6th EUPOS Meeting

NATIONAL REPORT OF SLOVENIA

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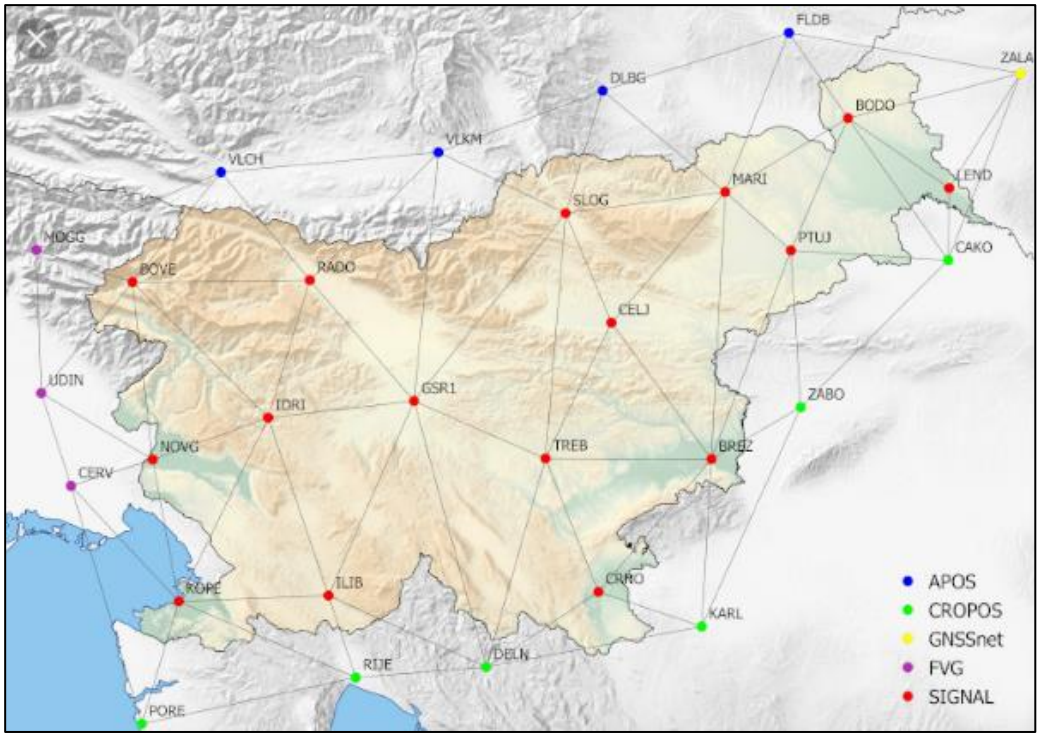
PRESENTATION TOPICS

- **Active GNSS Networks: SIGNAL & Zero Order**
- **EUREF Slovenia 2016 GNSS Campaign: Results, Implementation & Future Challenges**
- **New Coordinate and Height Reference Systems in Slovenia**
- **Other Activities**

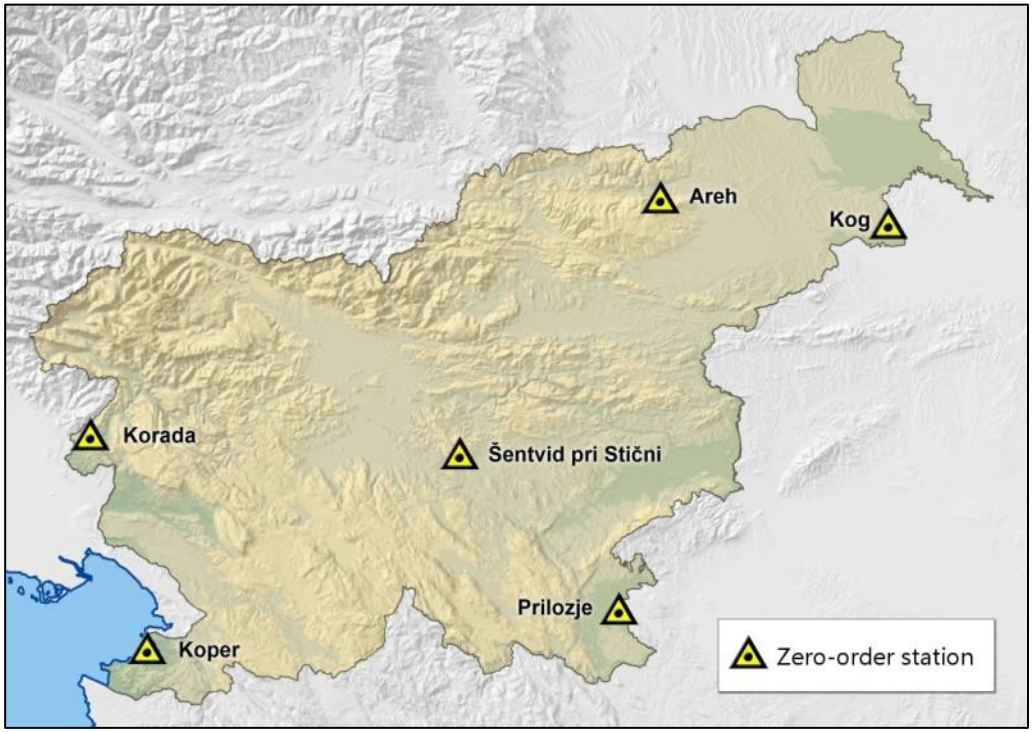
SIGNAL NETWORK (GBAS)

- **16** continuously operating GNSS stations in Slovenia (8 Trimble + 8 Leica)
- +**14** continuously operating GNSS stations in Austria, Croatia, Hungary & Italy
- **1** EPN station (GSR1 – Ljubljana, EUREF Class A)
- Trimble Pivot Platform



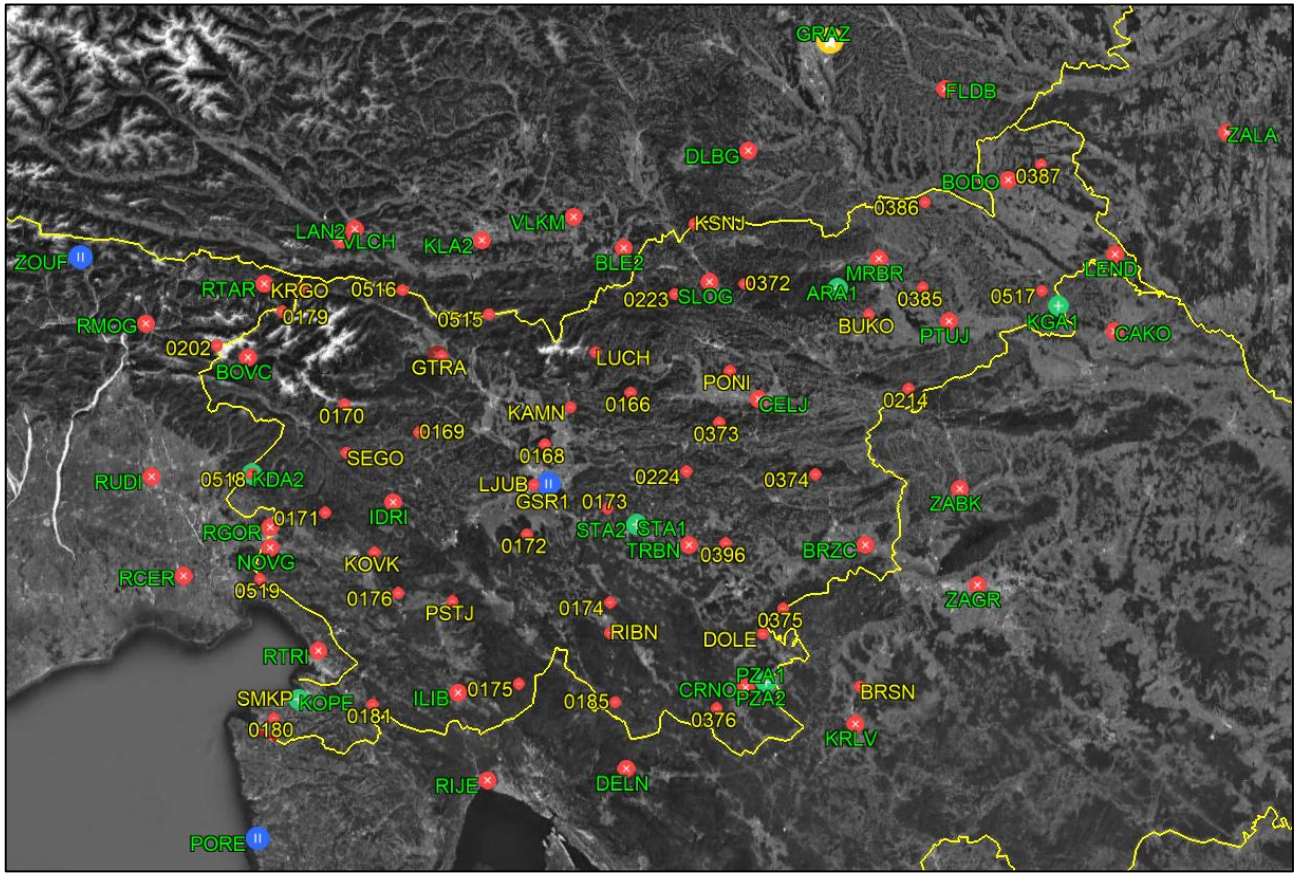
ZERO ORDER GNSS NETWORK

- **6** continuously operating GNSS stations in Slovenia (Leica)
- **4** of them are **twin stations**, **1** combined with a **tide gauge station**, **1** with a **seizmic station**, **1** near an old **triangulation point**, **1** near an **absolute gravimetric point**;
  all stations connected to the first order levelling network
- Operating for more than 3 years, Alberding Quality Control



EUREF SLOVENIA 2016 GNSS CAMPAIGN

- **48** passive GNSS stations in Slovenia (EUREF points from old campaigns)
- **69** continuously operating GNSS stations
- **80** consecutive daily sessions with the mean epoch 2016.75
- Minimum constraint solution, coordinates only (EUREF Class B, ETRS89/D17)



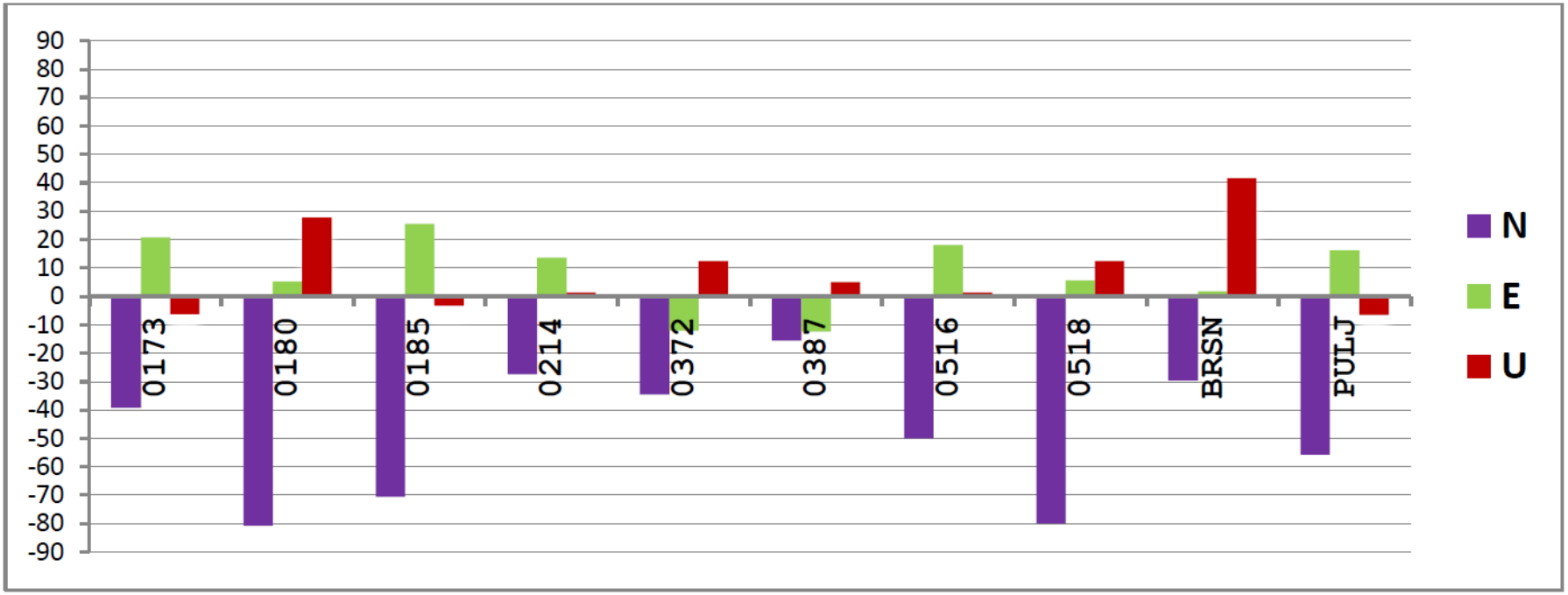
EUREF SLOVENIA 2016 GNSS CAMPAIGN

The Goals of the Campaign

- **To check and improve the consistency** of coordinates in the passive (EUREF points) and active (SIGNAL stations) networks
- **To connect EUREF and SIGNAL Networks** with the newly established Zero-Order Network
- **To find an evidence for active tectonics** in the EUREF densification area (20 years after the first realization of ETRS89)

EUREF SLOVENIA 2016 GNSS CAMPAIGN

Differences between ETRS89/D96 & ETRS89/D17 coordinates



Large coordinate differences!

Up to **80 mm** north component

EUREF SLOVENIA 2016 GNSS CAMPAIGN

The Results of the Campaign

- **ETRS89/D17 coordinates** (EUREF Class B solution, accepted in Amsterdam 2018) IGb08/ETRF2000, epoch 2016.75

- **ETRS89/D96-17 coordinates** (compromise practical solution to be used in the SIGNAL Network as an improved set of coordinates – optimal rigid transformation in order to be as much as possible close to the previous realization)
  Optimal 6 parameter transformation from IGb08/ETRF2000, epoch 2016.75, into ITRF96/ETRF96, epoch 1995.55:

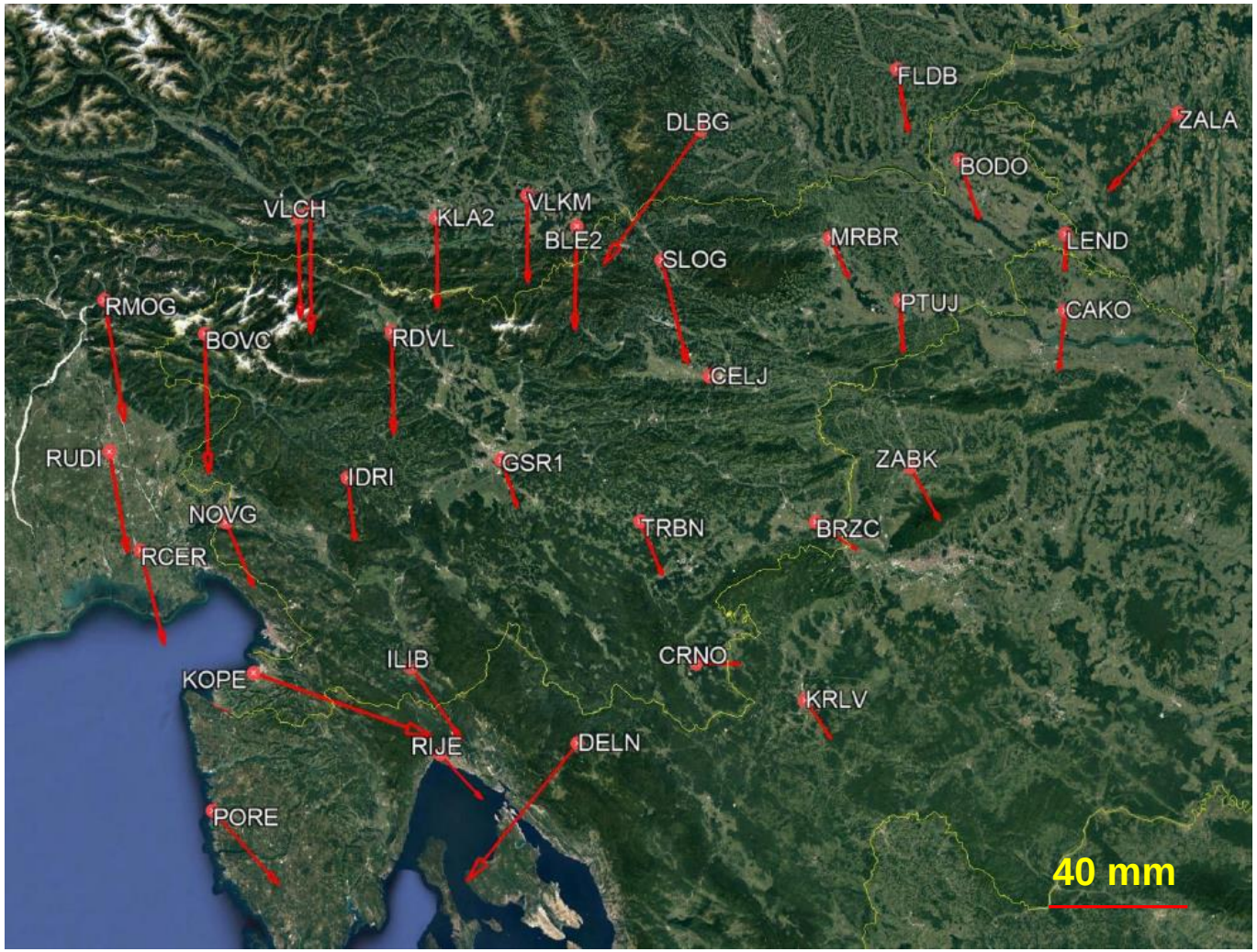
Transformation parameters from D17 to:

SOLUTION	Tx	Ty	Tz	D	Rx	Ry	Rz
UNITS---------->	mm	mm	mm	ppb	.001"	.001"	.001"
D96-17	236.64	-98.51	-201.27	0.00	-17.791	3.673	-24.369

- **ETRF2000 velocities** for the passive EUREF points
  (more than 20 years data span: campaigns from 1994, 1995, 1996, 2007 & 2016)

EUREF SLOVENIA 2016 GNSS CAMPAIGN

Hz corrections of ETRS89/D96 (into ETRS89/D96-17) coordinates

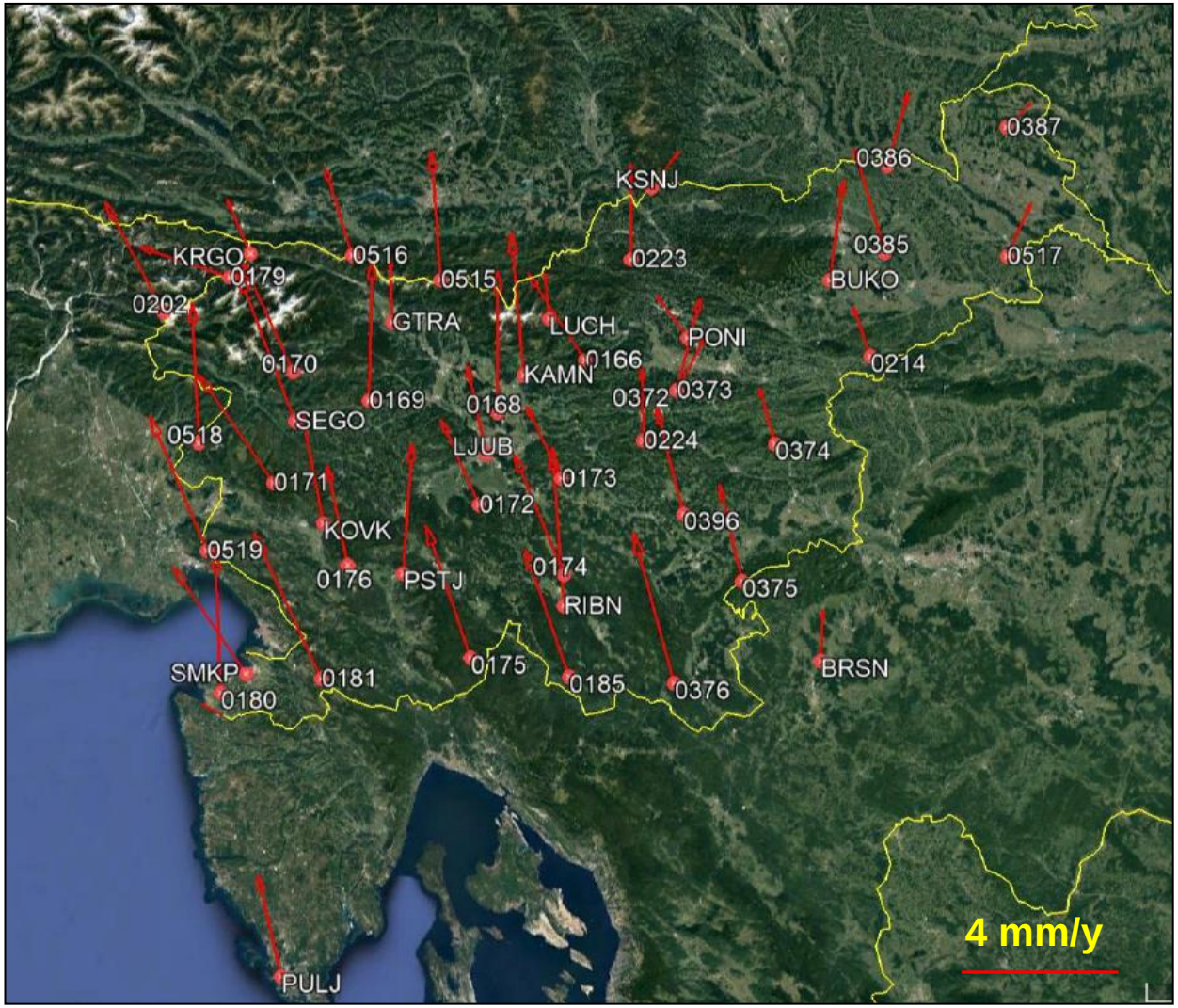


Large coordinate corrections!

Estimated median Hz component is **23.1 mm**

EUREF SLOVENIA 2016 GNSS CAMPAIGN

Estimated ETRF2000 horizontal velocities



Nonhomogeneous HZ velocities!

Estimated median Hz component is **2.7 mm/y**

EUREF SLOVENIA 2016 GNSS CAMPAIGN

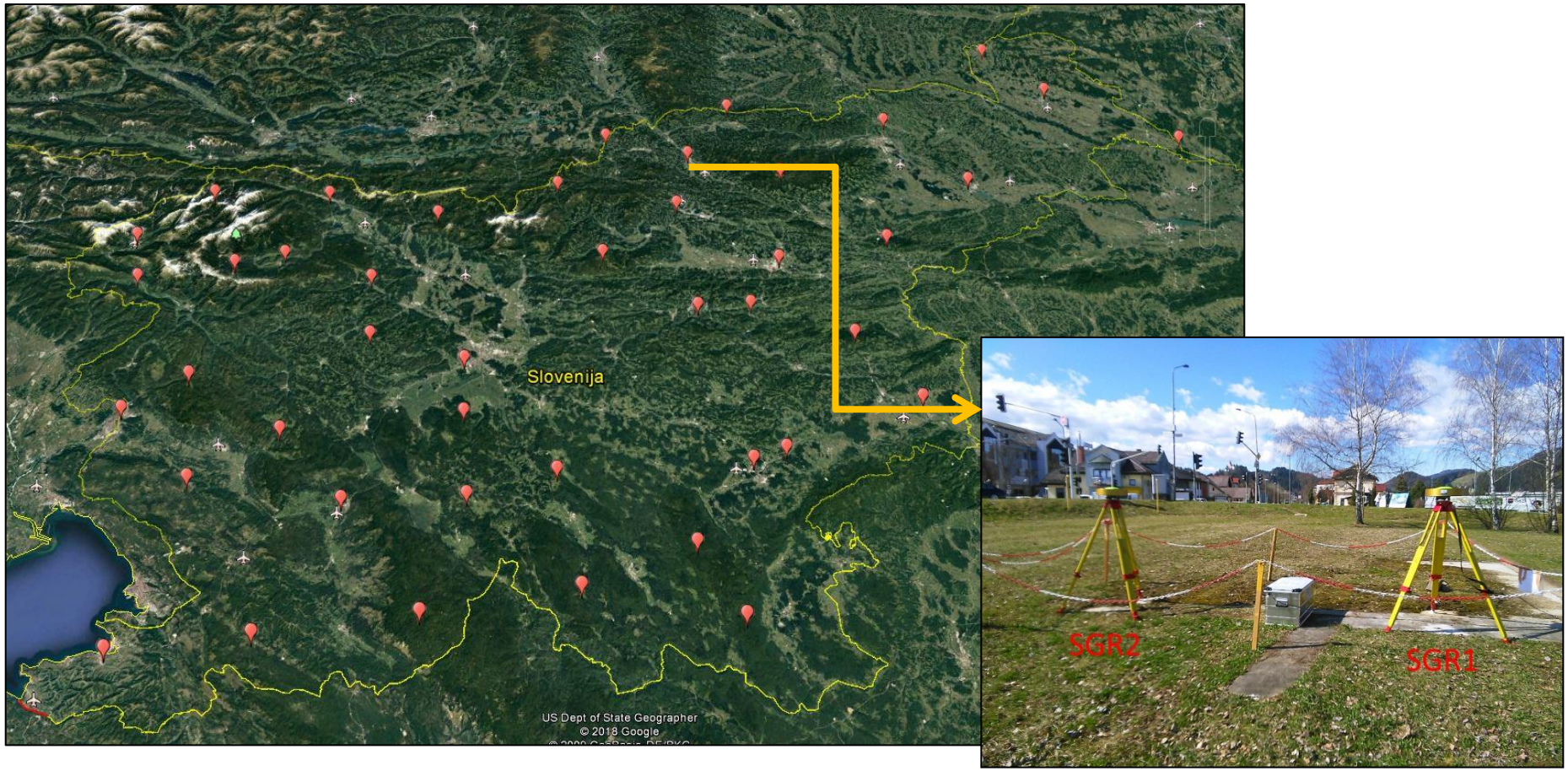
Implementation of the Results of the Campaign

- **Testing of the impact of changes to the RTK services**
  - testing environment /backup server/
  - various receivers (Leica, Trimble, Javad …) and RTK services (SST, VRS, MAC …)
  - checking coordinate differences: ETRS89/D96 vs ETRS89/D96-17

EUREF SLOVENIA 2016 GNSS CAMPAIGN

Implementation of the Results of the Campaign

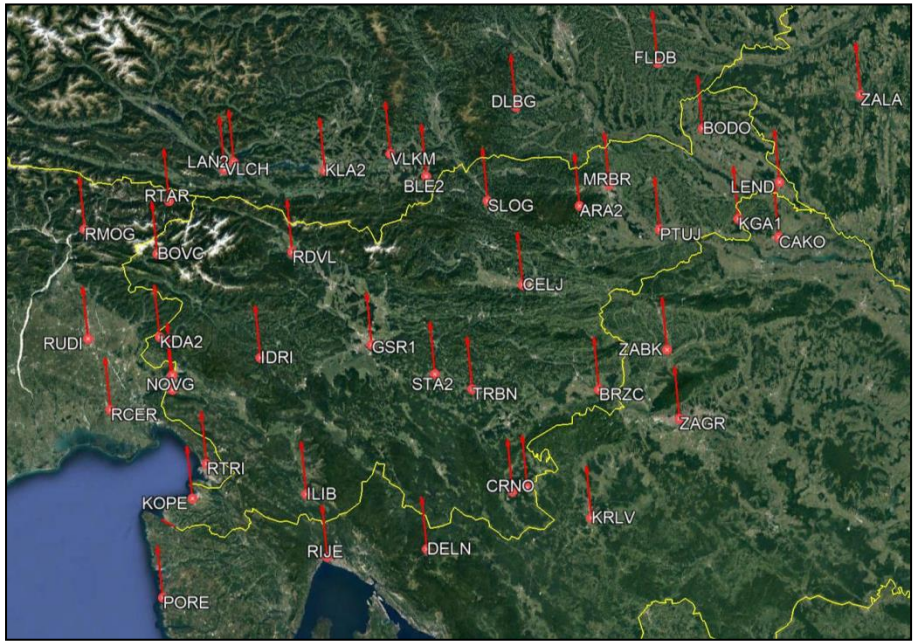
- **Testing of the impact of changes to the RTK services**
  – cuntrywide GNSS test network:



EUREF SLOVENIA 2016 GNSS CAMPAIGN

Implementation of the Results of the Campaign

- **Changes in the SIGNAL network planned for January 1, 2020**
  - new log files for all SIGNAL stations
  - changes in the Trimble Pivot Platform software
    - ETRS89/D96-17 coordinates of stations ← distribution coordinates
    - ETRF2000 velocities for GSR1 (Ljubljana) used for all stations
      … to assure better production coordinates (in ITRF2014, current epoch)



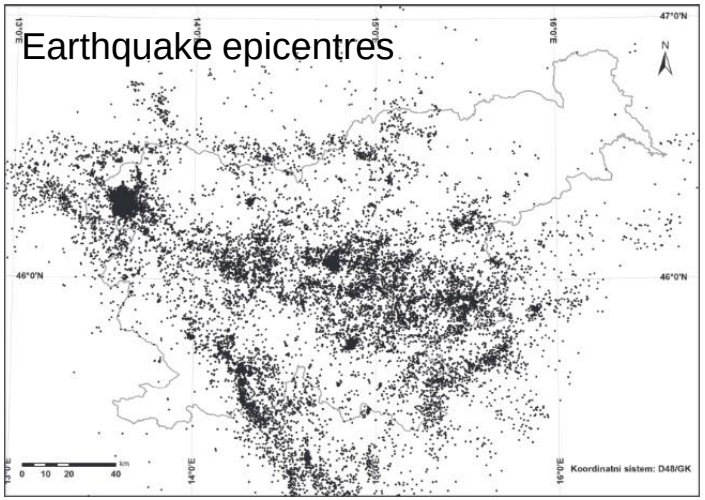
Hz component is
2.0 mm/y

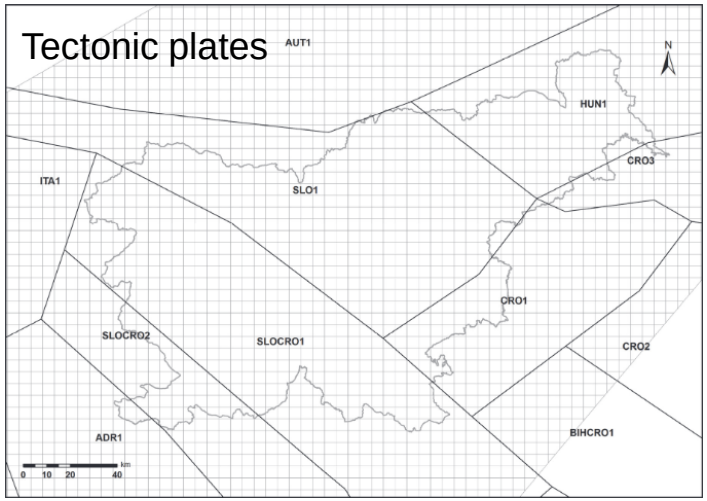
SIGNAL & ZERO ORDER NETWORKS

Future Plans and Open Issues

- **First set of velocities in the SIGNAL and Zero Order Networks** (for the three-year time span) is expected (December 2019)

- **Are they sufficient for the EUREF dense velocity field?** … having in mind
  - the quality of stations (roofs of buildings)
  - the density of stations (average displacement ~50 km)
  - the active tectonics of the area concerned





SIGNAL & ZERO ORDER NETWORKS

Future Plans and Open Issues

- **Do we need densification of active GNSS networks?**
  eg. passive geodynamic GNSS network
  what period is recommended for the GNSS campaigns?

- **Do we need to consider the implementation of a (semi)kinematic reference frame in the future?**

- **Cetrifying criteria for private GNSS network coorection providers?**

NEW COORDINATE AND HEIGHT REFERENCE SYSTEMS

New height reference system was established (SVS2010)

- **New levelling data**
  measurements in years 2005–2015

- **New height datum**
  based on the Koper tide gauge … replaced old Trieste datum
  mean epoch 10. 10. 2010

- **New height reference surface**
  quasi-geoid model SLO_VRP2016/Koper

NEW COORDINATE AND HEIGHT REFERENCE SYSTEMS

Transformation into the ETRS89
has been finished for all national spatial datasets!

- **National transformation model was used**
  continuous and reversible triangle-based model
  field tests for cadastral dataset (80 test areas – mostly towns);
  - accuracy ~10 cm but
  - some areas found to be inconsistent with the national CRS (systematic errors)

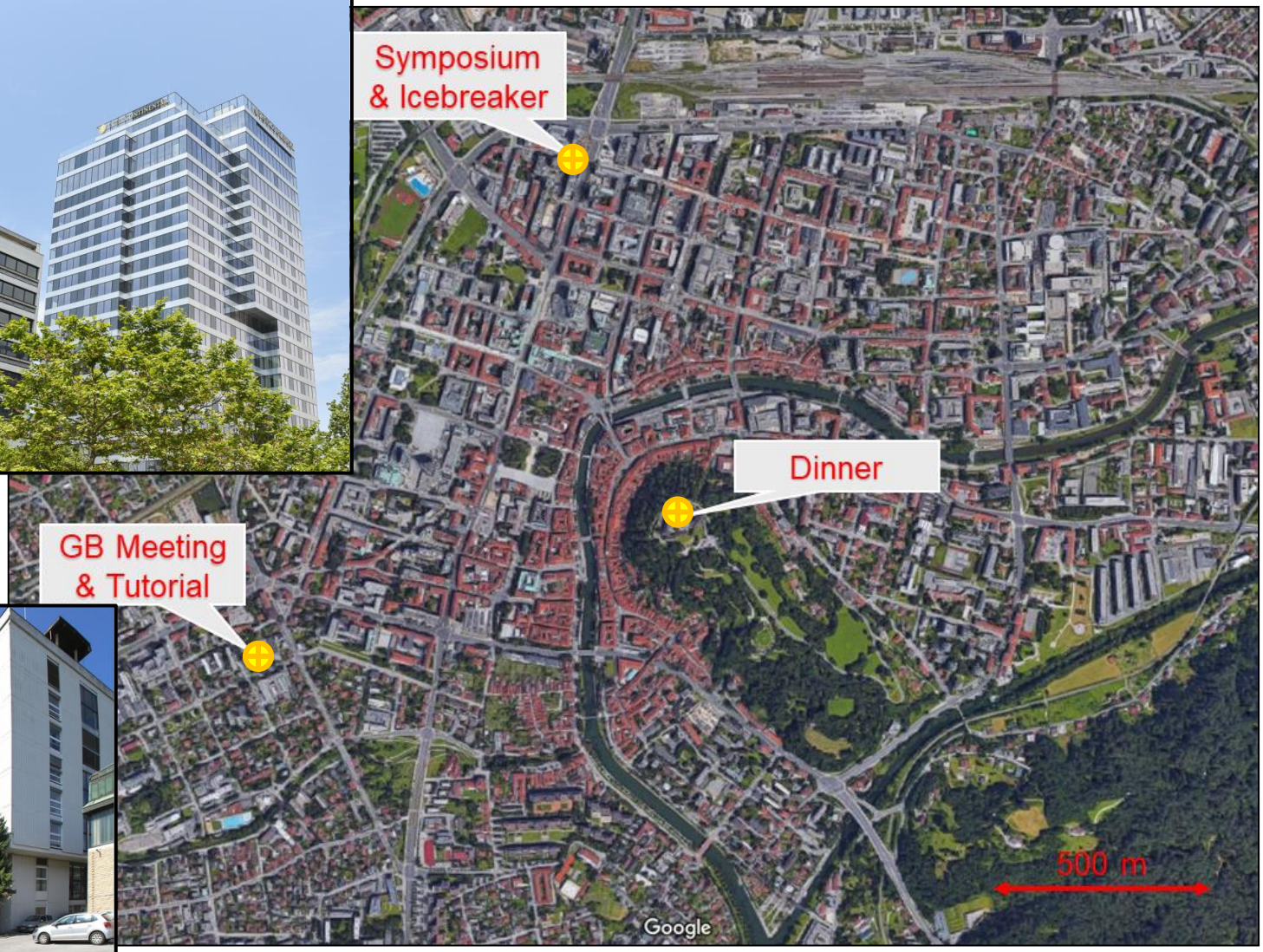
- **Freware transformation tools**
  supporting most popular vector and raster formats

- **Revised EPSG Geodetic Parameter Registry**
  new EPSG codes for CSes, CRSes & transformations

OTHER ACTIVITIES

You Are All Welcome!

The next EUREF Symposium is in LJUBLJANA, May 27–29, 2020



OTHER ACTIVITIES

The next EUREF Symposium

- Planed and realised activities were presented
  at the EUREF GB Meeting in Warsaw on October 15, 2019

- The **Tutorial** is titled »**Quality and Legal Management of Data and Products of Active GNSS Networks**«
  and will consists of three parts:

  1) Legal issues and relations between public and private active GNSS networks
  2) Quality assurance and monitoring of active GNSS networks
  3) Role of active GNSS networks to acces national coordinate and height reference frames

Suggestions are Welcome!

Thank you for your attention

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