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National Report of Slovenia to the EUREF 2026 Symposium in Paris

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Abstract
The so-called SLO4D project has just been completed. The main project achievements are an updated national combined geodetic network, a national geokinematic model implemented in a time-depended reference frame transformation software, and a study of the 4D national coordinate reference system, which is expected to be introduced in the near future. Other recent projects and research activities deal with the height datum transformation, renovation of the levelling networks, gravity gradient determination, and the risk of jamming and spoofing of GNSS signals. An applied research project on geodetic technical and cultural heritage is being completed this year.

Terrestrial Reference System
The motivation for the SLO4D Project was presented at the 2025 EUREF Symposium in Covilhã [1]. Its main achievements are:

- a densified national combined (zero-order) geodetic network,
- a national geokinematic model, and
- a study on a 4D national spatial reference system.

Two new zero-order network points are built up in order to fill the gaps [2]. Now, it includes seven sites (Figure 1). Six of them are twin GNSS stations and five of the latter are equipped with InSAR corner reflectors (Figure 2). Three of these stations are EPN stations: Areh, Korada, and Prilozje.

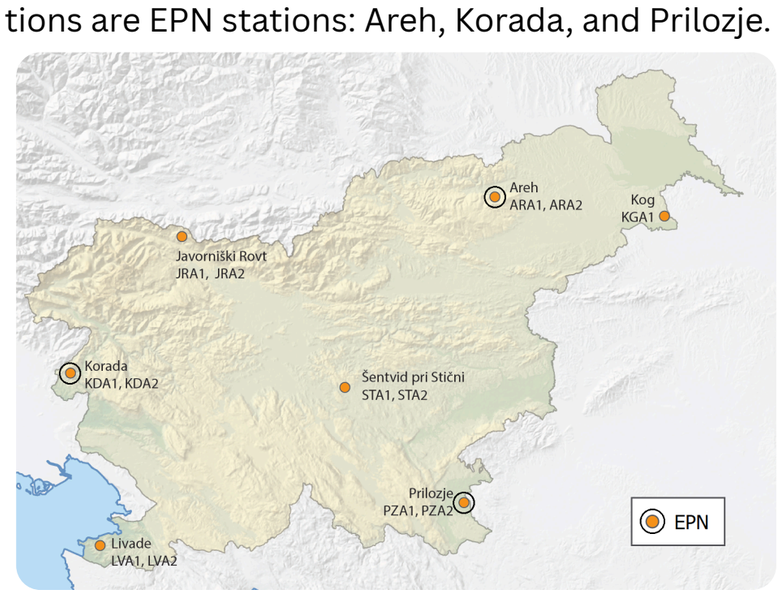


Figure 1: National combined (zero-order) geodetic network


Figure 2: Zero-order station Prilozje with InSAR corner reflectors

The national geokinematic model provides GNSS-based 3D velocities in the ETRF2000 (Figure 3). The velocities are calculated for a square grid with a grid cell side of 10 km. Coordinate time series data are collected for 44 GNSS stations of the SIGNAL and Zero-Order Networks. The grid points' velocities are determined by least-squares collocation [3]. The model has been implemented in a freeware tool for time-dependent coordinate transformations between the national and international terrestrial reference frames [4]. The next step is a detailed plan for the implementation of a semi-kinematic terrestrial reference frame.

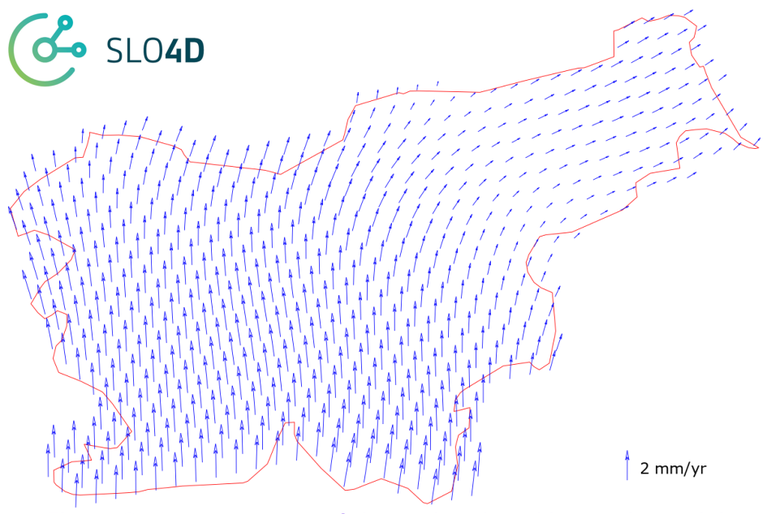


Figure 3: Hz component of the national geokinematic model

The SIGNAL Network consists of 16 GNSS stations plus 14 stations from the neighbouring countries. The Grid Check approach [5] is applied to check the consistency of GNSS services and products of the SIGNAL Network with the national terrestrial reference frame. A square grid with a grid cell side of 25 km is used for testing (Figure 4). AUSPOS and CSRS-PPP free online services are used for processing daily RINEX and VRS RINEX data [6].

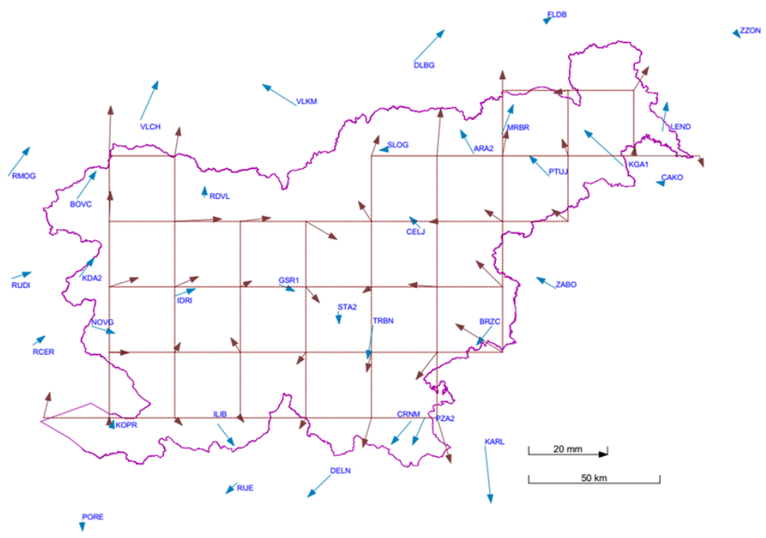


Figure 4: Validation of the GNSS services and products (Grid Check)

Height Reference System
A height datum transformation model was created, based on more than 2100 benchmarks using kriging interpolation (Figure 5). The external accuracy estimated by using ~8700 control benchmarks is 9.9 mm [7]. A freeware transformation tool is available – SVS2000/TS ⇔ SVS2010/KP [8].

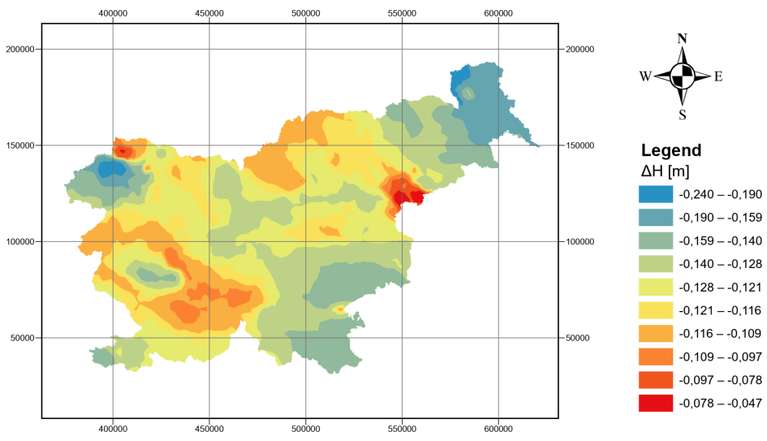


Figure 5: Height transformation surface – SLO-HTS2024

Other recent activities on the height reference system include renovation of some levelling networks in urban areas [9], and research focused on the gravity gradient determination [10].

Other Applied and Research Projects
A research project on the risk of jamming and spoofing of GNSS signals for the positioning and navigation services was completed in autumn 2025. Field tests and simulations in the lab (using GNSS simulator) were conducted. One of the project activities was to design a prototype system for GNSS signal interference detection [11, 12]. Simultaneously, research on the performance of low-cost GNSS receivers was carried out [13, 14].
An applied project on old geodetic and boundary marks and their promotion as technical/geodetic heritage is going to be completed in autumn 2026. The project took care of the registration of some of the monuments in the national Register of Cultural Heritage [15]. The research also provided some interesting scientific outputs [16].

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