The Use of Non-National CORS in Cadastral Surveying: the Slovenian Perspective

P. Pavlovčič Prešeren, B. Stopar, K. Ritlop, M. Triglav Čekada, S. Berk,

K. Medved and O. Sterle

University of Ljubljana
Faculty of Civil and Geodetic Engineering

GEODETIC INSTITUTE OF SLOVENIA

REPUBLIKA SLOVENIJA
MINISTRSTVO ZA OKOLJE IN PROSTOR
GEODETSKA UPRAVA REPUBLIKE SLOVENIJE

Motivation

How should I maintain the geometric consistency of cadastral data?

University of Ljubljana
Faculty of Civil and Geodetic Engineering

Contents

- access to the Slovenian coordinate system provided by SIGNAL
- GNSS station quality verification
- Smartnet in Slovenia
- single GNSS station verification
- case studies and results

Cadastral surveying in Slovenia: current status

Slovenian legislation

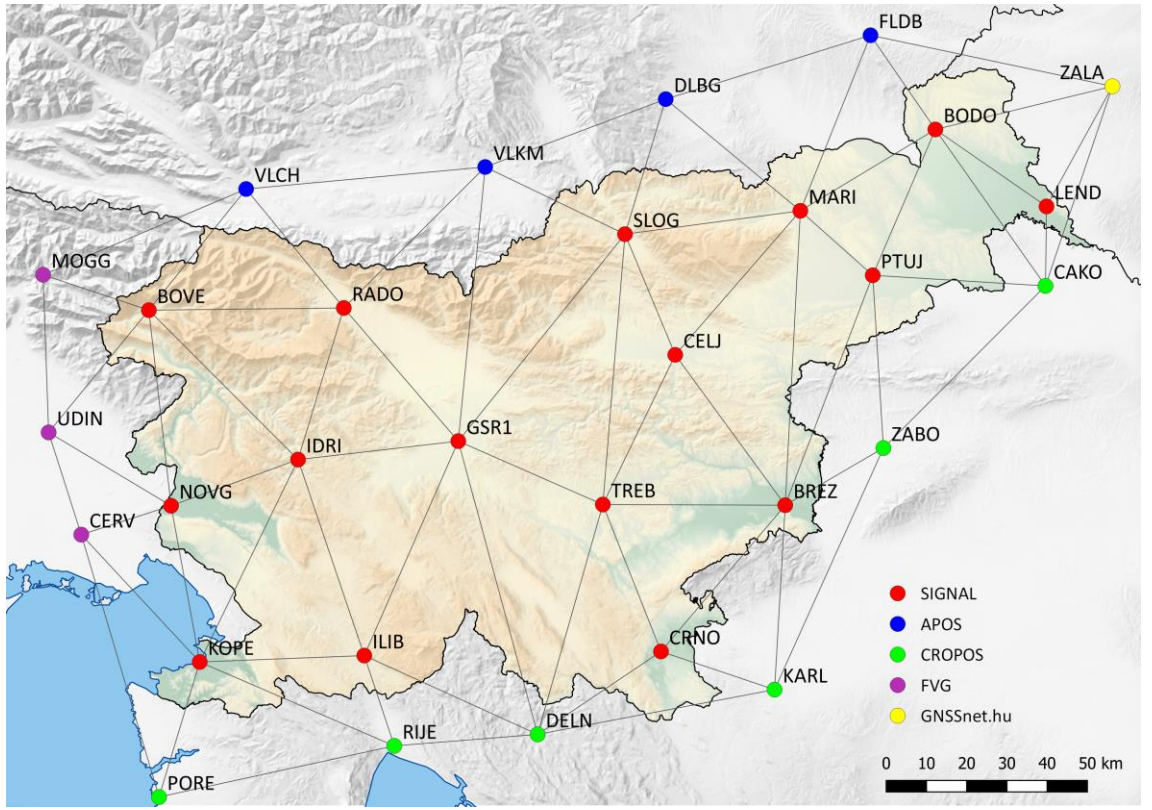
Cadastral points must be determined in the current realization of the coordinate system:

- from 2008 in the coordinate system **D96/TM** (EUREF 1994–1996 GPS campaigns)

- from 2020 in the coordinate system **D96-17/TM** based on the updated realization (EUREF 2016 GNSS campaign).

Very important fact

Since the establishment of the Slovenian GNSS network of CORS – SIGNAL (SI–Slovenia, G–Geodesy, NA–NAvigation, L–Location) in 2007, **access to the national coordinate system is provided by SIGNAL**.

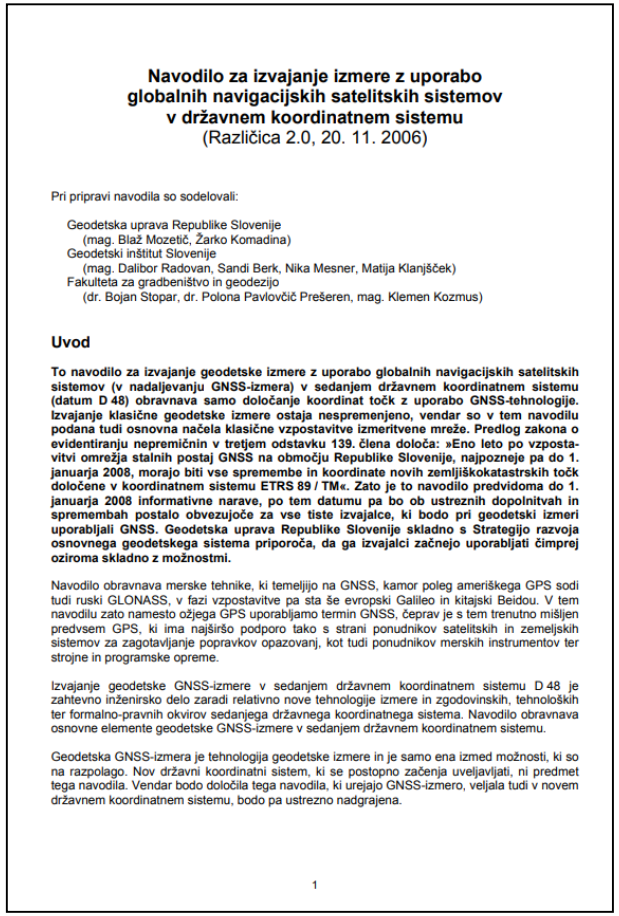


Instructions for GNSS surveying in the national coordinate system (November 2006)

The purpose to standardise basic measurements procedures with:

- verification of instruments
- calculation procedures
- transformation
- production of documentation for the needs of geodetic services and

maintenance of spatial data sets managed by the Surveying and Mapping Authority of the Republic Slovenia.



Navodilo za izvajanje izmere z uporabo globalnih navigacijskih satelitskih sistemov v državnem koordinatnem sistemu
(Različica 2.0, 20. 11. 2006)

Pri pripravi navodila so sodelovali:

Geodetska uprava Republike Slovenije
(mag. Blaž Mozetič, Žarko Komadina)
Geodetski inštitut Slovenije
(mag. Dalibor Radovan, Sandi Berk, Nika Mesner, Matija Klanjšček)
Fakulteta za gradbeništvo in geodezijo
(dr. Bojan Stopar, dr. Polona Pavlovčič Prešeren, mag. Klemen Kozmus)

Uvod

To navodilo za izvajanje geodetske izmere z uporabo globalnih navigacijskih satelitskih sistemov (v nadaljevanju GNSS-izmera) v sedanjem državnem koordinatnem sistemu (datum D 48) obravnava samo določanje koordinat točk z uporabo GNSS-tehnologije. Izvajanje klasične geodetske izmere ostaja nespremenjeno, vendar so v tem navodilu podana tudi osnovna načela klasične vzpostavitve izmeritvene mreže. Predlog zakona o evidentiranju nepremičnin v tretjem odstavku 139. člena določa: »Eno leto po vzpostavitvi omrežja stalnih postaj GNSS na območju Republike Slovenije, najpozneje pa do 1. januarja 2008, morajo biti vse spremembe in koordinate novih zemljiškokatastrskih točk določene v koordinatnem sistemu ETRS 89 / TM«. Zato je to navodilo predvidoma do 1. januarja 2008 informativne narave, po tem datumu pa bo ob ustreznih dopolnitvah in spremembah postalo obvezujoče za vse tiste izvajalce, ki bodo pri geodetski izmeri uporabljali GNSS. Geodetska uprava Republike Slovenije skladno s Strategijo razvoja osnovnega geodetskega sistema priporoča, da ga izvajalci začnejo uporabljati čimprej oziroma skladno z možnostmi.

Navodilo obravnava merske tehnike, ki temeljijo na GNSS, kamor poleg ameriškega GPS sodi tudi ruski GLONASS, v fazi vzpostavitve pa sta še evropski Galileo in kitajski Beidou. V tem navodilu zato namesto ožjega GPS uporabljamo termin GNSS, čeprav je s tem trenutno mišljen predvsem GPS, ki ima najširšo podporo tako s strani ponudnikov satelitskih in zemeljskih sistemov za zagotavljanje popravkov opazovanj, kot tudi ponudnikov merskih instrumentov ter strojne in programske opreme.

Izvajanje geodetske GNSS-izmere v sedanjem državnem koordinatnem sistemu D 48 je zahtevno inženirsko delo zaradi relativno nove tehnologije izmere in zgodovinskih, tehnoloških ter formalno-pravnih okvirov sedanjega državnega koordinatnega sistema. Navodilo obravnava osnovne elemente geodetske GNSS-izmere v sedanjem državnem koordinatnem sistemu.

Geodetska GNSS-izmera je tehnologija geodetske izmere in je samo ena izmed možnosti, ki so na razpolago. Nov državni koordinatni sistem, ki se postopno začenja uveljavljati, ni predmet tega navodila. Vendar bodo določila tega navodila, ki urejajo GNSS-izmero, veljala tudi v novem državnem koordinatnem sistemu, bodo pa ustrezno nadgrajena.

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Non-National CORS and access to the national coordinate system

The private sector has established several GNSS stations because of:

- difficulty of accessing the SIGNAL network via mobile connections
- the cost of the SIGNAL service
- use of GNSS stations for other purposes

Although their quality is not verified by the authority, **they are used as a reference for positioning in the national coordinate system.**

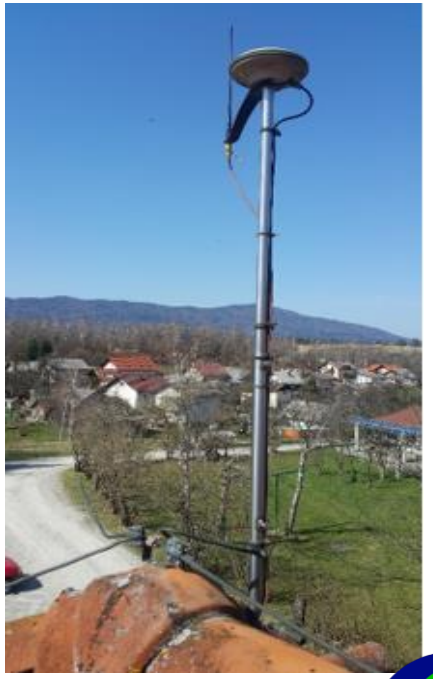
Basic questions for GNSS station verification

How to verify CORS?

What are the tolerances?

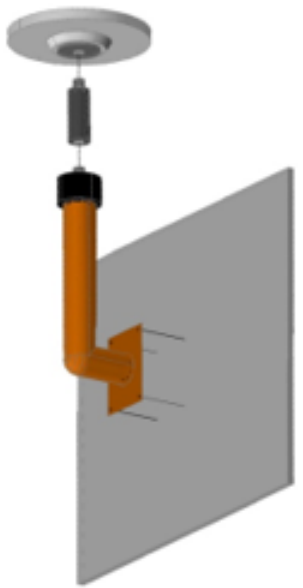
How can they be verified in practice, given that GNSS positions are essentially a stochastic process?

- The fundamental quality parameter of any GNSS point is stability.
- Long term events should be verified using daily files and from other stations.
- One of the criteria for the quality of a GNSS reference station is the internal consistency.



Non-National CORS: problems to be discussed

- insufficient documentation of private GNSS stations regarding the:
  - location
  - stabilisation
  - conditions for observation acquisition
  - connection to the coordinate system (computation)
- unknown documentation of determination of coordinates
- use of the single-station method even at distances greater than 15 km…



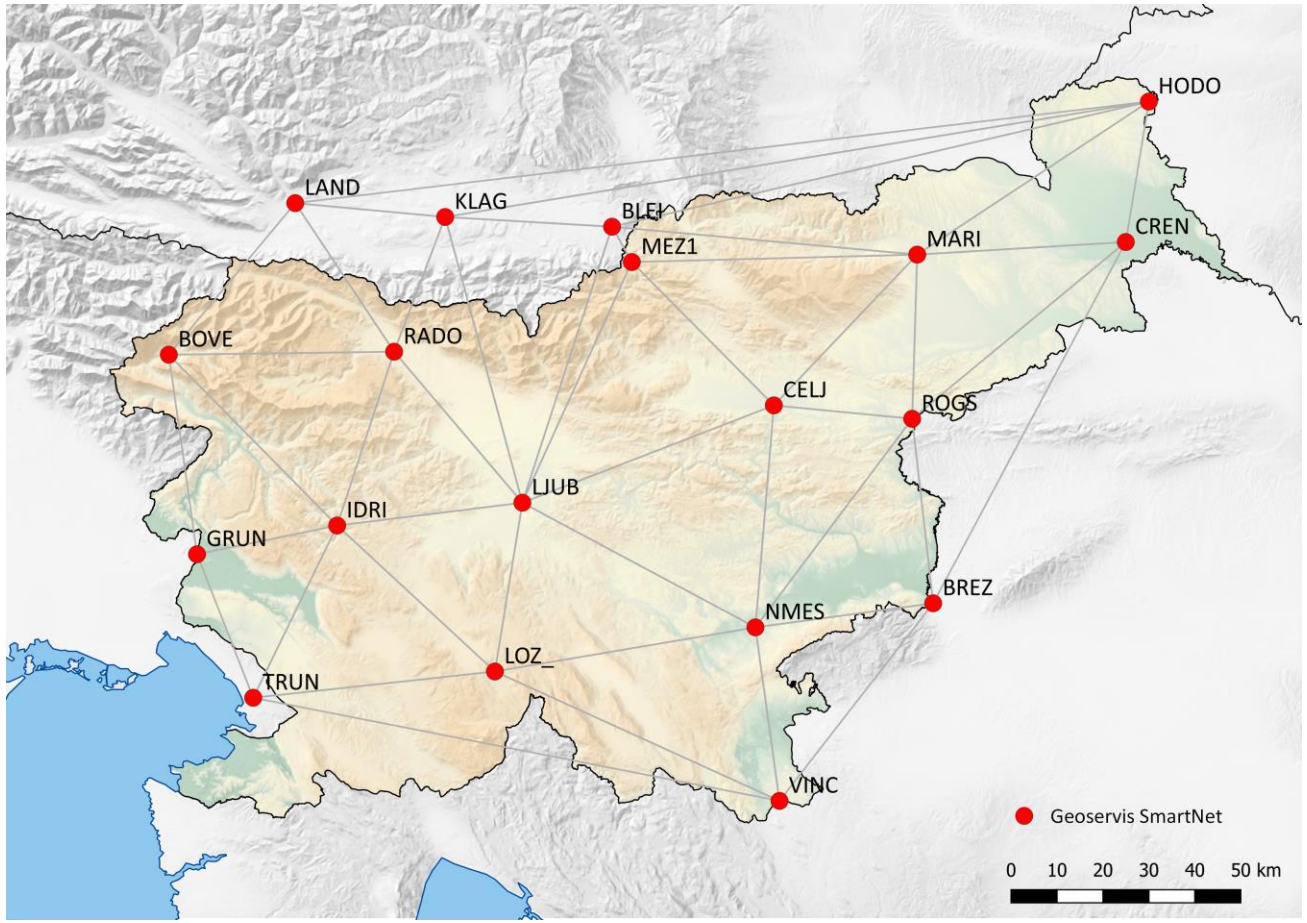
Stategy of processing?
Software used to gain coordinates?

Geometric inconsistency of the coordinate system on the level of detail.

SmartNet in Slovenia: access to SIGNAL

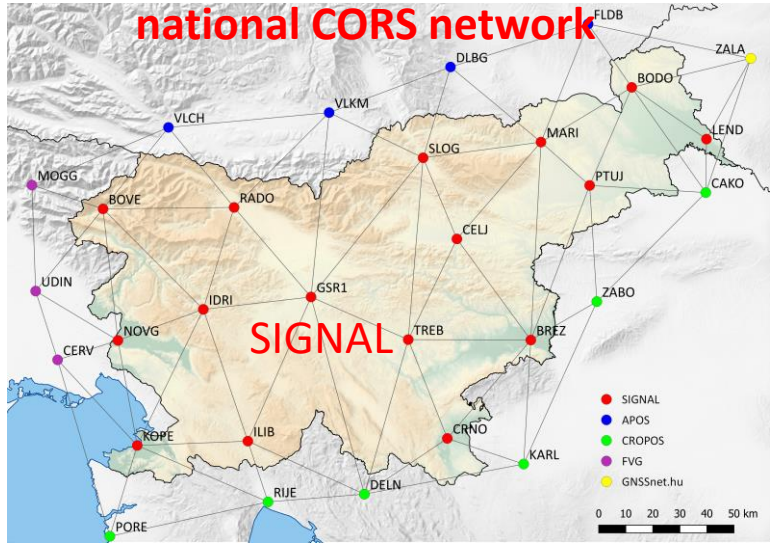
private CORS network

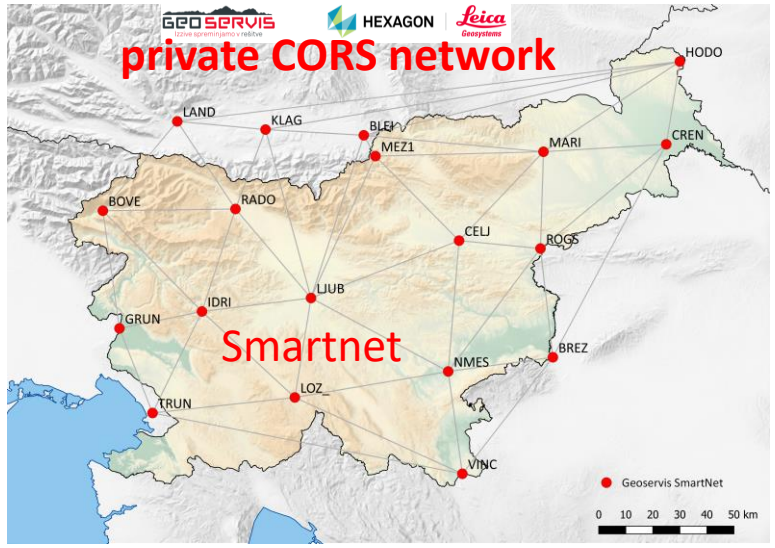
national CORS network

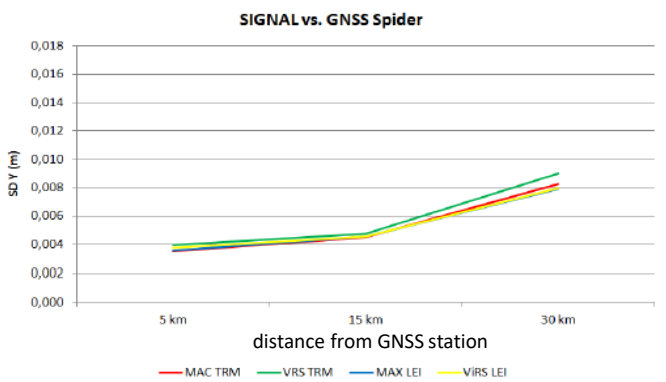


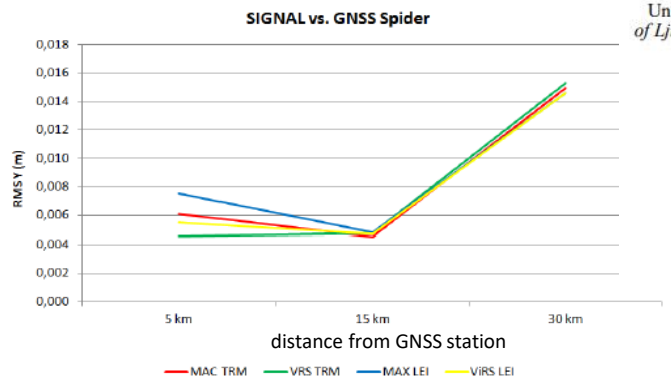
- calculation in ITRFyy and ETRS89 twice a year on a 14-day observations (*Bernese GNSS Software*)
- every second-day ***Cross-check*** with the coordinates of SIGNAL

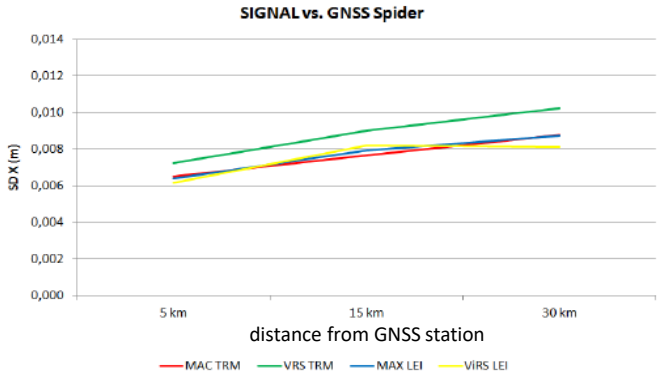
Consistency of position determination

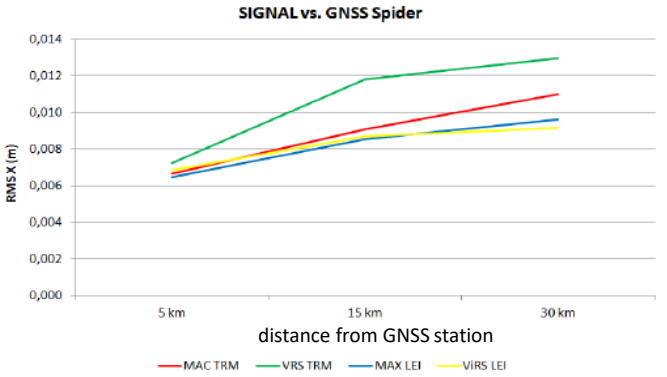


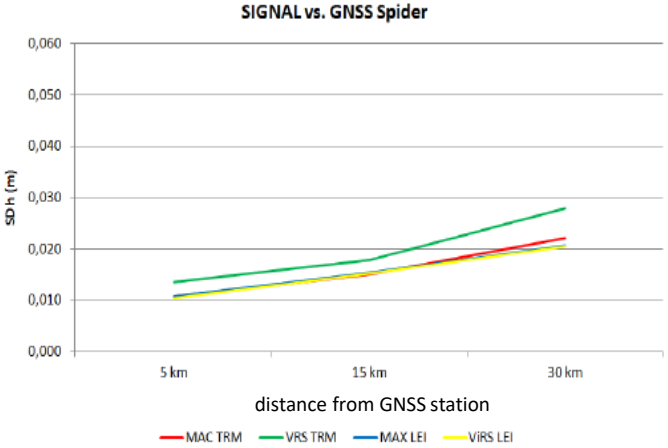


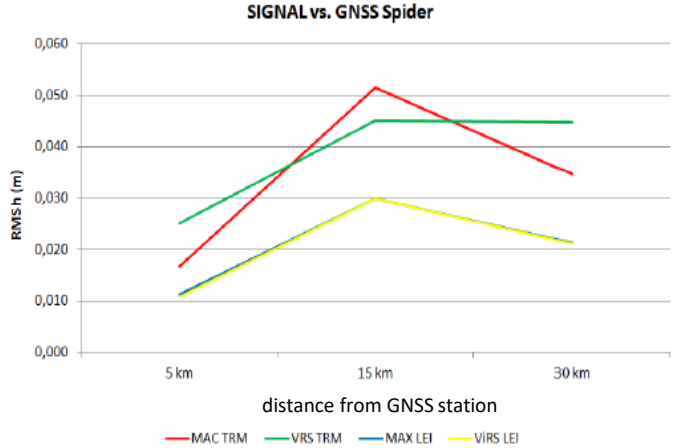












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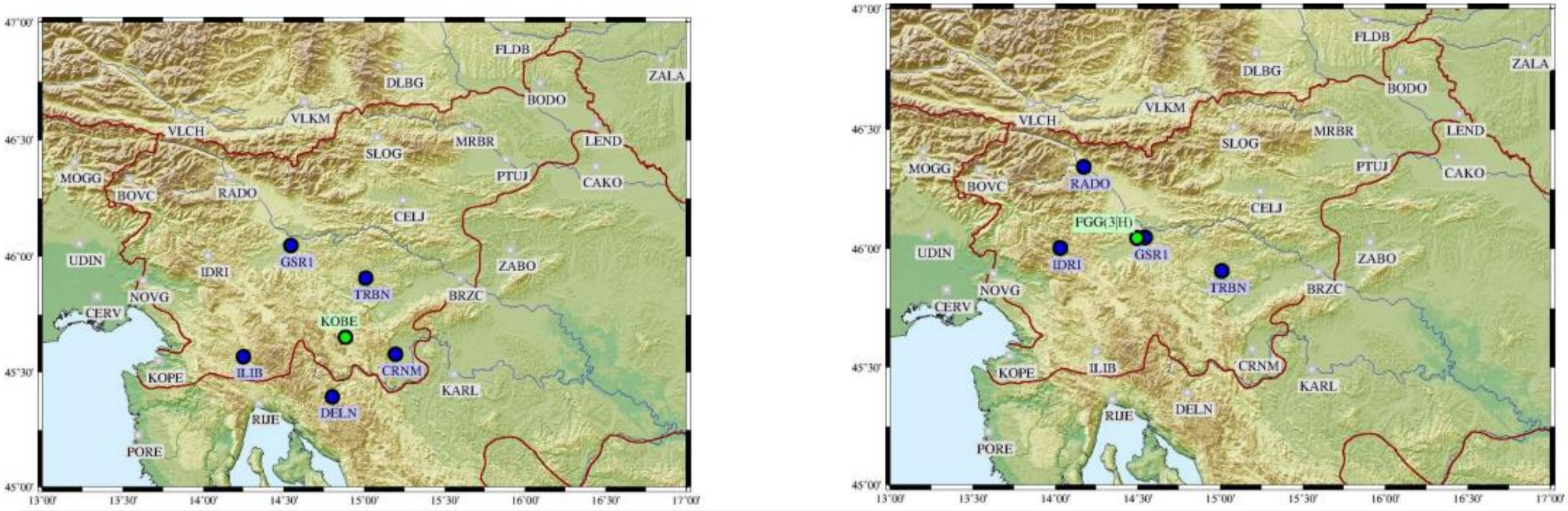
Single GNSS station: activities to preserve the geometric consistency on the level of detail

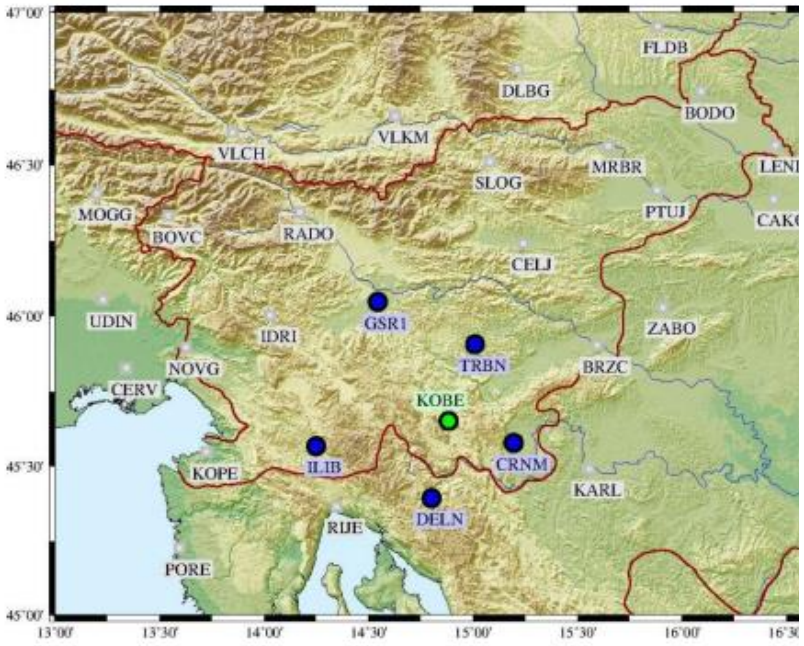
Testing of two non-national single GNSS stations to define:

a) observation length and periodicity to re-compute coordinates

b) the area from station to be used for single-station RTK

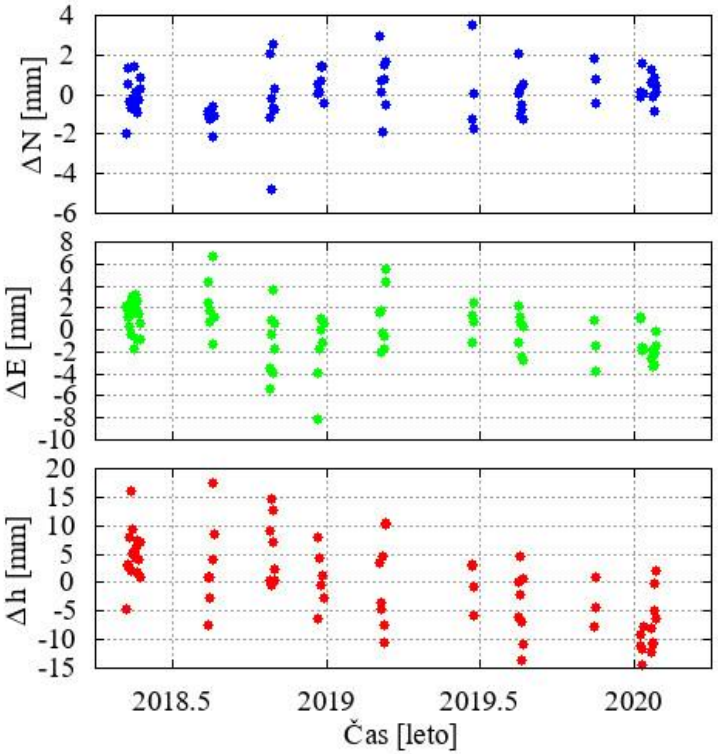


Testing GNSS station KOBE



KOBE: GPS observations only

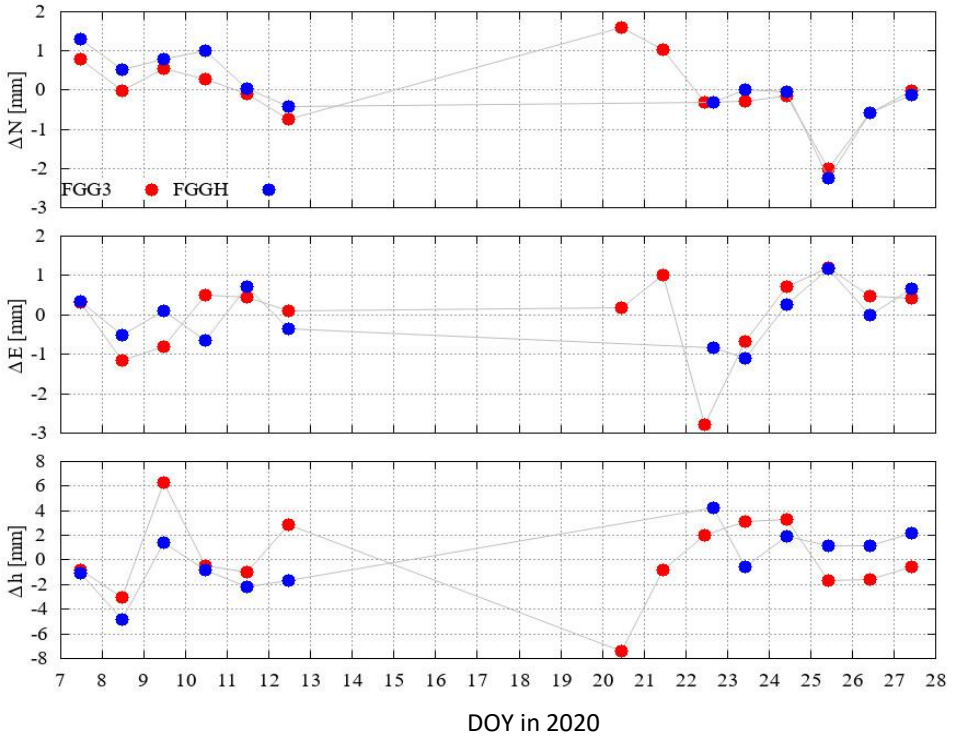
GNSS station	Δn_{min} [mm] Δn_{max} [mm] **$\sigma_{\Delta n}$ [mm]**	Δe_{min} [mm] Δe_{max} [mm] **$\sigma_{\Delta e}$ [mm]**	Δh_{min} [mm] Δh_{max} [mm] **$\sigma_{\Delta h}$ [mm]**
CRNM	-2.0 3.5 **1.2**	-6.1 3.6 **1.8**	-7.6 7.0 **3.4**
DELN	-7.0 5.7 **2.2**	-3.9 3.0 **1.3**	-7.1 6.3 **3.3**
GSR1	-1.6 3.18 **0.9**	-2.6 2.7 **1.0**	-5.2 6.5 **1.8**
ILIB	-3.6 2.3 **1.0**	-9.7 5.1 **2.5**	-3.6 20.8 **3.2**
TRBN	-2.2 2.6 **1.0**	-3.7 2.5 **1.2**	-8.0 5.0 **2.9**
KOBE	-4.8 3.5 **1.3**	-8.1 6.6 **2.5**	-14.3 17.5 **7.3**



	N [mm]	E [mm]	h [mm]
Mean RMS	1.5	3.1	5.4
Max. RMX	4.1	5.9	9.7

Testing GPS and GPS+GLONASS stations

The same location:
FGG3: GPS + GLONASS
FGGH: GPS



	N [mm]	E [mm]	h [mm]
Mean RMS	0.5	1.7	5.0
Max. RMS	0.8	2.4	5.8

Concluding remarks

- the results showed that time series of coordinates should be available for each GNSS station; the latter should be checked regularly;
- Smartnet allows the same quality of coordinates as SIGNAL;
- for each individual GNSS station a procedure of quality stabilization and coordinate determination should be performed and documented;
- single GNSS station: at the control points the coordinates should be verified with those obtained directly with SIGNAL or Smartnet products.

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I will check several solutions to be sure…

and to maintain the geometric consistency of cadastral data.

Acknowledgement

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Thank you for your attention!

Contacts:

University of Ljubljana
Faculty of Civil and Geodetic Engineering
Jamova cesta 2, SI-1000 Ljubljana, Slovenia

Geodetic Institute of Slovenia
Jamova cesta 2, SI-1000 Ljubljana, Slovenia

The Surveying and Mapping Authority of the Republic of Slovenia
Zemljemerska ulica 12, SI-1000 Ljubljana, Slovenia

Polona Pavlovčič Prešeren: polona.pavlovcic-preseren@fgg.uni-lj.si
Bojan Stopar: bojan.stopar@fgg.uni-lj.si
Oskar Sterle: oskar.sterle@fgg.uni-lj.si
Klemen Ritlop: klemen.ritlop@fgg.uni-lj.si
Mihaela Triglav Čekada: mihalea.triglav@gis.si
Sandi Berk: sandi.berk@gov.si
Klemen Medved: klemen.medved@gov.si