EUPOS
European Position Determination System

12th EUPOS® Council and Technical Meeting

National Report of Slovenia

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Presentation topics

- National Geokinematic Model Released
  - Metadata, formats
  - Comparison with EuVeM2022
  - Implementation to Trimble Pivot Platform

  - Implementation to a freeware tool for time-dependent datum transformations

- New Instructions for Geodetic Surveying
  - Instructions for GNSS Surveying
  - Instructions for Combined Geodetic Surveying (GNSS + other geodetic measurement techniques)

- InSAR Corner Reflectors Installed at the Zero-Order Geodetic Network Stations

National Geokinematic Model

Published in
ETRF2000@2016.75

Two versions:

- **GKM_SVN2026_TM**

  Grid cell: 10 km × 10 km
  Grid pts: 39 × 30 = 1170
  Grid area: 380 km × 290 km
  Format: ASCII
  (№ e n h vE vN vU)

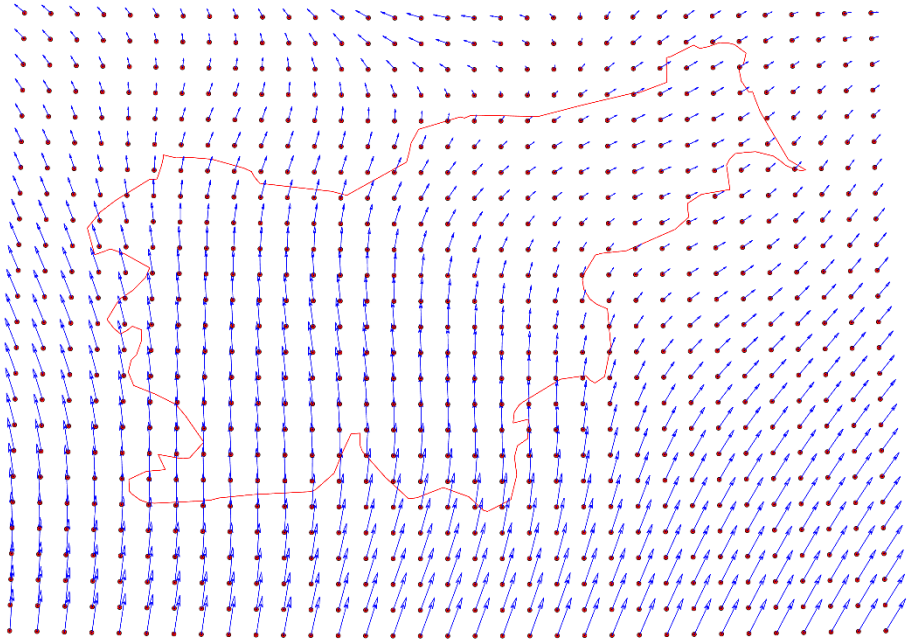
- **GKM_SVN2026_Geo** →

  Grid cell: 0.08° × 0.12°
  (~9 km × ~9 km)
  Grid pts: 33 × 25 = 825
  Grid area: ~300 km × ~220 km
  Format: ASCII
  (№ λ φ h vE vN vU)

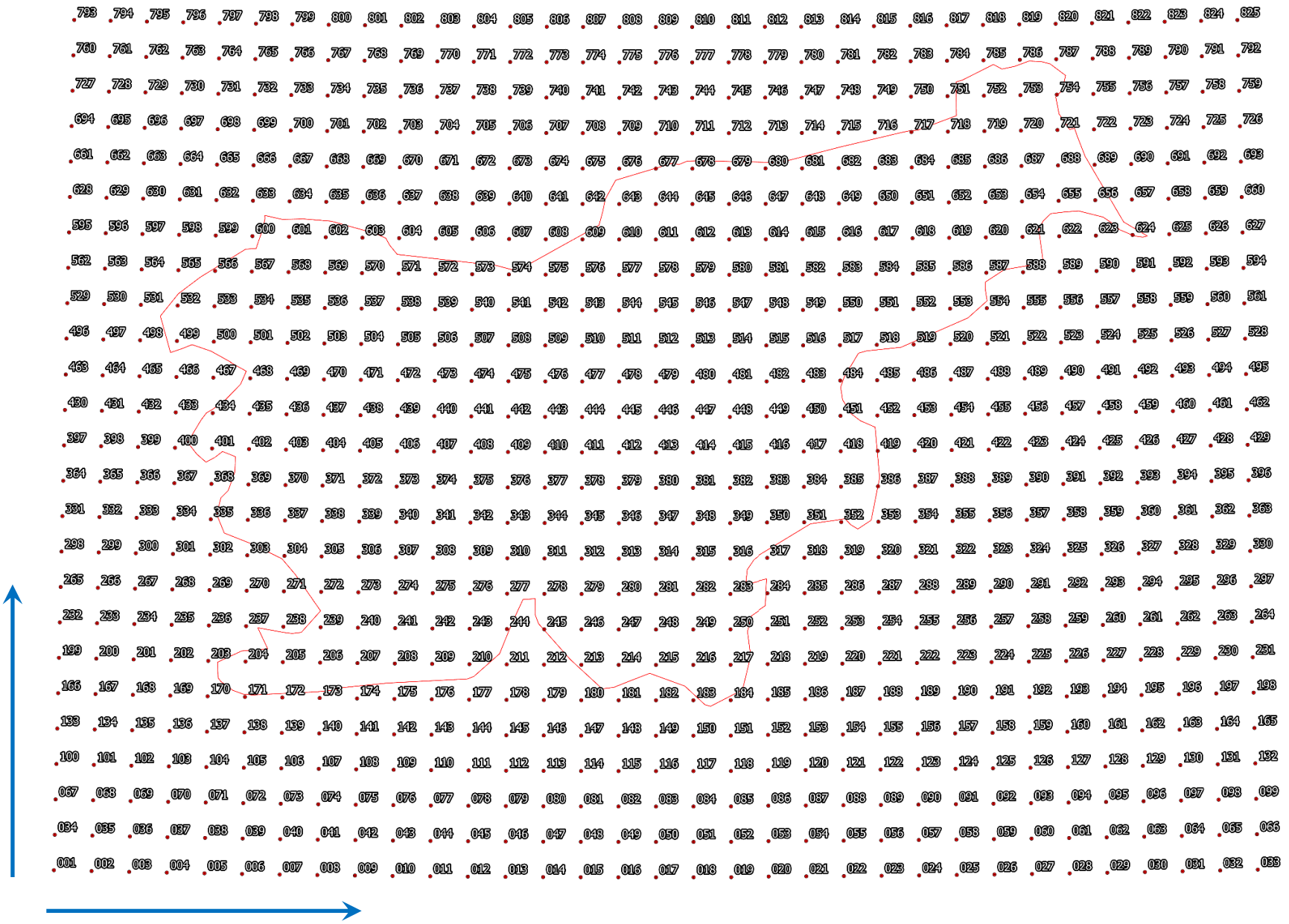
Metadata in Slovene and English

Access:

- GKM_SVN2026_TM.zip
- GKM_SVN2026_Geo.zip



National Geokinematic Model: GKM_SVN2026_Geo



National Geokinematic Model

Some statistics

- **Based on time series at 44 GNSS stations** in Slovenia and its neighbourhood

- **Horizontal velocities**

  −0.63 mm/yr ≤ vE ≤ +0.80 mm/yr
  +0.25 mm/yr ≤ vN ≤ +2.37 mm/yr

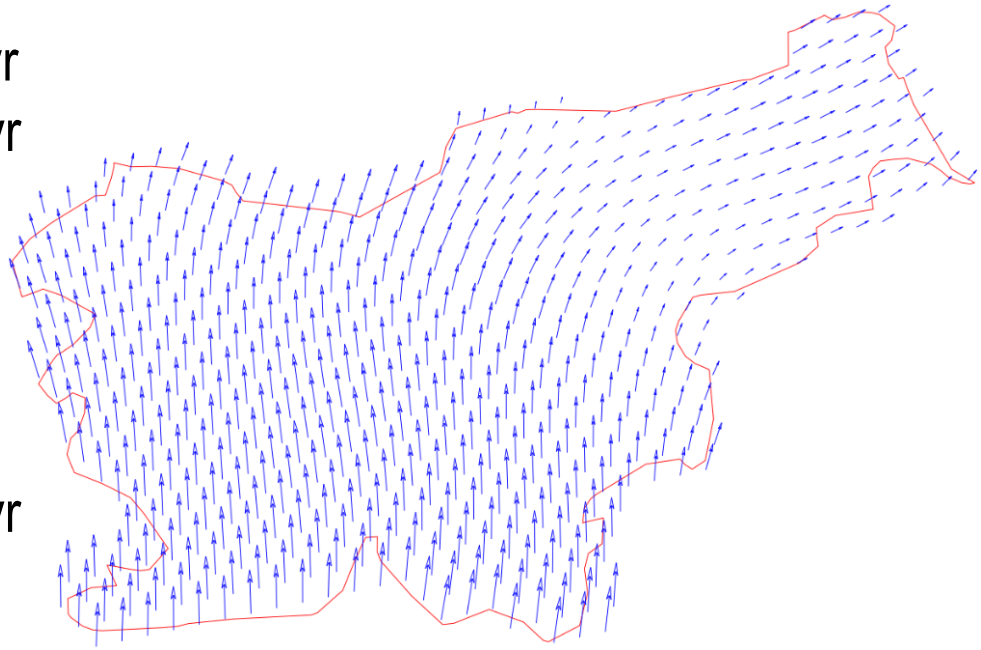
  Up to 7 cm in 30 years

- **Vertical velocities**

  −1.33 mm/yr ≤ vU ≤ −0.23 mm/yr

Slovenia is deforming:

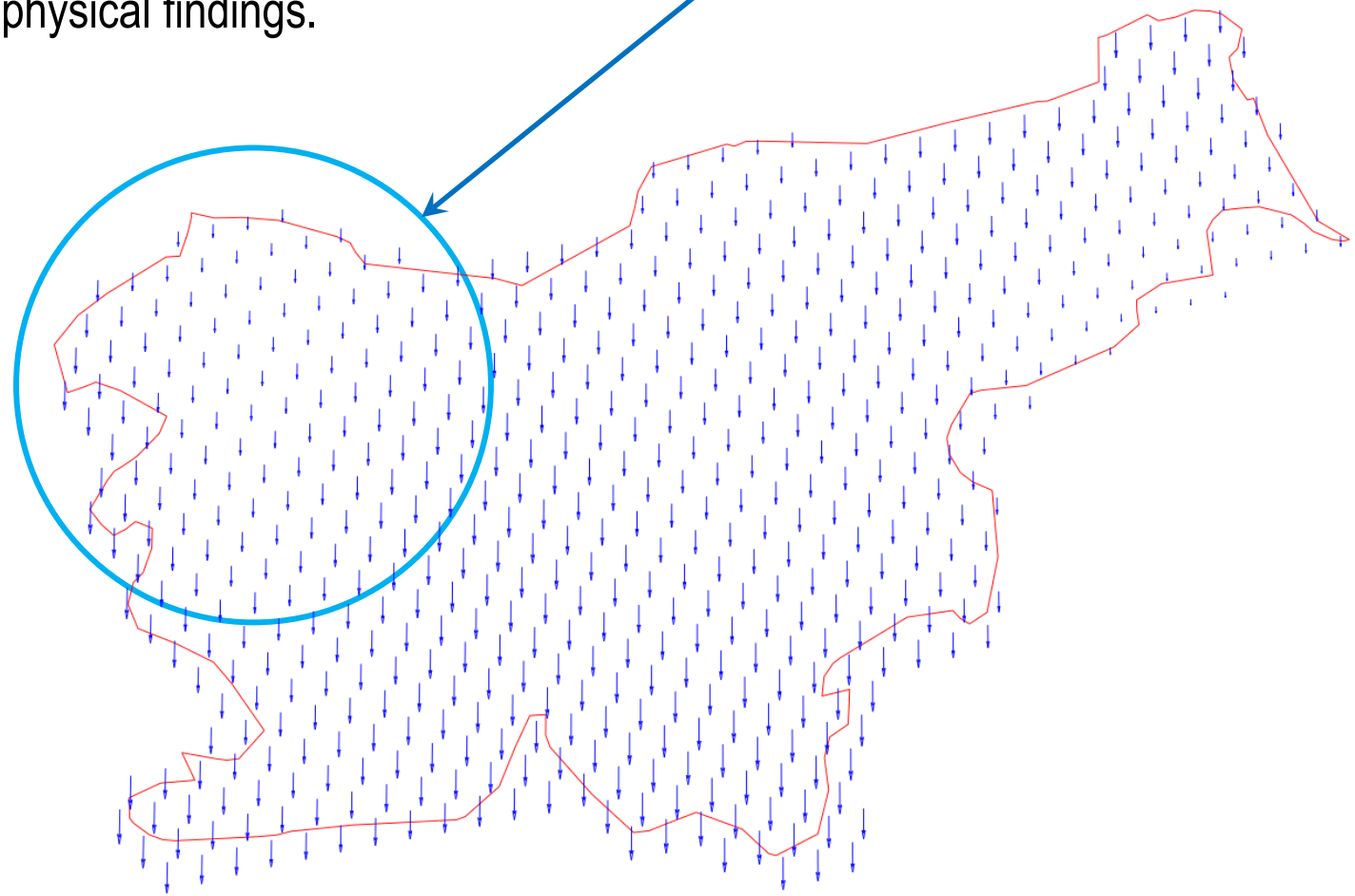
- *Extension* in east direction
- *Compression* in north direction



National Geokinematic Model

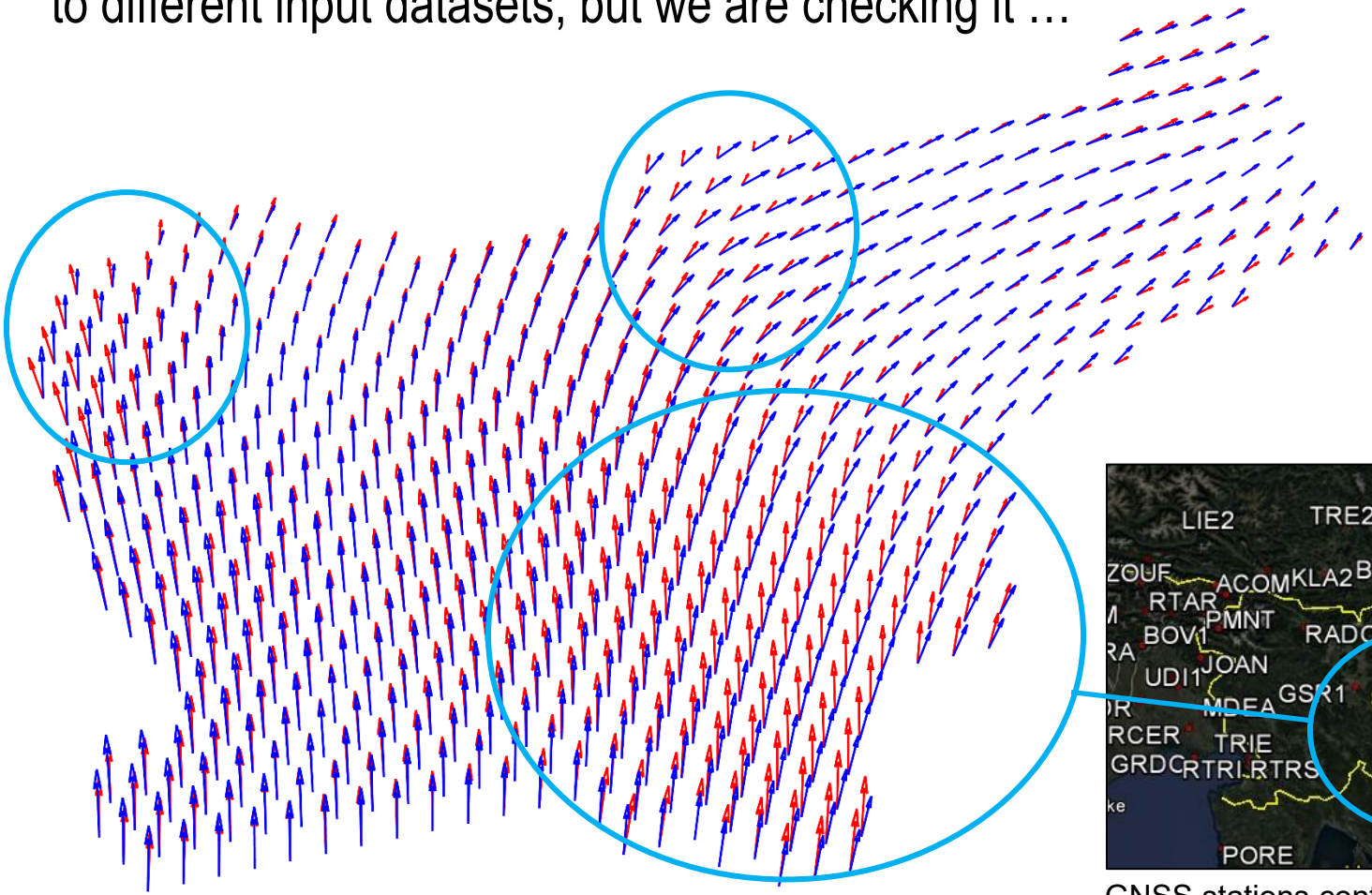
Remark:

Vertical velocities in ETRF2020 differ from those in ETRF2000 by about +0.45 mm/yr, which would result in positive velocities (uplift) in the Alps – in accordance with geophysical findings.



National Geokinematic Model vs EuVeM2022

Some discrepancies between the national geokinematic model (in red) and the EuVeM2022 (in blue) can be observed. They can probably be attributed to different input datasets, but we are checking it …

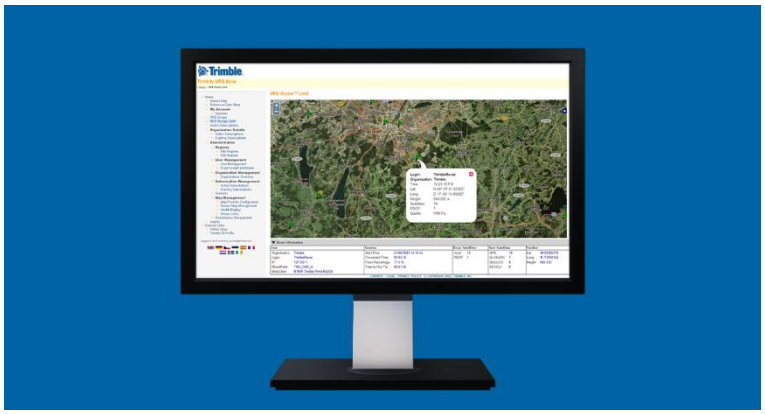


GNSS stations contributed to EuVeM2022

Implementation of the National Geokinematic Model into Trimble Pivot Platform

Implementation of the model into Trimble software is in progress. However, their requirement is that (in contrast to geoid models) the geokinematic or deformation model should be »official«. They want to see it in the national legislation.

Luckily, our *Act on the National Geodetic Reference System* is in the process of being amended (for other reasons) and the national geokinematic model will also be mentioned.



Implementation of the National Geokinematic Model into a Free Transformation Software

The model is implemented into the ITRS-SI software (version 1.2).

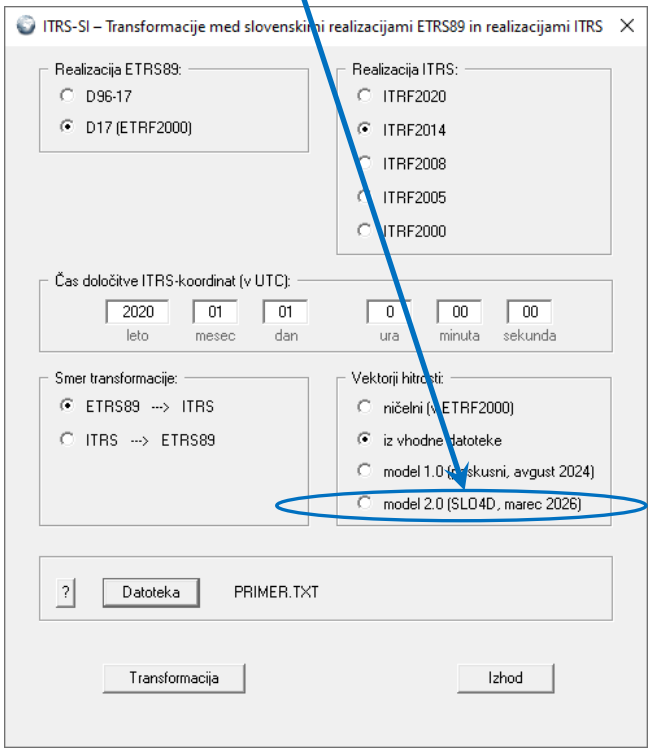
It can be used for transformation of coordinates (and velocities) in Slovenia between:

needed for **PPP**

- latest Slovenian realizations of ETRS89 and latest realization of ITRS, e.g.
  D96-17 ⇔ ITRF2020@2026,25
- two epoch of a realization of ITRS, e.g.
  ITRF2014@2019,15 ⇔ ITRF2014@2024,50
- two realizations of ITRS, e.g.
  ITRF2014@2020,00 ⇔ ITRF2000@1996,50
- two latest Slovenian realizations of ETRS89, e.g.
  D17 (ETRF2000@2016,75) ⇔ D96-17

ITRS-SI – free desktop application for time-dependent datum transformation that enables the use of:

- zero velocities in ETRF2000
- national geokinematic model
- velocities from an input file (*.VEL)



New Instructions for Geodetic Surveying (for real-estate cadastre)

- Technical supplementary to the *Rules on the Maintenance of the Real-Estate Cadastre* (regulation document); the latter defines the required accuracy of cadastral points.
- The *Instructions for Geodetic Surveying* describe surveying equipment, field survey methods, and data processing procedures that provide the required accuracy of cadastral surveying.
- The Instructions cover GNSS surveying and combined methods:
  GNSS + tacheometry
  + (aero)photogrammetry
  + (aerial) laser scanning

- GNSS surveying comprises:
  - Static and Fast Static GNSS surveying
  - Real Time Kinematic (RTK) GNSS surveying
  - Post-Processing Kinematic (PPK) GNSS surveying

New Instructions for Geodetic Surveying (for real-estate cadastre)

The Instructions distinguish surveying of:

- cadastral points (boundary marks, corners of buildings)
- survey points (permanent or temporary survey marks)

The accuracy of coordinates/heights of points is defined with:

- r95 … radius of the 95% confidence circle for the coordinates
- $\sigma 95_h$ … half-length of the 95% confidence interval for the heights

The required accuracy of cadastral points:

- $r95 \leq 0.10$ m
- $\sigma 95_h \leq 0.20$ m (for characteristic heights of buildings)

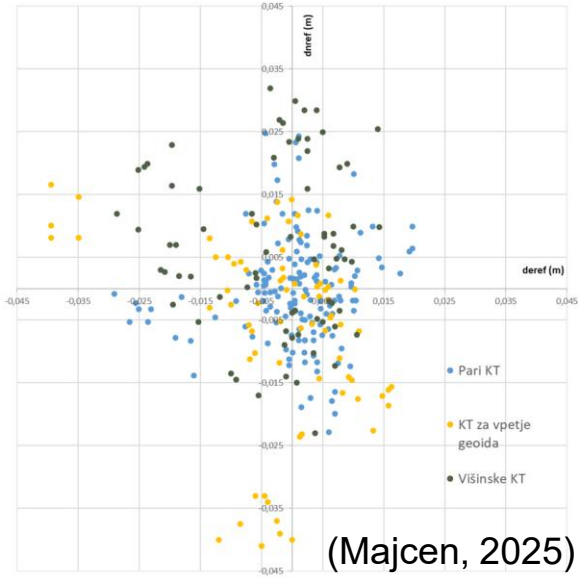
roof ridge, roof pitch, ground floor

The required accuracy of survey points is about three times higher:

- $r95 \leq 0.04$ m
- $\sigma 95_h \leq 0.07$ m

New Instructions for Geodetic Surveying (for real-estate cadastre)

The accuracy defined for survey points is based on test RTK GNSS measurements in the passive GNSS control network – more than 1400 repeated surveys in 2019–2025



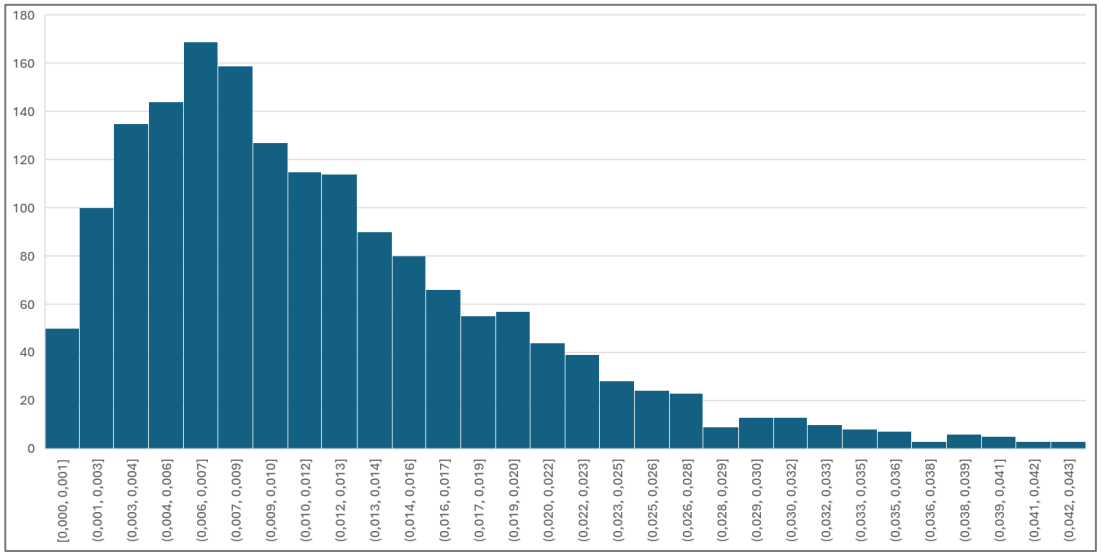
(Majcen, 2025)

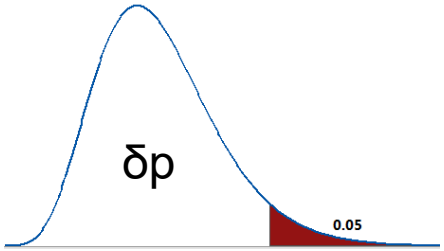
The achieved accuracy (for the arithmetic mean from two independent RTK measurements) is:

- $r95 \leq 0.032$ m
- $\sigma 95_h \leq 0.063$ m

New Instructions for Geodetic Surveying (for real-estate cadastre)

The analysis of discrepancies of double RTK GNSS surveys in the passive GNSS control network provides threshold values tied to 95% intervals for the horizontal positions





The threshold positional discrepancy (allowed offset) for cadastral points:

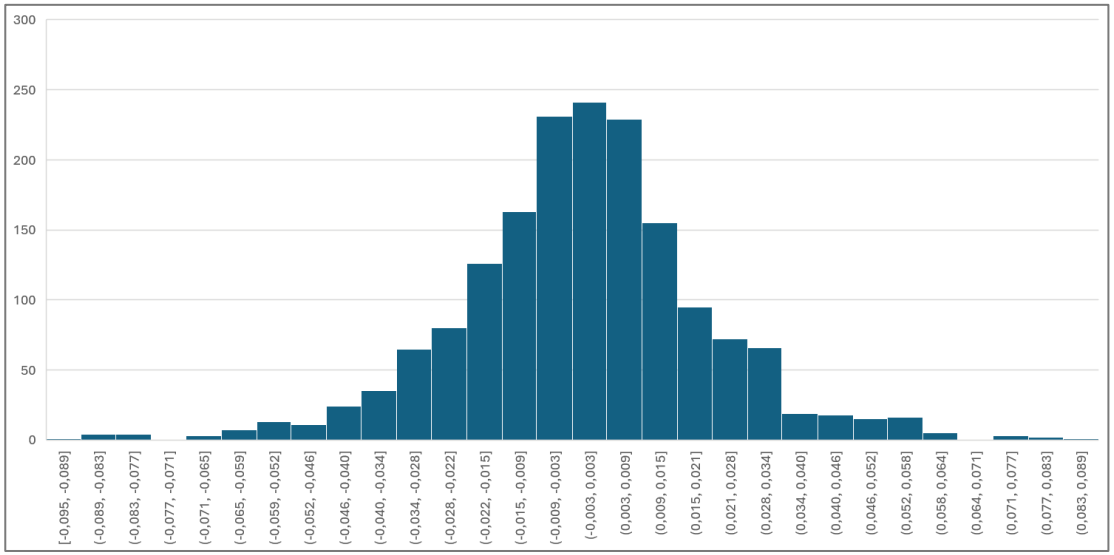
- $\delta p \leq 0.09$ m

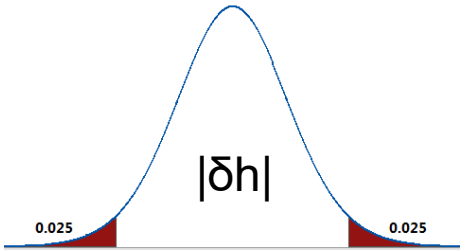
The threshold positional discrepancy for survey points:

- $\delta p \leq 0.03$ m

New Instructions for Geodetic Surveying (for real-estate cadastre)

The analysis of discrepancies of double RTK GNSS surveys in the passive GNSS control network provides threshold values tied to 95% intervals for the ellipsoidal heights





The threshold positional discrepancy for cadastral points:

- $|\delta h| \leq 0.15$ m

The threshold positional discrepancy for survey points:

- $|\delta h| \leq 0.05$ m

New Instructions for Geodetic Surveying (for real-estate cadastre)

The *Instructions for Geodetic Surveying* allow the use of private GNSS CORS networks, but define the:

- rules for establishing such networks
- rules for determining the station coordinates

These rules refer directly to the:

- *EUPOS Guidelines for Single Site Design* … for station design
- *Guidelines for EPN Stations* … for station equipment
- *Guidelines for EUREF Densifications* … for coordinate computation

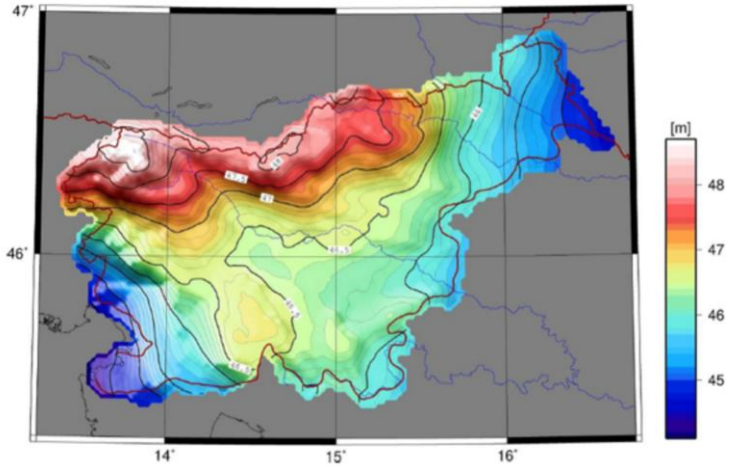
The positioning services should provide:

- coordinates in the national projected CRS: D96-17/TM (EPSG 3794)
- heights in the national HRS: SVS2010/Koper (EPSG 8690)

New Instructions for Geodetic Surveying (for real-estate cadastre)

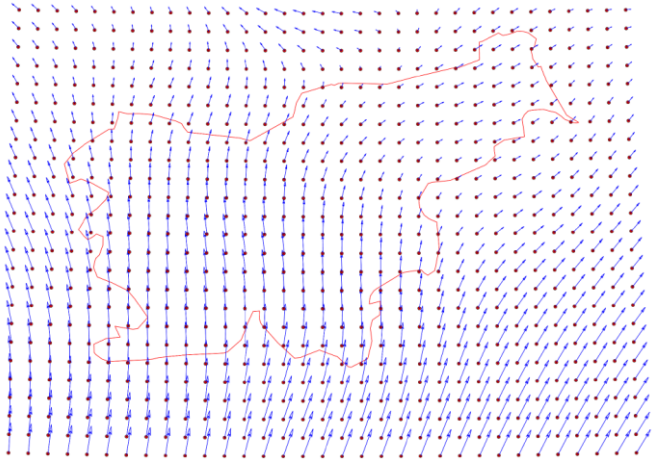
The *Instructions for Geodetic Surveying* prescribe the connections:

- between the ellipsoidal (D96-17) and normal heights (SVS2010/Koper) via the national quasi-geoid model: SLO_VRP2016/Koper



- between the national TRF (D96-17) and realizations of ITRS by considering the national geokinematic model: SLO_GKM2026

(e.g. for PPP survey)



Instalation of InSAR Corner Reflectors
at the Zero-Order Combined Geodetic Network

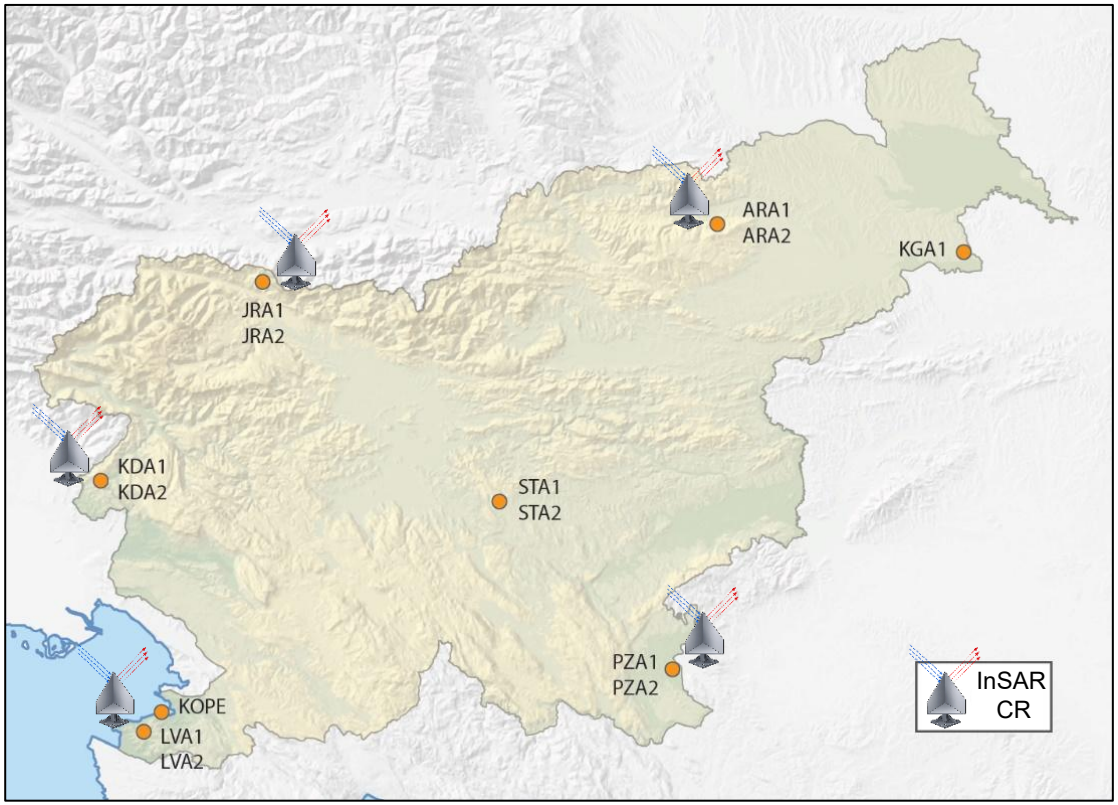
7 continuously operating GNSS stations, 6 of them are twin stations.

All stations connected to the first order levelling network.

Stations collocated with:

- absolute gravimetric point (1)
- seizmic station (1)
- InSAR corner reflectors (5)

NEW



Instalation of InSAR Corner Reflectors
at the Zero-Order Combined Geodetic Network

Areh (EPN, EPOS)

Instalation of InSAR Corner Reflectors
at the Zero-Order Combined Geodetic Network

Javorniški Rovt

Instalation of InSAR Corner Reflectors
at the Zero-Order Combined Geodetic Network

Korada (EPN, EPOS)

Instalation of InSAR Corner Reflectors
at the Zero-Order Combined Geodetic Network

Livade

Instalation of InSAR Corner Reflectors
at the Zero-Order Combined Geodetic Network

Prilozje (EPN, EPOS)

Thank you for your attention

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