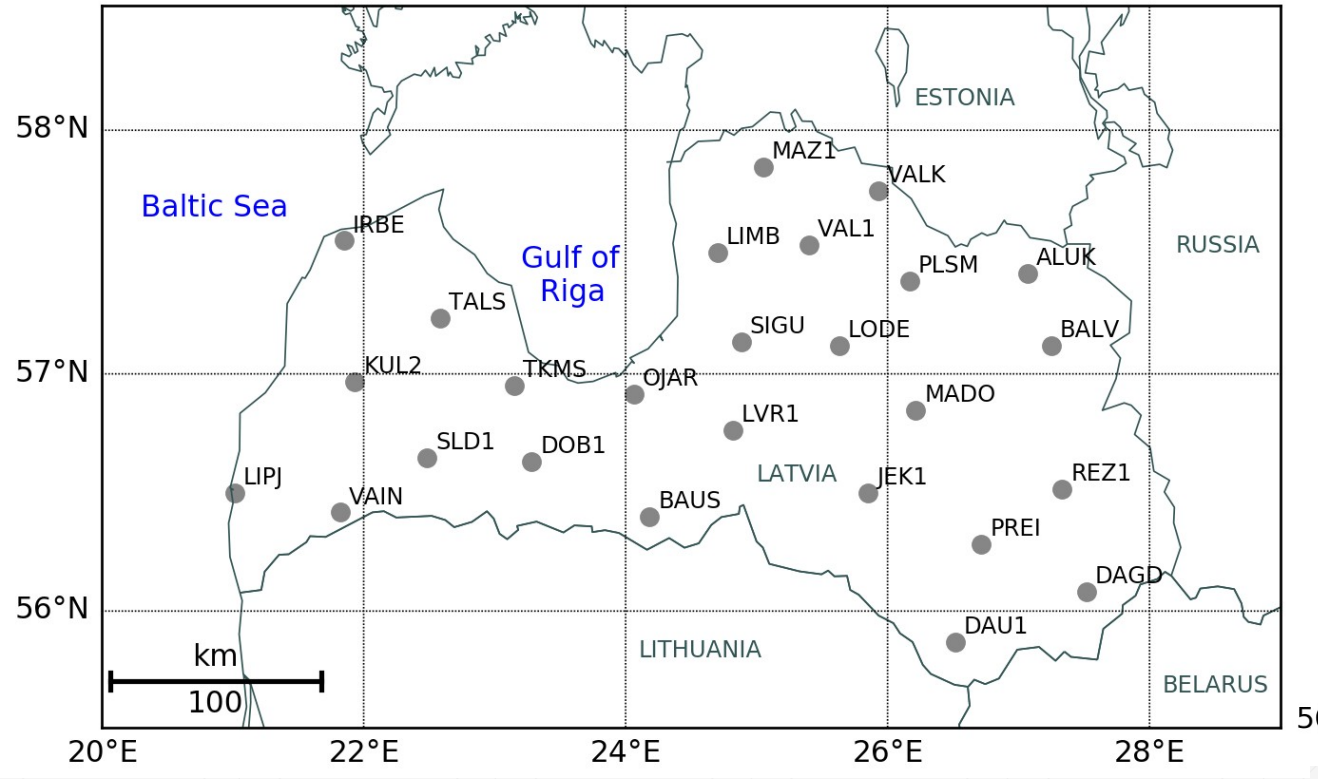


Fiducial stations from EPN/IGS networks:

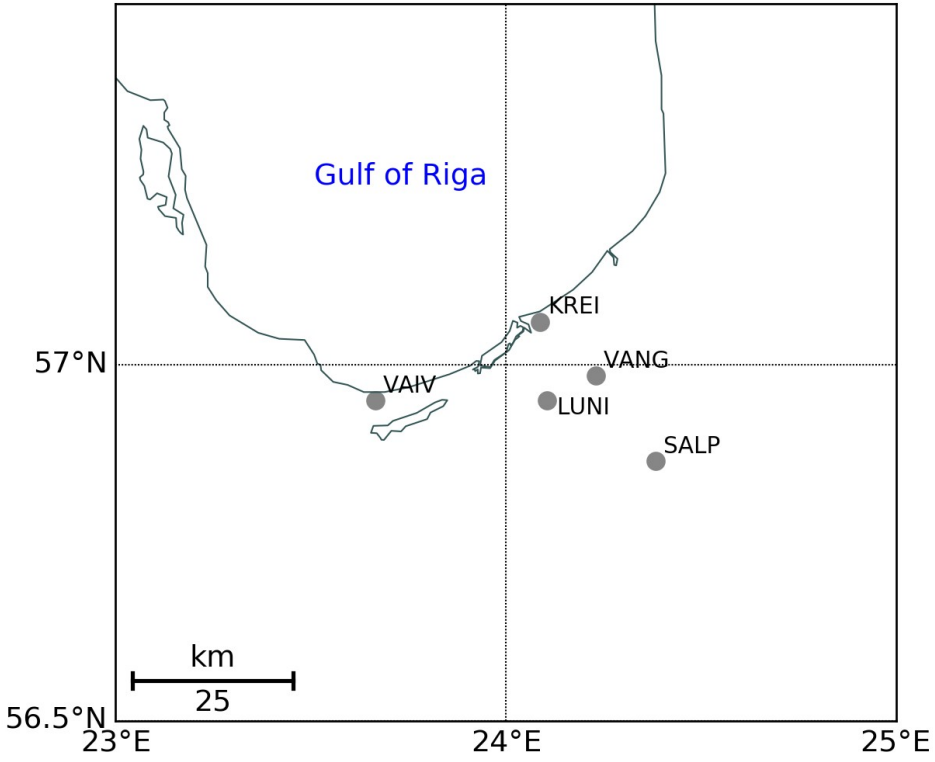
- BOR1 (Borowiec, Poland),
- GLSV (Kiev, Ukraine),
- JOZE (Jozefoslaw, Poland),
- MAR6 (Gavle, Sweden),
- MDVJ (Mendeleevo, Russia)
- METS (Metsahovi, Finland)
- ONSA (Onsala, Sweden),
- RIGA (Riga, Latvia)

Latvian CORS

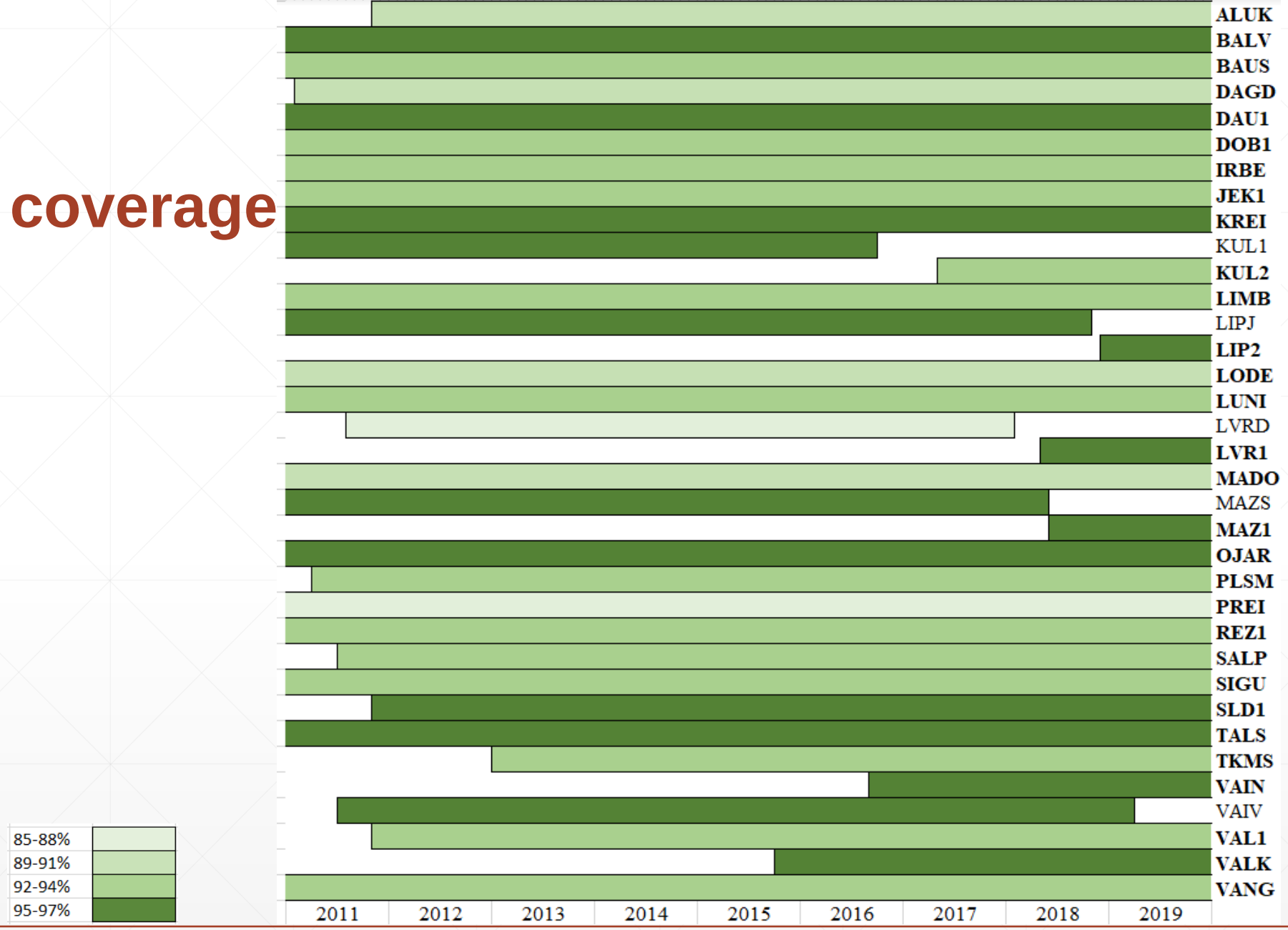
LatPos



EUPOS-Riga



Data coverage



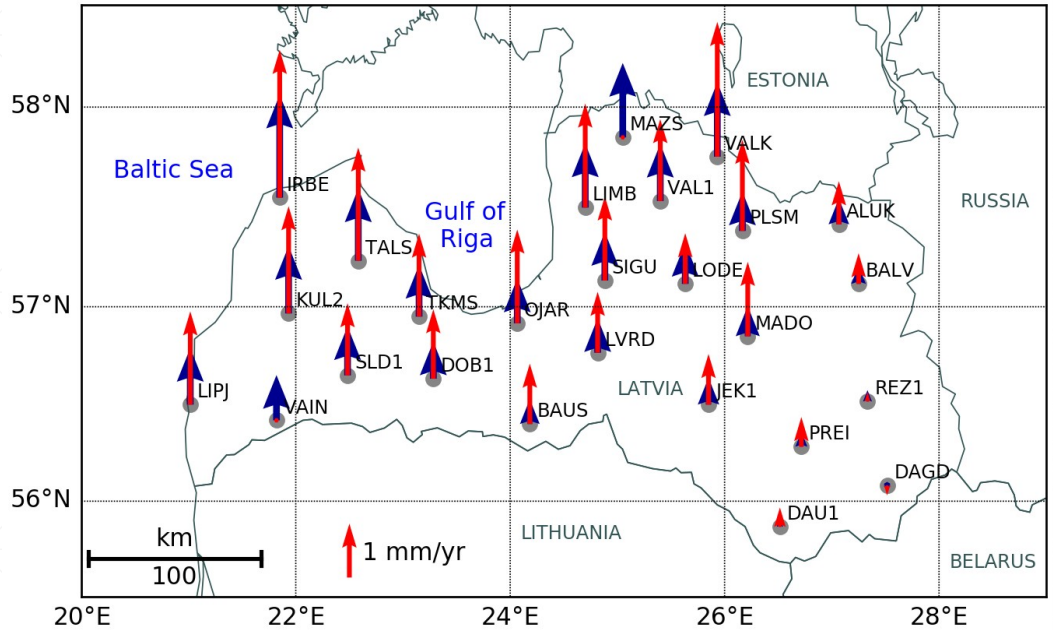
Tsview software

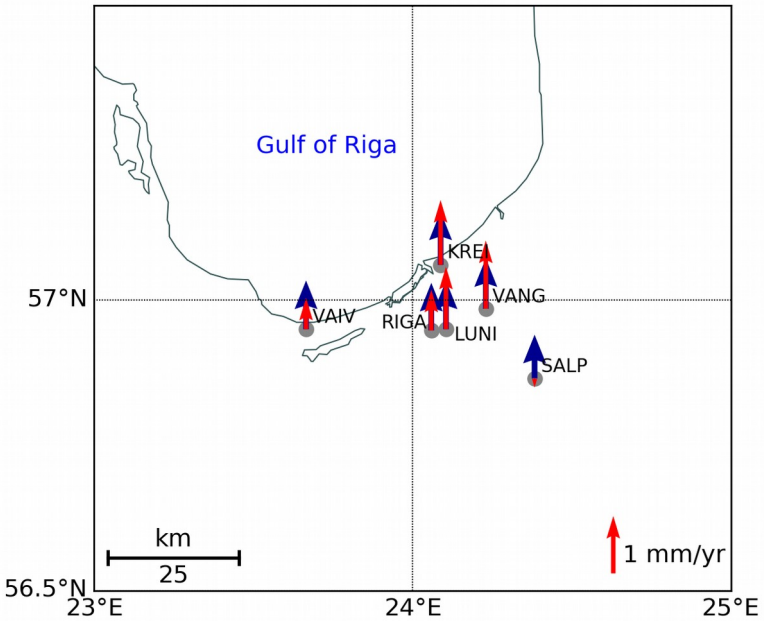
- Obtained daily Bernese solutions (2011 – 2019.7) transformed to ETRF2000 (Boucher and Altamimi, 2011; Altamimi, 2018);
- Outlier removal using 3σ criterion;
- Inclusion of breaks due to antenna/receiver change, GLONASS introduction, shift to IGS14 or other reasons;
- Appending moved stations - KUL2, LIP2, LVR1, MAZ1;
- Estimation of velocities, annual and semi-annual components and standard uncertainties (RealSigma option).

	Velocities (mm/yr)			Uncertainties (mm/yr)		
	Up	North	East	Up	North	East
	ITRF2008	ETRF2000	ETRF2000			
ALUK	0.80	-0.09	0.03	**0.37**	0.09	0.08
BALV	0.57	-0.35	0.05	**0.25**	0.05	0.09
BAUS	1.12	-0.29	0.10	0.12	0.10	0.08
DAGD	-0.19	-0.16	-0.05	0.20	0.06	0.06
DAU1	0.36	-0.06	-0.31	0.15	0.07	0.03
DOB1	1.29	-0.18	-0.14	0.06	0.04	0.08
IRBE	2.74	-0.38	-0.04	0.18	0.06	0.06
JEK1	0.94	-0.40	-0.03	**0.22**	0.06	0.10
KUL2	1.99	-1.09	-0.04	**0.22**	0.10	**0.14**
LIMB	1.93	-0.69	0.17	0.12	0.10	0.06
LIP2	1.73	0.03	-0.33	0.10	0.10	0.04
LODE	0.94	-0.30	0.29	**0.22**	**0.13**	0.09
LVR1	1.13	-0.05	0.03	**0.23**	**0.13**	**0.14**
MADO	1.38	-0.40	-0.65	0.12	0.06	0.08
MAZ1	0.90	-2.40	0.32	0.15	**0.28**	0.08
OJAR	1.74	-0.54	-0.50	0.16	**0.13**	**0.21**
PLSM	1.69	-0.57	-0.24	0.18	0.10	0.08
PREI	0.55	-0.12	-0.06	**0.26**	0.09	0.10
REZ1	0.18	-0.30	-0.15	**0.33**	0.09	0.10
SIGU	1.56	-0.09	-0.15	0.09	0.06	0.06
SLD1	1.34	-0.51	-0.08	0.15	**0.11**	**0.27**
TALS	2.10	-0.46	-0.01	0.14	0.07	0.06
TKMS	1.54	-0.19	0.17	0.12	0.08	**0.12**
VAL1	1.52	-0.27	-0.30	0.11	0.06	0.06
VALK	2.50	-0.17	0.38	0.20	**0.13**	**0.14**
KREI	1.13	-0.28	0.33	**0.23**	0.07	**0.12**
LUNI	1.09	-0.65	-0.10	0.16	0.08	**0.11**
SALP	-0.16	-0.46	-0.33	**0.43**	**0.14**	**0.12**
VAIV	0.55	-0.30	0.29	**0.21**	0.07	0.10
VANG	1.19	-0.25	0.31	0.20	0.06	**0.13**
RIGA	0.71	-0.30	0.05	**0.21**	0.08	0.08

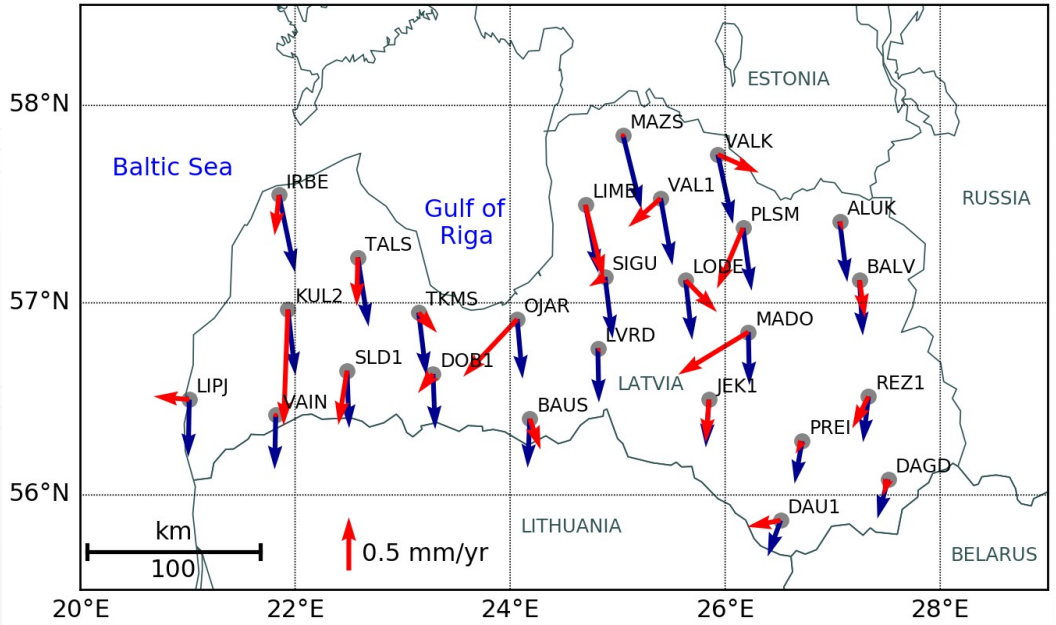
	Offsets				Seasonal signal (>1mm)	Unmodelled signal
	A/R	GLO	14	U		
ALUK		X	X			N
BALV	X		X		E	
BAUS	X	X	X			
DAGD	X	X	X	X	U	
DAU1			X			
DOB1			X			
IRBE		X	X			
JEK1		X	X			
KUL1				X	N U	
LIMB			X			N
LIPJ			X			
LODE	X		X	X		N
LVRD	X	X	X			N E
MADO			X			
MAZS			X		N U	N E U
OJAR	X	X	X			N E
PLSM	X		X		N	
PREI		X	X	X	E U	
REZ1		X	X		N U	N
SIGU			X		U	
SLD1		X	X		E	E
TALS		X	X			
TKMS		X	X		N	
VAL1			X			
VALK			X			
KREI		X	X			E
LUNI		X	X			E
SALP		X	X		N E U	N U
VAIV		X	X			E
VANG		X	X		U	E
RIGA	X		X			

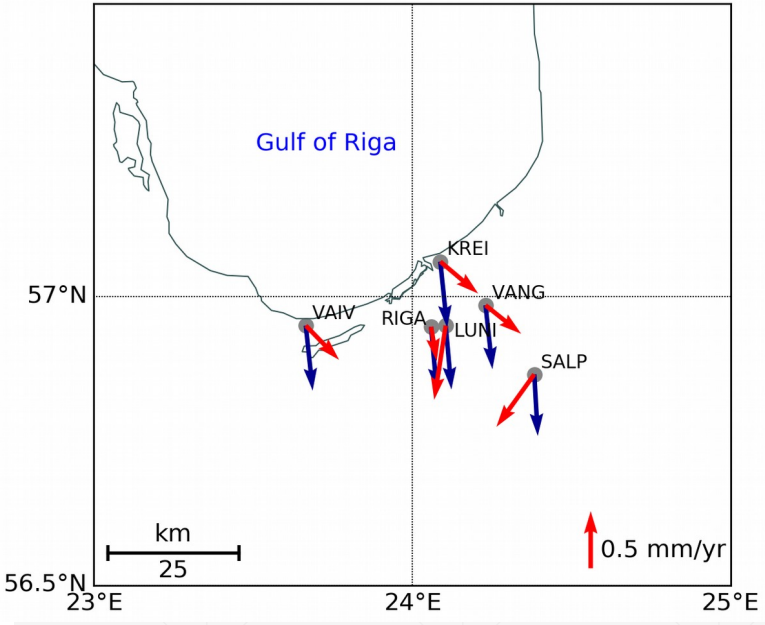
LatPos (left), EUPOS®-Riga and RIGA (EPN) station (right) vertical velocities from the daily solutions: 2011-2019.7 (red); vertical velocities from the model *NKG2016LU_abs* (blue) in ITRF2008.





LatPos (left), EUPOS®-Riga and RIGA (EPN) station (right) horizontal velocities from the daily solutions: 2011-2019.7 (red); horizontal velocities from the model *NKG_RF03vel* (blue) in ETRF2000.





Future work

- Investigation of station noise properties;
- Reprocessing already started for 2011-2014 using both GPS and GLONASS observations to avoid offsets due to GLONASS introduction;
- Extending the length of the time series – reprocessing of the earlier data: 2007-2010.

Digital Zenith Camera by GGI

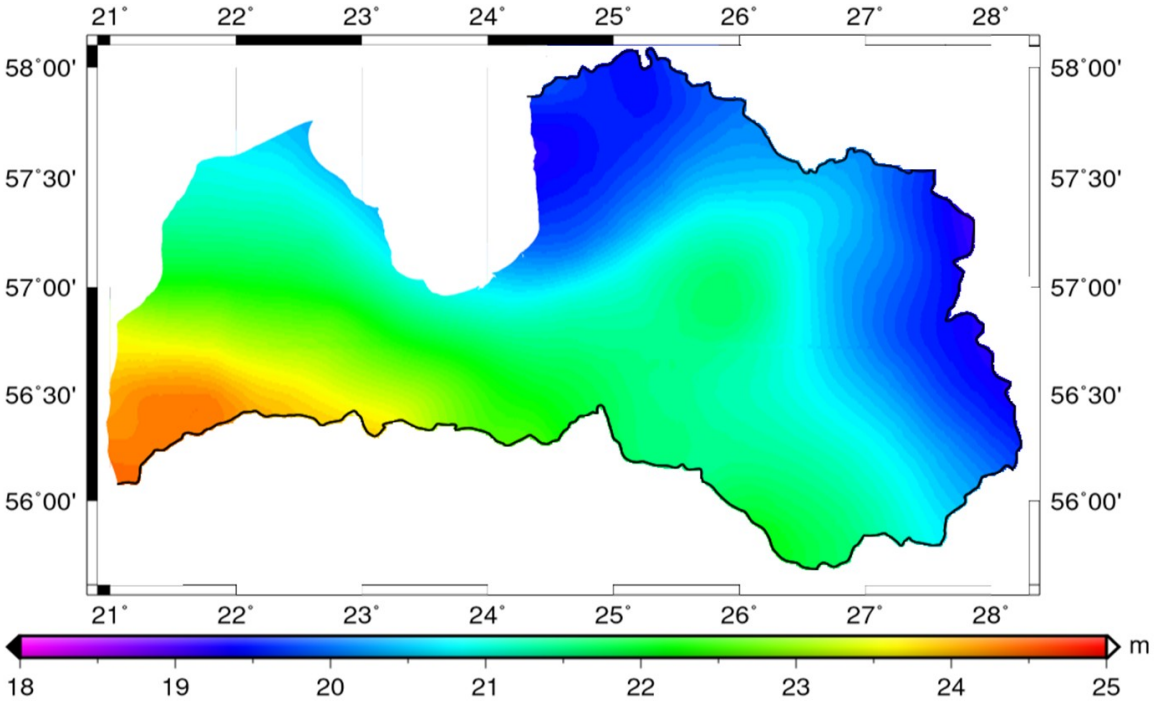
Vertical deflection measurement accuracy ~0.1 arcsecond.

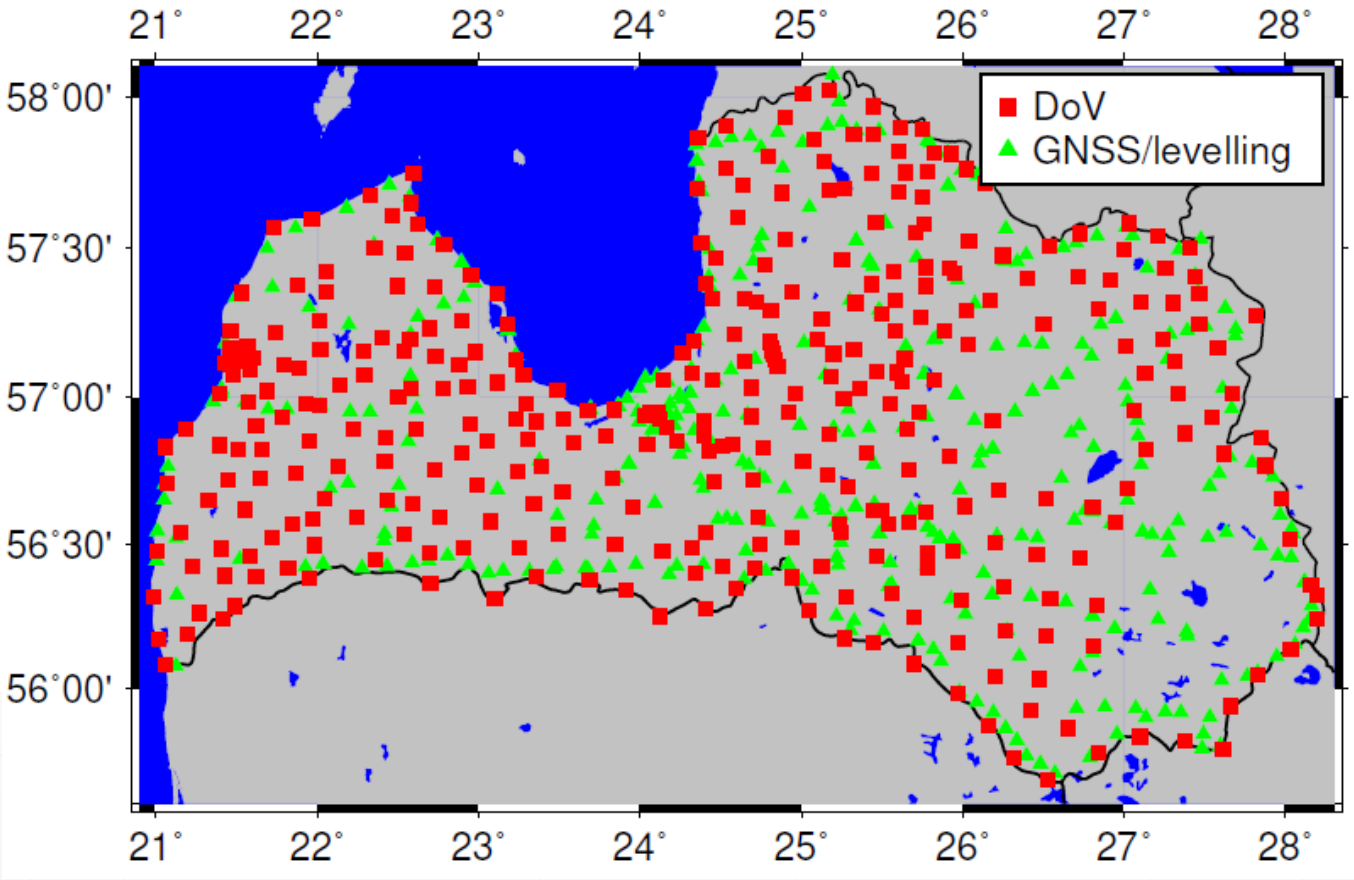
Tripod with detachable rotating part:

- astrometric quality coma free 8-inch catadioptric telescope;
- two-axis electronic HRTM tiltmeter (resolution ~0.02 arc milliseconds);
- GNSS receiver (plane coordinate accuracy <0.6m with SBAS);
- CCD matrix 8.3 MPx,
- linear actuators with resolution of <0.01 µm;
- on-board computer MinnowBoard;
- WLAN for communication with remote laptop;

Accurate levelling, setting of azimuth and prescribed schedule of observations are done automatically.

Geoid determination in Latvia including DoV data





- 357 sites (2017-2019)
- 1 – 1.5 hours per site
- max 6 sites per night
- accuracy ~ 0.1"
- differences from GGM+:
  - average 0.02"
  - rms 0.4"

- applications:
  - regional geoid models,
  - local geological features,
  - alternative to levelling.

Thank you!

Contribution of GGI – EPN Densification Analysis Centre

Inese Vārna

NATIONAL DEVELOPMENT PLAN 2020

EUROPEAN UNION
European Regional Development Fund

INVESTING IN YOUR FUTURE

ERDF project No. 1.1.1.1/16/A/160