

GLOSS - National Report

Denmark - 2025

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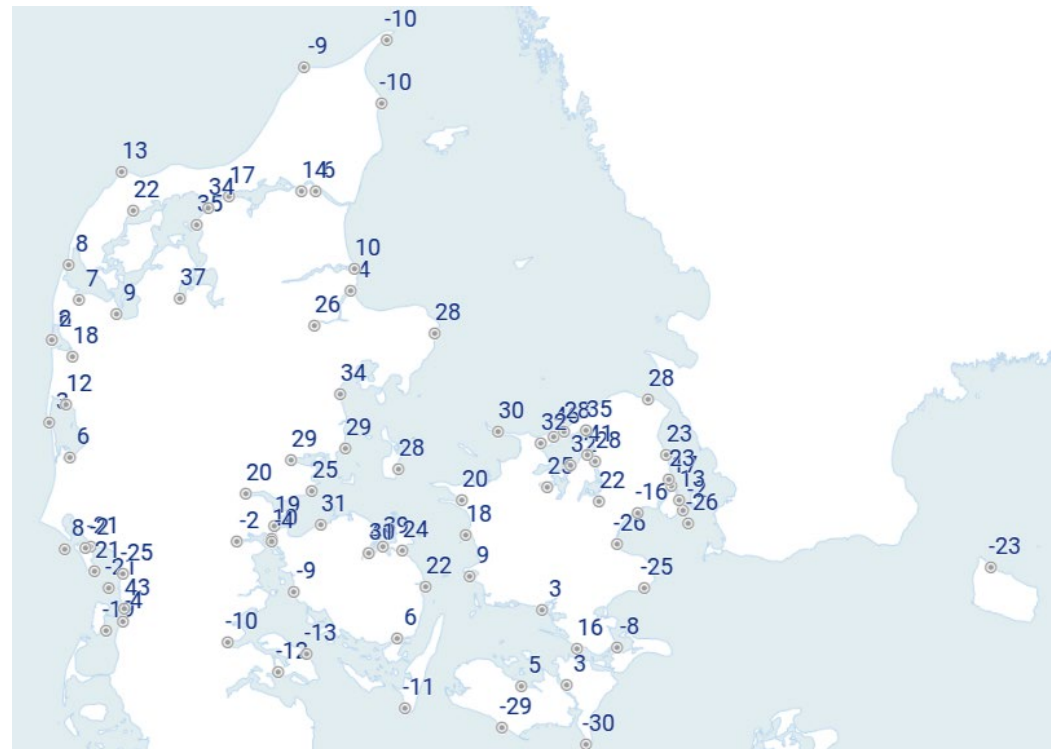
Kristian Keller, Agency for Climate Data (KDS)

Denmark

DMI, Coast Directorate and some harbour authorities run about **80 tide gauges**. The instantaneous sea levels together with time series for 8 days (2 days prognoses) are shown on the web site at DMI (<https://www.dmi.dk/maalingers-seneste-24-timer/>)

Equipment:

- acoustic type
 - TD instrument
 - Bobble sensor
 - pulse radar
-
- GNSS CORS (8 stations)



Denmark

Data delivery:

The IOC Sea Level Station Monitoring Facility: 1 stations (Hirtshals)







PSMSL: 14 stations (+3 historical)

National Storm Surge Warning



Denmark

The following 14 DMI sites are included in PSMSL network

| | | | |
|---|-----------------------|---------|---------|
|  | 130/001 Gedser | 54 34 N | 11 56 E |
| | 130/011 Rødbyhavn | 54 39 N | 11 21 E |
|  | 130/016 Tejn | 55 15 N | 14 50 E |
| | 130/021 København | 55 42 N | 12 36 E |
| | 130/031 Hornbæk | 56 06 N | 12 28 E |
| | 130/041 Korsør | 55 20 N | 11 08 E |
| | 130/051 Slipshavn | 55 17 N | 10 50 E |
|  | 130/062 Fynshav | 55 00 N | 09 59 E |
| | 130/071 Fredericia | 55 34 N | 09 45 E |
|  | 130/081 Aarhus | 56 09 N | 10 13 E |
| | 130/091 Frederikshavn | 57 26 N | 10 34 E |
|  | 130/101 Hirtshals | 57 36 N | 09 58 E |
| | 130/111 Hanstholm | 57 07 N | 08 36 E |
|  | 130/121 Esbjerg | 55 28 N | 08 26 E |

 with GNSS at Gedser, Tejn, Fynshav, Aarhus, Hirtshals, and Esbjerg (New ESB5)

Greenland

DTU Space is running the tide gauges at:

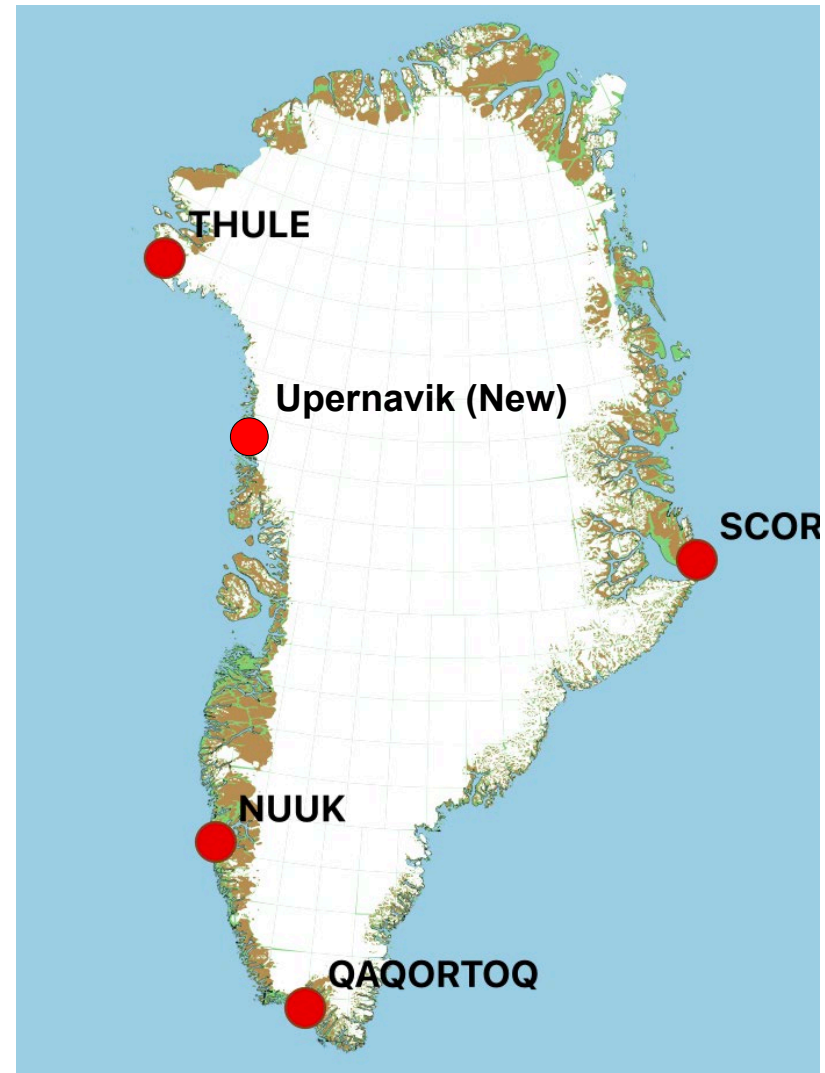
- Qaqortoq / Julianehåb
- Pituffik / Thule
- Ittoqqortoormiit / Scoresbysund
- Nuuk / Godthåb, and
- New: Upernavik

Equipment:

- Valeport MIDAS CTD+ (replacing old Aanderaa WLR7 sensors)
- GNSS (all)

Data delivery from all 5 stations:

- IOC Sea Level Station Monitoring Facility
- GLOSS Fast Delivery for UHSLC
- GLOSS Core and PSMSL (in progress)



Developments within GNSS-IR

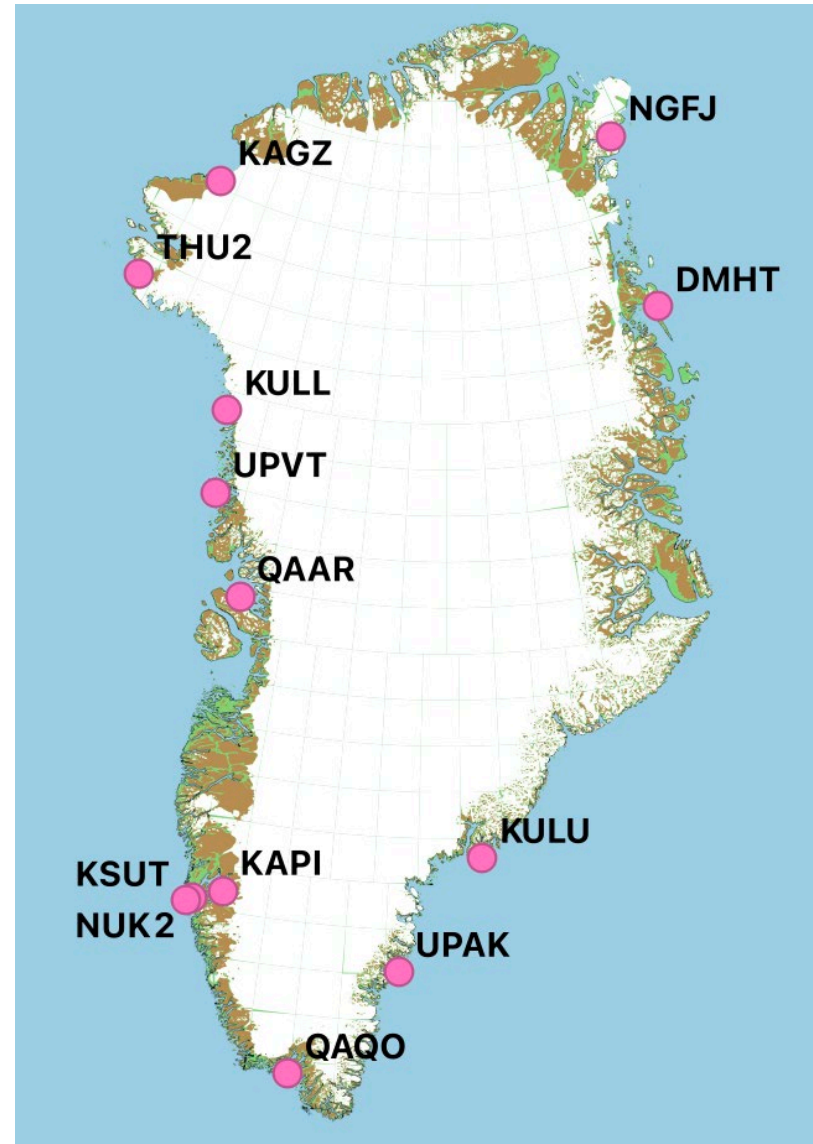
GNSS-IR experiments are carried out at the following 14 sites:

New dedicated stations:

- NUK2
- QAQO
- DMHT

and

- 11 GNET stations suitable for GNSS-IR



Developments within GNSS-IR

Overview of Stations Used for GNSS-IR in Greenland

| Station ID | Latitude | Longitude | Ellipsoidal Height | Operational Time | Antenna Type | Performance (1-5) |
|------------|-------------|--------------|--------------------|------------------|--------------|-------------------|
| NGFJ | 80° 34' 6" | -16° 50' 28" | 34 | 2024 → | LEICA AR20 | 4 |
| UPAK | 63° 5' 44" | -41° 18' 57" | 120 | 2024 → | LEICA AR20 | 4 |
| QAQO | 60° 42' 55" | -46° 2' 52" | 74 | 2012 → | LEICA AR20 | 4 |
| QAAR | 70° 44' 25" | -52° 41' 18" | 26 | 2007 → | LEICA AR20 | 4 |
| KULL | 74° 34' 50" | -57° 13' 37" | 72 | 2007 → | LEICA AR20 | 3 |
| THU2 | 76° 32' 13" | -68° 49' 30" | 21 | 1998 → | LEICA AR20 | 4 |
| PLPK | 66° 53' 52" | -34° 1' 60" | 66 | 2007 → | LEICA AR20 | 3 |
| UPVT | 72° 47' 19" | -56° 8' 47" | 31 | 2024 → | Tallysmann | 5 |
| NUK2 | 64° 10' 16" | -51° 43' 13" | 51 | 2024 → | Tallysmann | 5 |
| KSUT | 64° 4' 15" | -52° 0' 28" | 41 | 2023 → | LEICA AR20 | 1 |
| KAPI | 64° 25' 56" | -50° 16' 16" | 44 | 2008 → | LEICA AR20 | 4 |
| KULU | 65° 34' 46" | -37° 8' 58" | 17 | 1996 → | LEICA AR20 | 2 |
| DMHT | 76° 46' 7" | -18° 40' 14" | 43 | 2024 → | Tallysmann | 5 |
| KAGZ | 79° 7' 55" | -65° 51' 11" | 73 | 2007 → | LEICA AR20 | 3 |

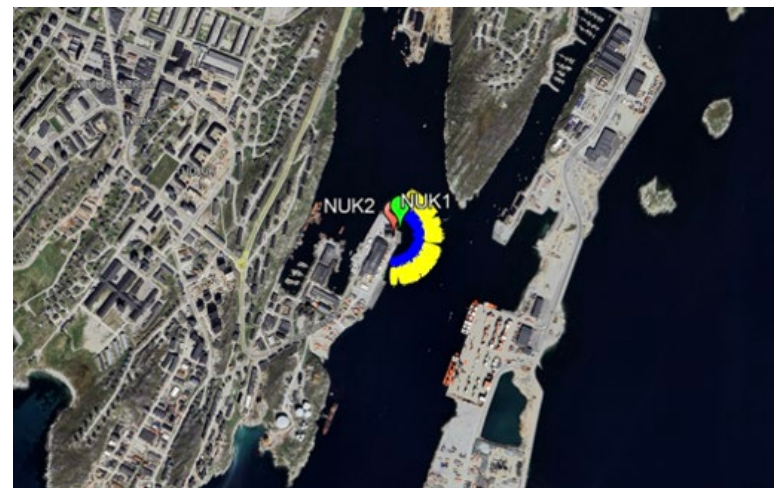
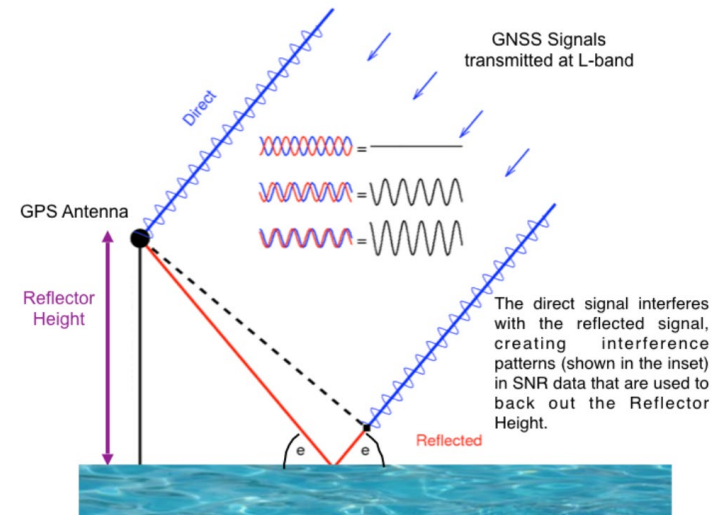
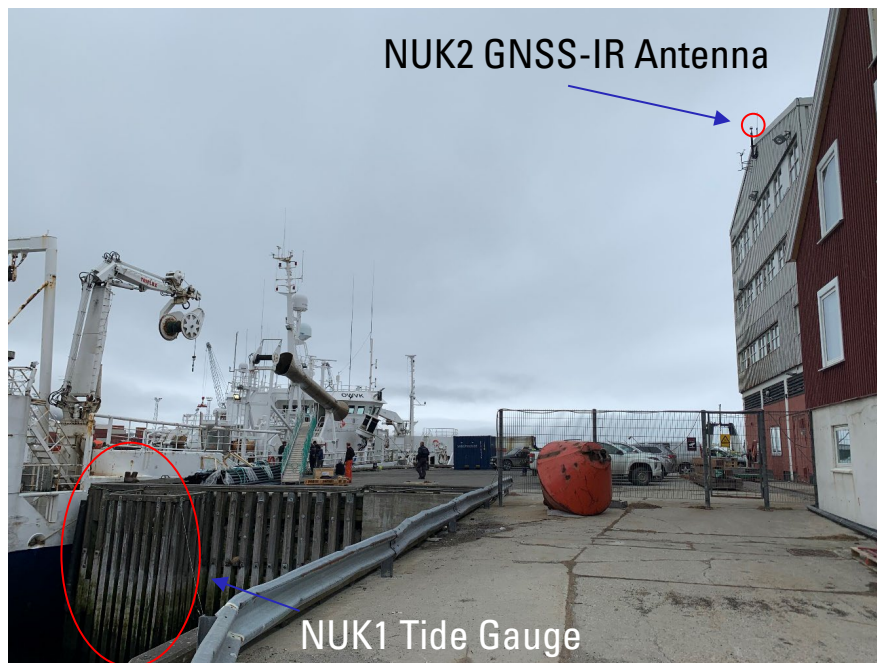
Table 2: Overview of the GNSS sites used for GNSS-IR estimations in Greenland. All sites with the Antenna type: AR20 are GNET sites. The remaining are GNSS-IR only sites. The performance measure is defined as a subjective angle on the performance of retrieving continuous time series.

Experiment in Nuuk

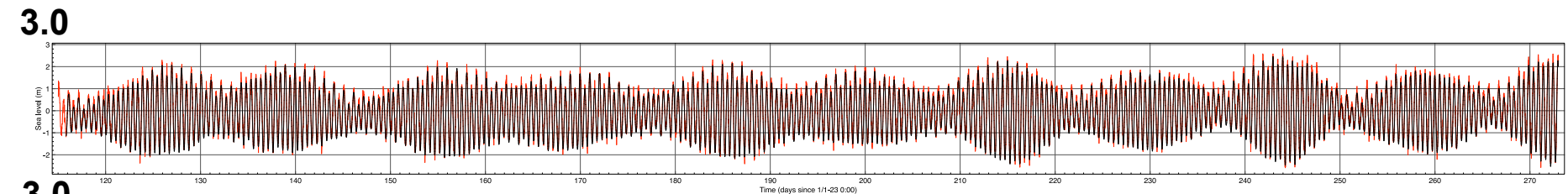
Comparing data from

- NUK1 pressure gauge
- NUK2 GNSS-IR

Data from 5 months (26 April 2023 to 30 September 2023).

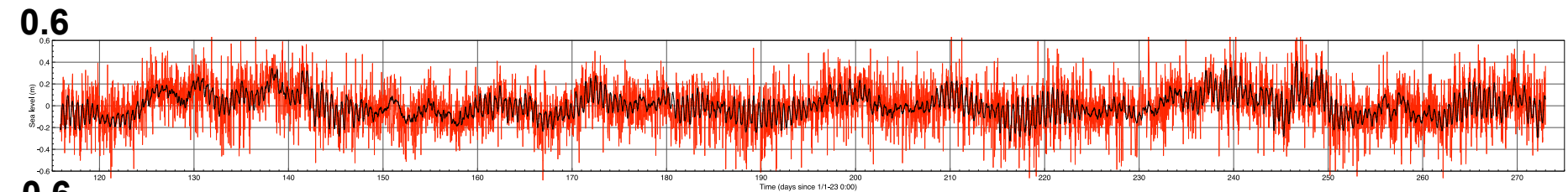


Experiment in Nuuk



Sea-level from the GNSS-IR station (red) and the pressure gauge (black).

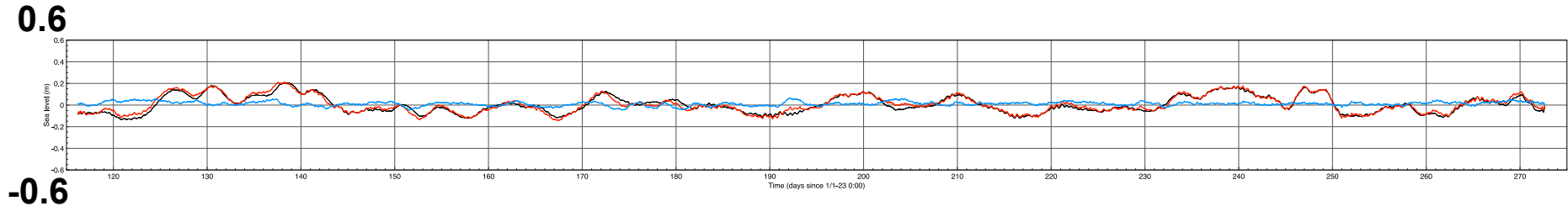
Estimation of coefficients of 8 tidal constituents show differences < 1 cm.



Sea-level with the tidal signal removed - GNSS-IR (red) and pressure gauge (black).

RMS drops from about 1.0 m to 10-20 cm

Experiment in Nuuk



Sea-level where the tidal signal has been removed and smoothed over 1-day intervals. The blue curve shows the differences.

| Standard deviation | Nuuk_GNSS | Nuuk_TG | Differences |
|--------------------|-----------|---------|-------------|
| Observations | 1.05 | 1.02 | 0.16 |
| Tide Model | 1.03 | 1.02 | 0.07 |
| Residuals | 0.18 | 0.11 | 0.15 |
| 24 hour averages | 0.08 | 0.08 | 0.02 |

Experiment in Nuuk

The main conclusion is that GNSS-IR clearly gives promising results.

The measurements are noisier than the measurements from the traditional pressure gauge (sampling; different reflection points).

The results of the tidal constituents as well as the daily averages correspond within very small deviations.

The GNSS-IR provides a direct link to the ITRF (remains to be verified).

