LECHNER TUDÁSKÖZPONT

INTEGRATION OF THE COMBINED GNSS/InSAR STATIONS INTO THE NATIONAL GEODETIC INFRASTRUCTURE

AMBRUS KENYERES, SÁNDOR TÓTH, BÁLINT MAGYAR, ROLAND HORVÁTH, ISTVÁN GALAMBOS

EUREF SYMPOSIUM2024

BARCELONA, 4-6 JUNE 2024

MOTIVATION AND OPPORTUNITIES

- NEW OPPORTUNITIES OFFERED BY GNSS and InSAR

  (a) INFRASTRUCTURE RECONSIDERATION

  - new integrated reference benchmarks – multitude of foreseen applications;
  - simplified and well tailored maintenance for height reference;
  - get rid of single benchmark issues („abandoned" benchmarks for decades)

  (b) STEP_1 FOR 4D GEODESY - ABILITY FOR KINEMATIC HEIGHT REFERENCE

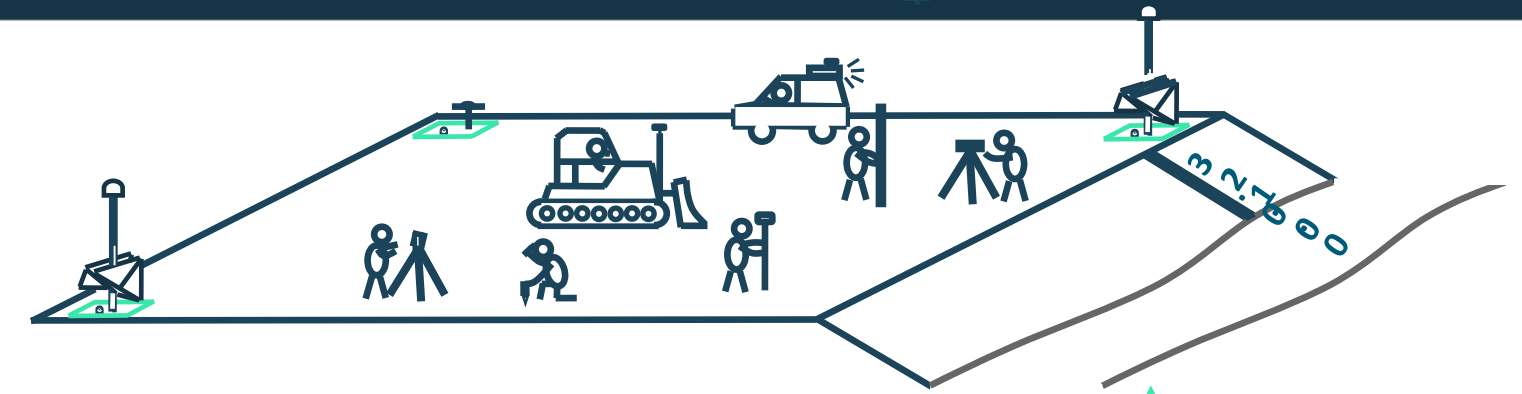
  - accurate geoid as static component
  - modelling of position time dependence from GNSS-InSAR integration (EGMS & national GMSs);

  (c) SUPPORT FOR HEIGHTING WITH MULTI-GNSS

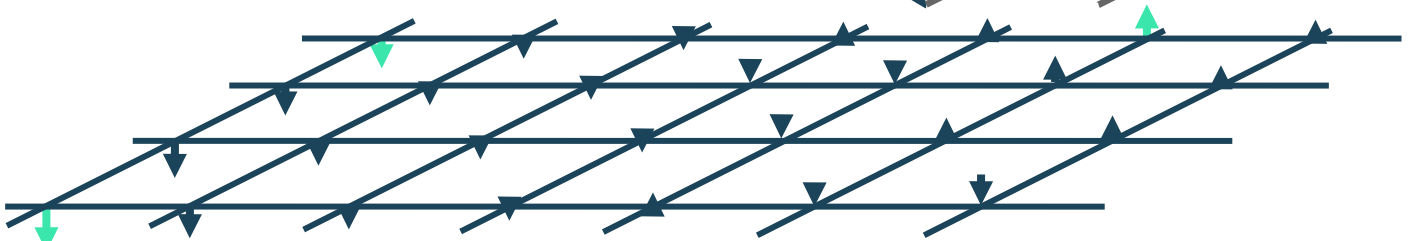
  - semi-kinematic transformation database in RTK equipments and online
  - multi-GNSS fully exploited

- ECONOMIC CONSTRAINT – LEVELLING NETWORK MAINTENANCE

SURVEYING PRACTICE



velocity model as an extra



Geoid as in the classical approach

(c) TS

PROOF OF CONCEPT: INGRIM* PROJECT

- A COMPLETELY NEW HEIGHT REFERENCE INFRASTRUCTURE
  - CORS + InSAR corner reflectors + levelling benchmark + gravimetry → MULTI-TECHNIQUE stations with MULTIPLIED application opportunities;

* Integrated Galileo Reference Infrastructure for Height Modernization

supported by ESA NAVISP

INTEGRATED STATION EXAMPLES

MKEK

MKKH

MPOG

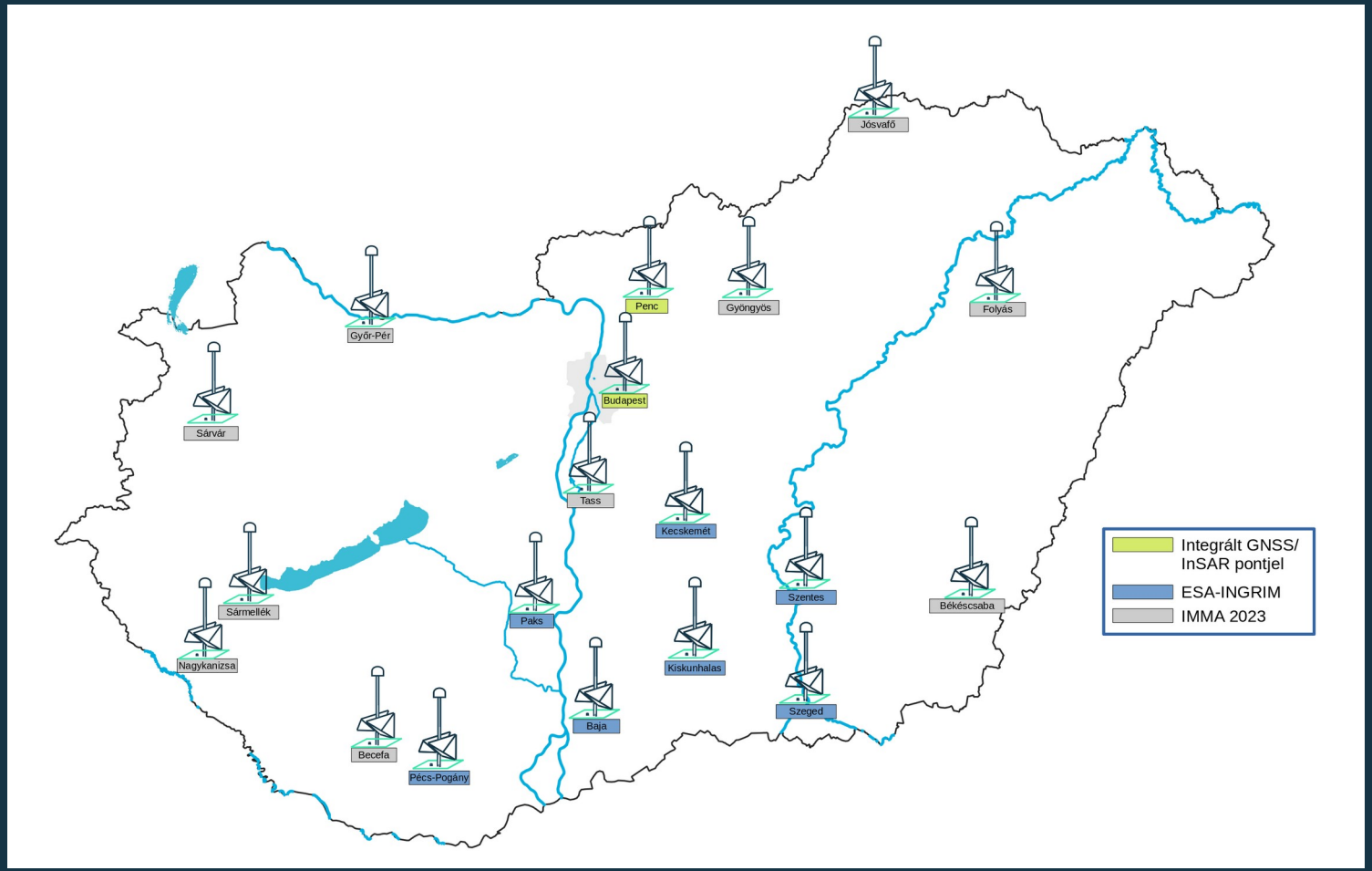
MSZE

MPAK

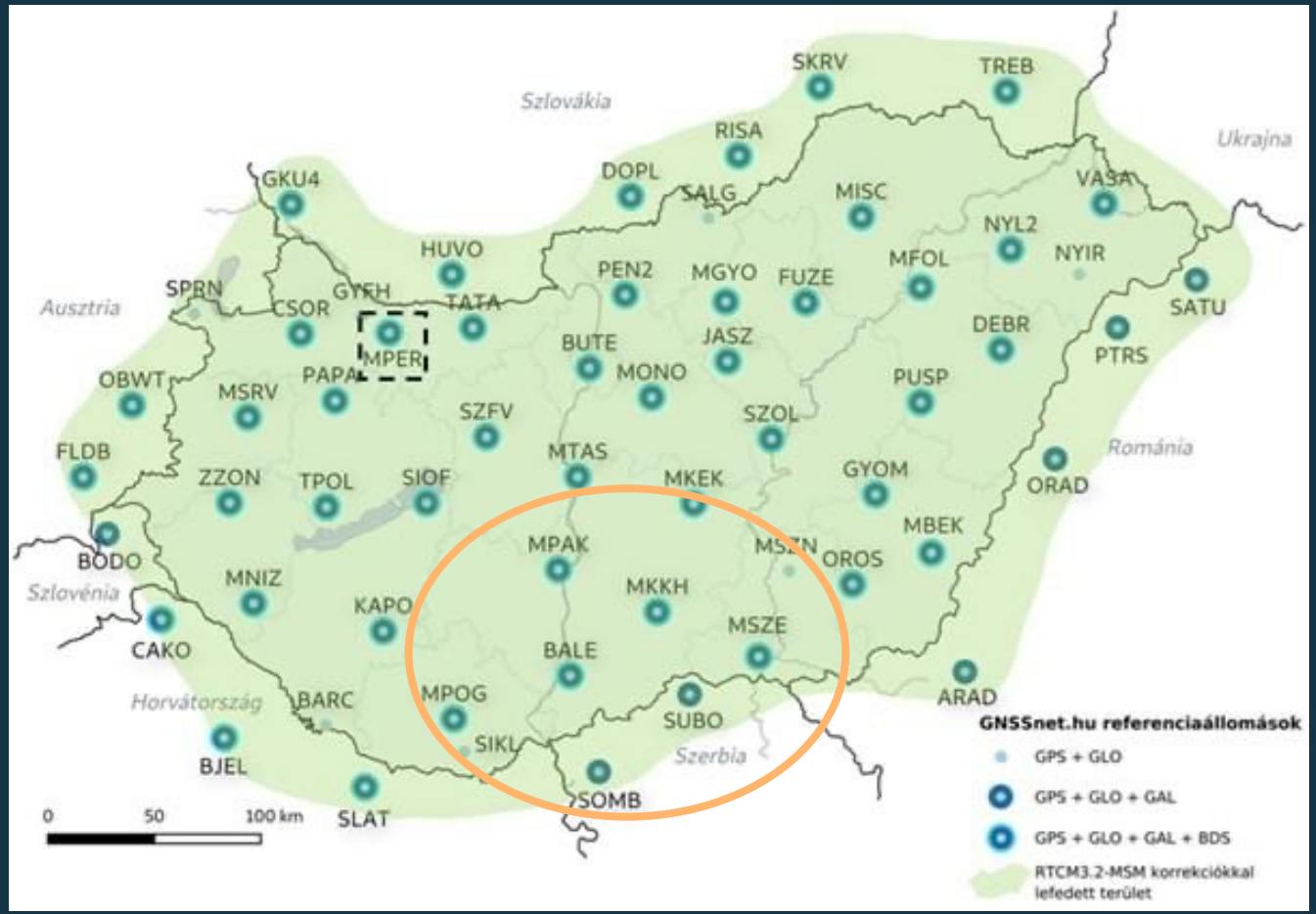
MBAJ

MSEN

INTEGRATED STATIONS AS OF JUNE 2024



INGRIM STATIONS IN GNSSnet.hu



PROOF OF CONCEPT: INGRIM* PROJECT

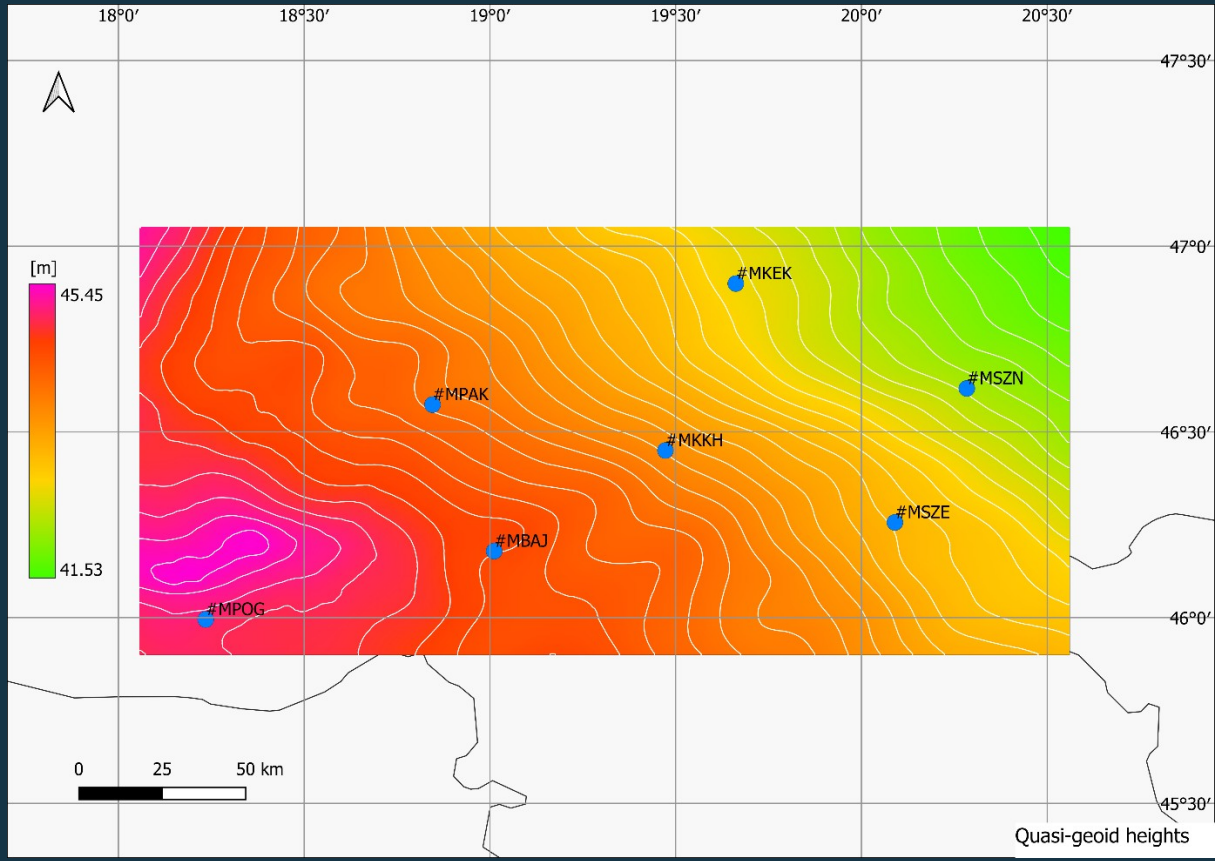
- A COMPLETELY NEW HEIGHT REFERENCE INFRASTRUCTURE
  - CORS + InSAR corner reflectors + levelling benchmark + gravimetry → MULTI-TECHNIQUE stations with MULTIPLIED application opportunities;
- SEMI-KINEMATIC HEIGHT REFERENCE HAD BEEN DERIVED
  - dense grid holding the ground motion information from GNSS + InSAR and used for converting spatial coordinates into local frames
  - EPND velocity model extensively used
  - Static (hardwired) → (semi)-kinematic with given reference epoch
  - → long term validity
- ALTERNATIVE OF TRADITIONAL HEIGHT REFERENCING

* Integrated Galileo Reference Infrastructure for Height Modernization

supported by ESA NAVISP

STATIC PART: GEOID

- Dedicated new gravimetric geoid based on Radial Basis Function approach
- Integration with existing GPS/leveling data measured in **2014** to remove reference frame biases. **This date defines the epoch!**
- Represents the static part of the height reference

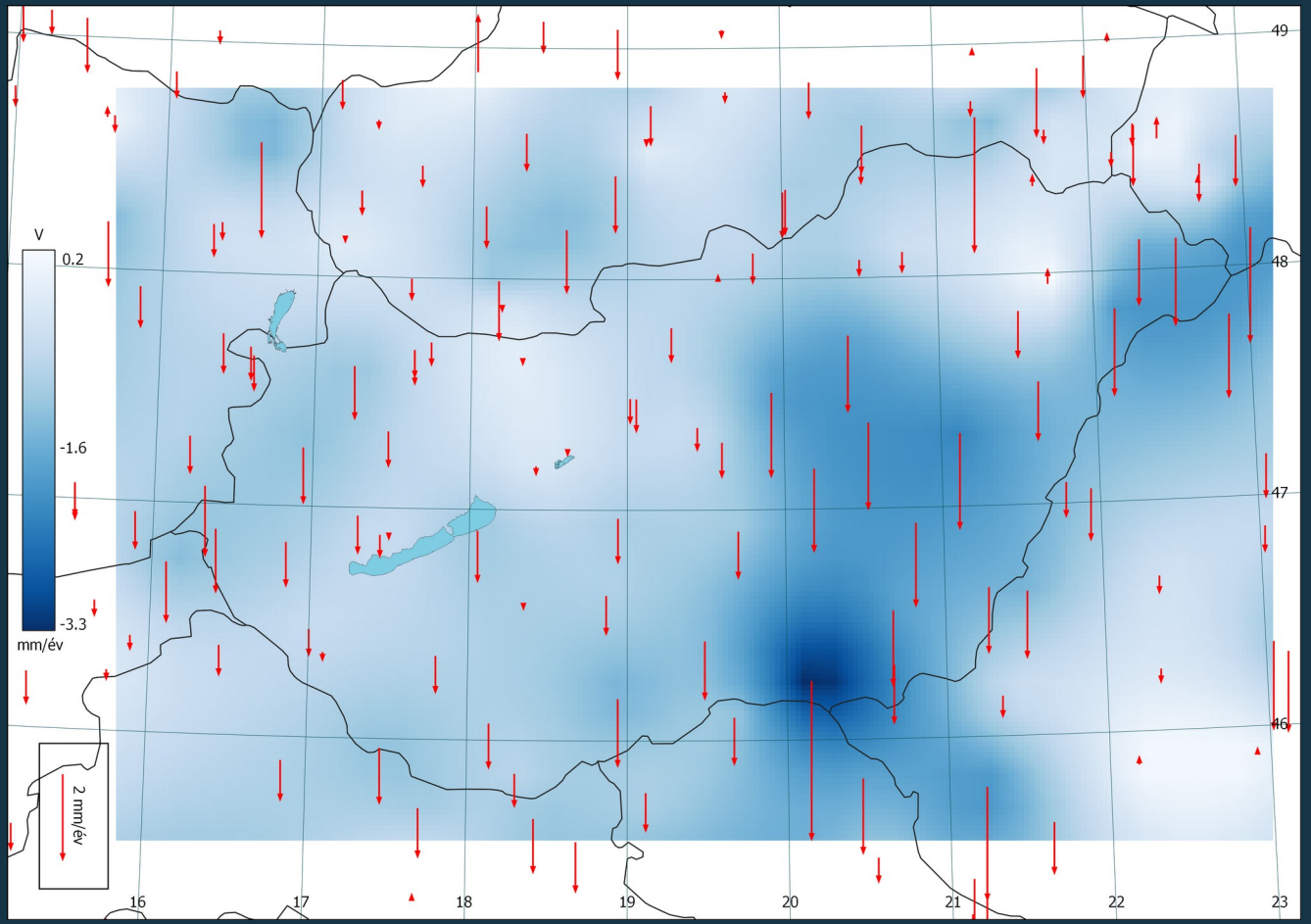


GNSS velocity model

Velocity grid based on the European scale EPND solution

Extended LS Collocation with **smoothing**

Serve as background model for the InSAR analysis



HYBRID HEIGHT REFERENCE

- static part from the geoid
- epoch dependent component from GNSS/InSAR velocity grid

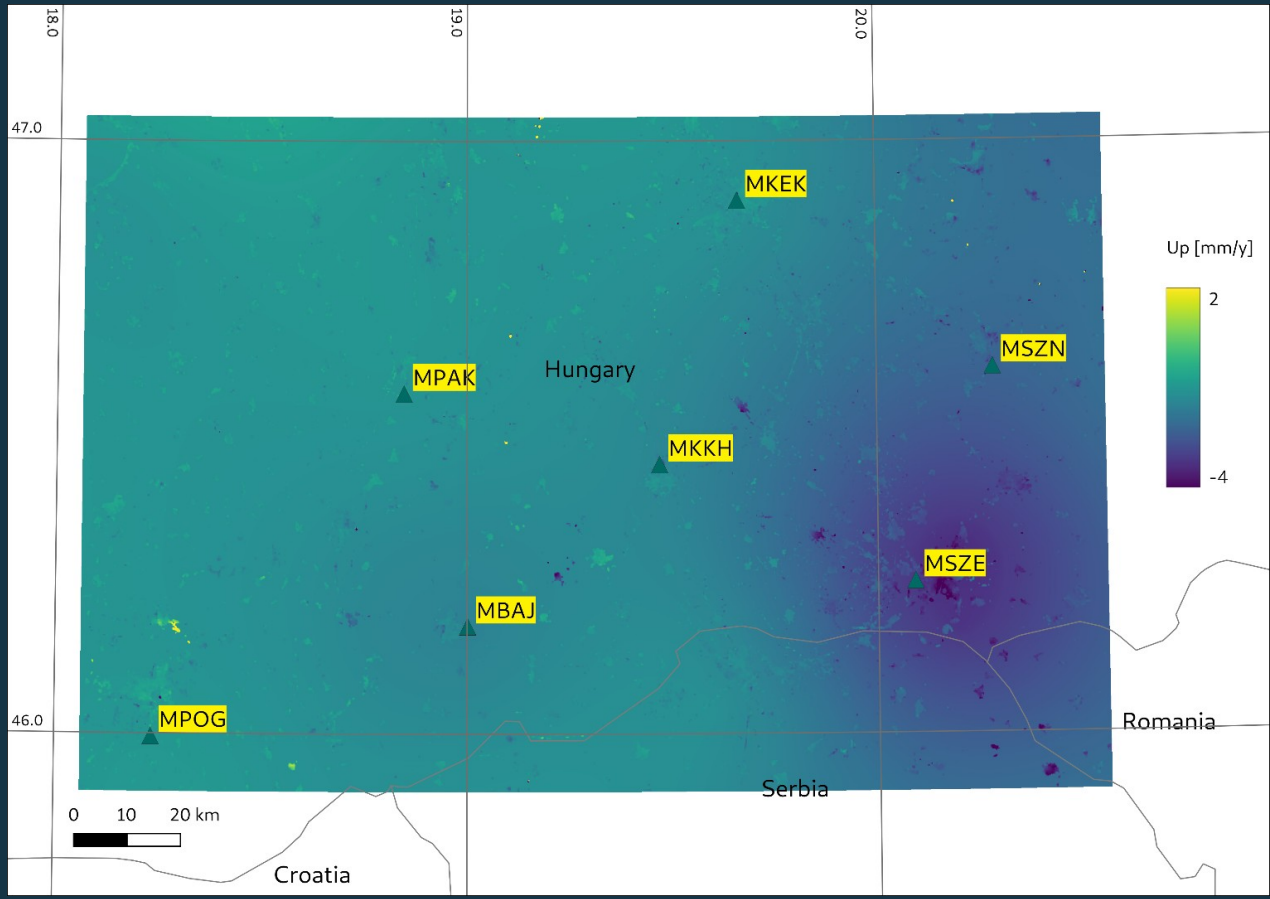
  t0 + (t-t0) x V

t0 is 2014 from geoid GPS leveling combination

→ semi-kinematic solution: periodic grid update

H(lev)=h(ell)-N(hybridHR)

Key: epoch harmonization



Kinematic part of the reference: GNSS velocity grid + InSAR analysis

PROOF OF CONCEPT: INGRIM* PROJECT

- **A COMPLETELY NEW HEIGHT REFERENCE INFRASTRUCTURE**
  - CORS + InSAR corner reflectors + levelling benchmark + gravimetry → MULTI-TECHNIQUE stations with MULTIPLIED application opportunities;
- **SEMI-KINEMATIC HEIGHT REFERENCE HAD BEEN DERIVED**
  - dense grid holding the ground motion information from GNSS + InSAR and used for converting spatial coordinates into local frames
  - EPND velocity model extensively used
  - static → (semi)-kinematic with given reference epoch
  - long term validity
- **ALTERNATIVE OF TRADITIONAL HEIGHT REFERENCING**

* Integrated Galileo Reference Infrastructure for Height Modernization

supported by ESA NAVISP

FIELD TEST AND VALIDATION

- ➔ prove the superiority of multi-GNSS;
- ➔ check environment dependency -„free" horizon vs covered site;
- ➔ compare the old transformation database with the new INGRIM solution;

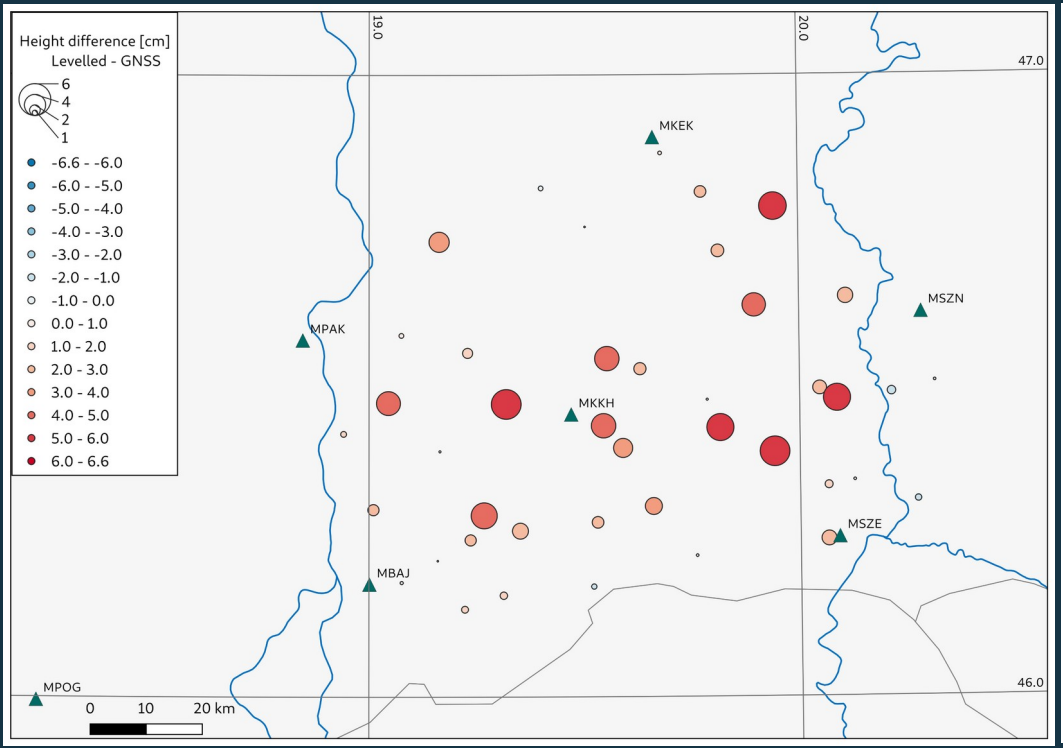
Two campaigns

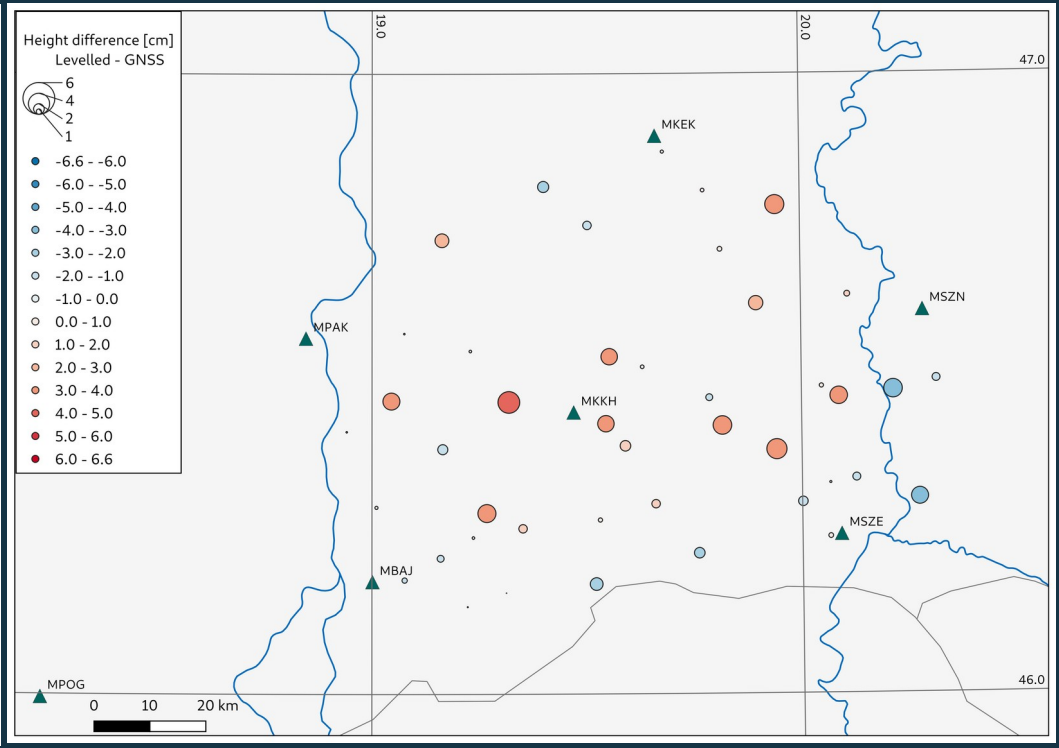
- Static measurements

  50+ benchmarks, 45 min measurement, postprocessing, over the full pilot area
- RTK campaign

  18 points in Szeged city, standard RTK, eccentric measurements

Static field campaign





Height differences of official book-kept values and "measured ones"

Standard transformation

INGRIM transformation

SUMMARY_1

- A resilient, multi-purpose geodetic reference infrastructure had been defined and started to be built, serving RTK positioning, heighting and scientific applications;
- We defined and realized a modernized, space technology-supported height reference system and the option for long term maintenance;
- The solution is highly rely on Galileo and also on Copernicus (Sentinel), flagships of EU programs;

SUMMARY_2

- The solution had been tested and its reliability was proved;
- INGRIM was a pilot, it is partially rely on existing background information (e.g. GNSS velocity field), the new components could be used in the coming years;
- The INGRIM approach was accepted by the decision makers in Hungary and its national scale extension is in progress (3 more years to go);

THANKS FOR YOUR ATTENTIOIN!

&

LOOKING FORWARD RENEWING EOMA!