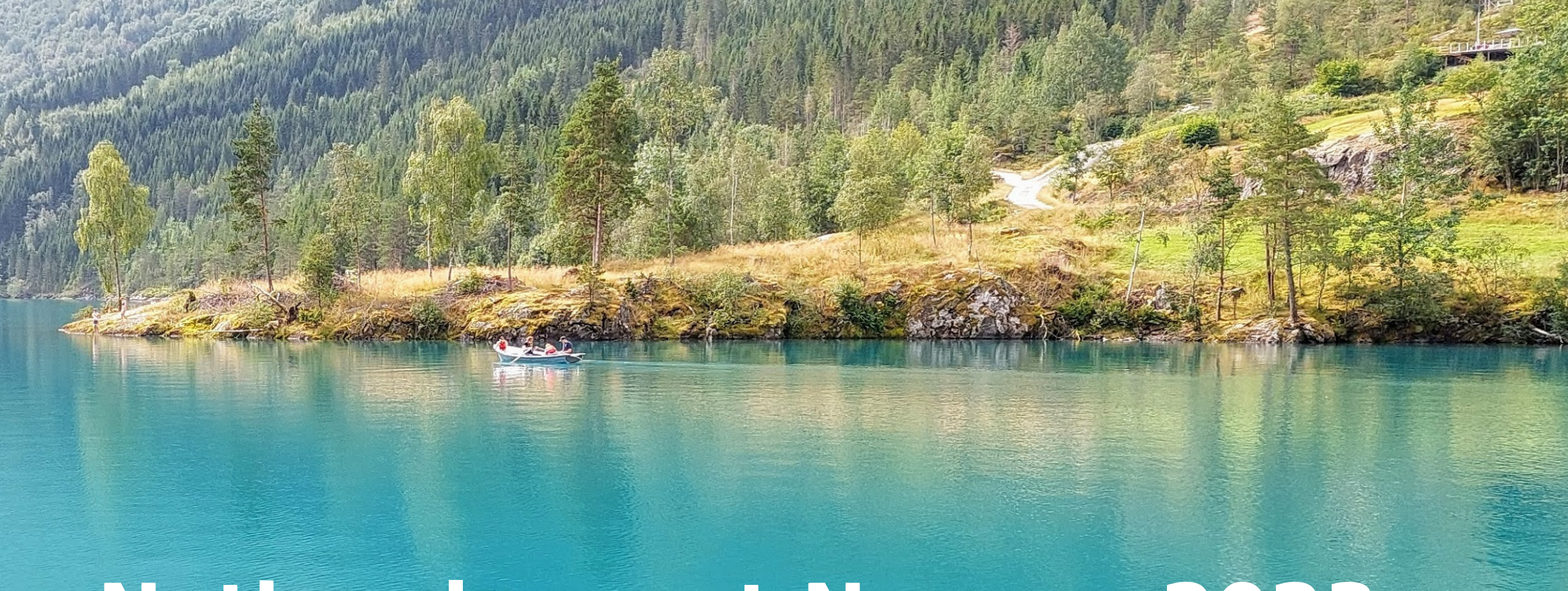


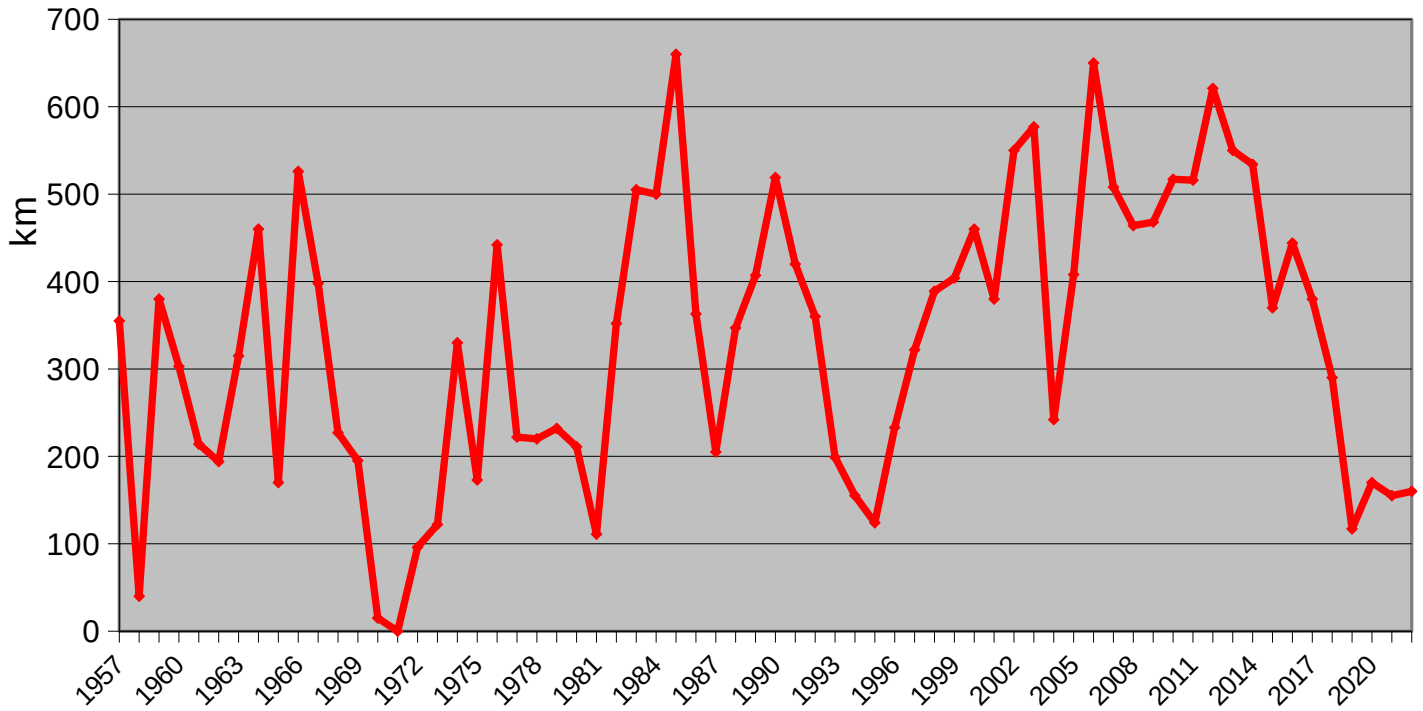
National report Norway 2023

Foto: Ove Christian Dahl Omang

Levelling production

Reducing the maximum distance to the nearest GNSS/levelling point from 15 to 10 km

Levelling to temporarily tide gauges



Kartverket

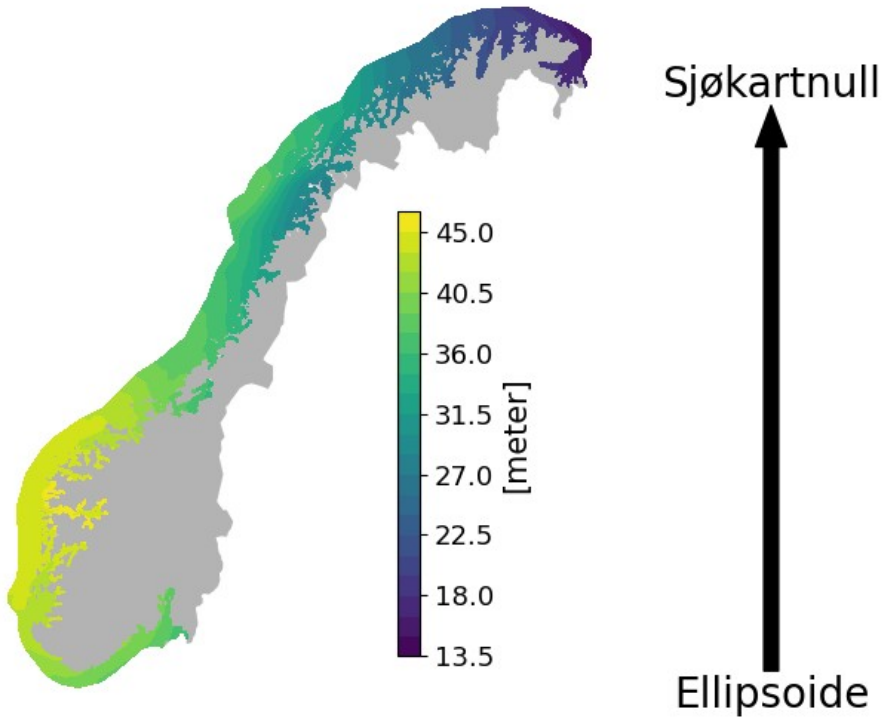
Utilization of global reference frames in geodata management

A focus project this year

- Global positioning system, like HAS (Galileo High Accuracy Service).
- Standards handling epochs
- Efficient transformations
- How to best store geodata in databases in terms of coordinate systems and reference frames
- Future of national ETRS-realizations

Kartverket

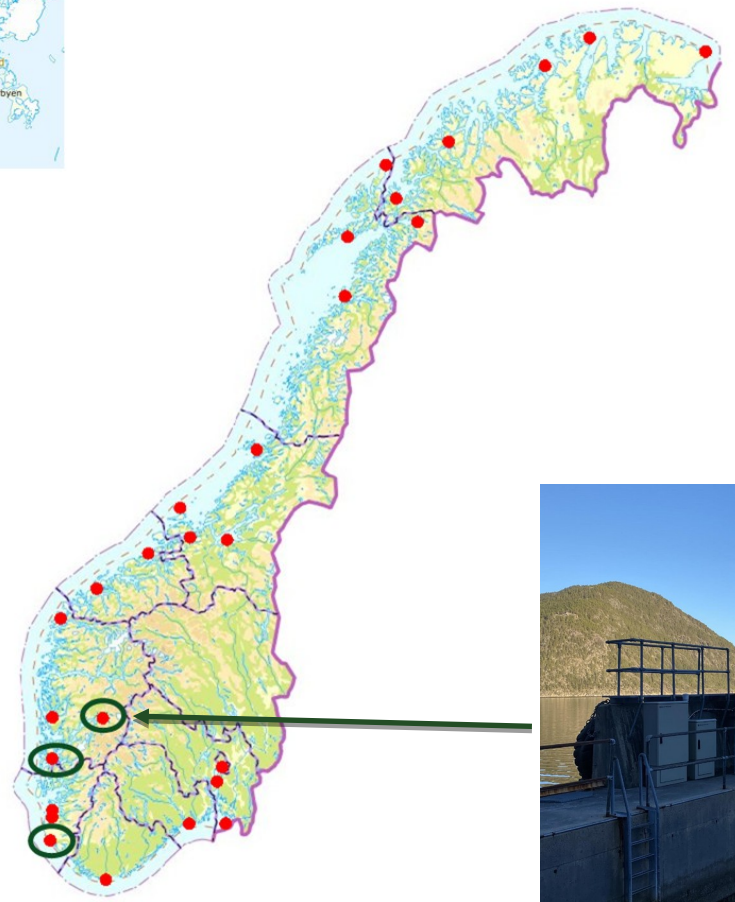
Chart Datum model



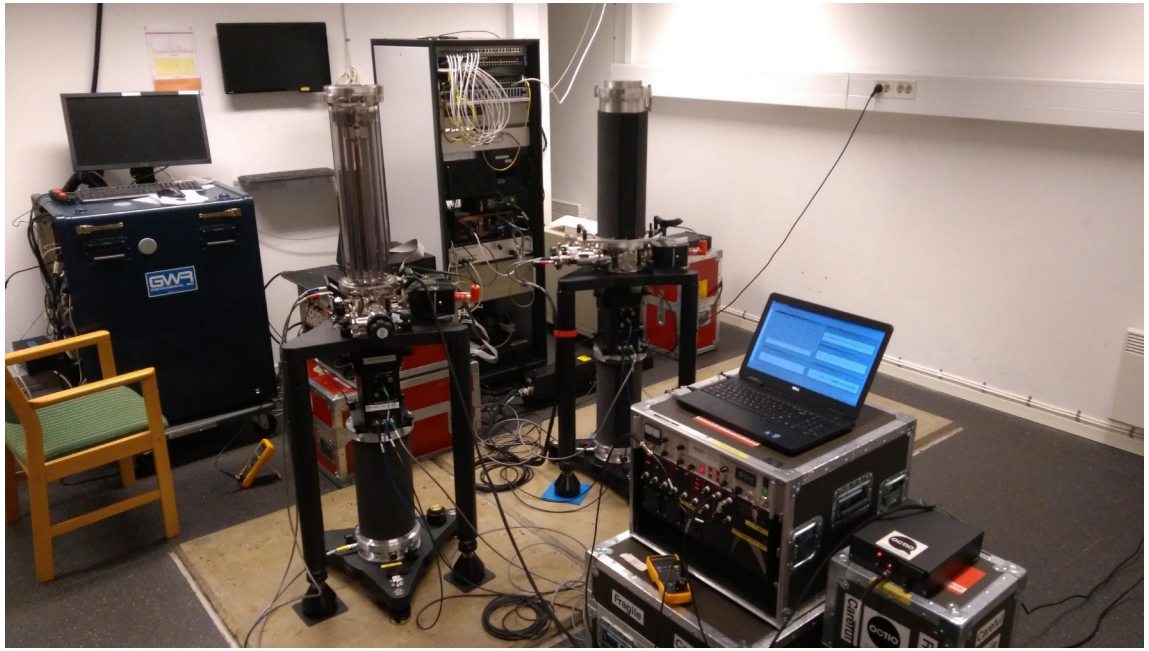
- Combination of other collocation models
- Step 1: calculate geoid model and mean dynamic topography – done simultaneously => the combination gives **Mean Sea Level relative ellipsoid**
  - Based on long and short term sea level measurements relative to NN2000 or the ellipsoid, levelling benchmarks, NKG2015 geoid, land uplift model
- Step 2: calculate **Chart Datum relative Mean Sea Level** in separate collocation
  - Based on harmonic analysis of sea level time series
- **Chart Datum relative ellipsoid** is the combination of these two

Expanding the Norwegian tide gauge network

- VannTett-project started in 2021
- Project aims to:
  - Expand the tide gauge network with at least 10 new permanent tide gauges co-located with permanent geodetic stations
  - Collect and crowdsource data from other (public authorities and the private sector)
- Status March 23:
  - 3 new tide gauges co-located with new or existing permanent geodetic stations
  - Plans for installing 3-4 new tide gauges in 23
  - Continue the focus on user needs



Absolute gravity

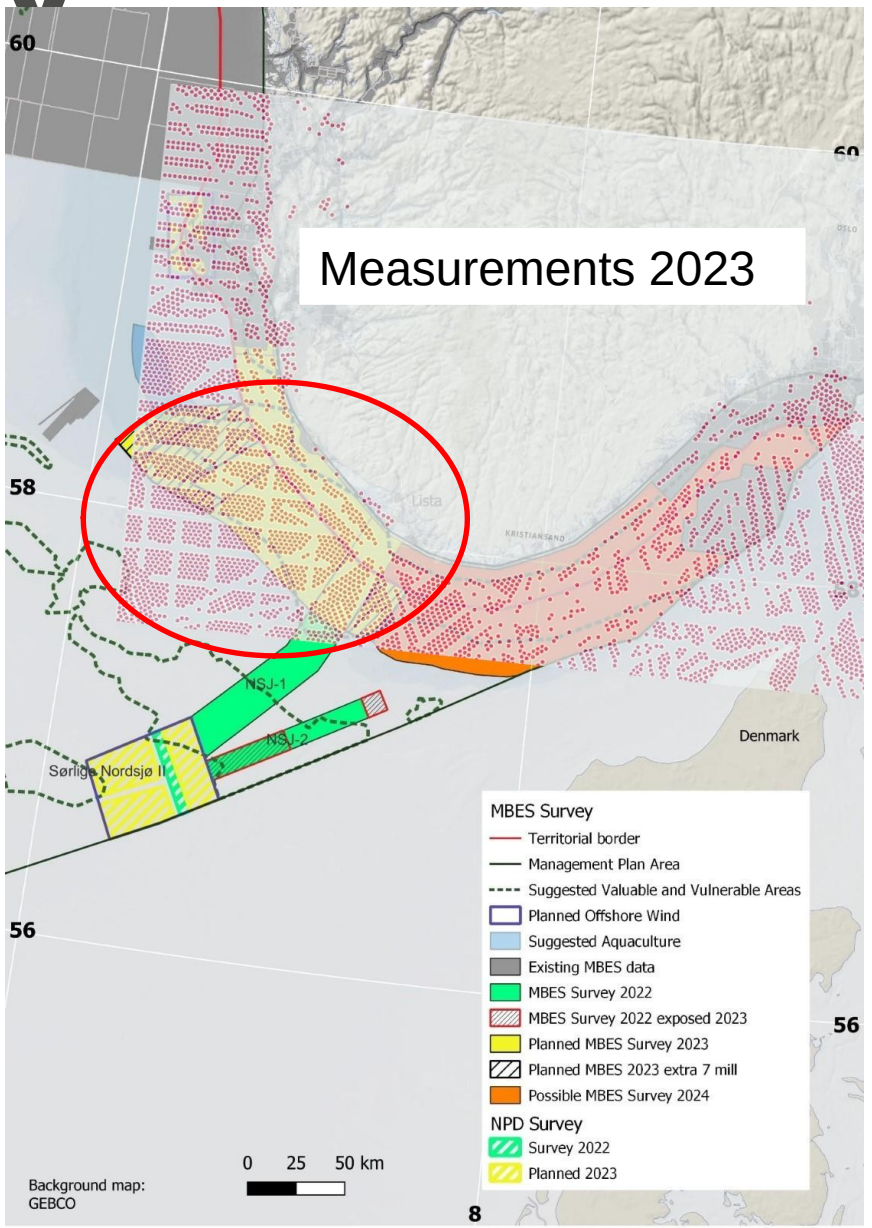


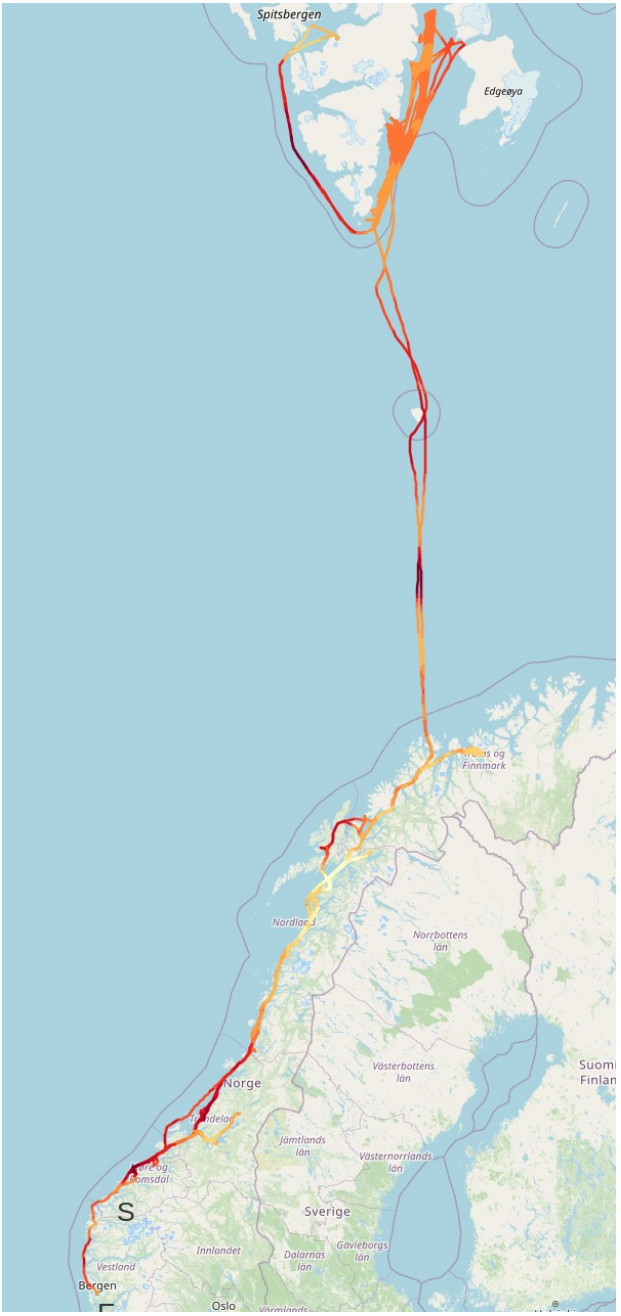
- Absolute gravity has been observed at 5 sites with FG5-226 and 1 site with A10-42.
- NMBU and Kartverket participated at the NKG CAG2022 in Onsala with FG5-226 and FG5X-250.

Kartverket

Marine Gravity

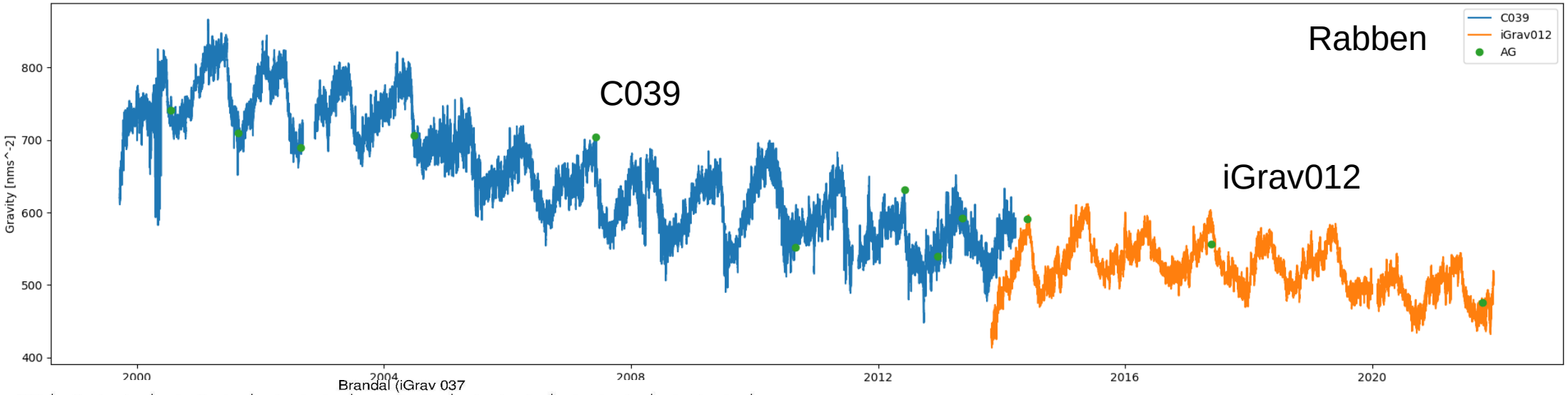
- Coast of Norway
- Svalbard area

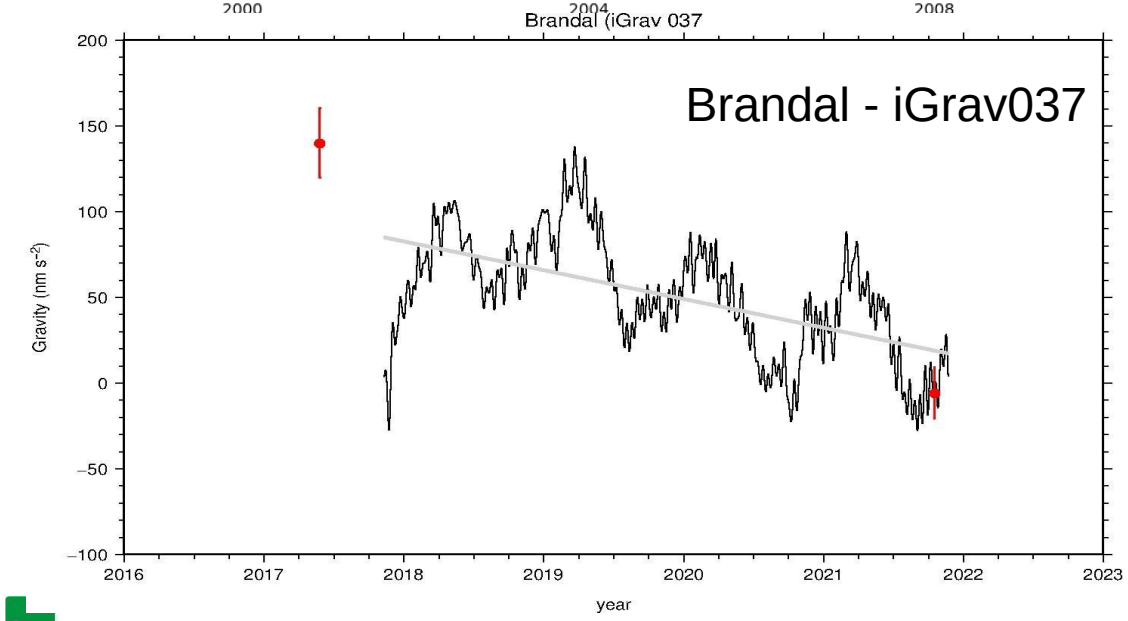




Kartverket

Superconducting gravity



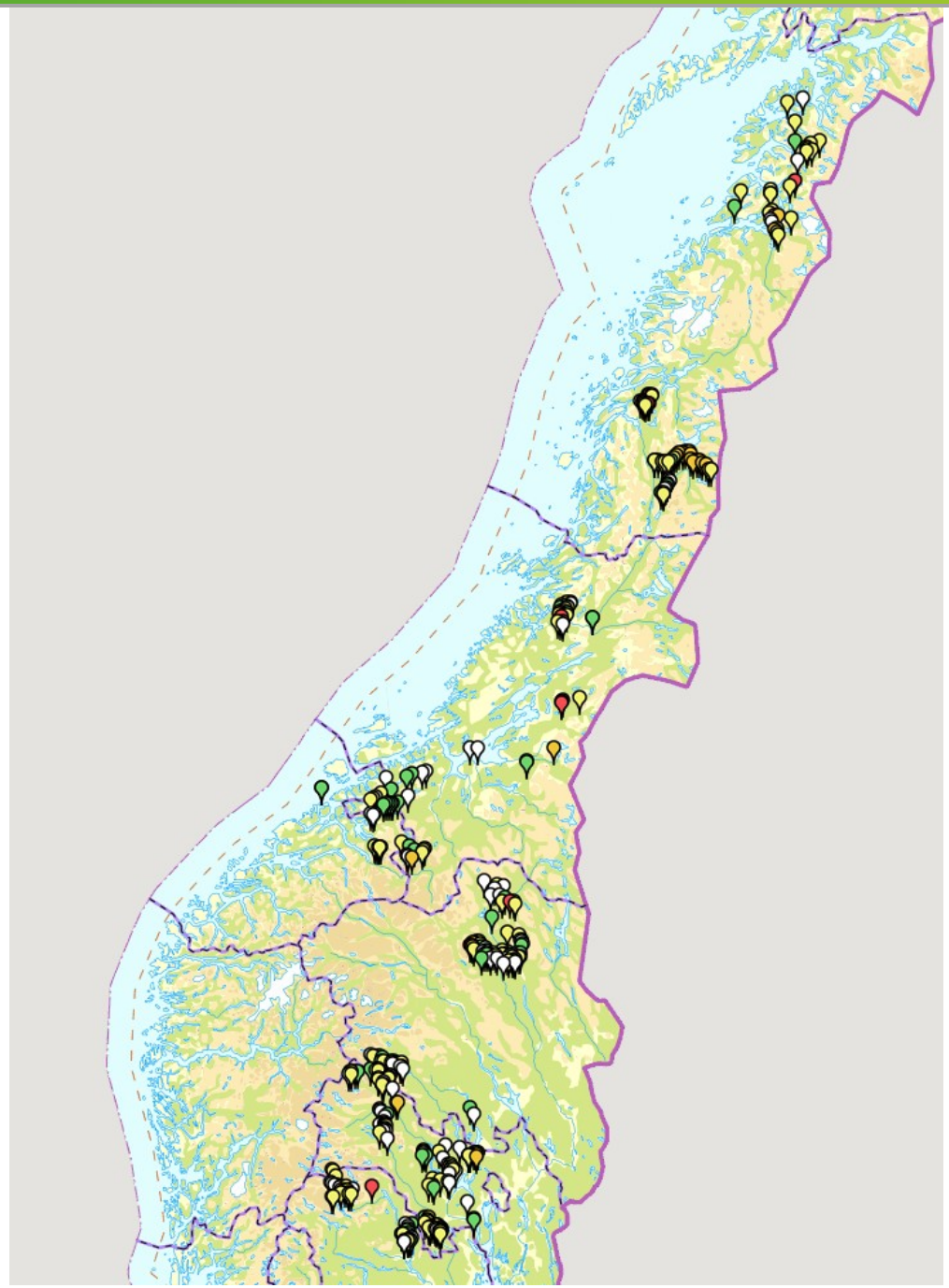


Next AG measurement 2024?

Kartverket

361 land gravity measuremets in 2022

Standard deviation of 2.1 mGal compared to existing database



Kartverket

Ny-Ålesund geodetic observatory

VLBI – NYALE13S and NYALE13N

- NMA Analysis Center – routinely processes R1 and R4 sessions for continuous EOP determination. Also processes T2, RV, RD and VGOS sessions.

- NYALE13S is an operational VLBI legacy radiotelescope, contributing to most R1, R4, intensive and RD sessions.
- NYALE13N is an operational VGOS radiotelescope, contributing to VGOS sessions once a month. From May, all possible VGOS sessions.

SLR plans

- 2023 - Gimbal and telescope assembly installation.
- 2024 – laser system will be installed
- 2025 - SLR fully operational

- 2025 – The observatory will be a fundamental station with all space geodetic techniques co-located

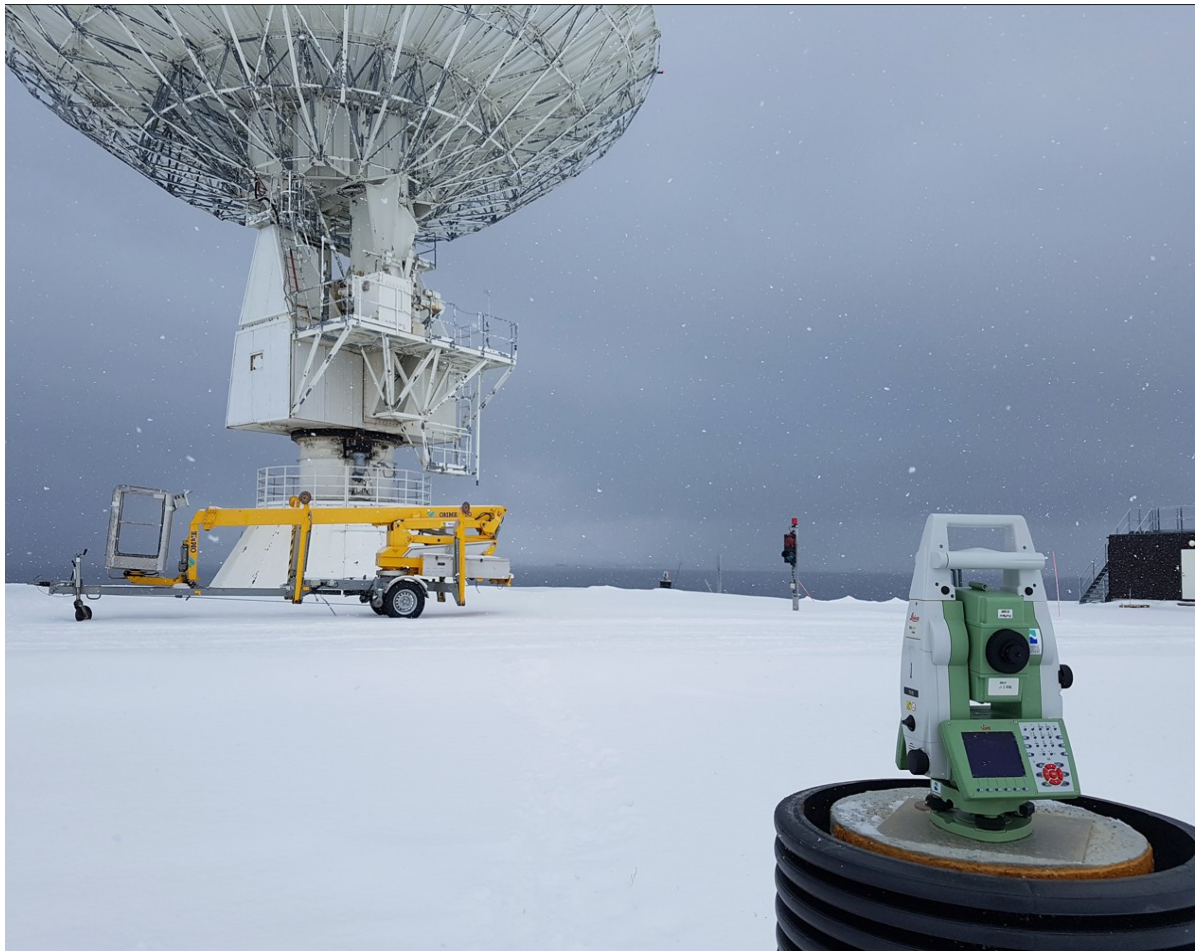
Dome and riser is installed in 2022.

Ny-Ålesund.
Stability and local tie.

The old 20 m VLBI-telescope will be dismantled this year.

This year the local tie campaign is going to include a last determination of the invariance point in the 20 m VLBI-telescope.

Stability is still an issue at the new observatory at Brandal. Levelling and total station measurements are done every year.



Proj

- NMA has decided to replace all transformation libraries and routines with proj, within the next years.

So far we have

- Implemented transformations between EUREF89 and ITRF2014/ITRF2000 based on NKG transformation
- Implemented the height reference frames NN1954 and NN2000
- Implemented transformations between EUREF89 and NGO1948 based on Triangle-based transformation
- Implemented Norway chart datum in Proj. Seamless transformation between land and ocean.
- New OpenAPI webservice based on Proj (https://ws.geonorge.no/transformering/v1/)

Yet to be done in Proj

- Support old reference frames, eg. ED50
- EUREF89 and ITRF2014 transformation for Svalbard
- Define Normal Null and vertical height transformation for Svalbard
- Local reference frames, eg. Oslo, Bergen, Trondheim

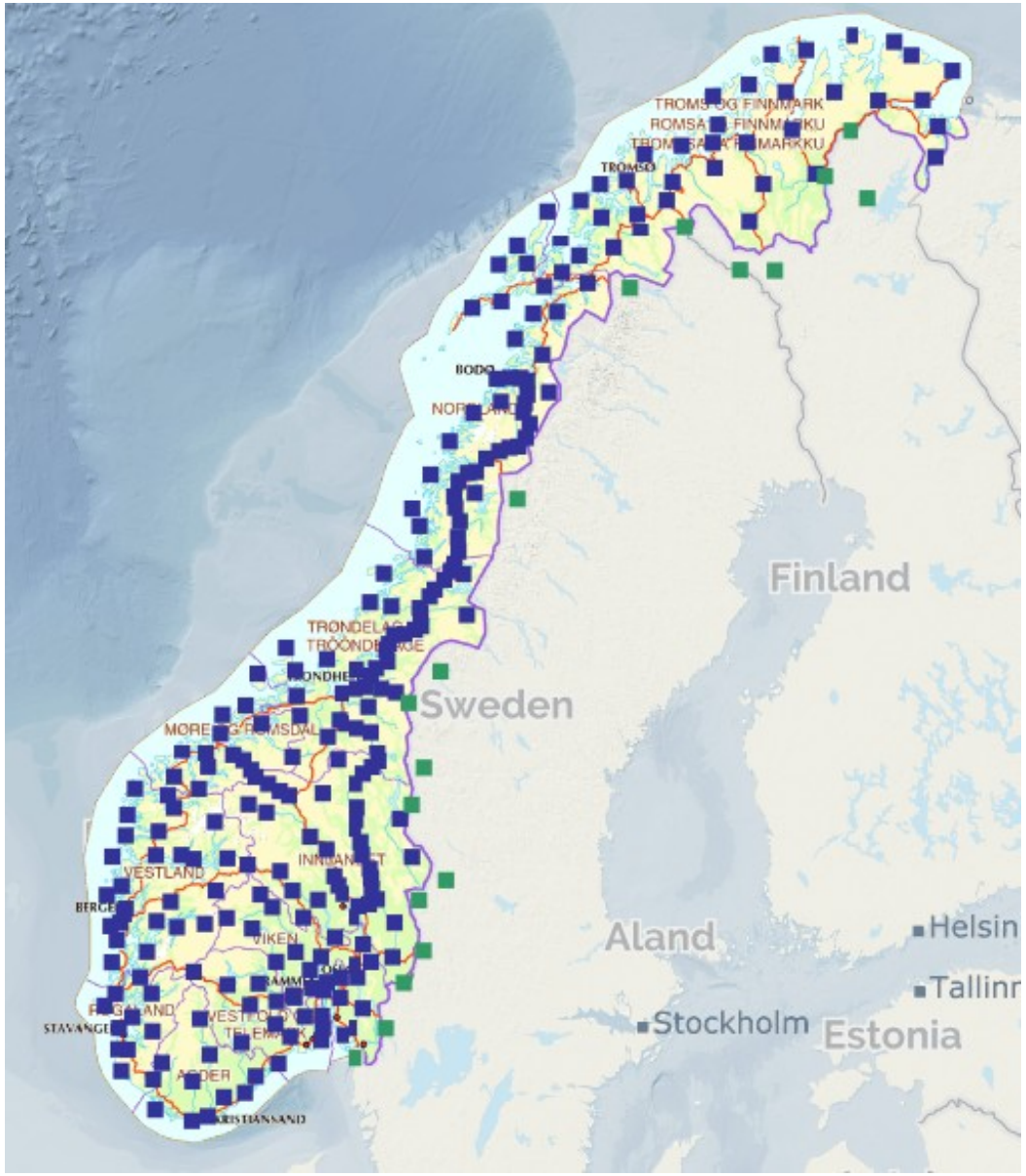
Goal

Make proj available on common platforms for most users.

Kartverket

Positioning services

- We are constantly increasing the number of users on the real-time positioning services.
- The Norwegian mapping authority (NMA) have 4200 unique users.
- Private companies have more than 15 000 unique users, based on the GNSS-stations from NMA.
- The main part of the increased use is machine control, but we also see new users within new areas of use.



GNSS stations

302 stations pr 14.02.2023

up from

210 stations pr 01.01.2018

The main reason for the increased number of stations

- Densification along non-electrified railway lines
- The station network of the private company, Leica, has been transferred to The Norwegian mapping authority

Kartverket

HyPos- National Hybrid Positioning Service for the Digital and Autonomous Societies of the Future

The Norwegian Mapping Authority wants to develop an accurate, scalable service for position determination in real time, with a larger coverage and higher redundancy than before.

(i) develop a new scalable method for broadcasting GNSS correction data;

(ii) use the telecommunications network's 5G as an independent source for position determination

(iii) develop a new hybrid positioning service using both GNSS Correction (i) and 5G broadcasting (ii)

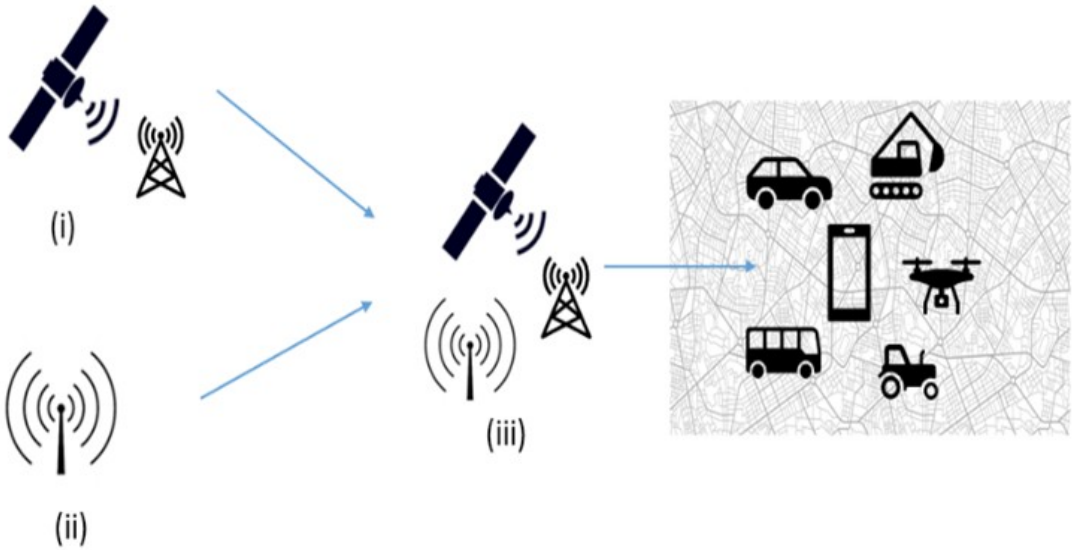


Figure 1. (i) GNSS with the Norwegian Mapping Authority's GNSS infrastructure, (ii) mobile network, (iii) hybrid positioning service.

Forskningsrådet Telia ERICSSON SINTEF Kartverket

Teapot - Technology for advanced positioning within the transport system

Main goals of the project:

- Identify the transport sector's need for positioning technology, especially with regard to Nordic conditions.
- Develop a procedure for how different technologies and methods for positioning can be combined using sensor fusion.
- Describe how cooperation between road authorities and actors within positioning can be organized and regulated without hampering Norwegian business and industry

Figure 1.The Norwegian Mapping Authority's Measuring Car with navigation system: GNSS, IMU, Odometer and LiDAR.

SINTEF

Statens vegvesen

NTNU

Kartverket

APPLIED AUTONOMY

Aventi

Forskningsrådet

Kartverket

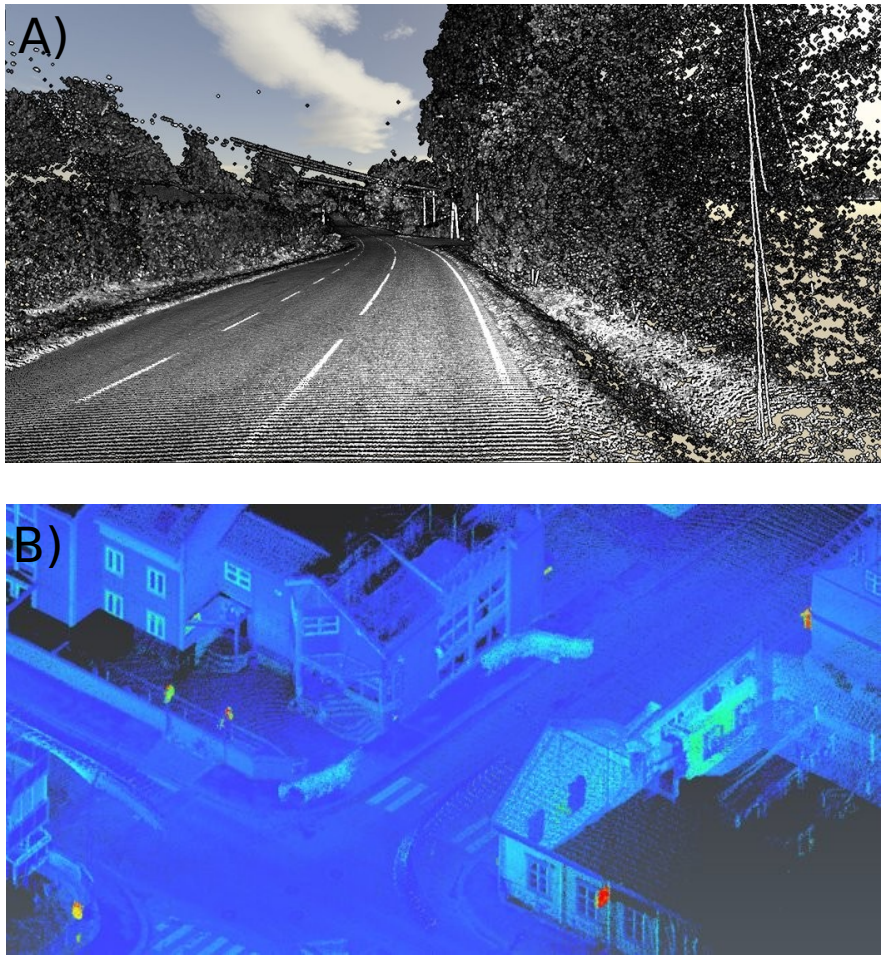
PISI- Point cloud in real-time for ITS

Work package 1

- Further develop the management solution for point cloud data
- Change the process for how point clouds are collected

Work package 2

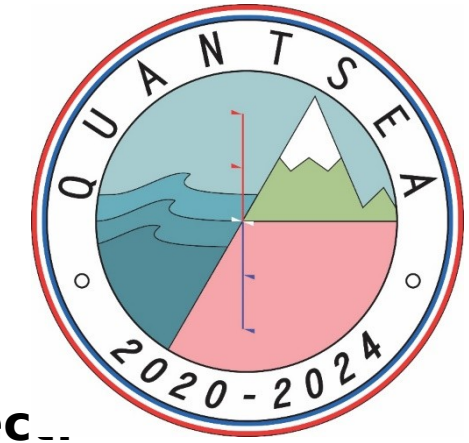
- Development of proof of concept for real-time data streaming of point cloud data for ITS applications
- Use of point clouds from vehicles in real time
- The Norwegian Mapping Authority is preparing for future needs from users



A) Point clouds in Høydedata.no and B) "raw point cloud" collected.

Kartverket

QUANTSEA



Project:
Quantifying Past and Future Sea Levels for Norway (QUANTSEA)

Rationale:
Use new glacioisostatic adjustment (GIA) modelling to improve century-scale relative sea-level (RSL) projections

... new postglacial RSL database will constitute an up-to-date calibration dataset for GIA modelling in Scandinavia

... additional implications for archeology, paleoclimatic/environmental variability, geodynamics, etc.

Team:

F. Chantel Nixon, NTNU-Geography
Max Holthuis, Ph.D. NTNU-Geography
Anders Romundset, NGU
Jan Mangerud, UiB-Earth Science
Stein Bondevik, HVL
Mark Furze, UNIS-Arctic Geology
Maurin Rosseau, M.Sc. UiB-Geography
Matthew Simpson, Kartverket
Halfdan Kierulf, Kartverket
Glenn Milne, University of Ottawa
Lev Tarasov, Memorial University

New Sea level report post IPCC AR6

FNs Klimapanel

Globalt kunnskapsgrunnlaget

Koordinerings ansvar

Miljø-direktoratet

Prosjektgruppen

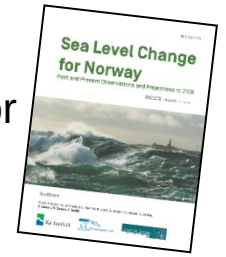
Kartverket

Norwegian Meteorological Institute

NORCE

NERSC

Nasjonalt kunnskapsgrunnlaget for klimatilpasning i kystsonen



Se havnivå

Veilederen

Havnivå og stormflo – samfunnssikkerhet i kommunal planlegging

dsb

Riksantikvaren

Business

NVE

Kystverket

DSB

Statens vegvesen

Kommunene

Forsikrings bransjen

Media

Forskning

Direktoratet for byggkvalitet

Folk flest

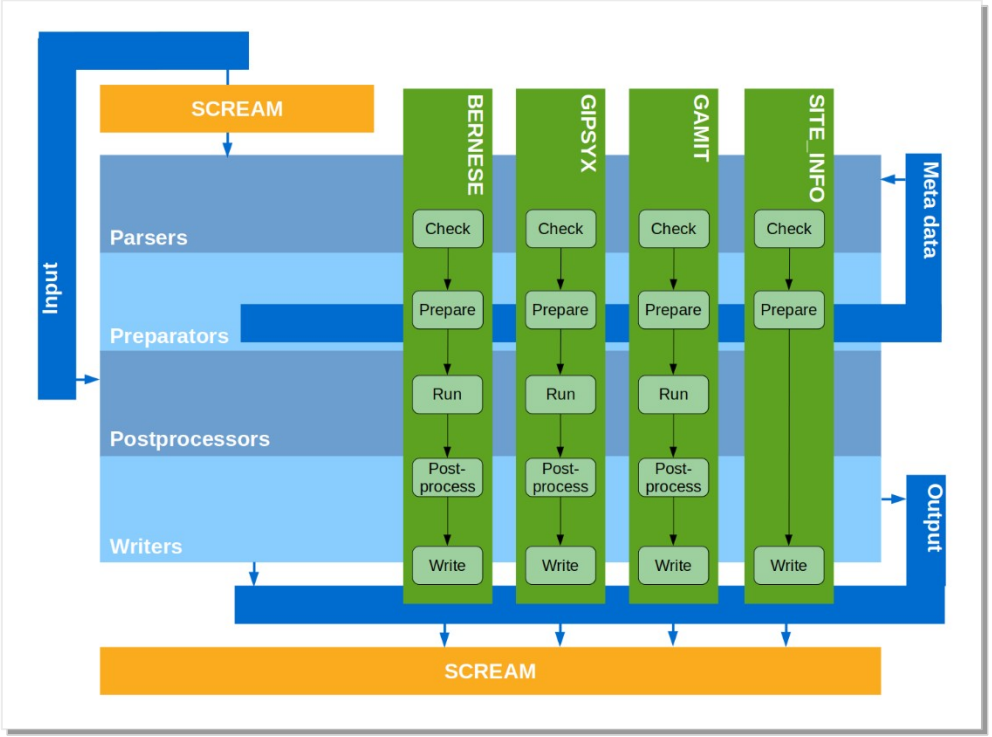
Avinor

Kartverket

Project: Operationalization of GNSS high-presicion analysis

Goals:

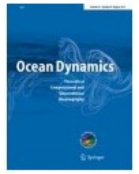
- Common program which can start processing of Bernese, GipsyX and Gamit automatically by collecting necessary input files and meta data
- Automated generation of station input files by using station information from SINEX/SSC files and database information
- Automated result analyses (e.g. GNSS timeseries analysis)



Kartverket

Ocean Dynamics
https://doi.org/10.1007/s10236-021-01492-7

Evolution of sea-level trends along the Norwegian coast from 1960 to 2100



Kristian Breili[1,2]

Received: 14 June 2021 / Accepted: 26 November 2021

Geophysical Journal International

Geophys. J. Int. (2022) **229,** 408–425
Advance Access publication 2021 November 27
GJI Gravity, Geodesy and Tides
https://doi.org/10.1093/gji/ggab482

Seasonal glacier and snow loading in Svalbard recovered from geodetic observations

H.P. Kierulf,[1,2] W.J.J. van Pelt,[3] L. Petrov,[4] M. Dähnn,[1] A.-S. Kirkvik[1] and O. Omang[1]

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[3]*Department of Earth Sciences, Uppsala University, 752 36 Uppsala, Sweden*
[4]*NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA*

Surveys in Geophysics
https://doi.org/10.1007/s10712-022-09762-9

Validation of Space-Wise GOCE Gravitational Gradient Grids Using the Spectral Combination Method and GNSS/Levelling Data

Martin Pitoňák[1] · Michal Šprlák[2] · Vegard Ophaug[3] · Ove C. D. Omang[4] · Pavel Novák[1]

Received: 16 May 2022 / Accepted: 15 December 2022

Geophysical Journal International

Geophys. J. Int. (2022) **231,** 1518–1534
Advance Access publication 2022 July 8
GJI Gravity, Geodesy and Tides
https://doi.org/10.1093/gji/ggac264

Time-varying uplift in Svalbard—an effect of glacial changes

Halfdan Pascal Kierulf,[1,2] Jack Kohler,[3] Jean-Paul Boy,[4] Emily C. Geyman,[3,5] Anthony Mémin,[6] Ove C. D. Omang,[1] Holger Steffen[7] and Rebekka Steffen[7]

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[3]*Norwegian Polar Institute, 9296 Tromsø, Norway*
[4]*Institut Terre et Environnement Strasbourg, (ITES, UMR7063: Université de Strasbourg, CNRS, ENGEES), 5 Rue René Descartes, 67081 Strasbourg, France*
[5]*Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, CA 91125, USA*
[6]*Université Côte d'Azur, CNRS, OCA, IRD, Géoazur, 06560 Valbonne, France*
[7]*Lantmäteriet, Geodetisk Infrastruktur, Lantmäterigatan 2c, 802 64 Gävle, Sweden*

sensors

MDPI

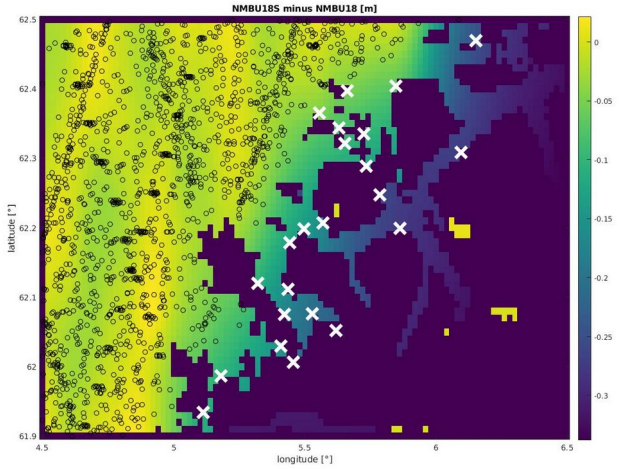
Article

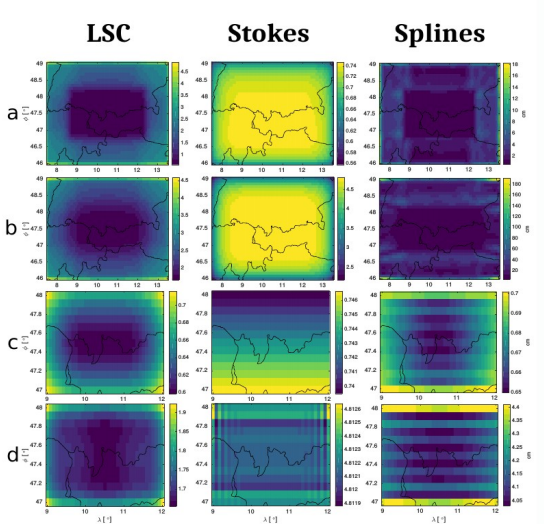
High Latitude Ionospheric Gradient Observation Results from a Multi-Scale Network

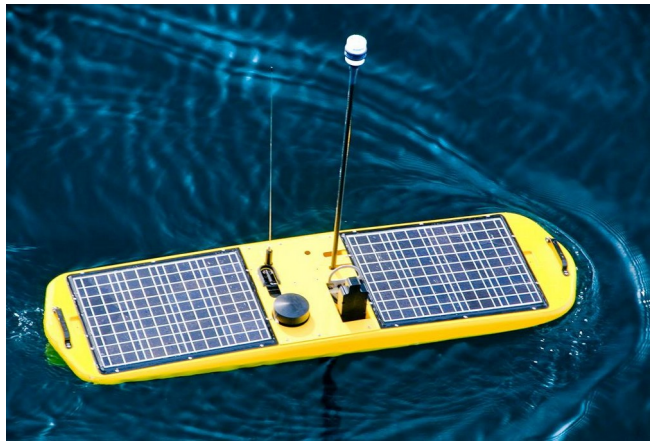
Nadezda Sokolova [1,*], Aiden Morrison [1] and Knut Stanley Jacobsen [2]

Research in physical geodesy at NMBU - general topics

- ✔ Observe GIA with absolute gravimetry
- ✔ Glacier mass balance with gravimetry
- ✔ Hydrological variations in terrestrial gravimetry
- ✔ Geoid and height system modernization
- ✔ Geodetic oceanography: sea-level change, coastal dynamics, coastal altimetry

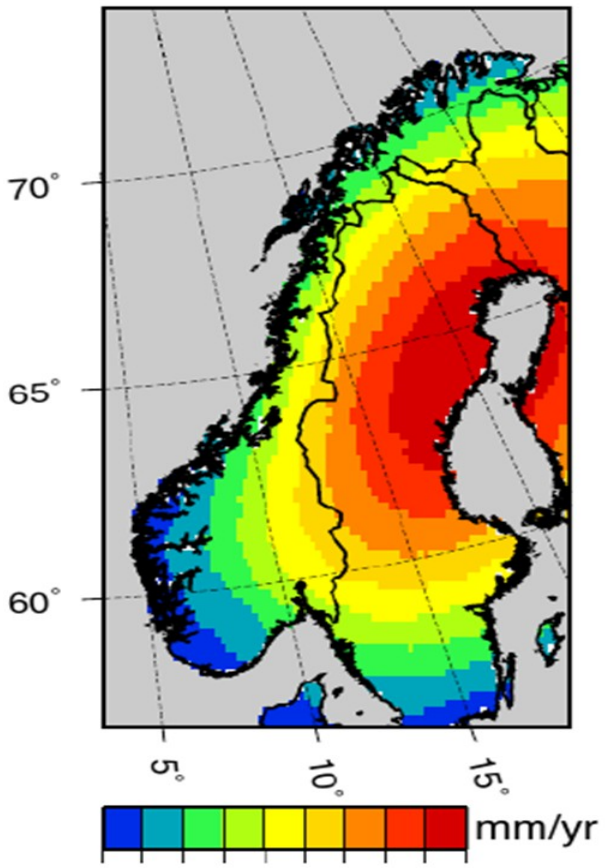


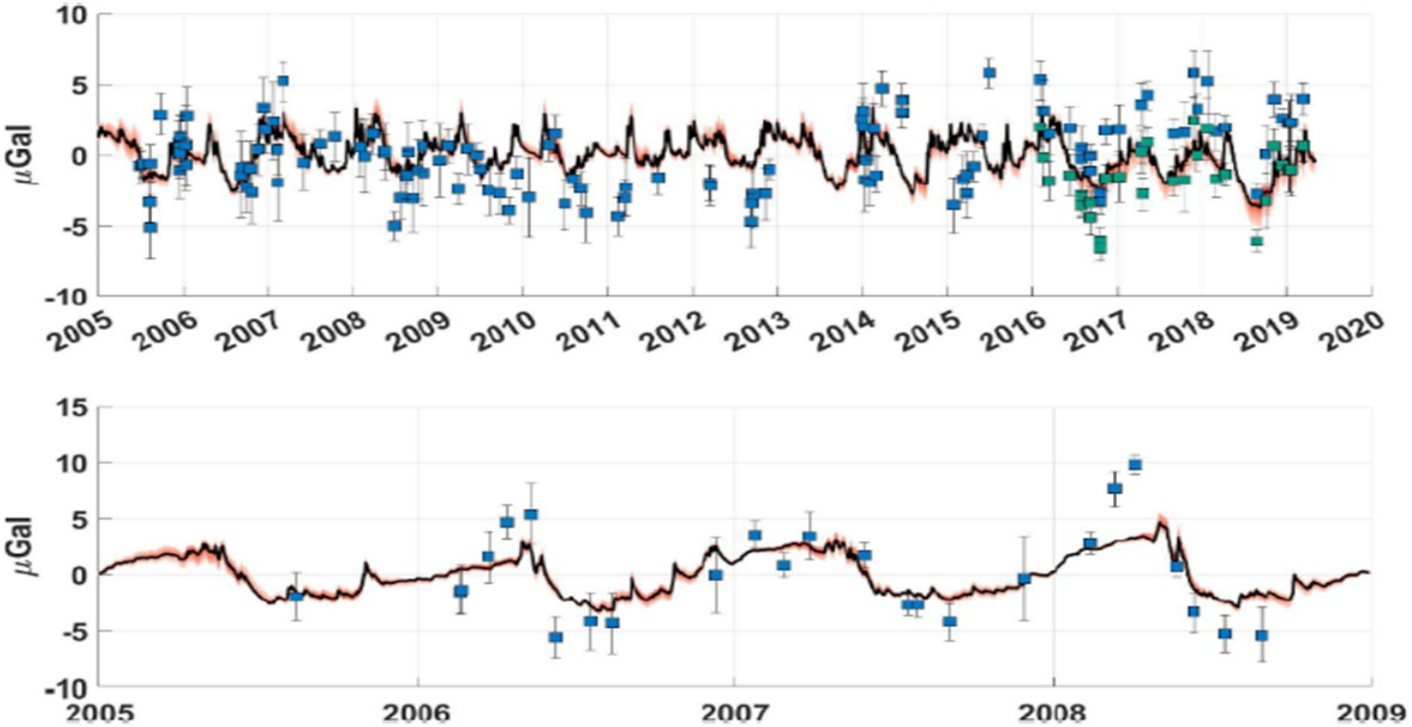




HYDROGRAV (2019–2022), Brian Bramanto

Norwegian University of Life Sciences





NMBU (øverst), Trysil (nederst)

- Up to 40% reduction of data variability at Trysil, less at NMBU (lower SNR)

JOURNAL ARTICLE

Reducing hydrological disturbances in absolute gravity observations by combining global hydrological models with a regional run-off model

B Bramanto ✉, K Breili, C Gerlach, V Ophaug, J G O Gjevestad

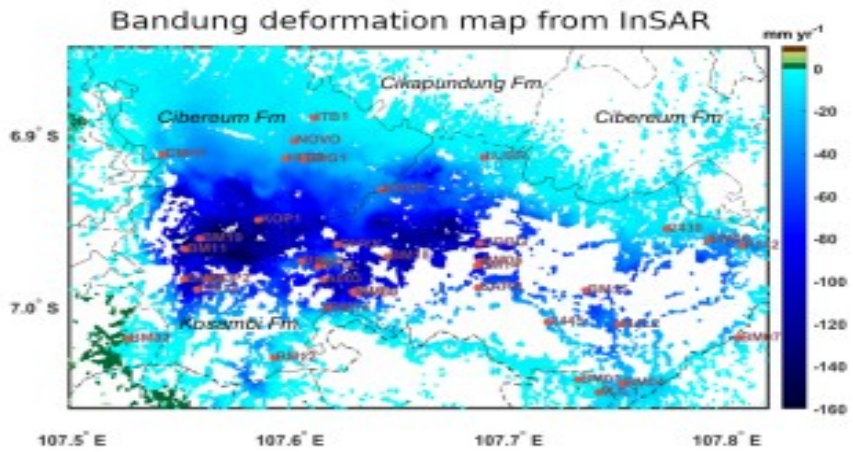
Geophysical Journal International, Volume 230, Issue 2, August 2022, Pages 976–994,
https://doi.org/10.1093/gji/ggac054
Published: 10 February 2022 **Article history** ▾

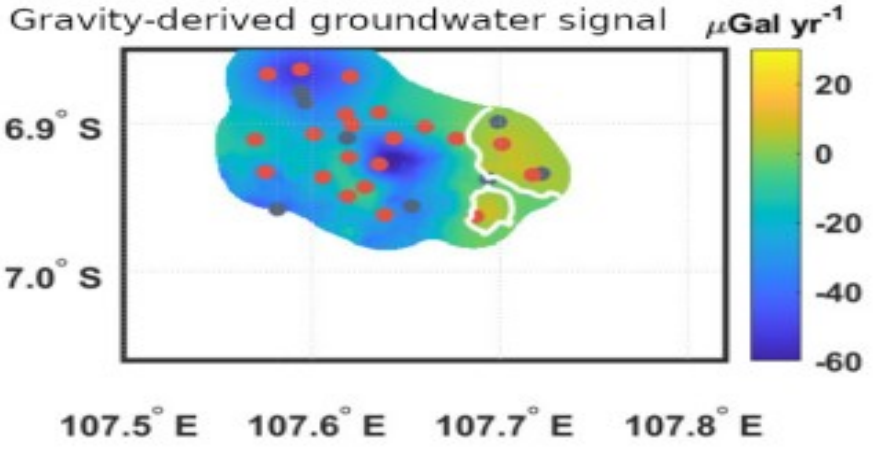
Can regional runoff models be used for correcting absolute gravity time series?

HYDROGRAV (2019–2023), Brian Bramanto

Norwegian University of Life Sciences

Geometric-gravimetric evidence for mass loss in the subsidence area of Bandung, Indonesia

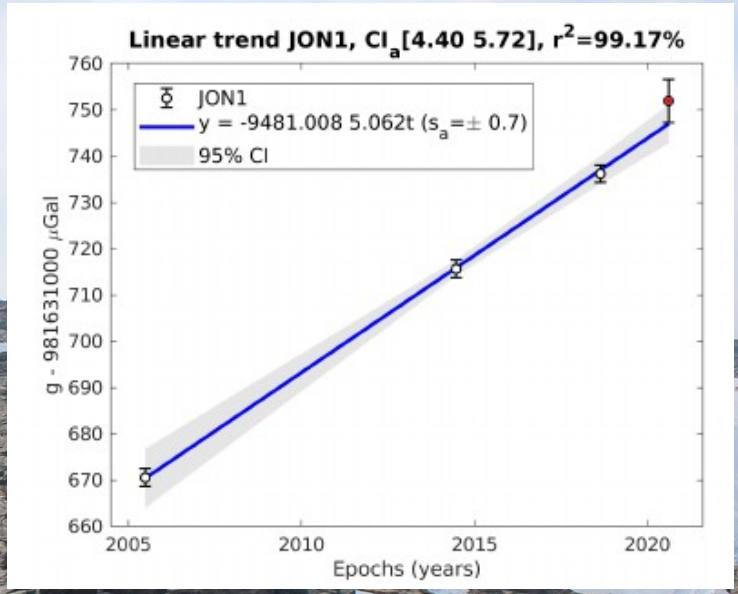




- The deformation-reduced gravity field suggests mass loss due to groundwater depletion
- Gravity-derived and in-situ groundwater tend to agree, but numbers are relatively uncertain

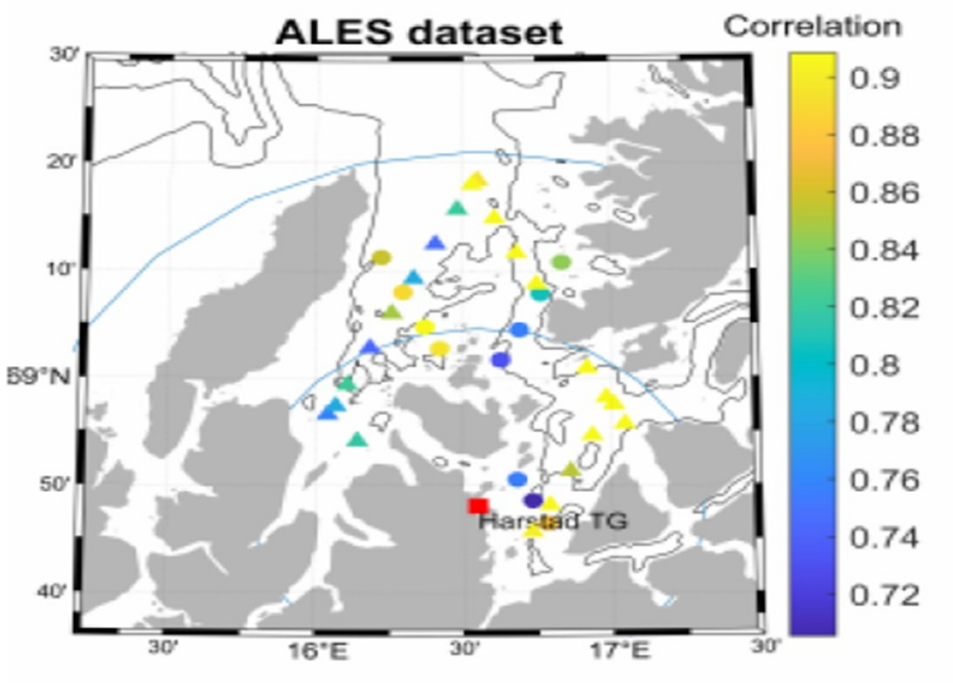
Brian will defend his PhD thesis on March 24, 2023.

Establishing a new absolute gravity site at Folgefonna glacier



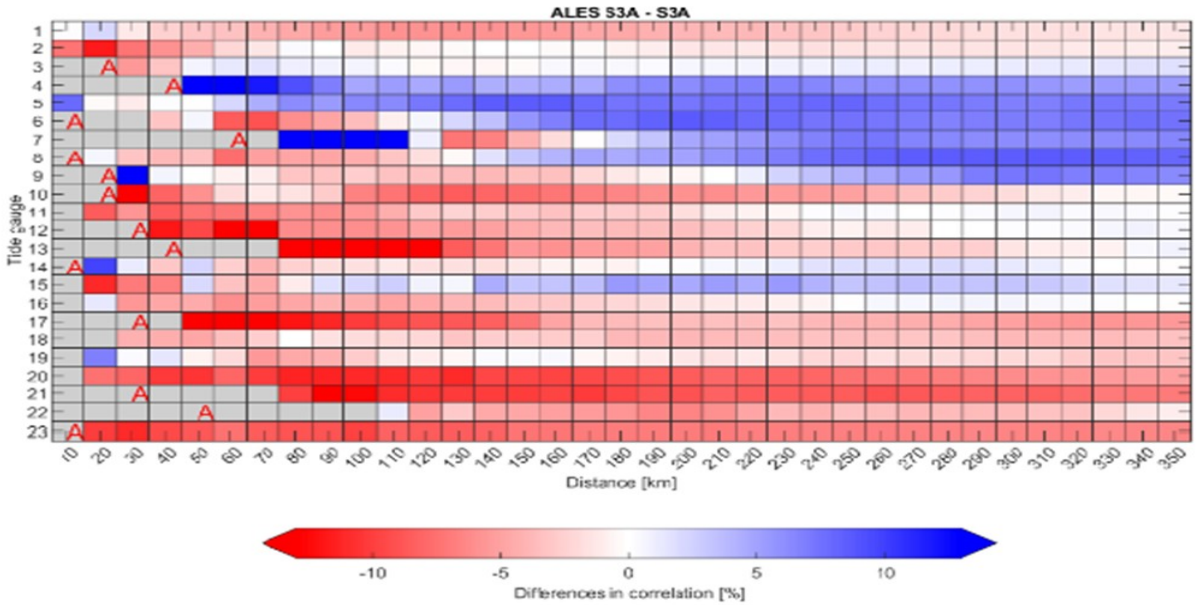
- Anomalous positive trend in gravity observed at the glacier since 2005
- Related to glacier mass balance?
- New observation site established 2020 to secure continuous monitoring
- Collaboration: Kartverket, Gravitude AS

SEGREF and SARGRAV (2021-2024)



Matea Tomić (PhD) and Gholamreza Joodaki (Postdoc)

- New geodetic products for the Norwegian coast: MSS, MDT, geoid
- Marine gravity field from altimetry observations
- Transformation between vertical datums on land and at sea



Wave measurements using a Wave Glider

Norwegian University of Life Sciences

Validation of ocean wave measurements using a Wave Glider and GNSS precise point positioning

Wave Glider as a new sensor for observing the wave field

- Equipped with a geodetic-grade GNSS receiver and antenna
- Deployed for 12 h off the coast of Northumberland, England, 15OCT19, at a wave buoy site
- Logging 5 Hz GPS and GLONASS data, processed with GipsyX in kinematic PPP mode

Newcastle University

Nigel Penna,
Andreja Sušnik,
Miguel Morales Maqueda

Geodesy group NMBU

- Prof. Jon Glenn O. Gjevestad
- Vegard Ophaug, postdoc
- Assoc. Prof. Ola Øvstedal
-
- Assoc. Prof. Kristian Breili (external/NMA)
- Assoc. Prof. Christian Gerlach (external/BAdW)

Partners

- Norwegian Mapping Authority (NMA)
- Geodesy and Glaciology group, Bavarian Academy of Sciences and Humanities (BAdW)
- DTU Space
- Newcastle University (UK)
- Nordic Geodetic Commission