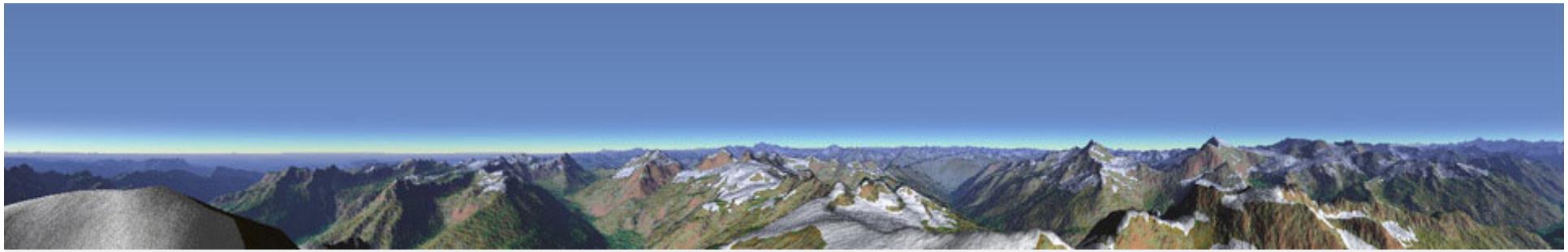

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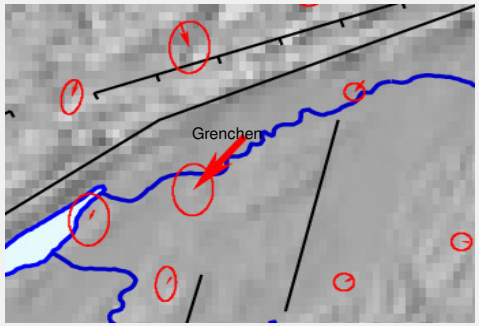
Bundesamt für Landestopografie
Office fédéral de topographie
Ufficio federale di topografia
Uffizi federal da topografia

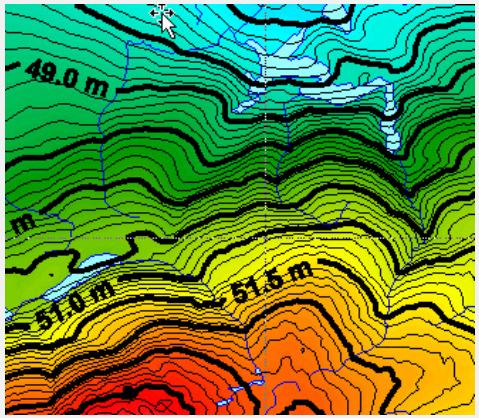
Results of the 3rd observation of the Swiss GPS Reference Network LV95 and status of the Swiss Combined Geodetic Network CH-CGN

E. Brockmann, D. Ineichen, U. Marti, A. Schlatter

Content

- GPS Campaign 2004
- Combination 1988 – 2004
- Comparisons with “official” coordinates
- Velocity results
- CH-CGN: New Geoid CHGeo2004





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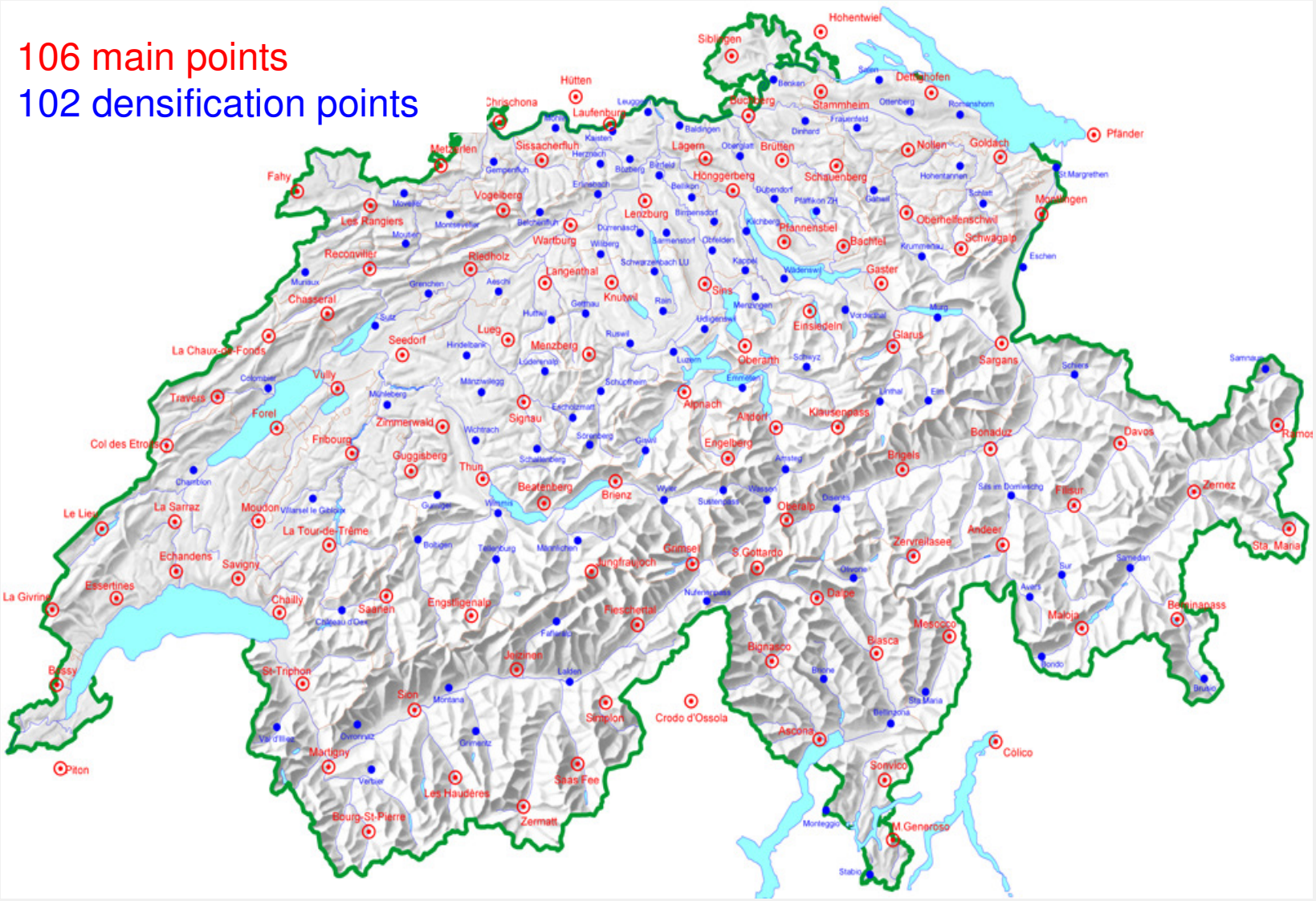
LV95 reference network

1988 - 1995

106 main points
102 densification points



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LV95 reference network (2)

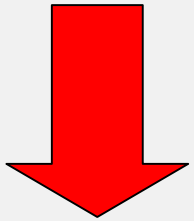
- Setup 1988 – 1995 (CHTRF95)
- Second observation 1998 (CHTRF98)
- Third observation 2004 (CHTRF2004)

Campaign 2004 Setup

- Permanent GPS network as backbone
- Only single occupations, 1 night of observations
- 11 weeks of observations

CHTRF2004: Analyses

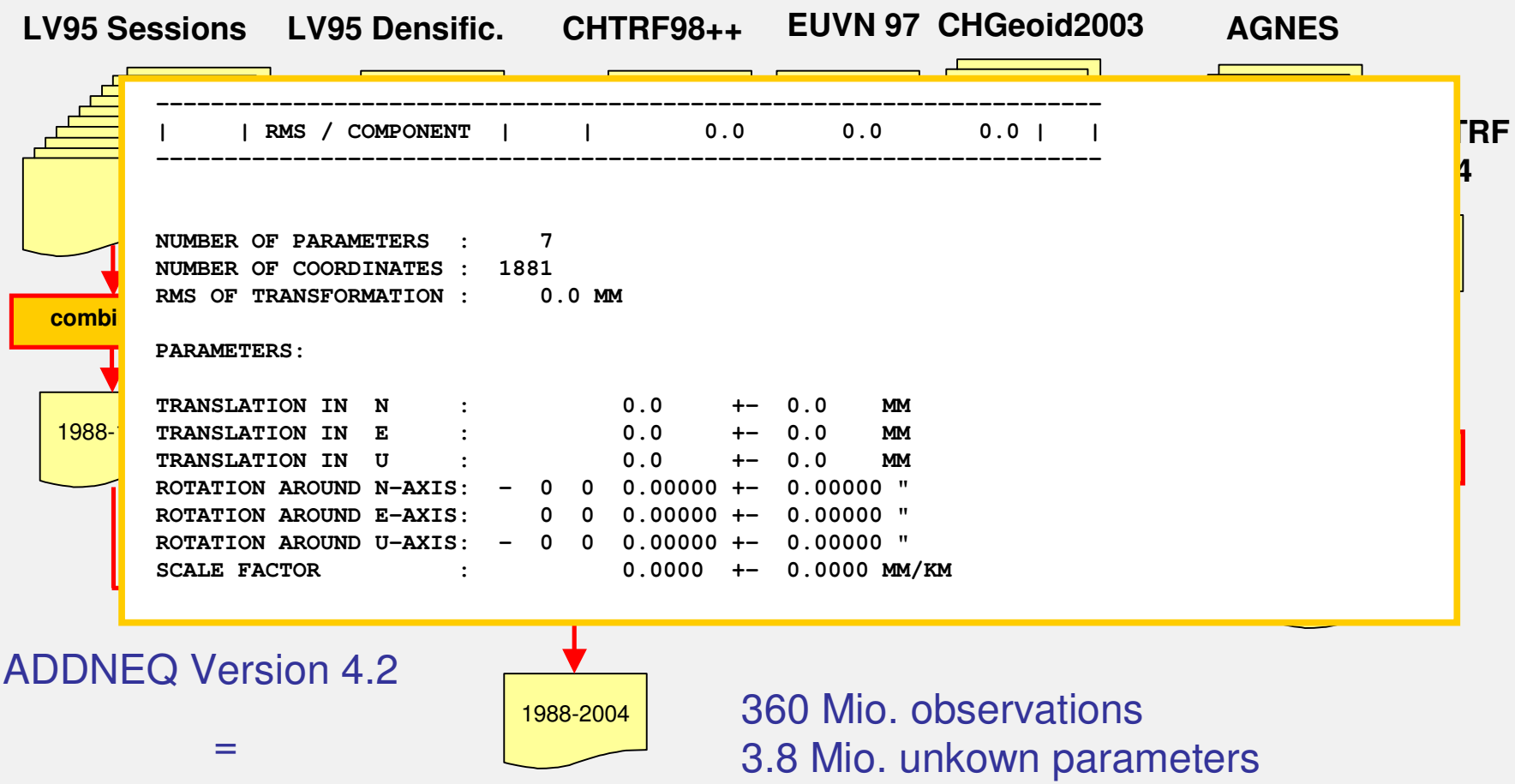
- 11 weeks of data collected by 13 observer
- 58 sessions, 289 files, 5289 hours
- Averaged observation time 18.3 Stunden
- 1680 24- and 36-hour files of permanent AGNES-sites
- # observations: 4.8 Mio / 40 Mio with AGNES



Semi-automated processing with
Bernese 4.2 (CPU time: about 8 days)

- 245 site coordinates

CHTRF2004: Common adjustment




```
-------------------------------------------------------------------
|     | RMS / COMPONENT  |     |        0.0       0.0       0.0 |   |
-------------------------------------------------------------------


NUMBER OF PARAMETERS  :     7
NUMBER OF COORDINATES :  1881
RMS OF TRANSFORMATION :     0.0 MM

PARAMETERS:

TRANSLATION IN  N     :           0.0     +-  0.0     MM
TRANSLATION IN  E     :           0.0     +-  0.0     MM
TRANSLATION IN  U     :           0.0     +-  0.0     MM
ROTATION AROUND N-AXIS:  -  0  0  0.00000 +-  0.00000 "
ROTATION AROUND E-AXIS:     0  0  0.00000 +-  0.00000 "
ROTATION AROUND U-AXIS:  -  0  0  0.00000 +-  0.00000 "
SCALE FACTOR          :           0.0000  +-  0.0000 MM/KM
```

ADDNEQ Version 4.2

=

ADDNEQ Version 5.0

360 Mio. observations
3.8 Mio. unkown parameters
627 site coordinates

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Common adjustment: statistics

Campaign	# stations	Helmert RMS north [mm]	Helmert RMS east [mm]	Helmert RMS up [mm]
1: LV95	302	2.1	2.2	11.3
2: LV95-Verdichtung	132	1.6	1.7	9.2
3: EUVN97	8	1.3	1.3	5.0
4: CHTRF98 ++	293	1.4	1.1	5.5
5: CHGeoid2003	66	1.2	0.6	1.6
6: CHTRF2004	245	1.9	1.6	5.7
7: AGNES	102	0.5	0.3	1.1

Total:	627	1.7	1.6	7.6

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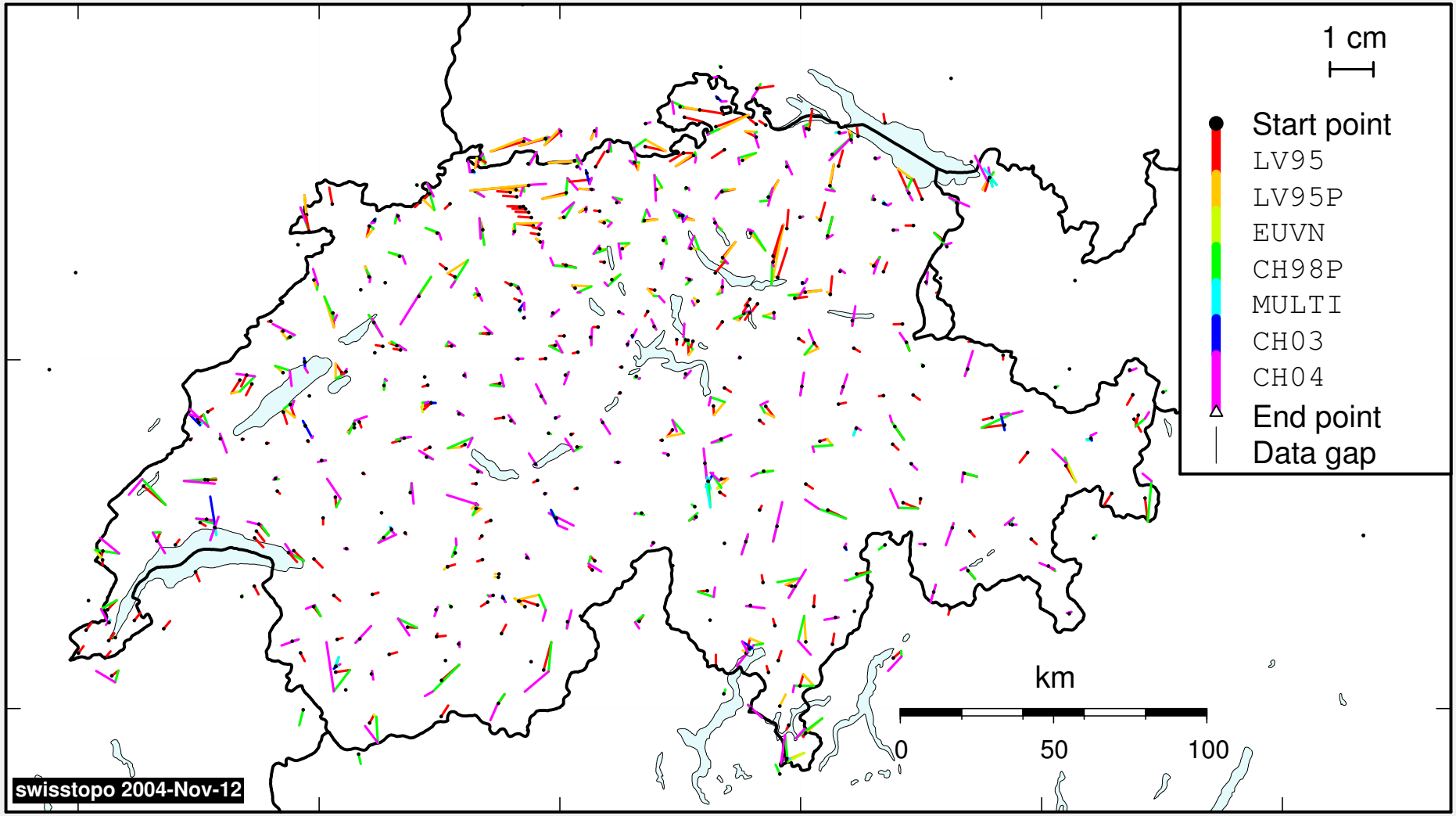
Adjustment residuals: horizontal components



627 Stationen

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Common adjustment: with velocities for 176 sites (>= 3 epochs observations)

Campaign	# stations	Helmert RMS north [mm]	Helmert RMS east [mm]	Helmert RMS up [mm]
1: LV95	302	1.4	1.6	11.2
2: LV95 Verdichtung	132	1.3	1.6	9.3
3: EUVN97	8	1.3	1.6	5.4
4: CHTRF98 ++	293	1.3	1.1	5.5
5: CHGeoid2003	66	1.0	0.4	1.4
6: CHTRF2004	245	1.3	1.1	5.7

Total (with velocities)	560	1.3	1.3	8.0

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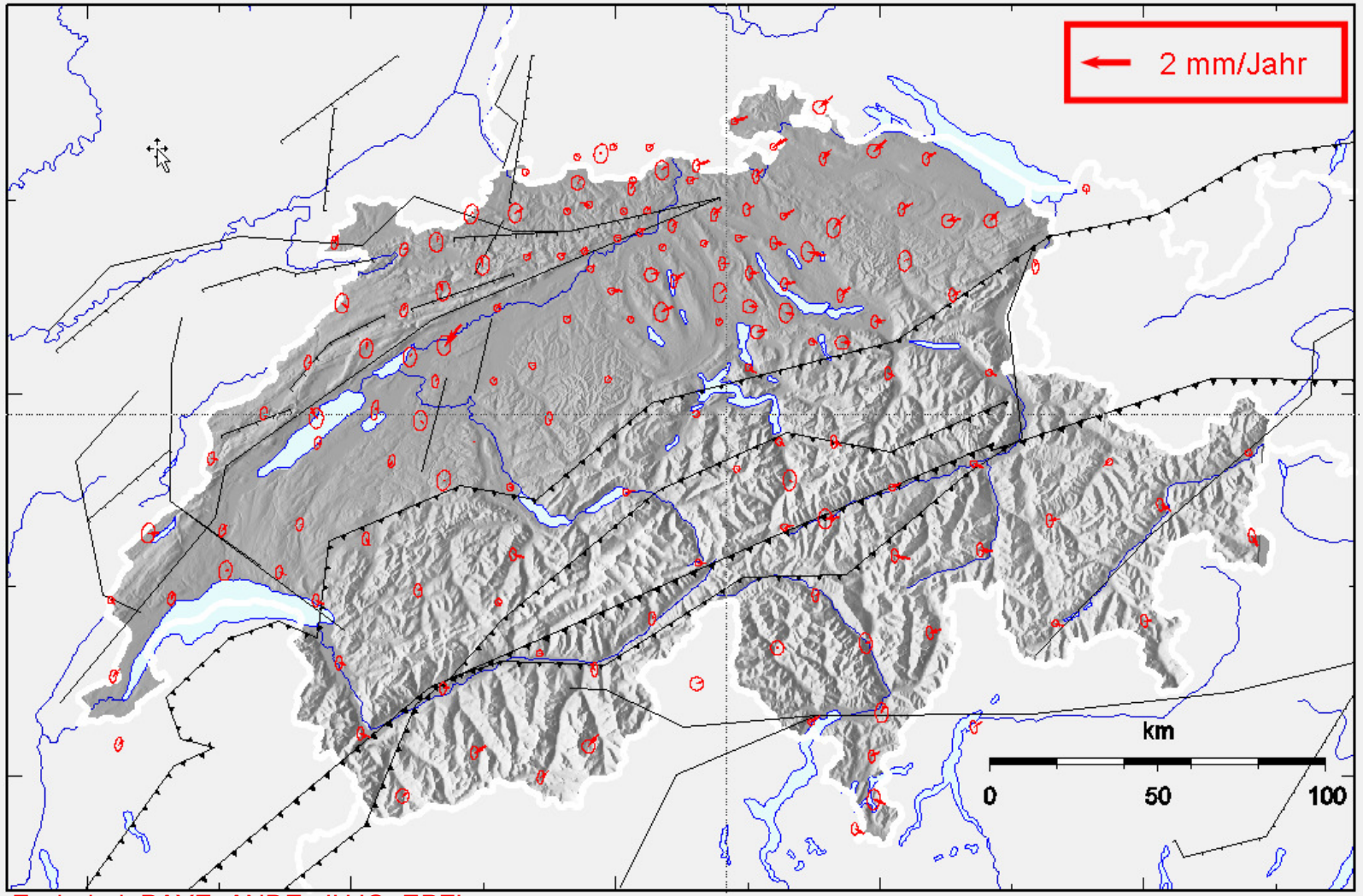
Horizontal velocities

176 stations (>= 3 epochs)



Excluded: PAYE, ANDE, JUJO, EPFL

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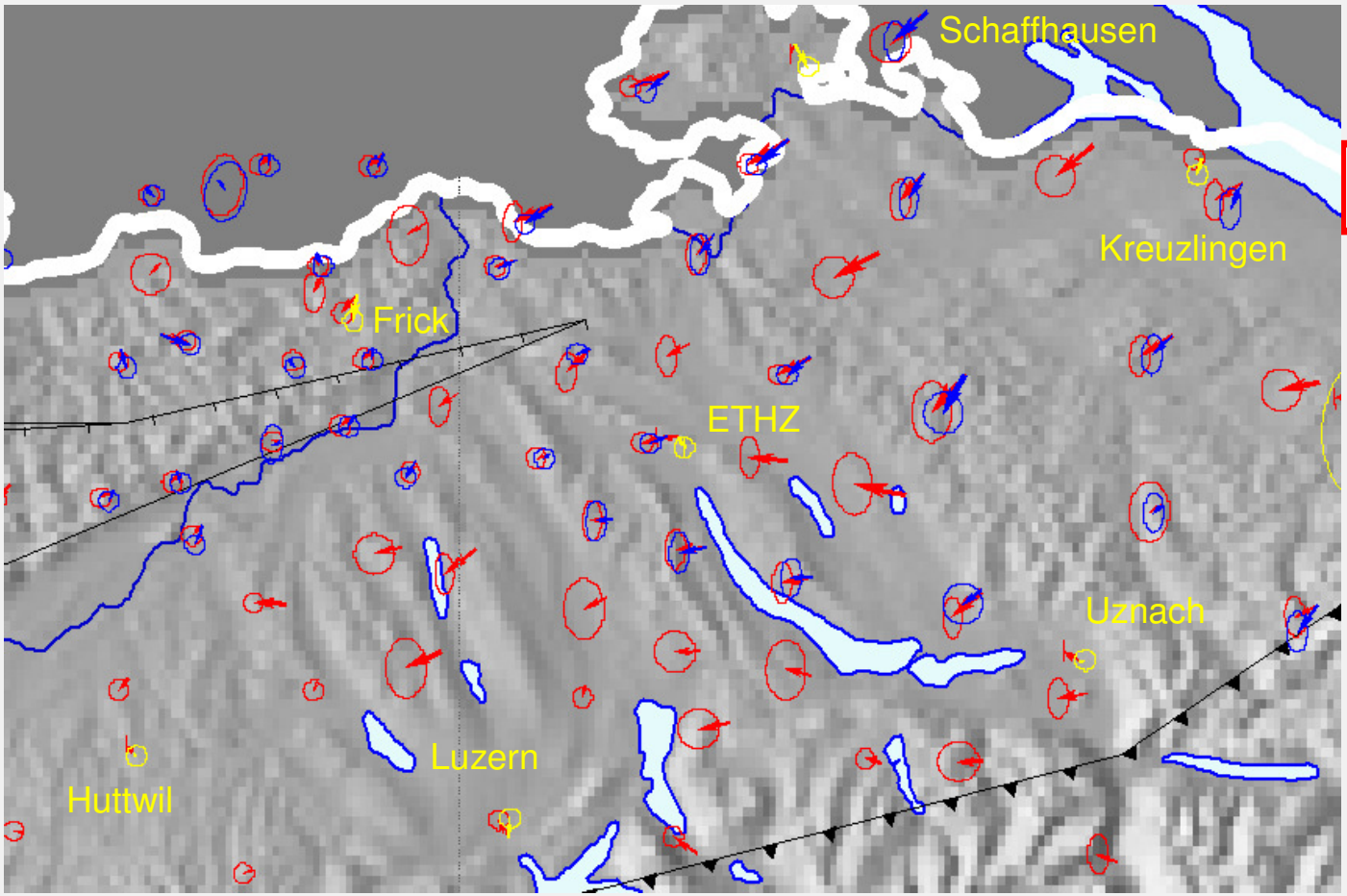
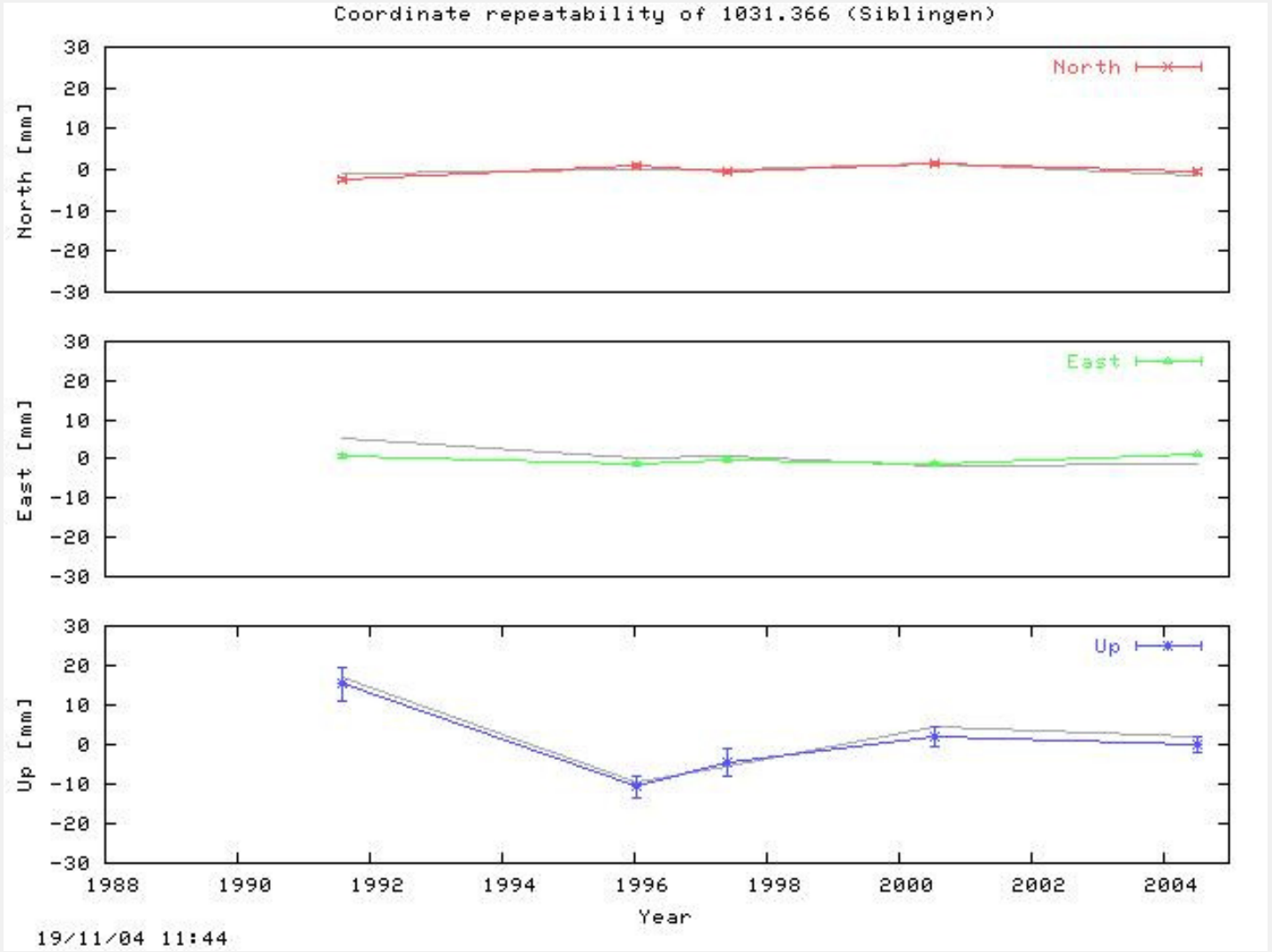
Movements in region north-east Switzerland ?



2 mm/Jahr

All campaign data used Partial data set used AGNES data only (reduced time span)

Example: Point „Sieblingen“



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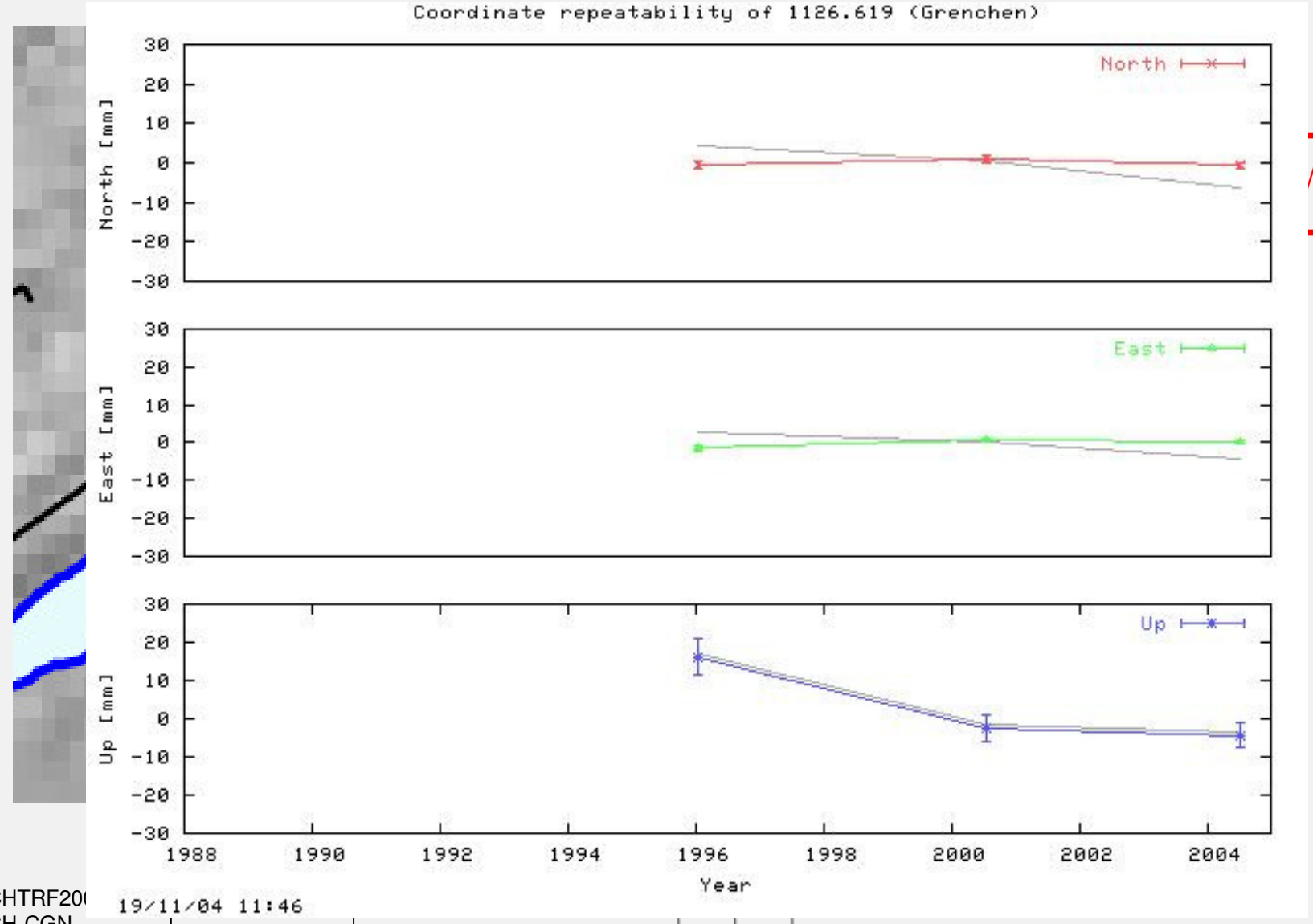
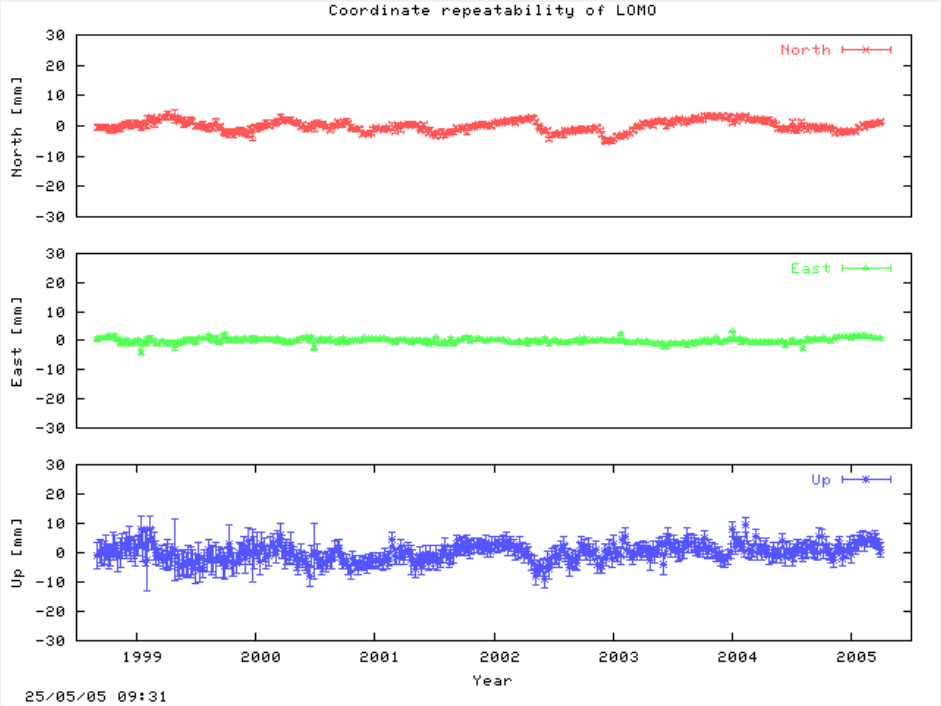
Instability: site Grenchen

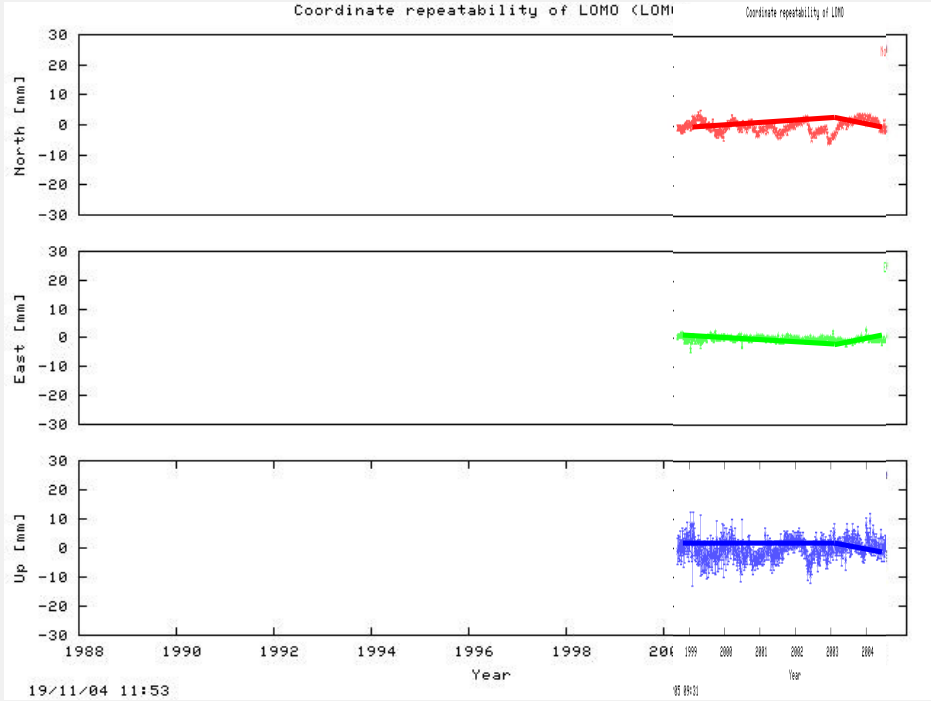


/Jahr

CHTRF20
CH-CGN

Velocities from permanent processing versus campaign processing





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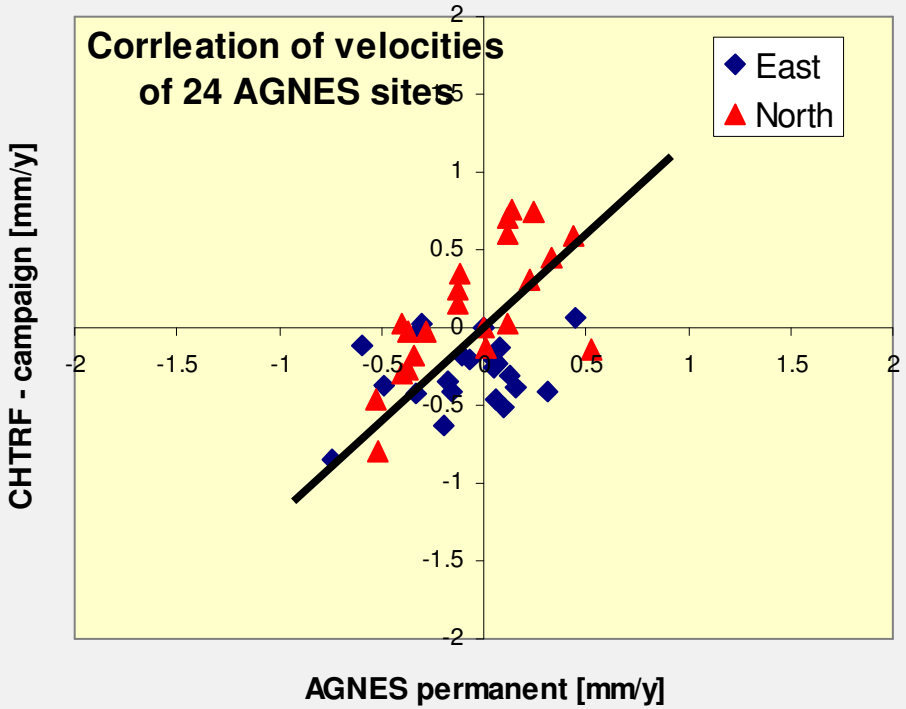
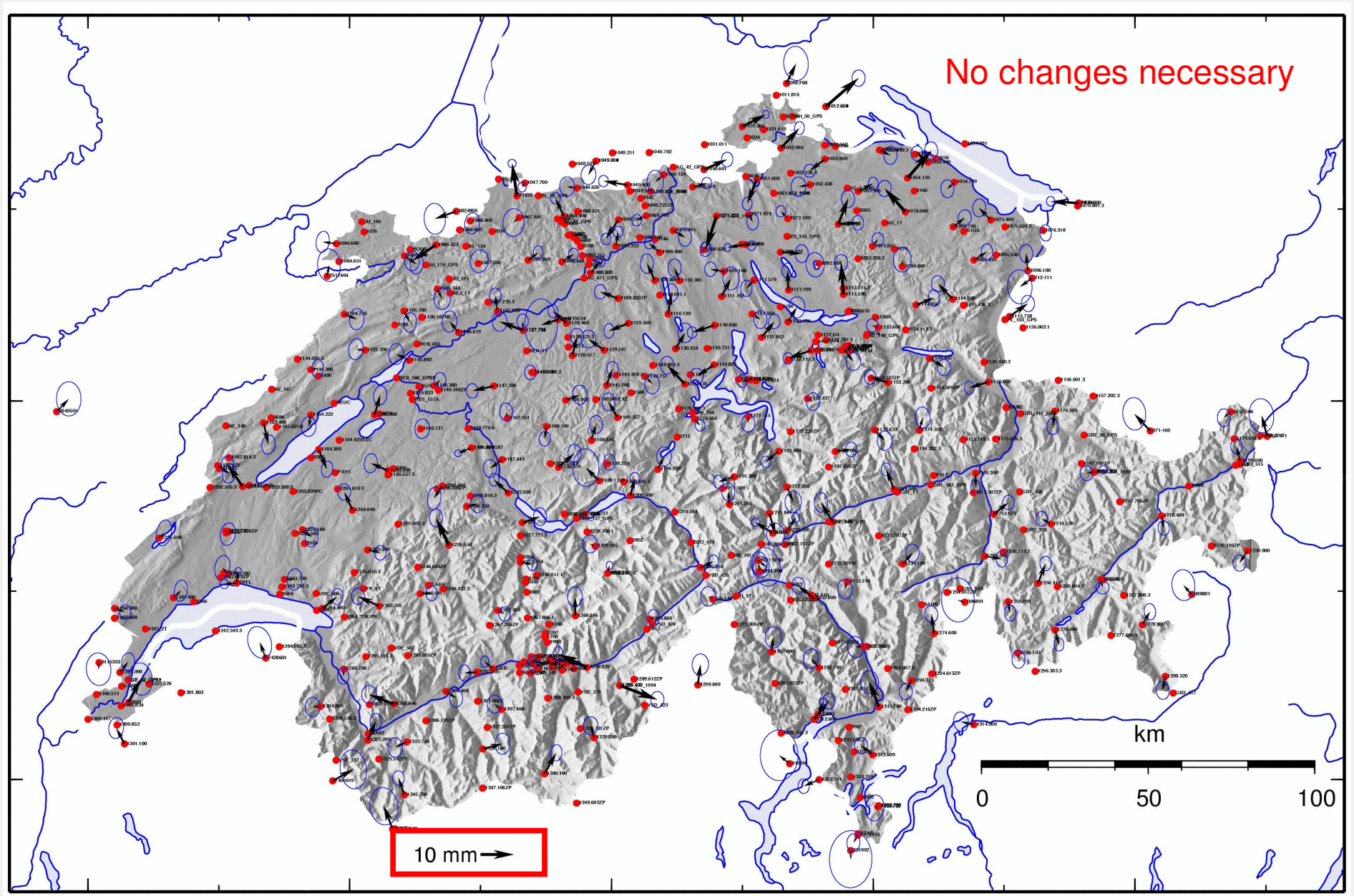
Velocity validation with AGNES results

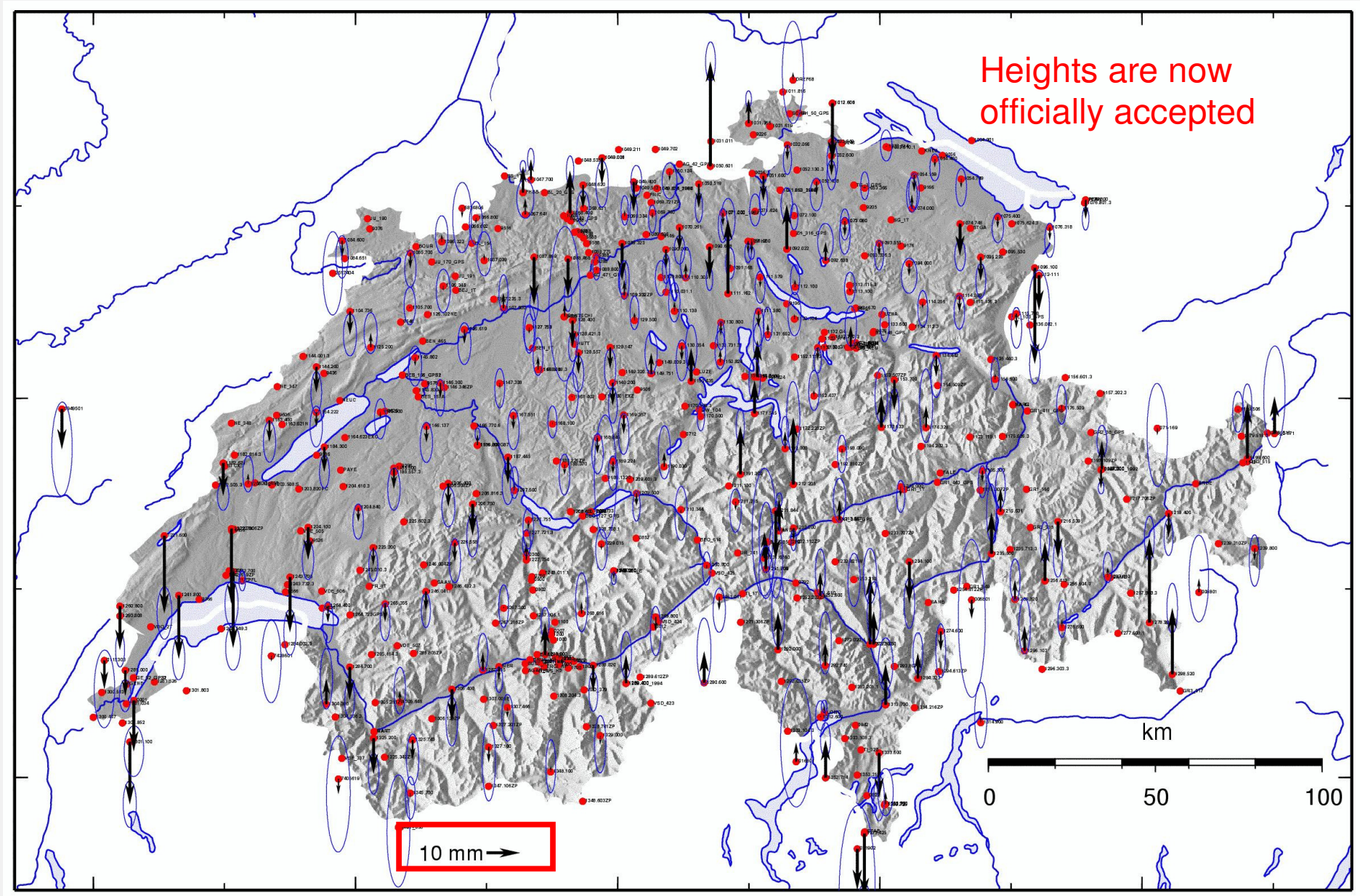


- 24 AGNES sites (3-6 years observations):
  - agreement permanent versus campaign is 0.3 mm/y (std)
  - velocites itself: 0.3 mm/y (std)
- LV95 sites (10-16 years observations): more reliable (!?)

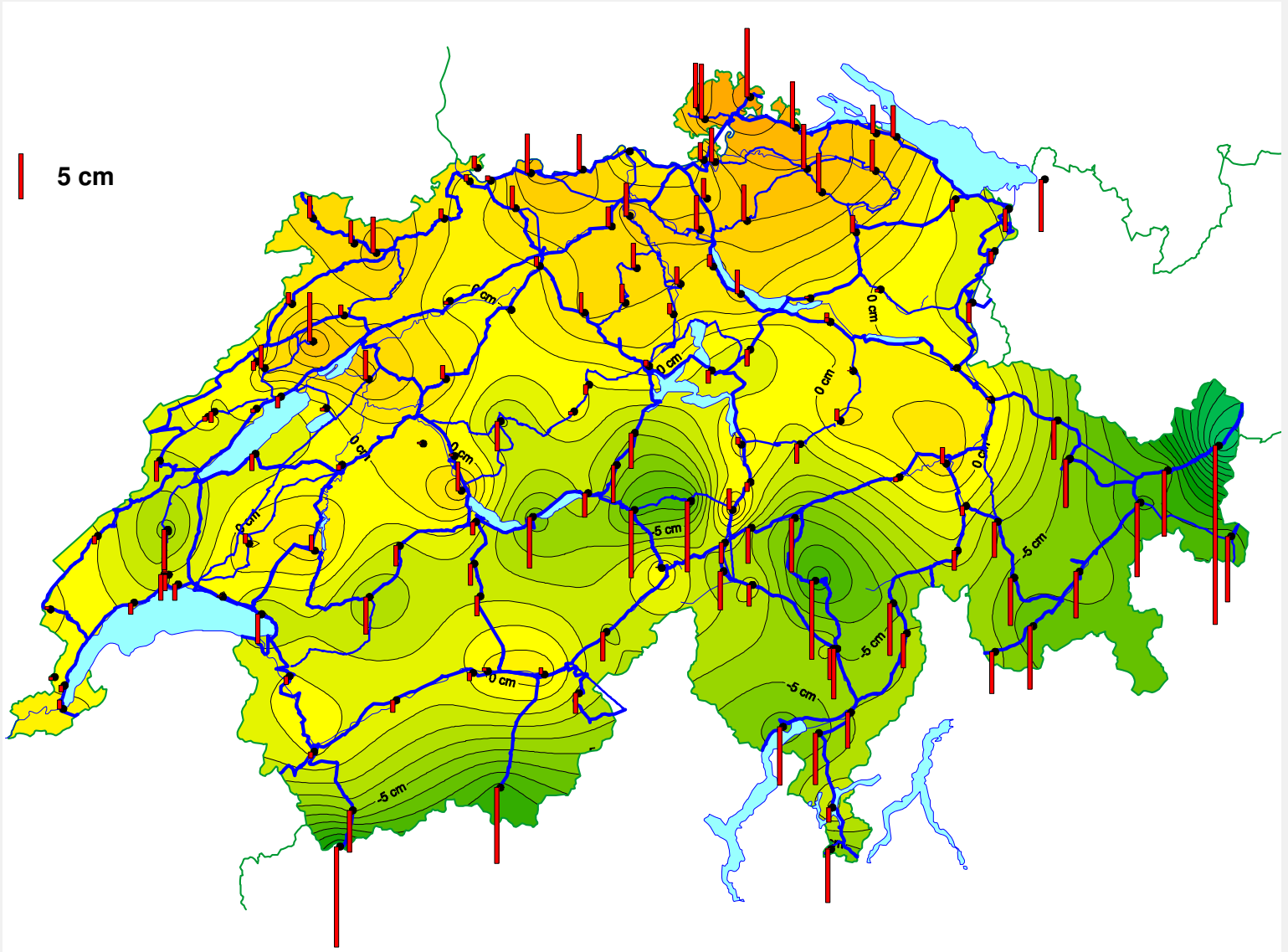
Differences CHTRF [mm] – LV95 (horizontal) [cm]



Differences CHTRF – LV95 (vertical)



GPS/Niv residuals to Geoid CHGeo98



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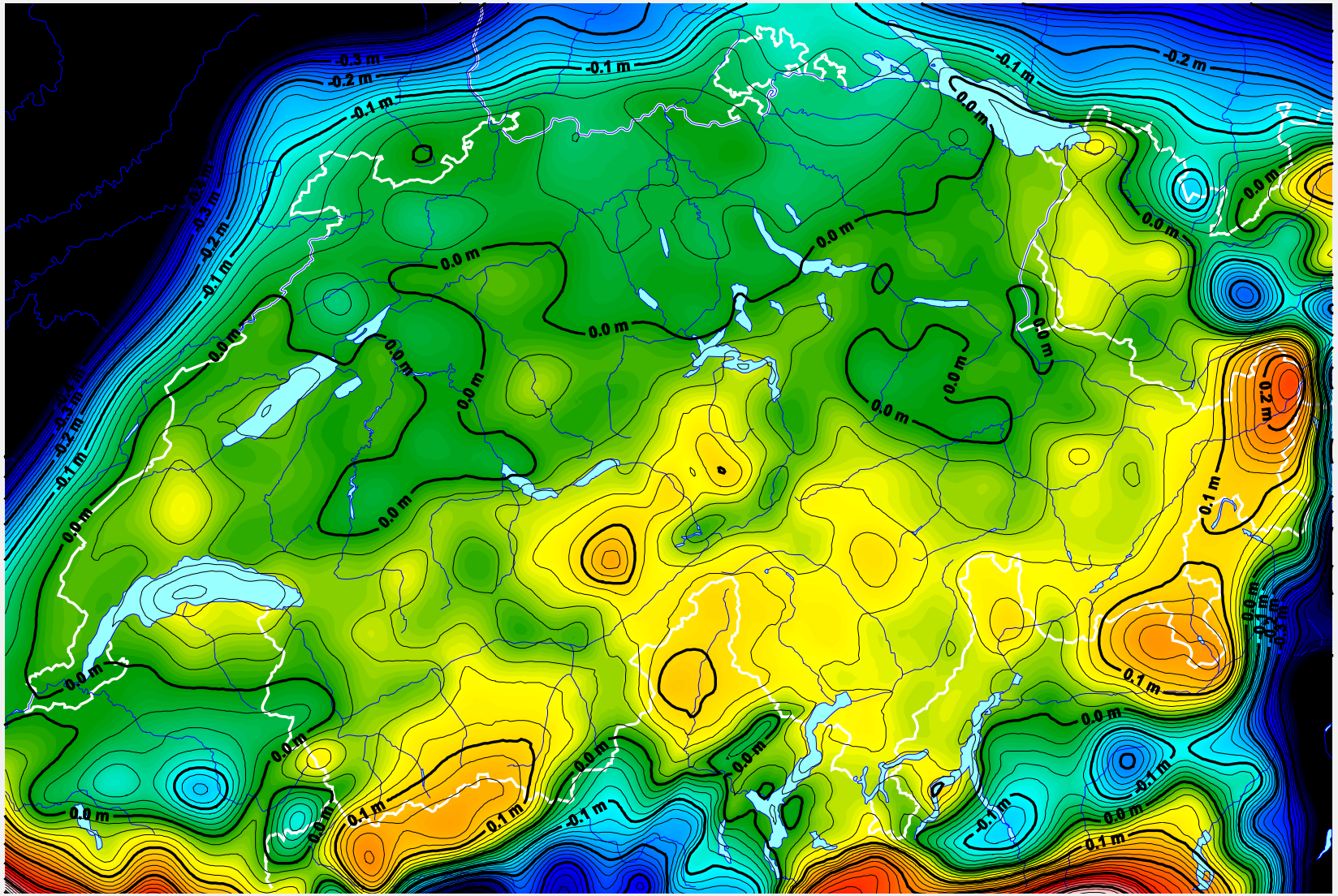
Improvement of the Geoid

- Additional measurements
  - GPS-levelling points
  - quality control and new observations of deflections of the vertical due to zenith camera measurements (October 2003)
- Improved mass models and digital terrain models
  - SRTM (instead DTED1)
- Method
  - usage of geoid model EGM96
  - usage of gravity measurements

- systematic behavior of a pure geoid based on deflections of the vertical and gravity of about 6 cm

➡ Fixing geoid to GPS-levelling („user friendly“)

Differences CHGeo2004 minus CHGeo98



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Summary

- CHTRF2004 planning, measurement, processing, documentation within 1 year
- Accuracy 5 mm (horizontal) 15 mm (vertical)
- High stability of the points. Velocities near the significance level (< 1.0-1.5 mm / year)
- GPS-levelling constraints the new geoid CHGeo2004
- Consistent / user friendly geoid ←→ physically modelled geoid: please visit our poster !!!

Thank you for your attention

Mont Vully