11th EUPOS® Council and Technical Meeting

National Report of Slovenia

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Presentation topics

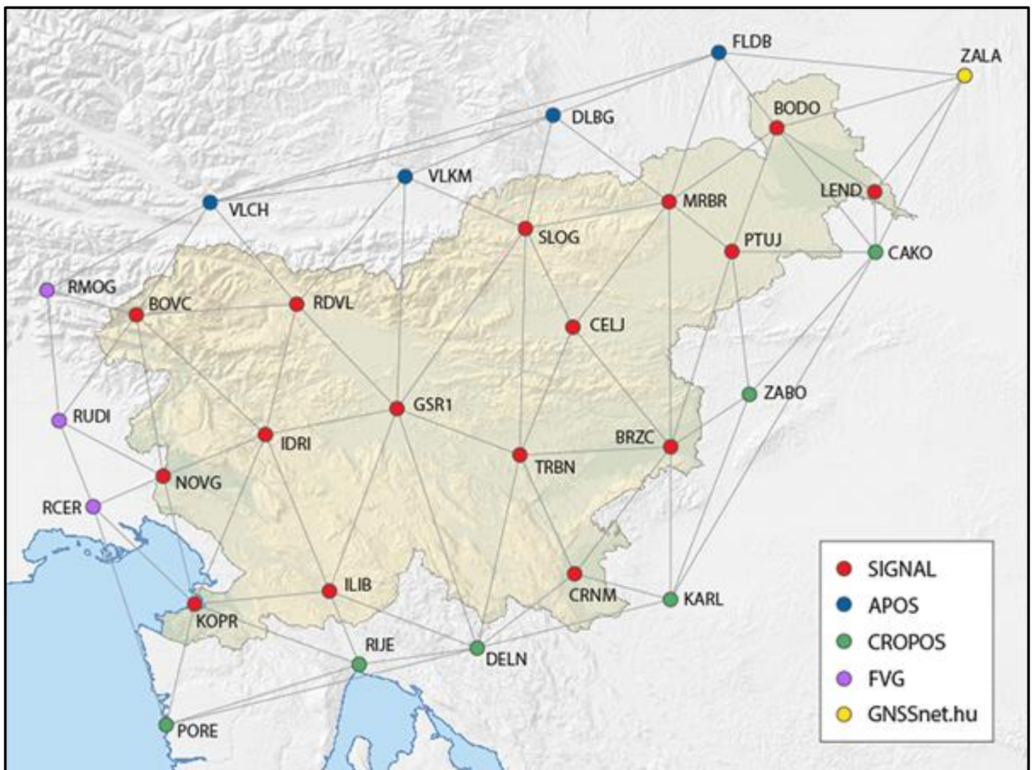
- CORS Networks: SIGNAL & Zero-Order Networks
- Passive GNSS Control Network & Testing Positionig Services
- Terrestrial Reference Frame:
  SLO4D Project: Towards a Time-Dependent Reference Frame
  New National Geokinematic Model
  Care4SIGNAL Research Project (on Jamming & Spoofing)
- Height Reference Frame:
  New Height Transformation Model
- Coordinate Reference System Support:
  EPSG & Trimble Database

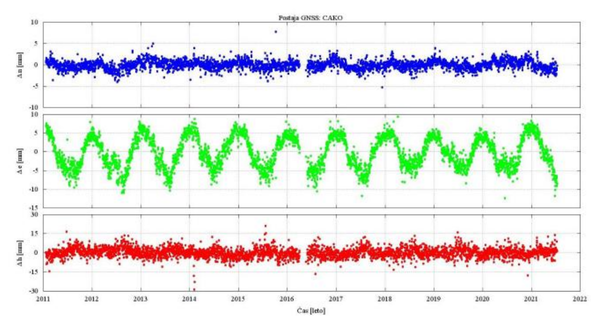
SIGNAL Network (GBAS)

https://gu-signal.si

- RTK services
- RINEX data
- Virtual RINEX data

- **16** continuously operating GNSS stations in Slovenia (9 ***Trimble*** + 7 ***Leica***)
- +**14** continuously operating GNSS stations in Austria, Croatia, Hungary & Italy
- **1** EPN station (GSR1 – Ljubljana)
- ***Trimble*** *Pivot Platform* + ***Alberding*** *Quality Control*



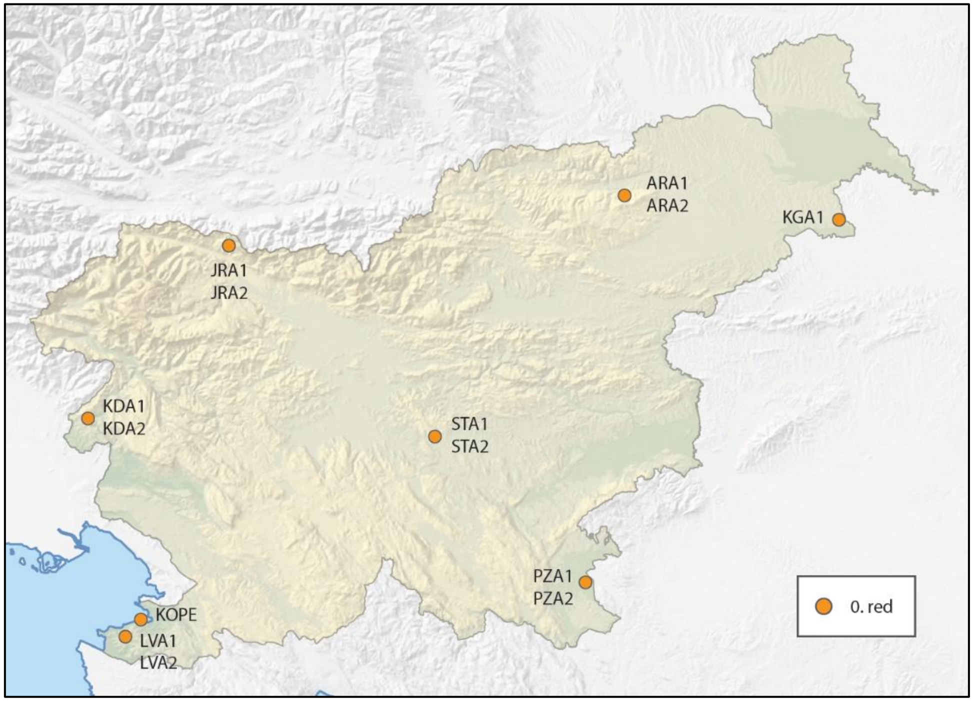


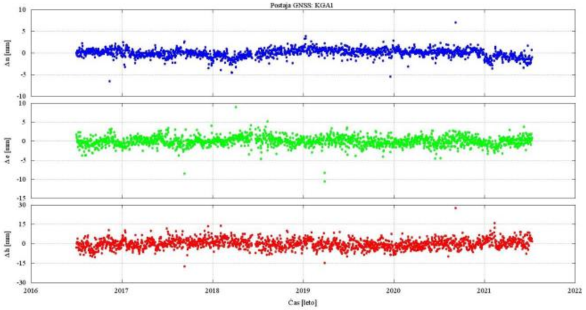
SIGNAL Network – News

- Trimble Pivot Platform (TPP) upgrade to v5.2.3 on both systems:
    - Backup system: August 2025
    - Main system: September 2025
- Trimble Pivot Platform (TPP) v5.2.3 with new settings (D96-17 datum with CORS velocities) in test phase on the backup system (as of August 2025) … test GNSS measurements in progress
- Upgrade of all GNSS receivers to the latest firmware
- In talks with Trimble to start testing TPP v5.3 beta on a new system (introducing a geokinematic model)

Zero-Order Geodetic Network

- **7** continuously operating GNSS stations in Slovenia (***Leica*** equipment)
- **6** of them are **twin stations**, **1** collocated 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
- 3 EPN stations (ARA2 – Areh, KDA2 – Korada, PZA2 – Prilozje)
- ***Alberding*** *GNSS Status Software*

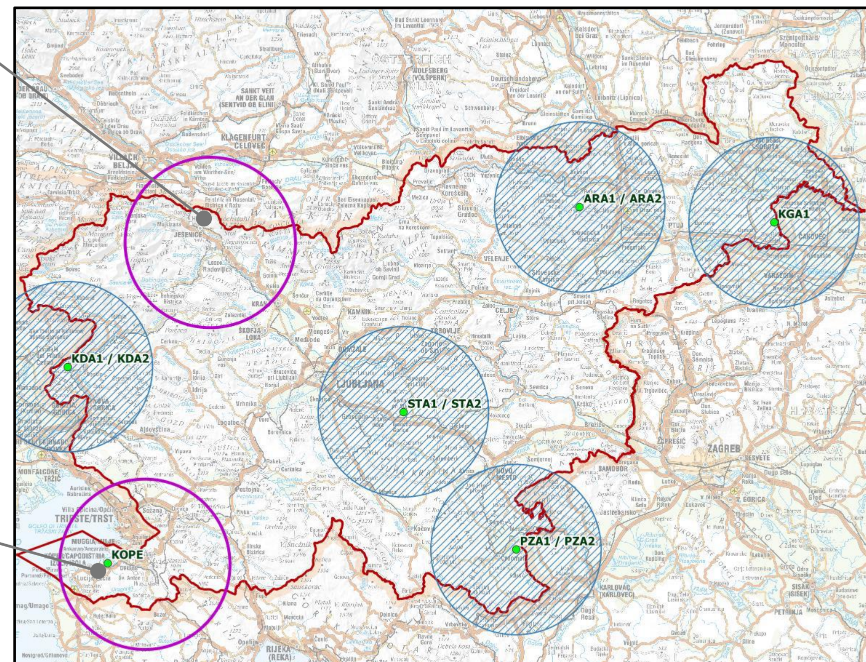




Zero-Order Geodetic Network – News

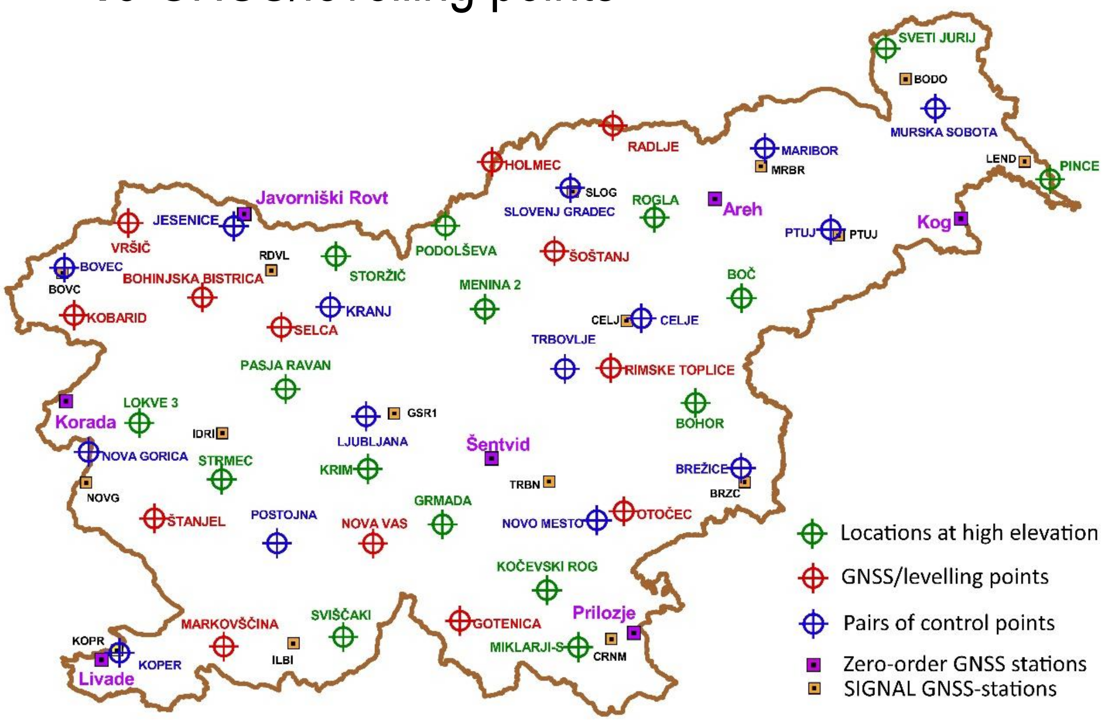
Densification of the network has been finished (***SLO4D project***).
Two new zero-order stations are now oparational (testing phase).

Public tender for **InSAR Corner Reflectors** on 5 zero-order stations in 2025

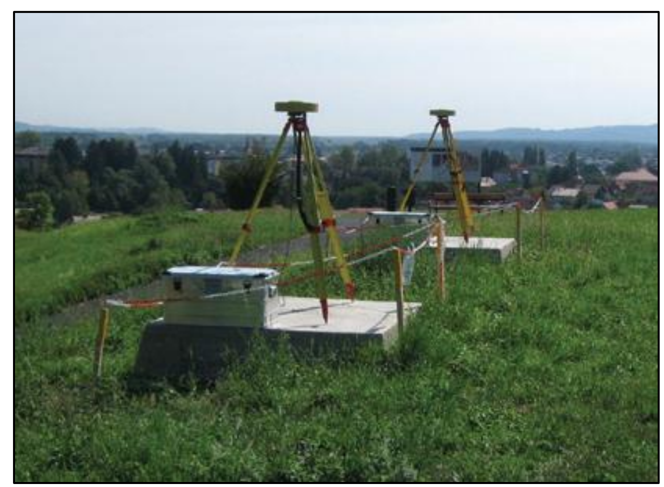


Passive GNSS Control Network

- **14** locations with callibration baselines (pairs of points) for testing according to ISO 17123-8
- **17** control points at high elevations
- **13** GNSS/levelling points



- Monitoring the quality of the SIGNAL network products and services
- Verifying GNSS measurement equipment and methods
- Available for SMA and private surveyors



Test Measurements in the Passive GNSS Control Network

284 test GNSS measurements in 2023

33 different locations

Various RTK services

2023	deref	dnref
MAX	0,020	0,032
MIN	-0,029	-0,024

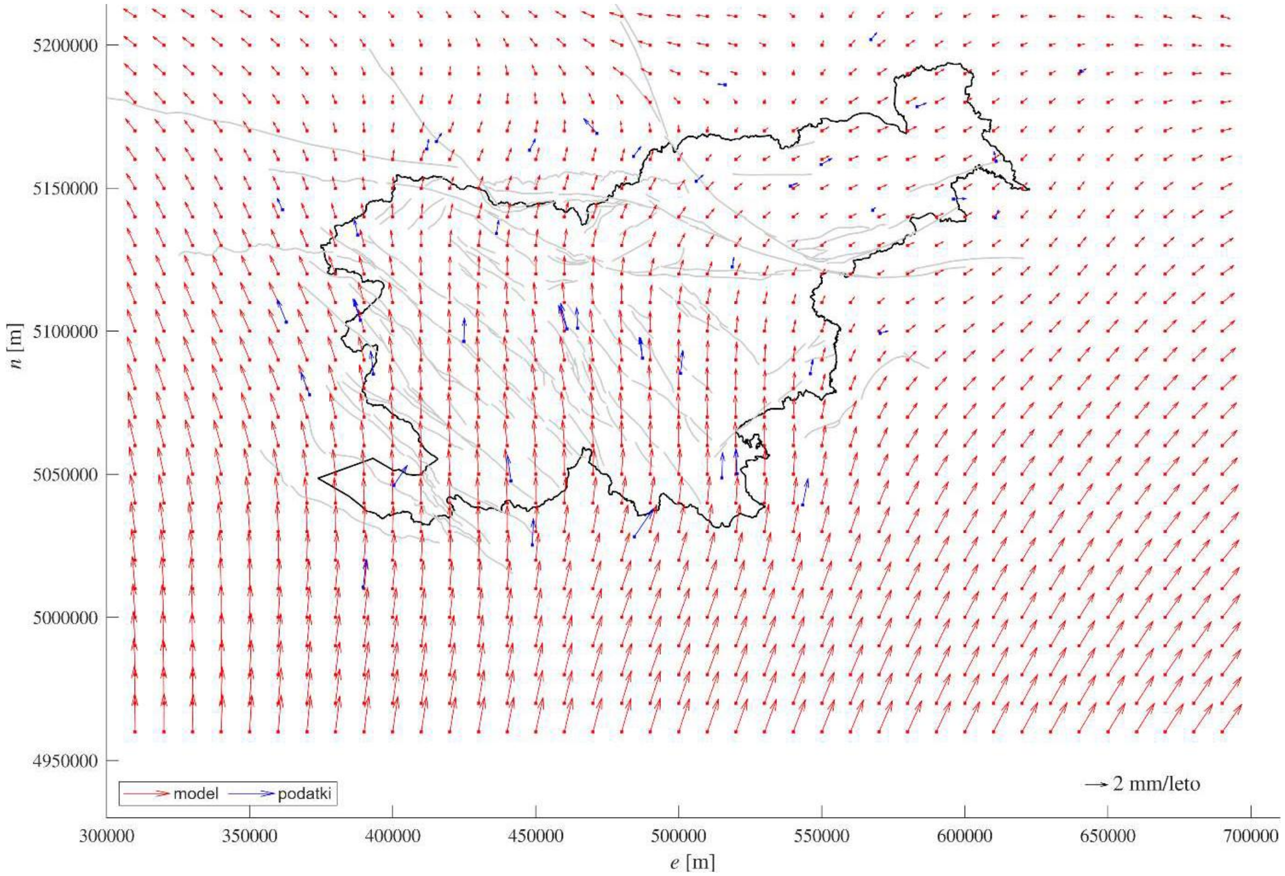
RTK accuracy estimation:

RMSEe	RMSEn
0,009	0,011
RMSEr	95%-RMSEr
0,014	0,024

National Geokinematic Model, v1.0

- Created by the University of Ljubljana
  for the Surveying and Mapping Authority (***SLO4D project***)

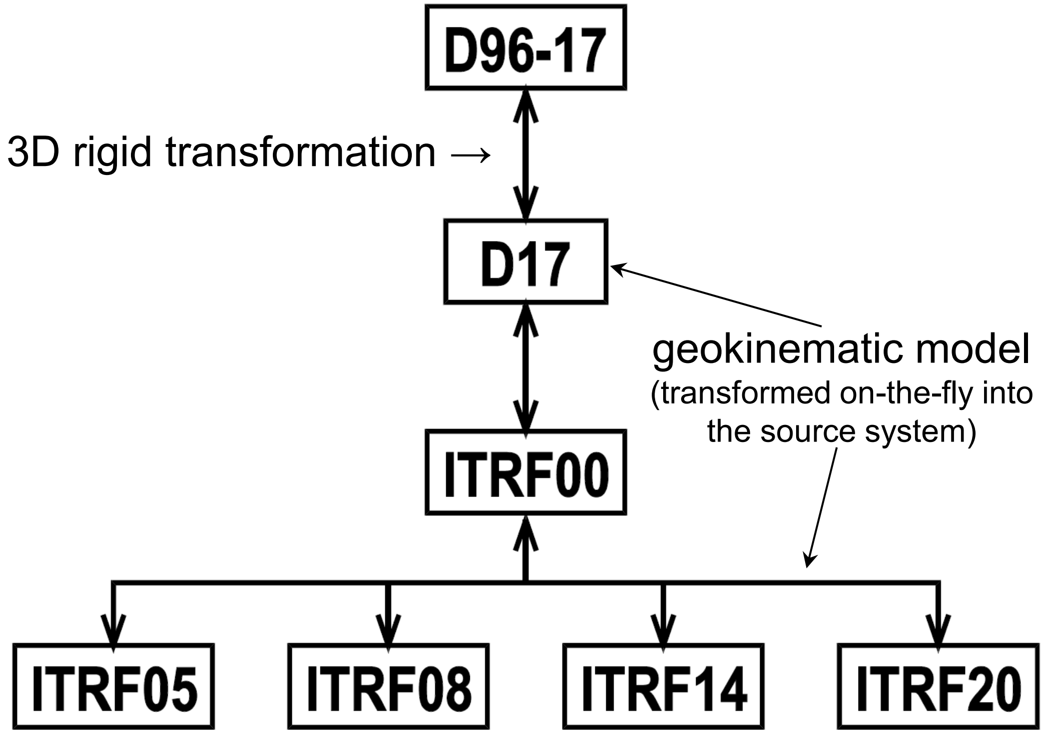
- GNSS-based 3D velocity model interpolated by least-squares collocation



Hz velocity components in the ETRF2000 reach up to **few mm/yr**.

Terrestrial Reference Frame – Connection to ITRS

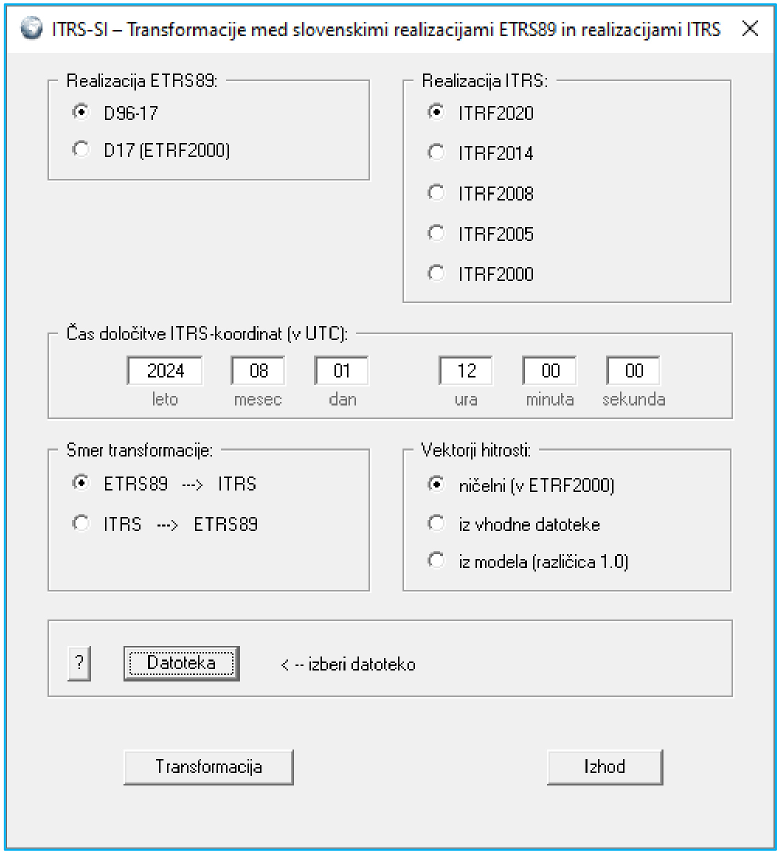
- **D96-17** – a new realization of **ETRS89** is connected to the latest ITRF releases via **ETRF00** (**D17**) and **ITRF00**:



ITRS-SI – free desktop transformation software supporting:

- zero velocities in ETRF00,
- national geokinematic model,
- velocities from an input file (*.VEL).

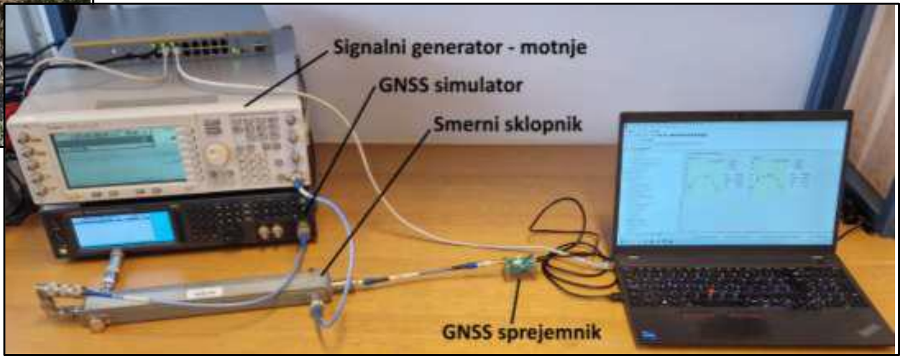
NEW



Terrestrial Reference Frame – **Care4SIGNAL** Project

- “Risk Assessment of GNSS Interference in the Slovenian CORS Network SIGNAL”
- Performed at the University of Ljubljana
  and co-funding by the Surveying and Mapping Authority

- study of **jamming** and **spoofing** of:
  - geodetic GNSS receivers,
  - low-cost GNSS receivers, and
  - smartphones
- **field** tests and simulations in the **lab** (using GNSS simulator)
- spectral analyses
- **methology** of GNSS interference detection based on artificial neural networks – GRU model



Research project V2-2342

Some results: Pavlovčič Prešeren et al. (2023) in *Remote Sensing* 15 (4), https://doi.org/10.3390/rs15041157

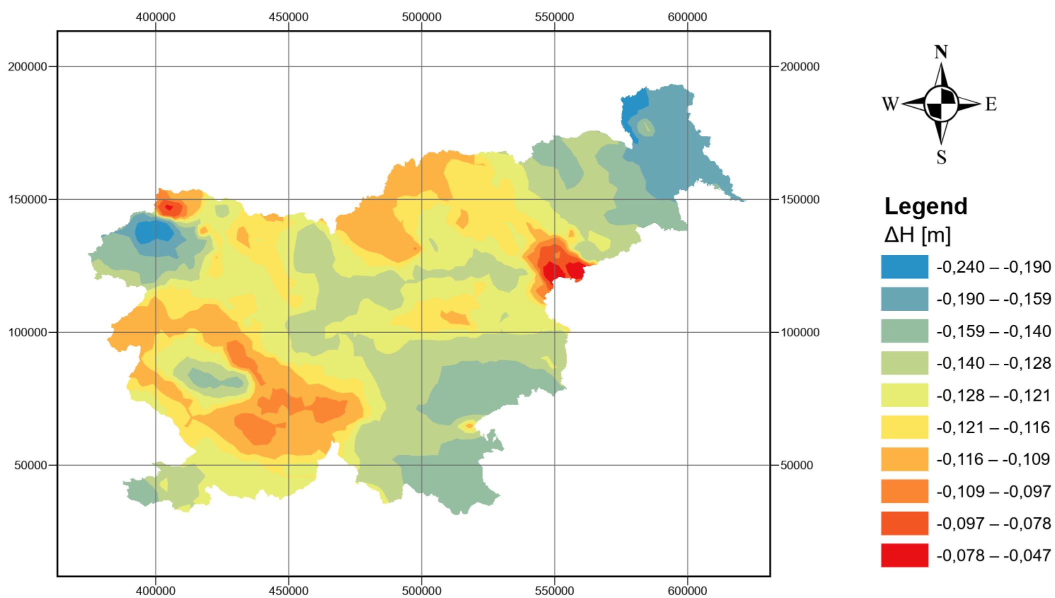
Height Reference Frame – Transformation to SVS2010

- **SVS2010** – national height reference system, adopted in 2018
- **SLO-VTP2024** – national height transformation model

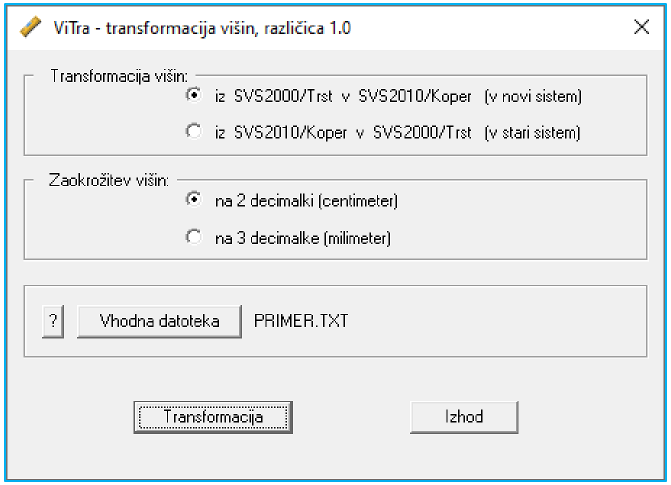
Height transformation between SVS2000 (Trieste) and SVS2010 (Koper):

- **155 mm** in Koper (tide gauge station)
- **240 mm** – max difference
- **132 mm** – average difference

- **3.3 mm** – internal accuracy
- **9.9 mm** – external accuracy based on 8693 control benchmarks



ViTra – free desktop transformation software



Research project V2-2294

More info: Koler et al. (2025) in *Geodetski vestnik* 69 (1), https://www.geodetski-vestnik.com/arhiv/69/1/11_Koler_at_al.pdf

Towards a 4D National Reference System

- ***SLO 4D project*** of the Surveying and Mapping Authority of the Republic of Slovenia
- … looking for a solution to implement the fourth (time) dimension in the national spatial reference system by:
  - involving a new national geokinematic model
  - defining transformation protokol and support for:
    - static GNSS surveys and PPP,
    - RTK GNSS positioning services,
    - spatial datasets maintenance,
    - location-based services, and
    - precise (sub-metre) navigation procedures
  - providing mechanisms (criteria and action plan) to maintain the national terrestrial reference frame (eg. when and how to update coordinates in CORS networks)
  - providing support for the users (workshops, guidelines, software solutions, web services etc.)

Coordinate Reference System Support – News

Adding a new geodetic datum to the ***EPSG Geodetic Parameter Dataset*** is in progress:

D96-17 as an **alias** to the existing **D96** (Slovenia 1996):

EPSG 6765 … ETRS89-D96

D96 … based on ETRF96/ITRF96 at 1995.55

D96-17 … based on ETRF00/ITRF00 at 2016.75 (redefinition / update of geodetic datum)

+ 7-parameter best-fit transformation into D96

Adding a new geodetic datum to the ***Trimble Coordinate System Database*** v2022.10

ETRS89/D96-17 available since 2025 in the ***Trimble Pivot Platform*** v5.2.3

Thank you for your attention

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