



MAA-AMET

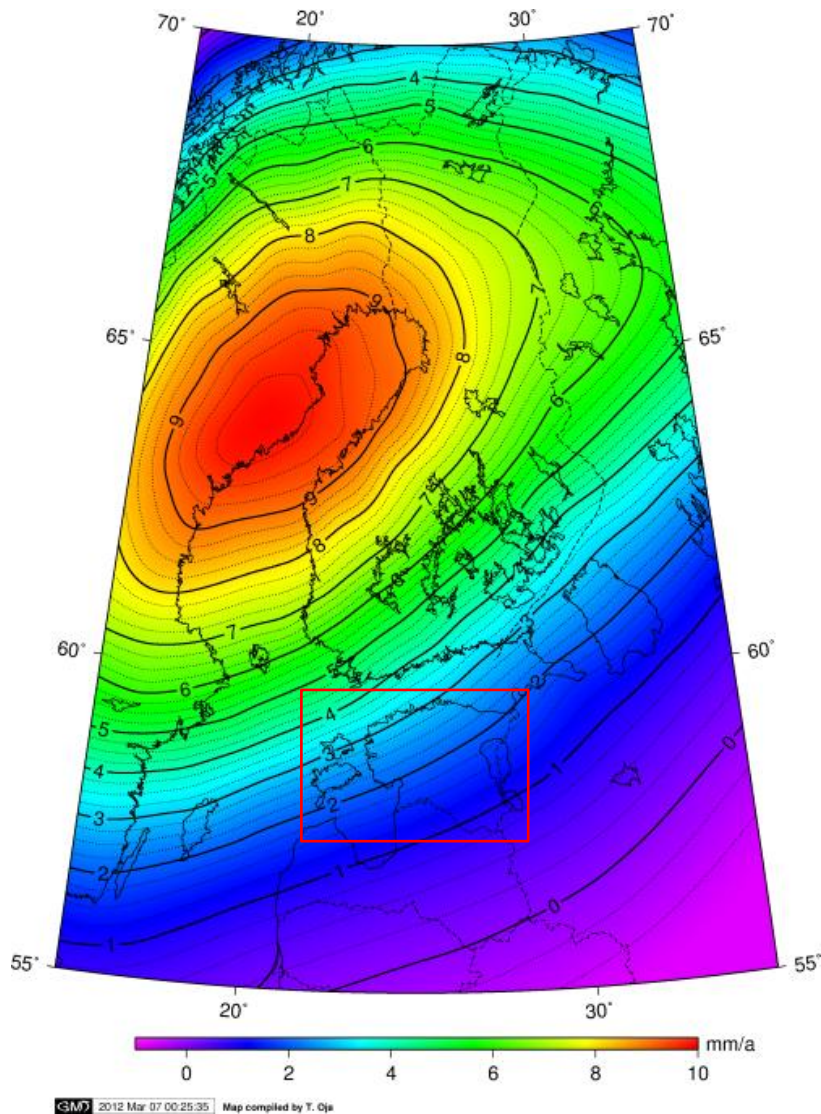
The verification of GIA in Estonia using GNSS data

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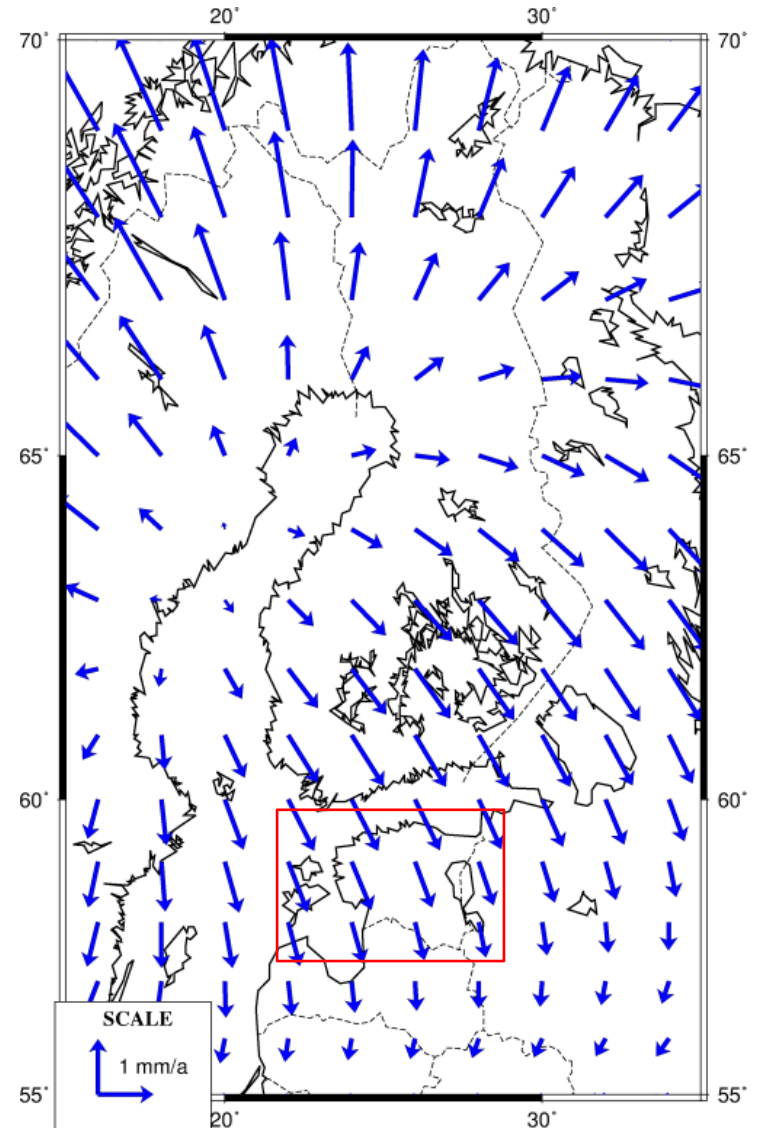
Topics:

- The effect of GIA in Estonia
- Crustal movements from two datasets:
 - GPS measurements of geodetic reference network in 1997 and 2008
 - Time series from the network of Estonian GNSS Reference Stations (ESTREF) observed in 2008-2014
- GIA modeling
- Comparisons

The effect of GIA in Estonia:



NKG2005LU_ABS (Ågren, Svensson 2007, Vestøl 2006, Lambeck et al 1998)



NKG_RF03vel (Milne et.al 2001, Lidberg 2004) 3

The data from Estonian geodetic network:

- Repeated measurements of 1st order points
 - 1st campaign in 1997.56 (RGP1997)
 - 2nd campaign in 2008.59 (RGP2008)
- Same equipment
 - Ashtech Z-12 GPS receivers with choke ring antennas
- Quite same measurement and computation methodology
 - The length of sessions 60...204 h
 - Data processing with Bernese (ver. 4.2, 5.0)

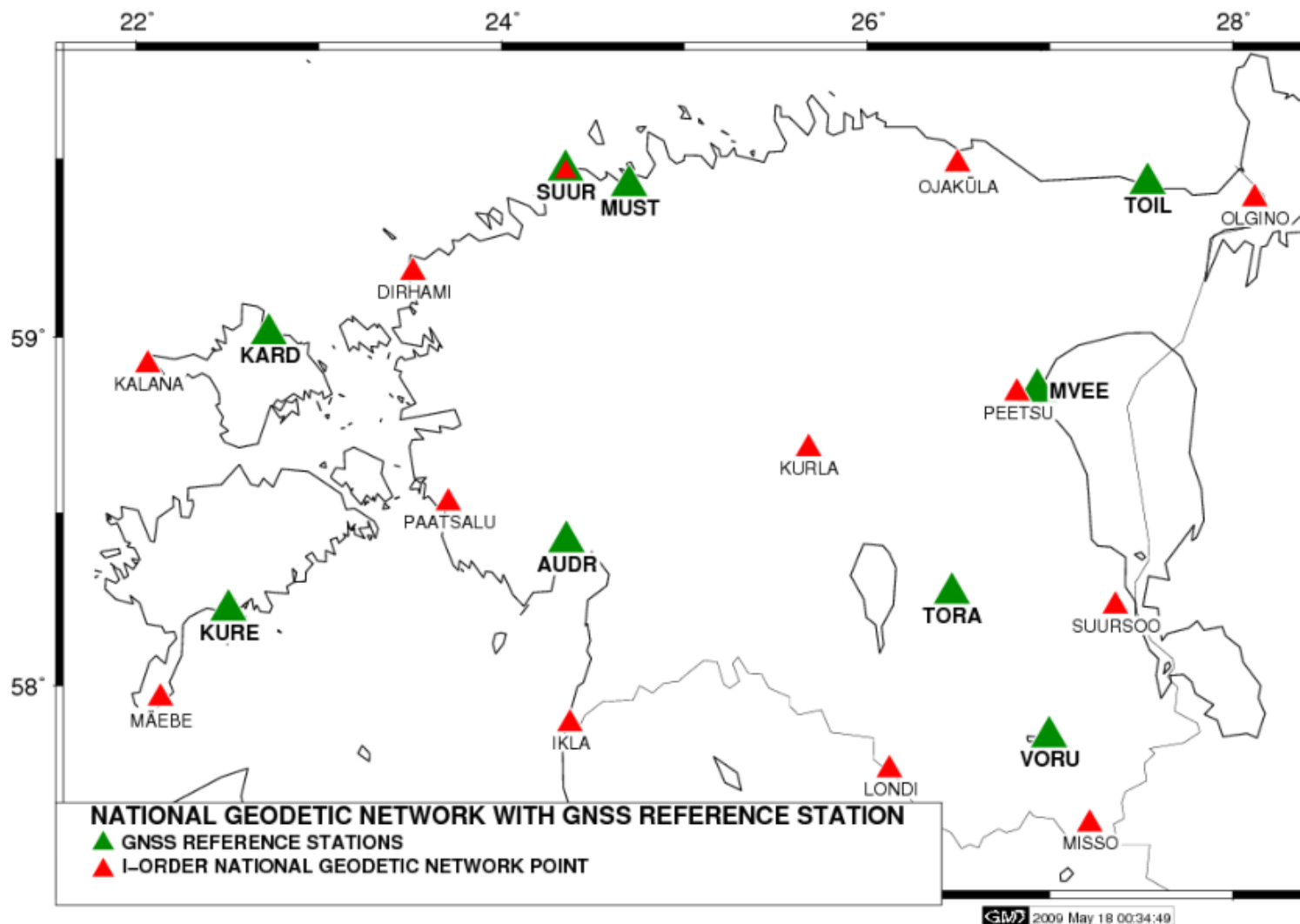


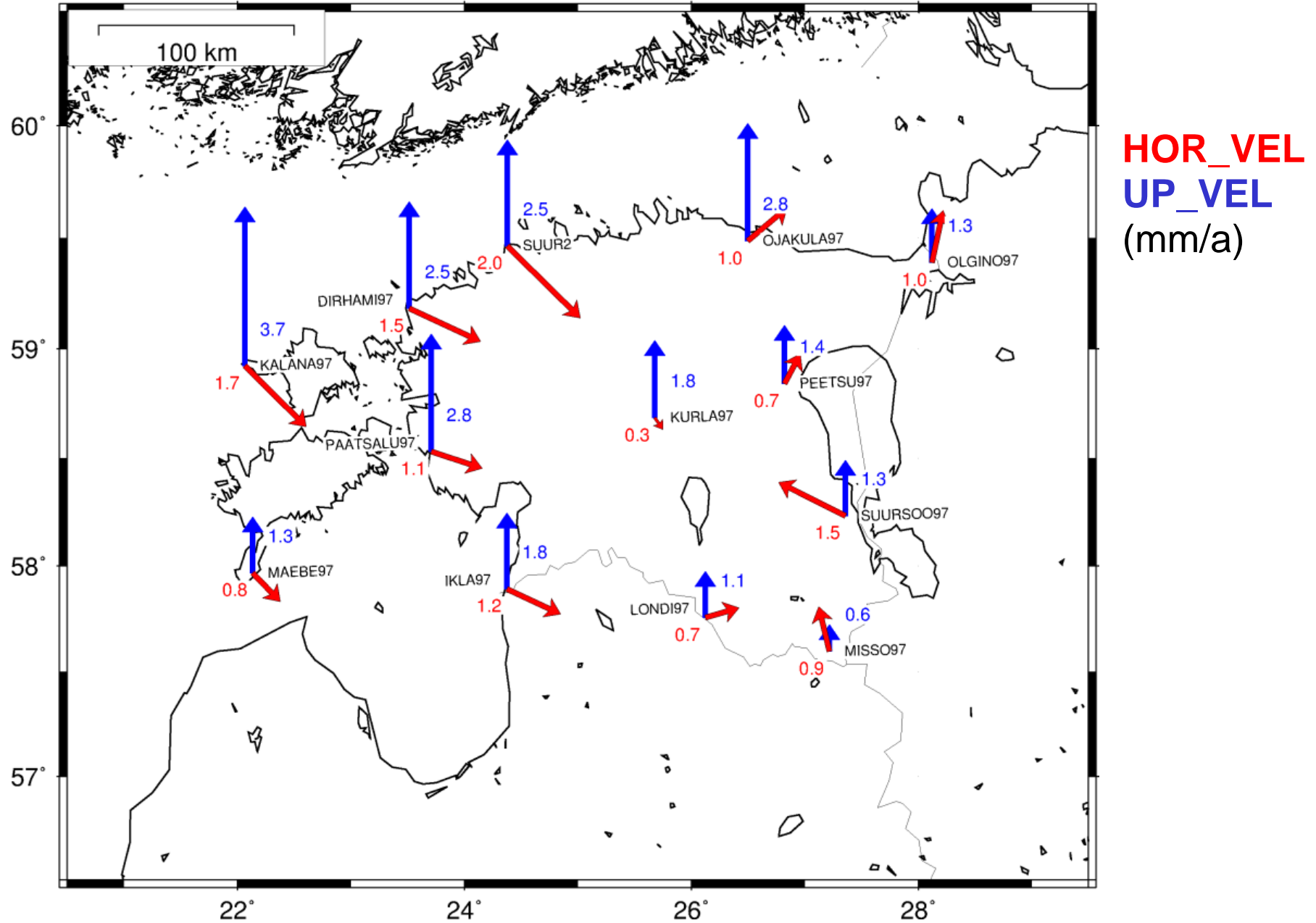
Fig. 1. *I-order Estonian National Geodetic Network and GNSS stations.*

Comparison of RGP1997 and RGP2008:

- Transformation of RGP1997 from ITRF96 to ITRF2005 (via www.epncb.oma.be)
- Velocities for 11 yrs (2008.59 – 1997.56) in ITRF2005
- ITRF2005 ARP - Absolute Rotation Pole (to remove EU plate motion effect) was used (Altamimi et al., 2007)

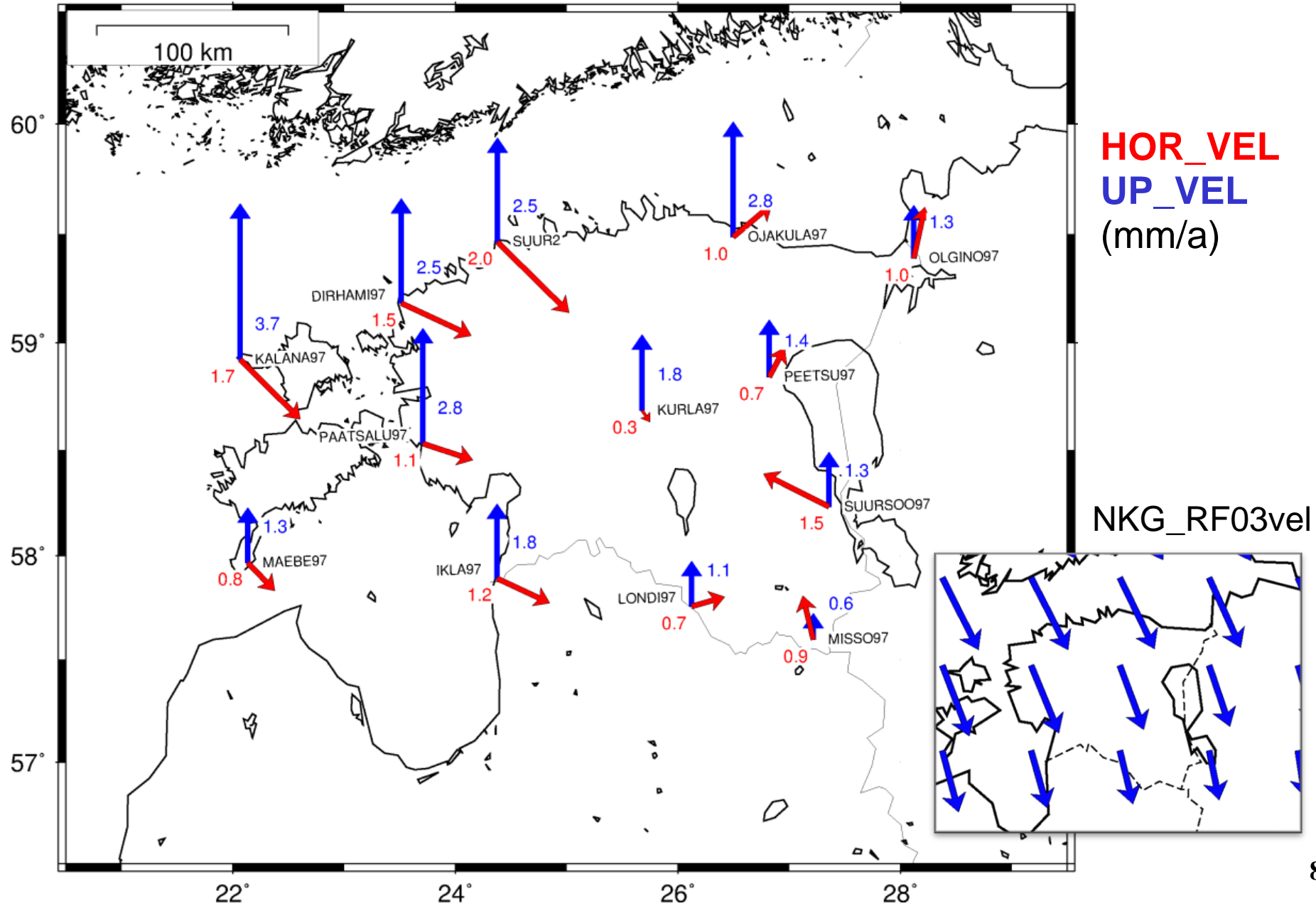
Comparison of RGP1997 and RGP2008:

GM 2012 Mar 05 20:02:59 RGP_motion_ITRF2005_A.ps, Compiled by T. Oja



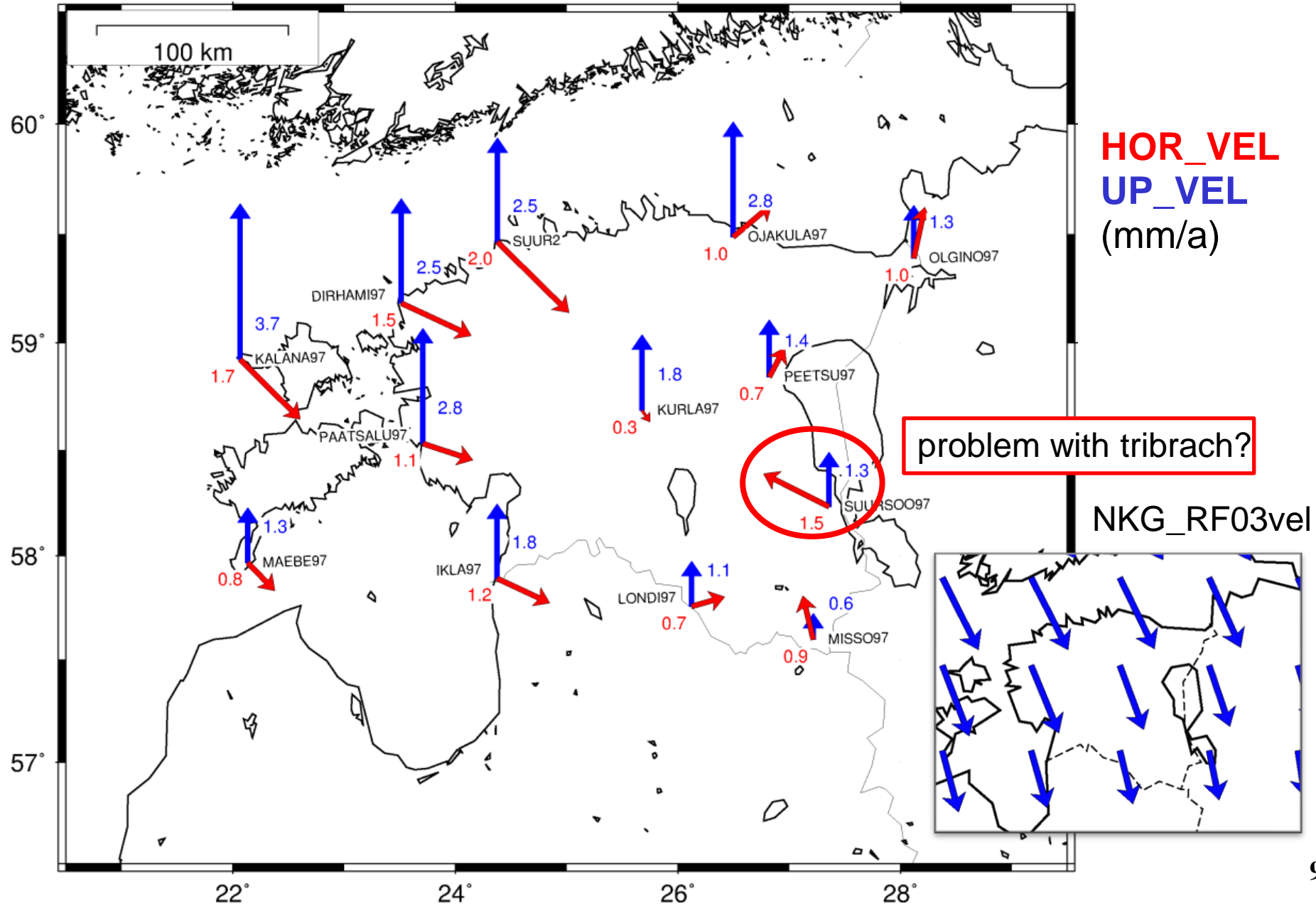
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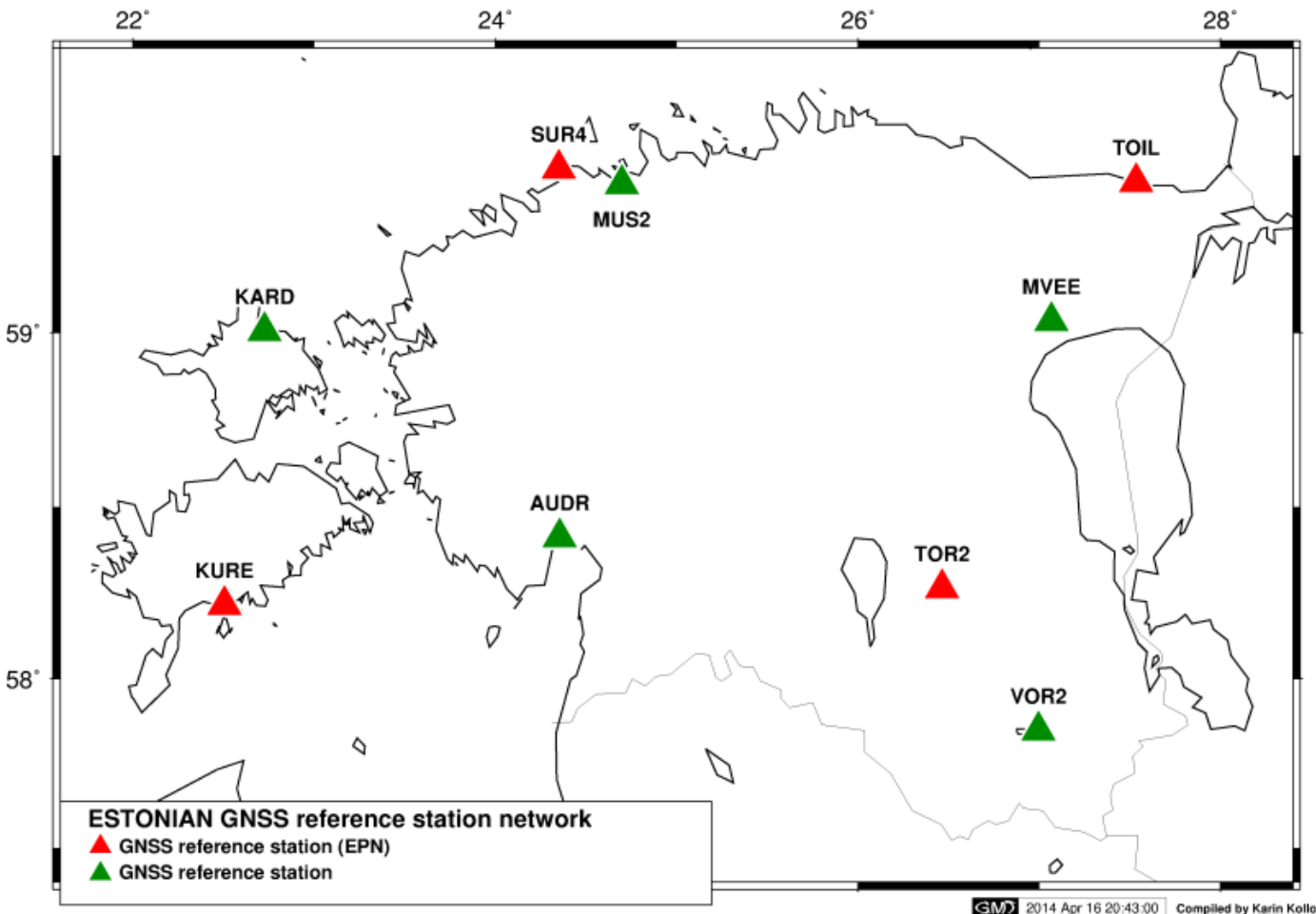


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ESTREF - Estonian GNSS Permanent Station Network in 2007-2014



□ KURE, SUR4, TOIL, TOR2 - stations of EUREF Permanent Network (EPN)

Time series from:

- 5 stations of ESTREF network (6 yrs of data)
 - Leica GRX1200GG PRO receivers and Leica GPS+GLONASS Choke Ring antennas together with LEIS dome
- 2 stations of private GNSS network (Trimble VRS Now) – 5 yrs of data
- Cumulative daily and weekly solution with Bernese 5.0 software
 - IGS05, since 2011 IGS08
 - Guidelines for EPN Analysis Centres and for NKG measurement campaigns were followed

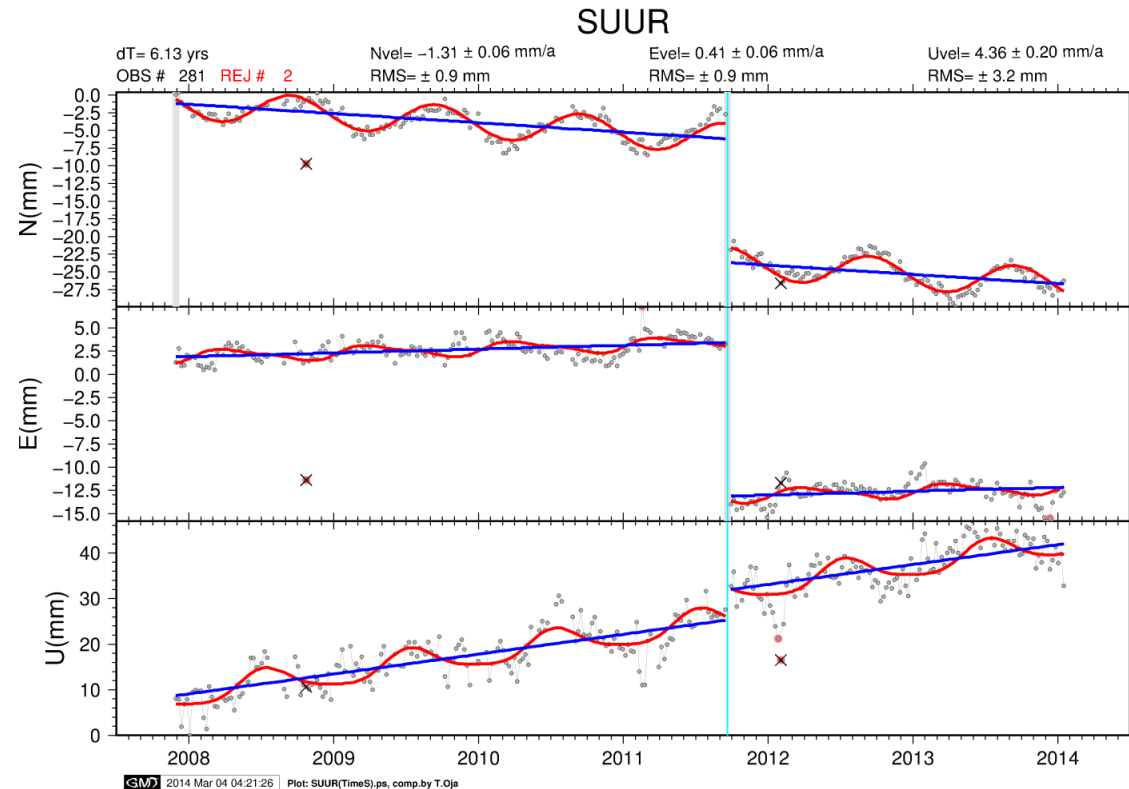
Analysis of time series:

- with CATS - Create and Analyse Time Series (Williams, 2008)
 - A fit of trend model to the daily/weekly time series of coordinates
 - The estimation of steps, periodical signals, constant velocities and their uncertainties
- ITRF2005 ARP was used to remove EU plate velocity

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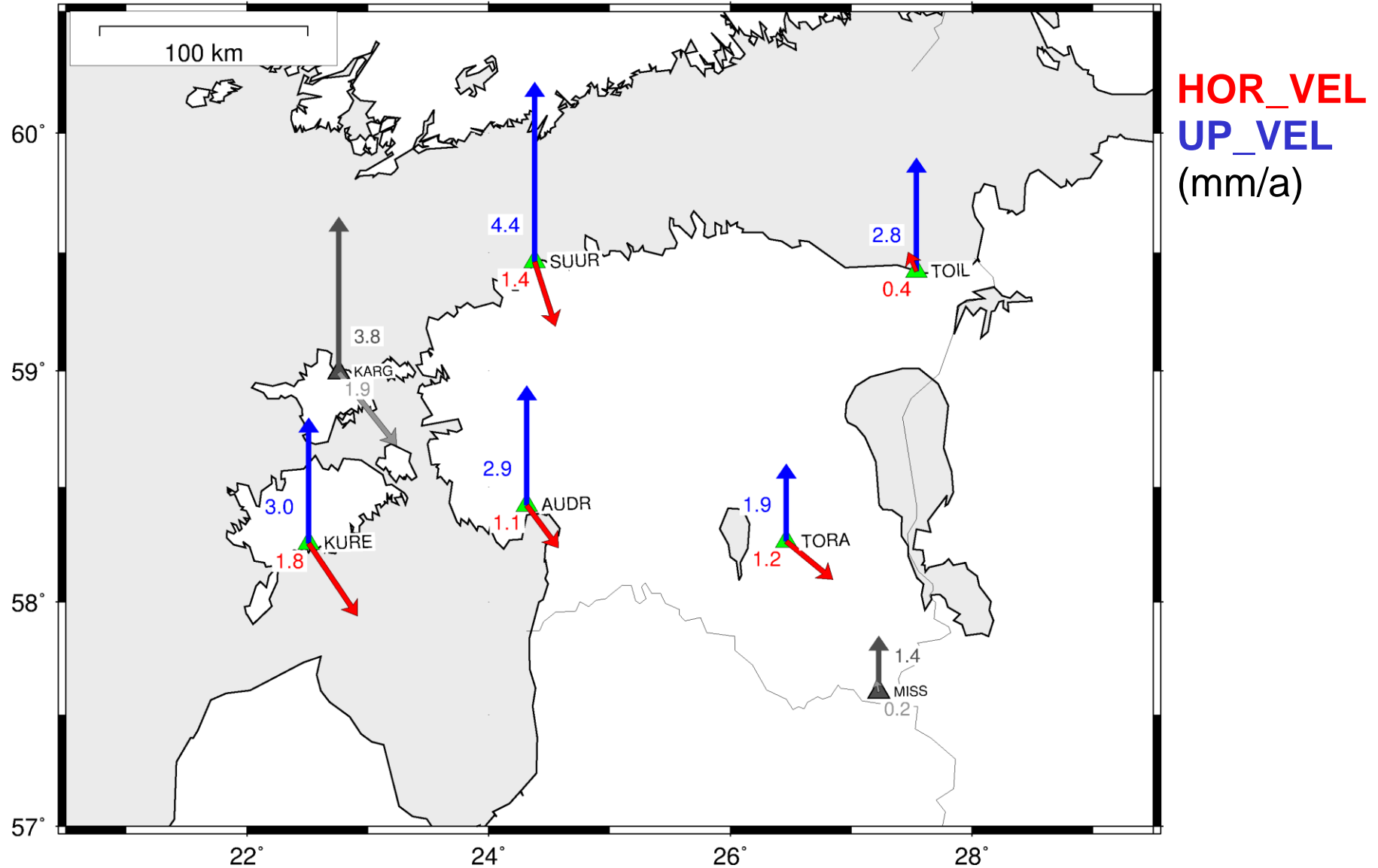
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Movements of GNSS stations:

GM 2014 Mar 04 05:09:42 EST_GNSS_VEL_2014-03.ps, Compiled by T. Oja

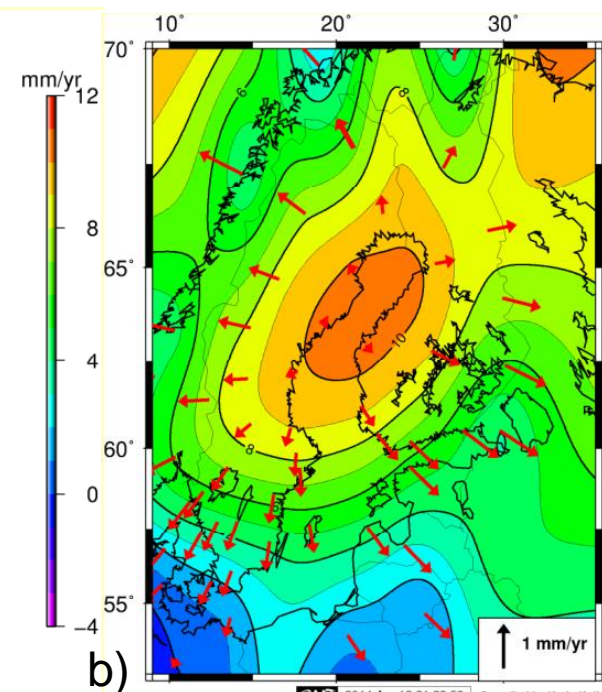
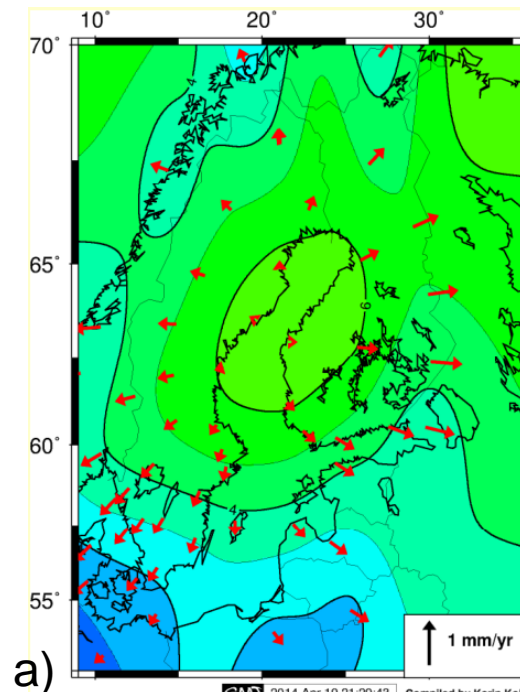


GIA modeling

- Open source software SELEN (Spada, Stocchi 2007)
- Ice model KL05 (Fleming and Lambeck, 2004?)
- For the physical Earth's model:
 - a) the nominal parameters (with KL05)
 - b) the optimum parameters from χ^2 -fitting based on the GNSS velocities (Lidberg et. al. 2010) \rightarrow UM $\sim 6 \times 10^{20}$, LM $\sim 6.5 \times 10^{21}$ Pa·s, LT ~ 75 km

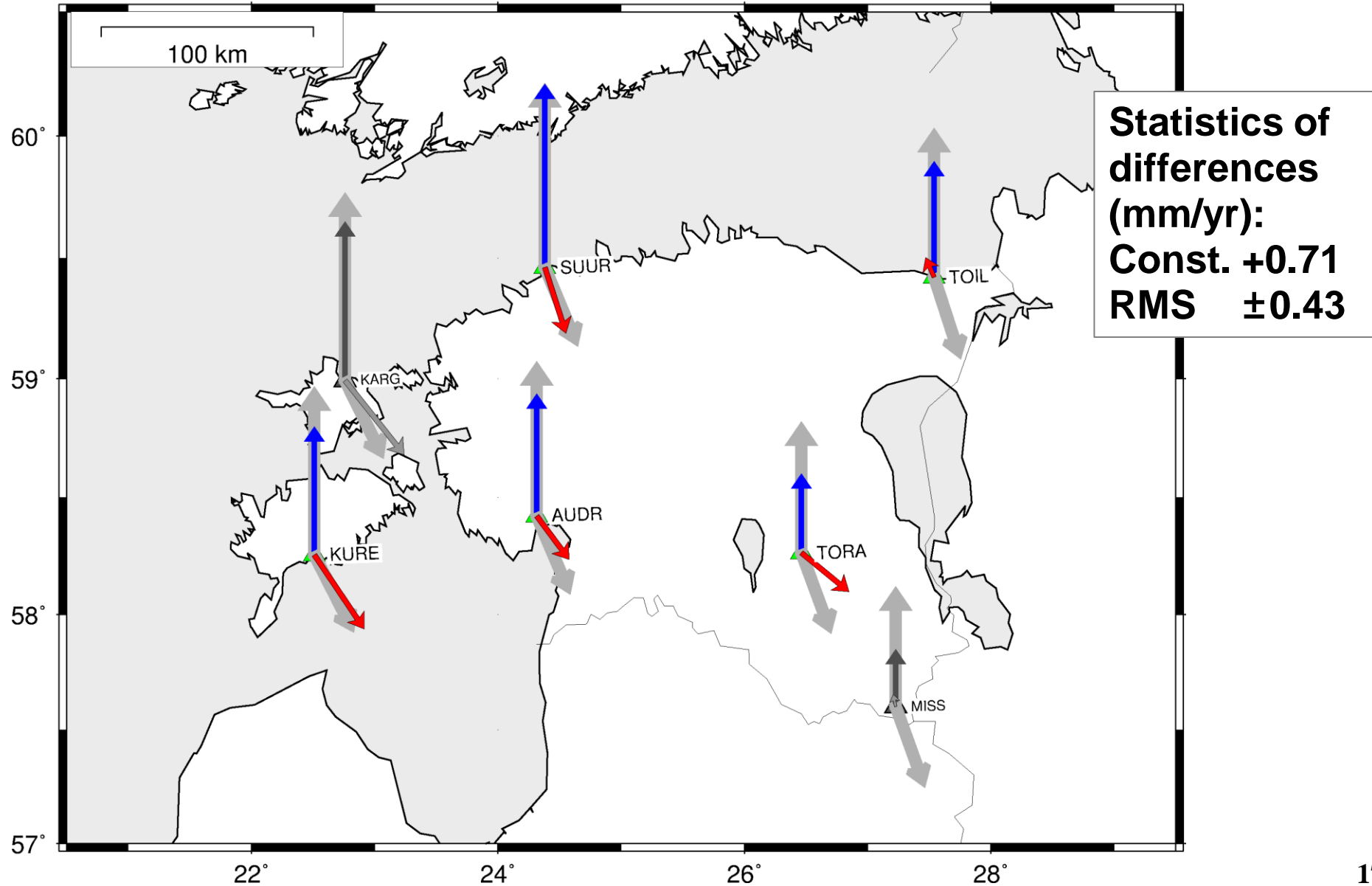
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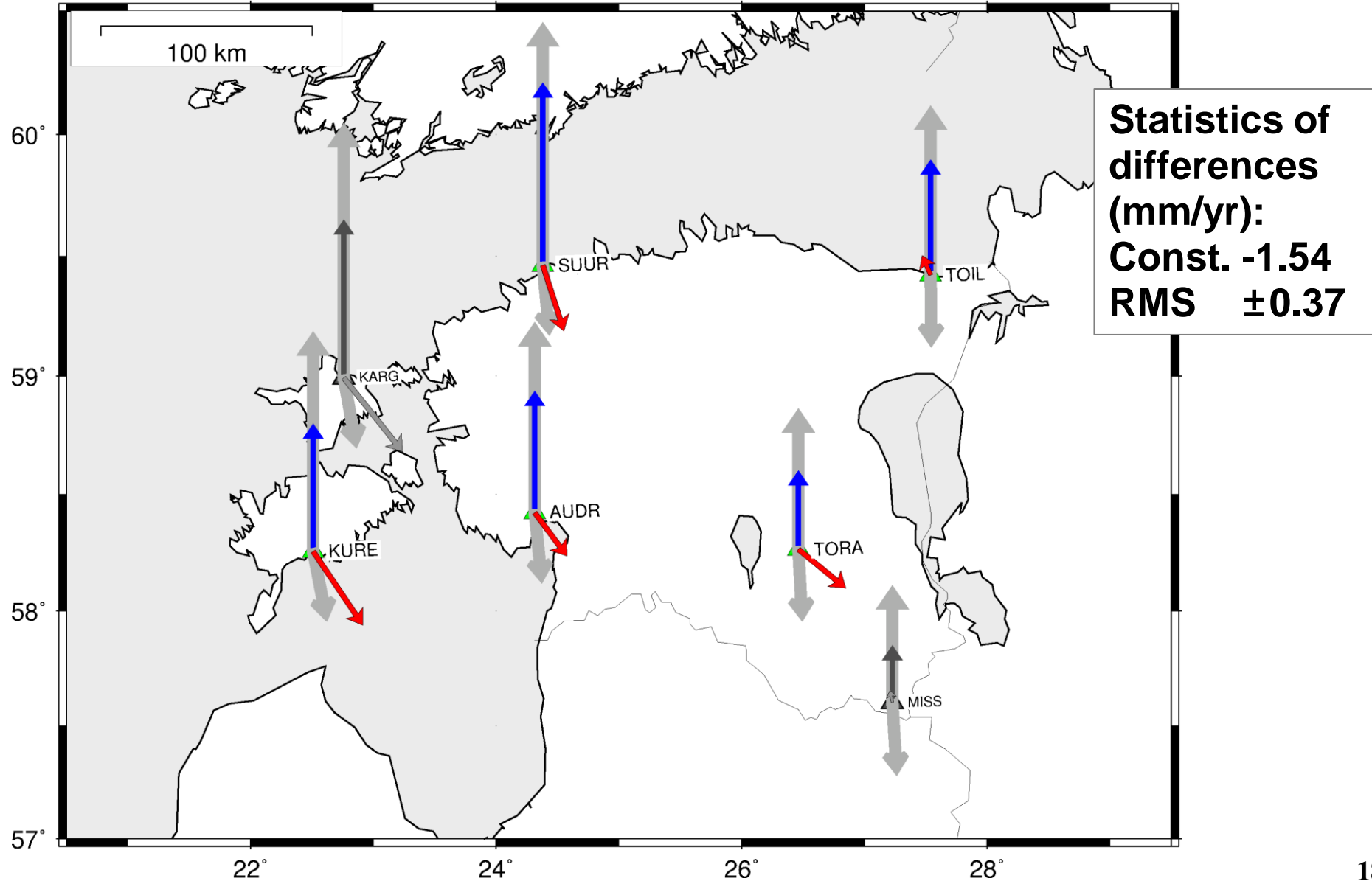
Comparison: GNSS vs GIA(KL05 + nom.param.)

GM 2014 Apr 22 08:05:30 ESTREFvsGIA(KL05defpar_KK).ps, Compiled by T. Oja



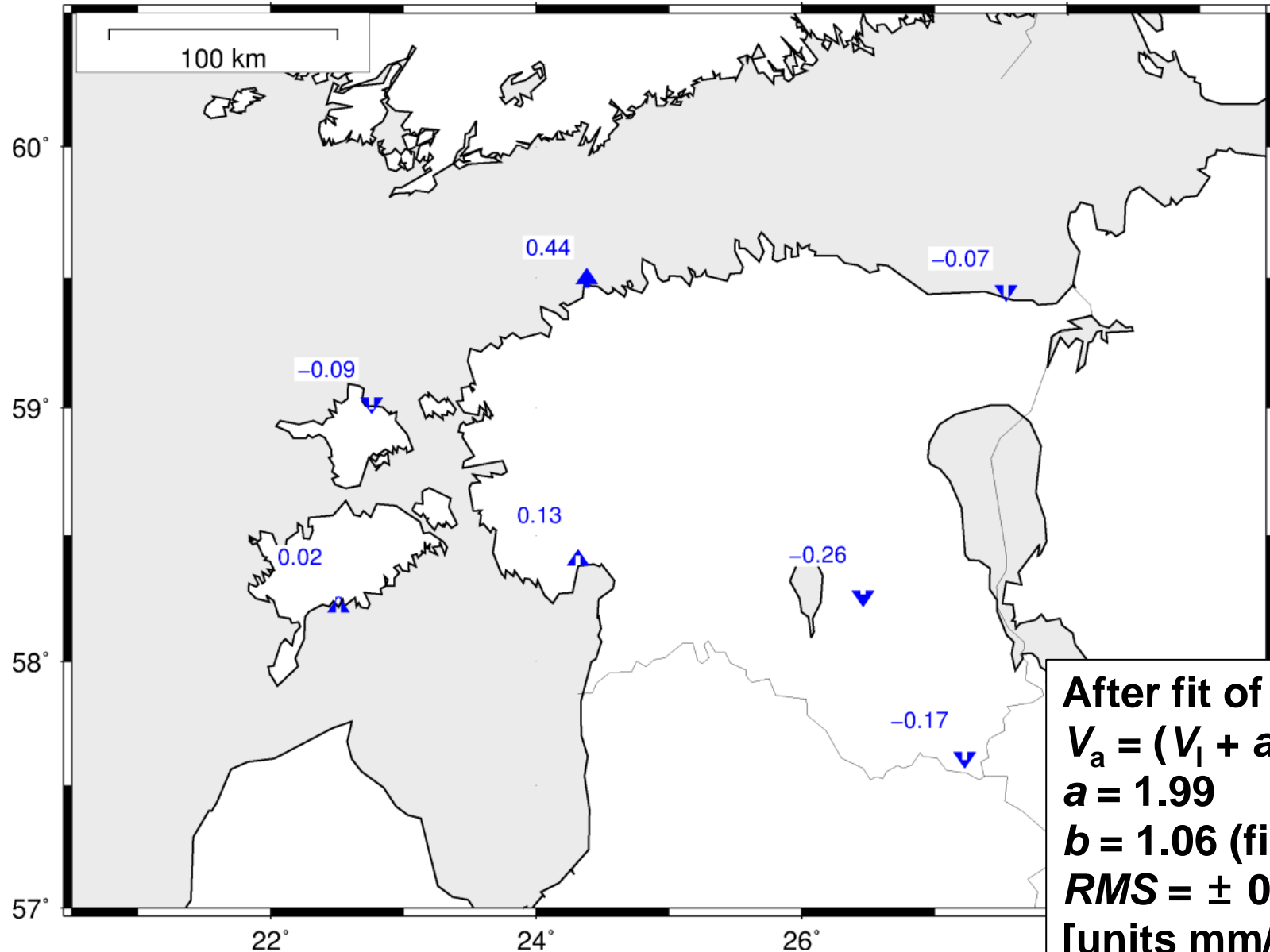
Comparison: GNSS vs GIA(KL05 + best fit with BIFROST)

GMD 2014 Apr 22 08:06:19 ESTREFvsGIA(BIFROSTbestfit_KK).ps, Compiled by T. Oja



Comparison of UP_VEL (GNSS vs NKG2005LU)

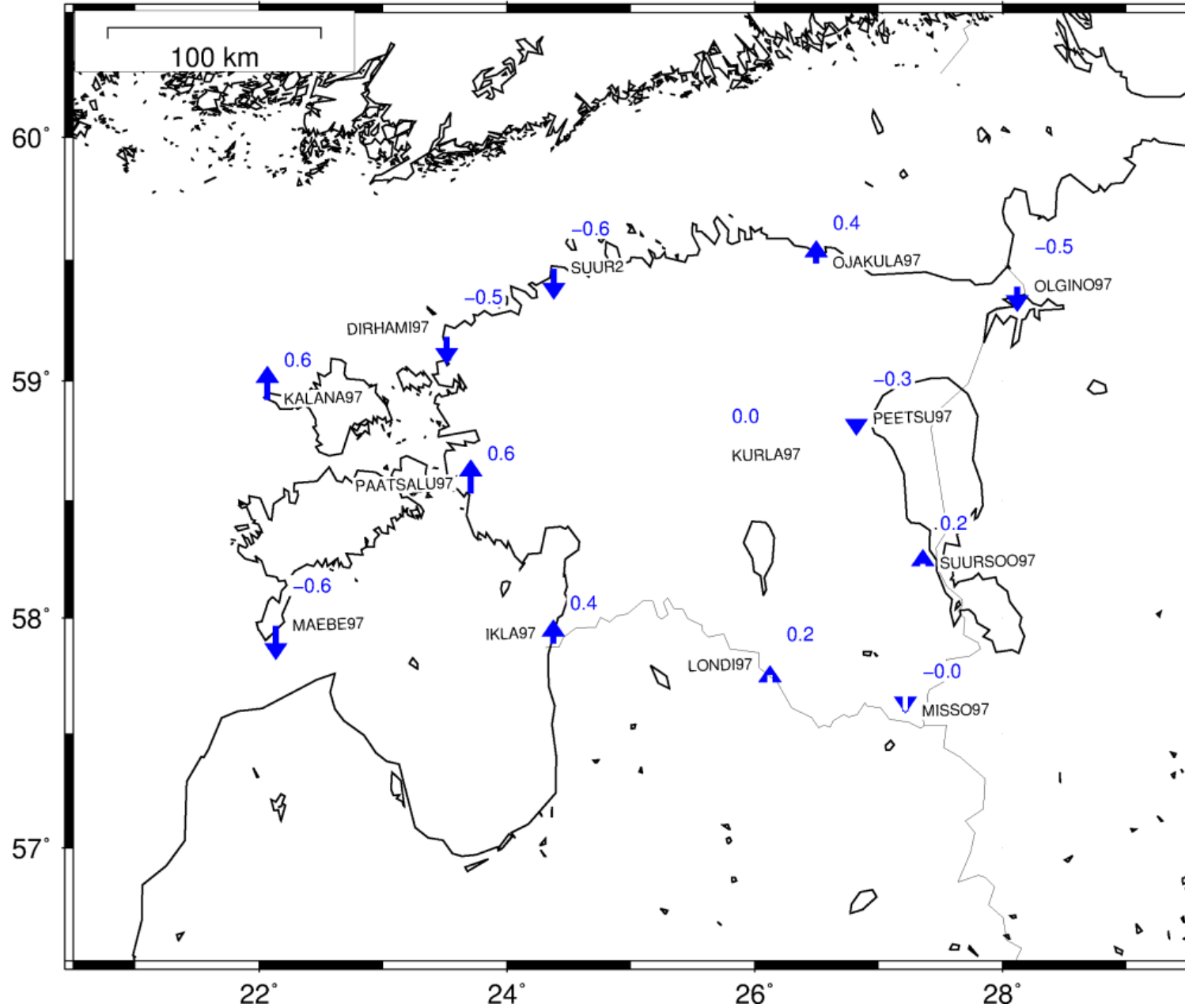
GM 2014 Mar 09 21:12:38 GNSS_EST_VEL_DIFF.ps, Compiled by T. Oja



After fit of the model
 $V_a = (V_l + a) * b$
 $a = 1.99$
 $b = 1.06$ (fixed)
 $RMS = \pm 0.23$
[units mm/yr]

Comparison of UP_VEL (RGP vs NKG2005LU_ABS)

GM 2012 Mar 06 22:35:09 RGP_motion_ITRF2005_DIFF_A-NKG2005LU(ABS).ps, Compiled by T. Oja



**DIFF
UP_VEL**
(mm/a)

Const. +0.2
RMS ± 0.44

Conclusions

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Thanks! Questions?