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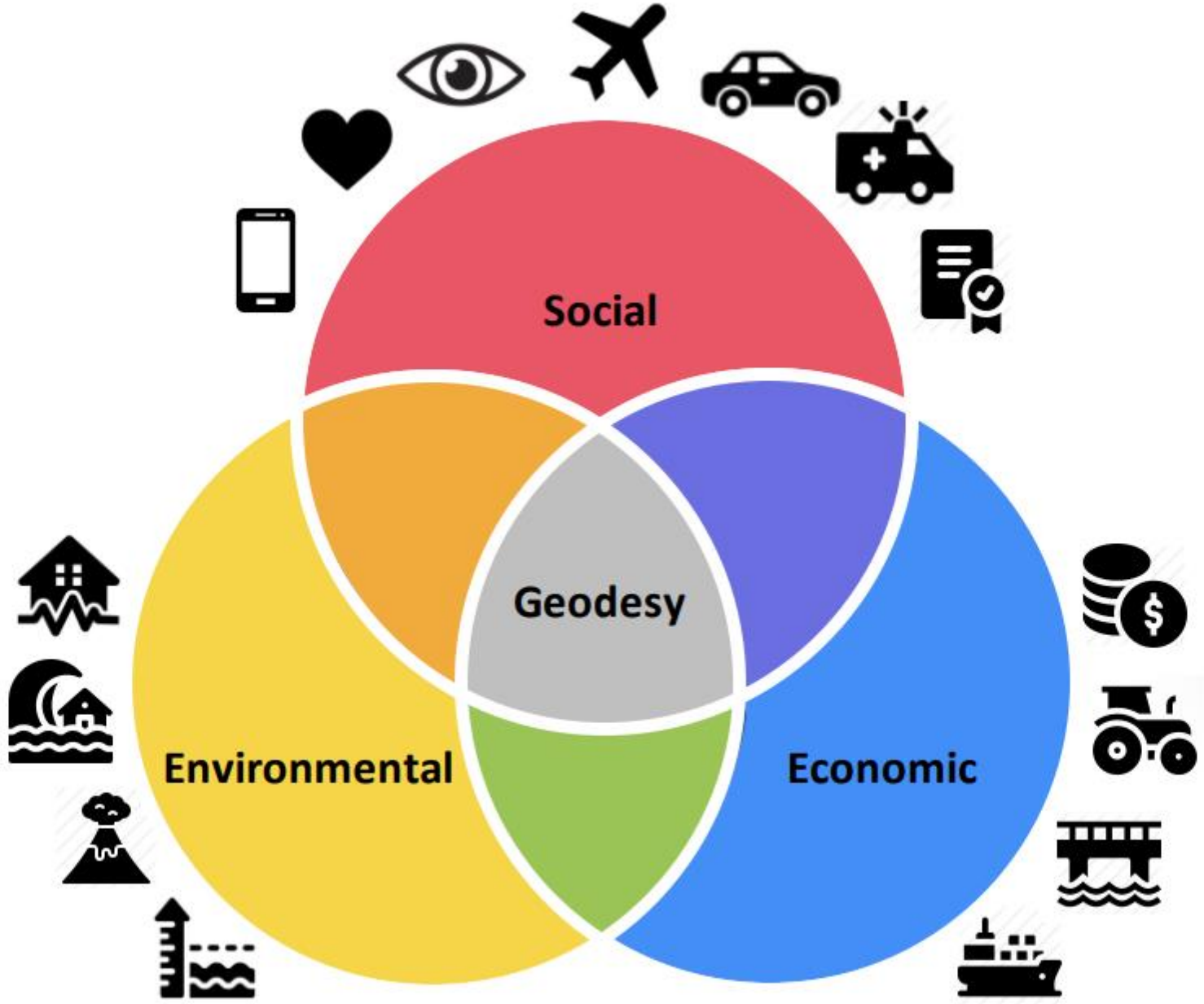
Introduction to Metsähovi Geodetic Research Station

Prof. Hannu Koivula

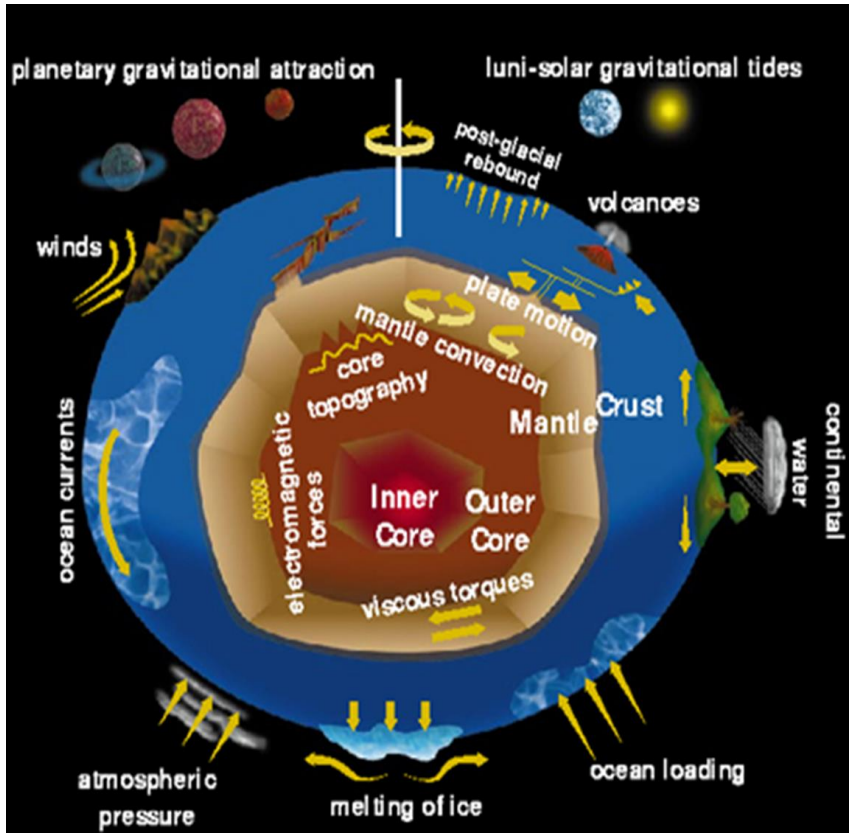
Director, Department of Geodesy and Geodynamics

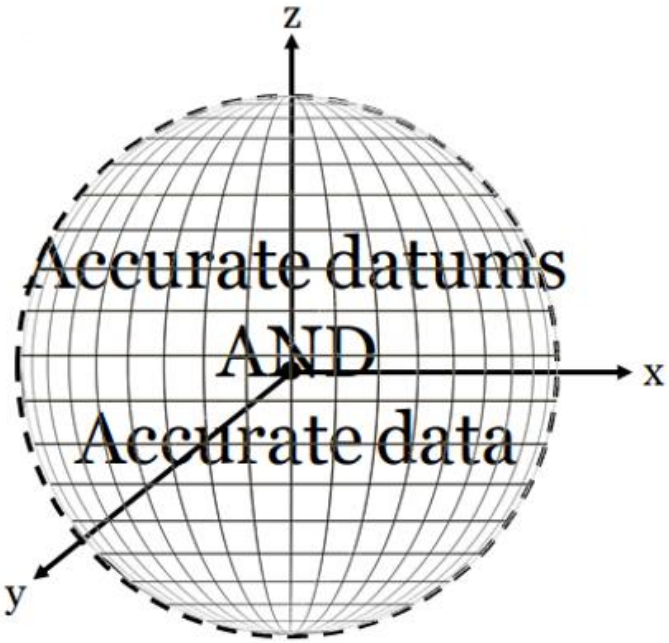
Finnish Geospatial Research Institute FGI, National Land Survey of Finland

Thirteenth Session of the United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM) 2 - 4 August 2023



We are living on a restless planet





Source: Dr Anna Riddell, Geoscience Australia

Going far together

Thirteenth Session of the United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM) 2 - 4 August 2023

- The need to know our location on earth down to the smallest possible measurement may only be satisfied by international collaborations in geodesy.
- Global geodesy is dependent on findable, usable, and inter-operable contributions from nations all around the globe, since **no single country can maintain the Global Geodetic Reference Frame alone**.
- By collaborating with the United Nations Subcommittee on Geodesy, international partners and stakeholders, the global geodetic community is able to **collectively leverage limited assets to the top of current geodetic knowledge and capability**

jpl.nasa.gov

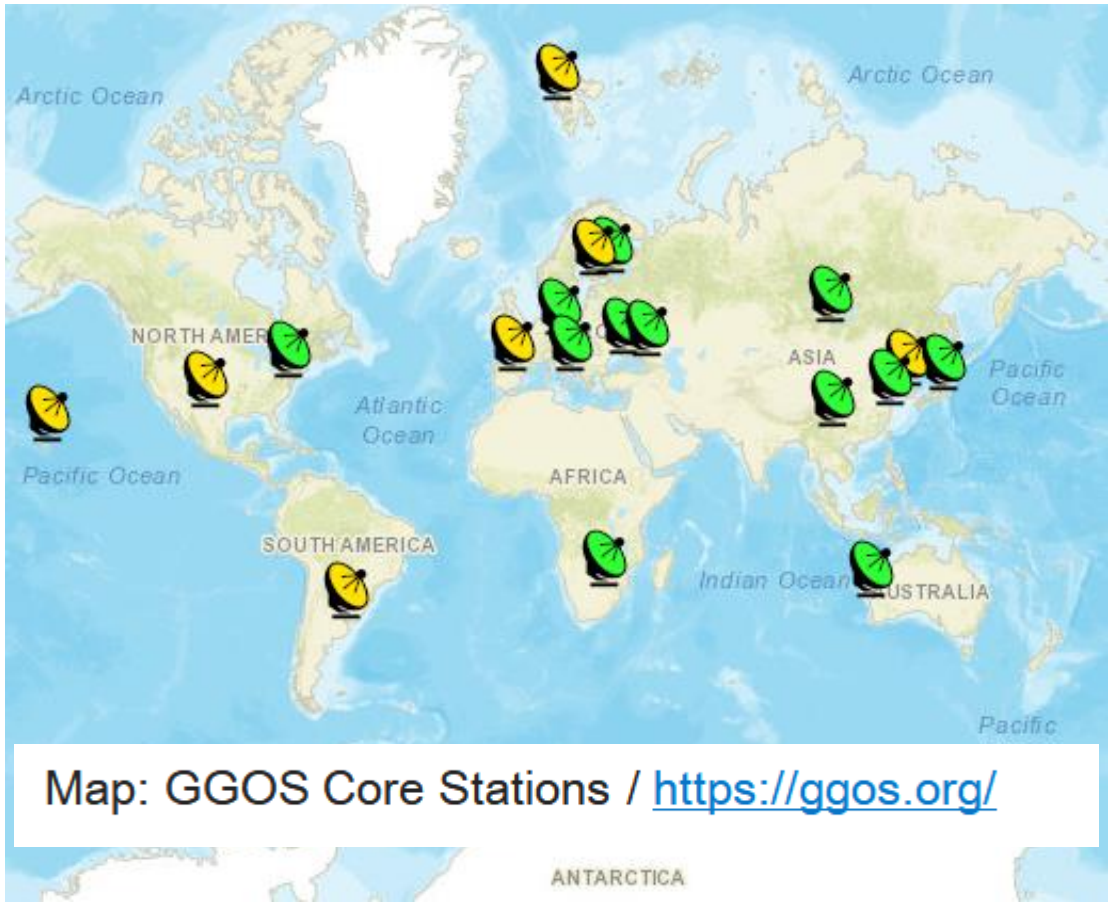
Global Geodetic Observing System GGOS

Provides the **reference frames** required for all location-dependent observations and thus contributes to the foundation of most Earth observations.

Provides the **measurement** of the **time-variable shape, gravity field, and rotation of the Earth**, and thus contributes to the **Earth observation database**.

Global Geodetic Core Sites

Sites with multi-technique instrumentation have the central role. They are the backbone of global geodetic observing system (GGOS) and data analysis. Global reference frames (both ITRF and ICRF) depend on multi-technique sites and their long-term time series.



Map: GGOS Core Stations / https://ggos.org/

Typical instrumentation at core stations

- GNSS (typically more than one)
- Satellite Laser Ranging (SLR)
- VLBI Global Observing System (VGOS)
- DORIS
- Local tie network / facilities

- Absolute gravimeter
- Superconducting gravimeter
- Environment detecting instruments
- Tide gauge
- Geodetic SAR reflector(s)
- et al.

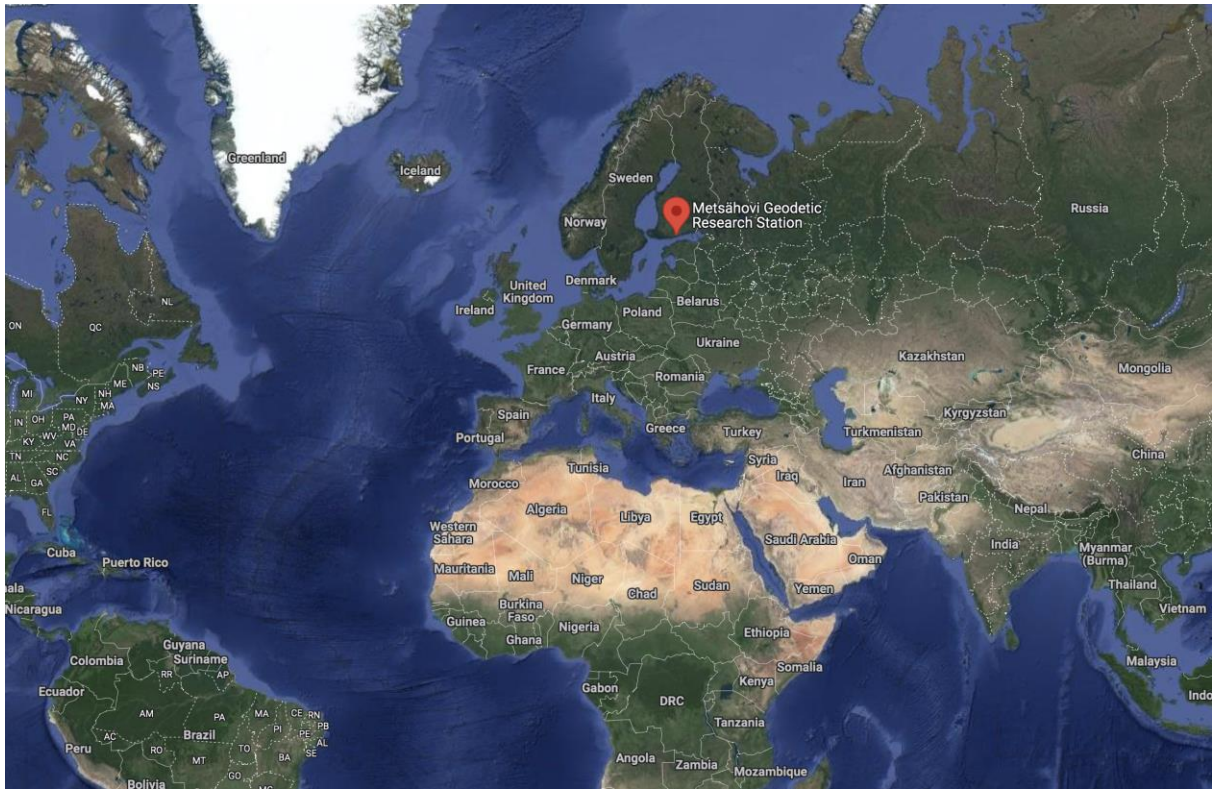
The instrumentation currently or soon operational at Metsähovi indicated in red color

Geodetic Core Sites

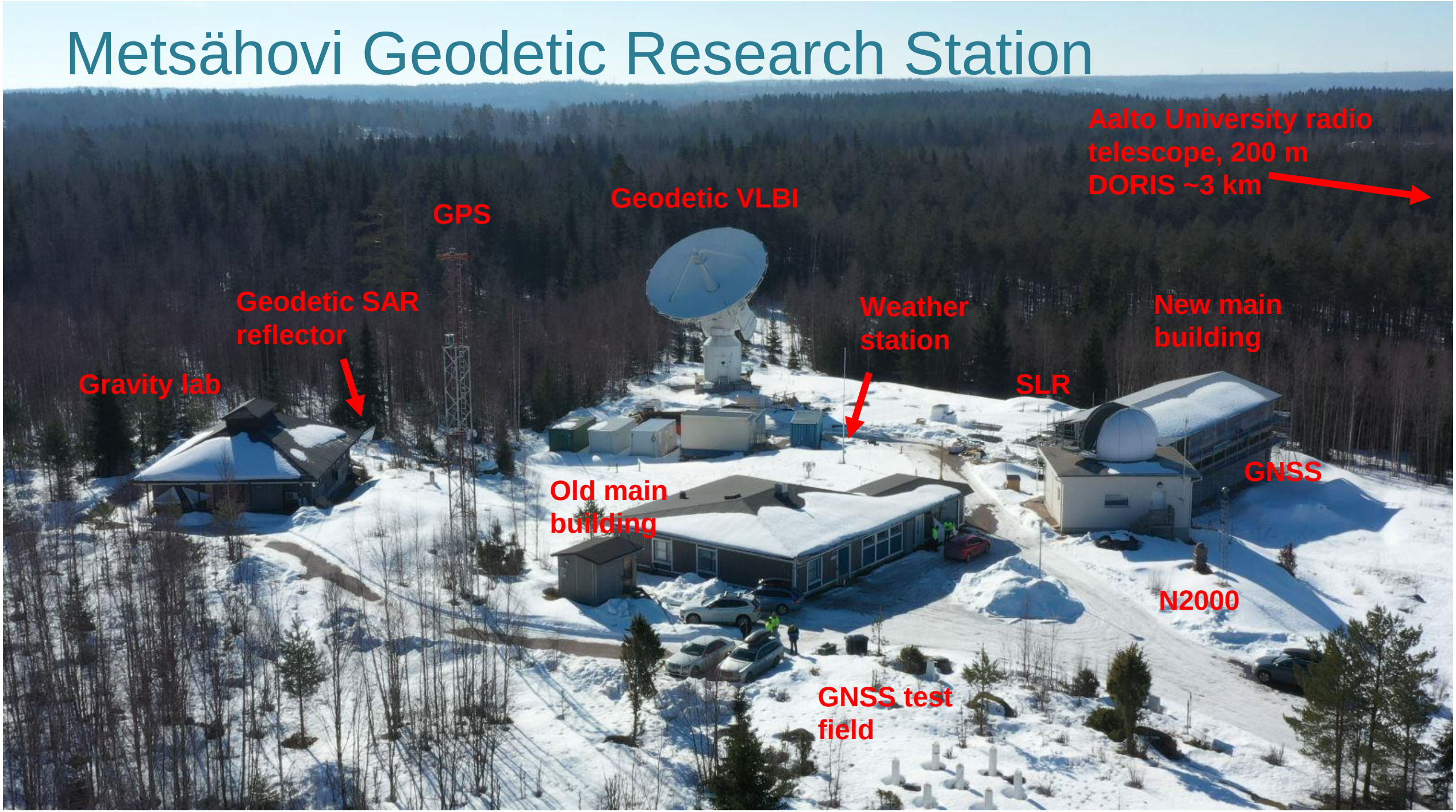
		VLBI	GNSS	DORIS	SLR	AG/SG
Earth orientation in space	Celestial Reference Frame	X				
	Nutation	X	(X)		(X)	
	Polar Motion	X	X	X	X	X
	Earth Rotation (UT1)	X				
	Length of Day (LOD)	(X)	X	X	X	
Referece frames	International reference frames	X	X	X	X	X
	Earth's center of mass		X	X	X	X
Global change	Earth's gravity field		X	X	X	X
	geoid					X
Positioning and navigation satellites	GNSS satellite orbits		X	X	X	
	Remote sensing satellite orbits		X	X	X	
	Ionosphere and troposphere	X	X	X		
	National reference frames		X			

Metsähovi Geodetic Research Station

- 60.21N, 24.39E
- The easternmost and northernmost geodetic core site within the EU
- Located in rural area near Helsinki, 45 min drive from city center
- All instrumentation founded on bedrock
- Metsähovi is the Finnish contribution to the UN 2015 GA resolution on Global Geodetic Reference Frame for Sustainable Development



Metsähovi Geodetic Research Station



Infrastructure at Metsähovi

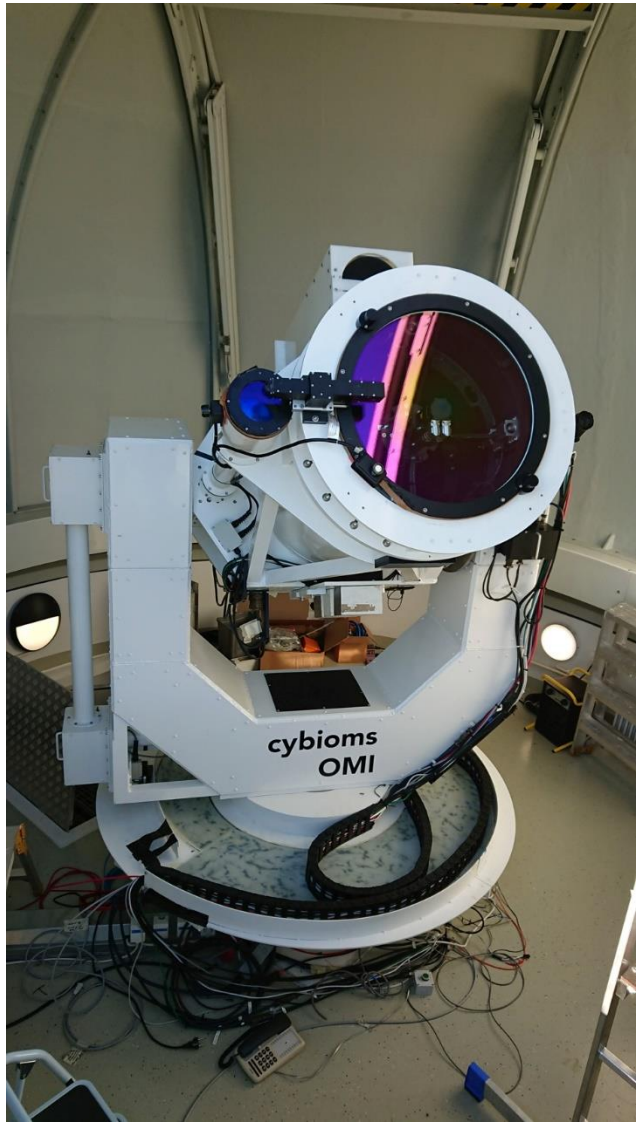
1) Satellite laser ranging (SLR), 1978, 3rd gen. 2015-24
2) Geodetic VLBI since 2004, VGOS 2016-24
3) Geodetic GPS/GNSS receiver, since 1992, upgrade (e.g.) 2014
4) Superconducting gravimeter 1994, new 2014/16
5) Absolute gravimeter FG5X-221, 1988, upgrade 2004, 2013
6) Pillar network + facilities for local ties
7) GPS/GNSS receiver, real-time NASA tracking network (NASA)
8) REGINA GNSS receiver. CNES France, 2013
9) DORIS beacon. CNES, France, 1992, upgrades 2013, 2021
10) Seismometer (Seismological Institute, Univ. of Helsinki)
11) A site for absolute gravimeter intercomparison
12) Fundamental gravity point of Finland
13) Fundamental point of the Finnish height system N2000, 2006
14) Pillar network for GNSS antenna calibration tests, 2014
15) A soil moisture tracking network
16) Vaisala weather station, 2015
17) Geodetic SAR retroreflectors (DLR, TuM, NLS) 2013, 2023

And more…

Geodetic VLBI

- Geodetic VLBI sessions have been observed since 2005 in collaboration with close-by Metsähovi Radio Observatory of Aalto University using their legacy radio telescope (a few sessions annually)
- A dedicated VGOS-compatible (single) radio telescope system for NLS/FGI
- 13.2 m VGOS radio telescope (MTM) built in 2019
- A 2.1-14 GHz QRFH broadband receiver (Yebes). First light with VGOS telescope was obtained in 2020
- Backend is DBBC3 + FlexBuff
- H-maser being procured, delays due to the global situation, for interim frequency from nearby Metsähovi Radio Observatory (Aalto Univ.) is used
- Commissioning 2021-2024

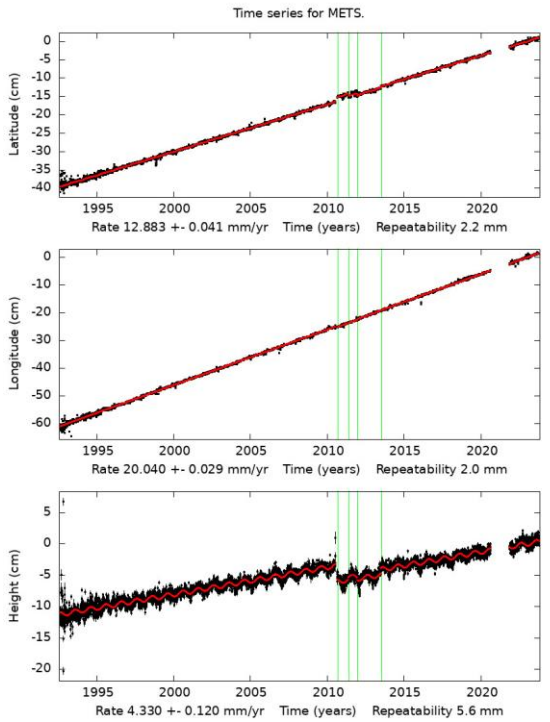
Satellite Laser Ranging (SLR)



- 3rd generation Metsähovi SLR system is being commissioned, major delays due to telescope subcomponent manufacturer, first measurements tentatively 2024
- 2kHz 532/1064nm laser (new in 2023)
- System fully capable of daytime operation
- Fast-moving telescope to minimize the target acquisition time
- New observatory building
- Aircraft avoidance primarily via ADS-B receivers, no radar
- Modifiable to allow SSA (space debris) measurements

GNSS

- Continuous GPS measurements since 1990 (IGS since 1994), all-in-view GNSS since 2013
- 2 IGS receivers (+1 at DORIS site), NASA/UNAVCO receiver and others for research, time, etc.
- Calibration/validation field for antennas

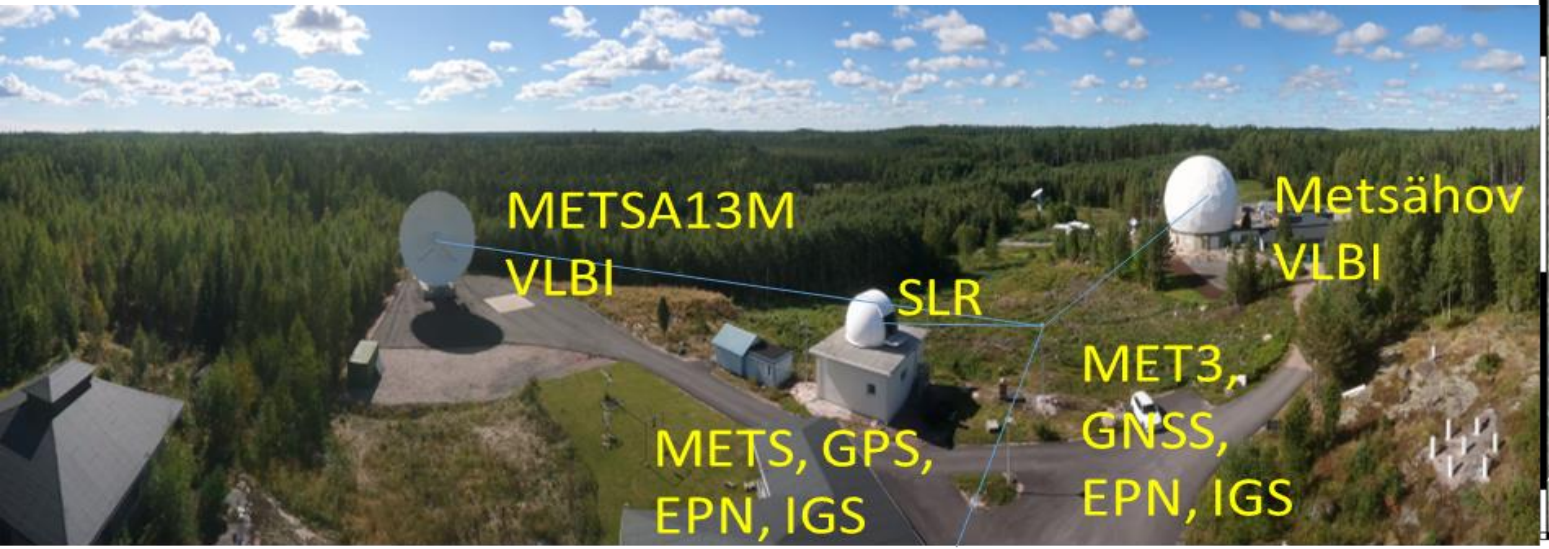


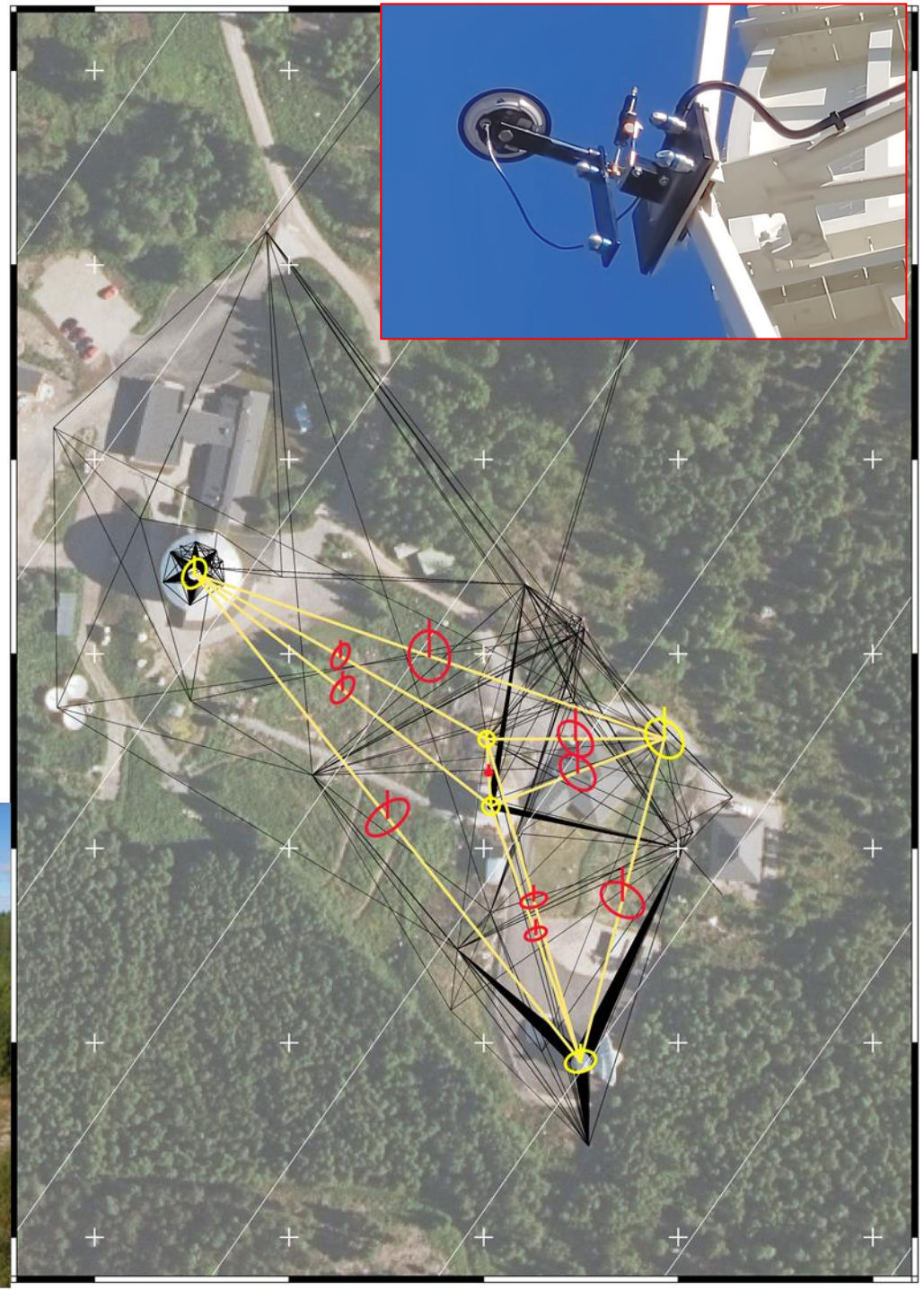
DORIS & REGINA

- Doris beacon since 1988
- 4th gen. beacon installed in 2021, and a new instrument cabin 2022
- Co-located with REGINA (CNES) GNSS receiver since 2013
- DORIS beacon is placed ~3 km from other Metsähovi instruments to avoid RFI, connected to main station with local tie measurements

Local ties

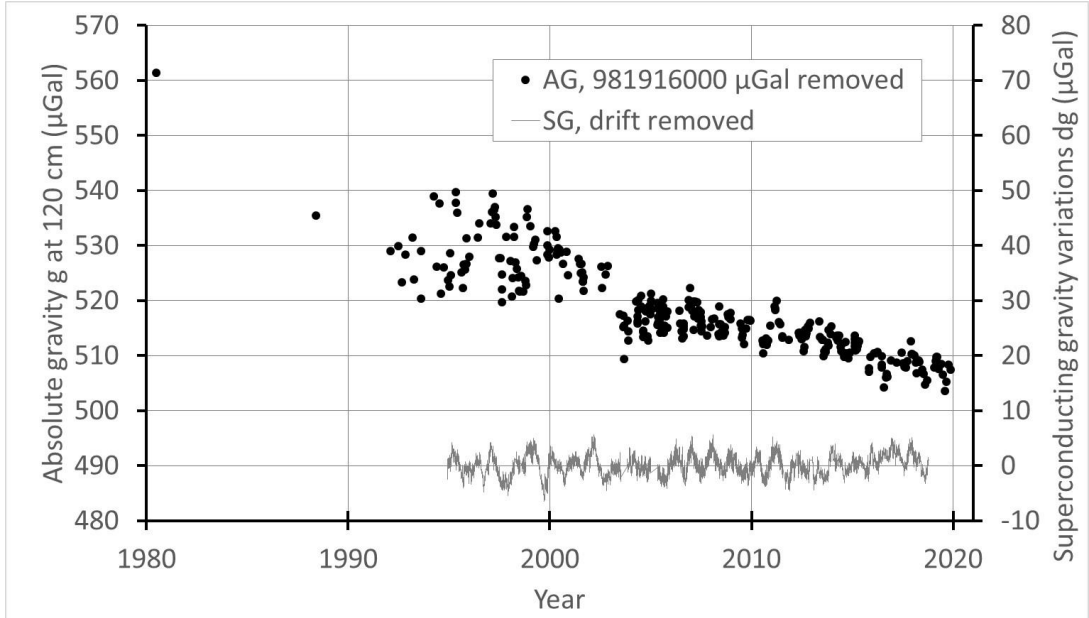
- The local survey and monitoring network consists of concrete pillars equipped with adapters for instruments.
- All local ties between the reference points in Metsähovi have been completed. Measurements will be repeated regularly.
- Readiness to continuous monitoring of the VGOS antenna with two GNSS antennas attached to the edges of the dish





Gravimeters

- First absolute gravimeter in 1988, AG upgraded to FG5X in 2013
- First superconducting gravimeter in 1994. SGs iOSG-022 and iGrav-013 have been operational since 2016
- Scintrex CG6 relative gravimeter was procured in 2021 within the project FLEX-EPOS supported by the Academy of Finland to complement our RG pool
- We are the National Standards Laboratory for free-fall acceleration (*g*)



New Main building

- The building was handed to us in August 2022
- New building designed with geodetic VLBI operation in mind
  - special attention to reducing RFI, including building-wide RF shielding mesh/netting
  - New fiber-optics data connection with 100Gb/s capacity was installed in 2022, mainly needed for the VGOS data transfer (current bottleneck in correlation centers' download speeds)

Conclusions

- Metsähovi Geodetic Research Station has provided various data products to IAG Services (e.g., ILRS, IGS, IVS, IDS) since 1978.
- Station upgrade started 2012, and all major instruments/systems have been now upgraded or in commissioning phase
  - GNSS, DORIS, and gravity equipment are operational and produce data for IAG Services
  - New VGOS and SLR systems are in commissioning phase
- Infrastructure and facilities have also been upgraded
- From beginning of 2023 the new Geodetic Infrastructure Unit of NLS is responsible for the functionality of instrumentation and measurement systems, as well as day-to-day operations
- FGI remains responsible for science, development, data quality and international contacts

Info: Visit to Metsähovi Geodetic Research station

- The buss will leave 13:30 from here
- Travel time is ~45 minutes
- **Metsähovi area is RF-free area so please put all your mobile devices into flight mode or off when entering the station.**
- Remeber warm clothes
- Researchers at the station are happy to ask all your questions
- Buss leaves back from Metsähovi 16:30

For more information: Poutanen, M. et al. (2023). Upgrading the Metsähovi Geodetic Research Station. In: International Association of Geodesy Symposia. Springer, Berlin, Heidelberg. https://doi.org/10.1007/1345_2023_203 (open access)