National Oceanography Centre

# PSMSL

(Permanent Service for Mean Sea Level)

## A new service providing sea level height data using GNSS sensors from around the globe

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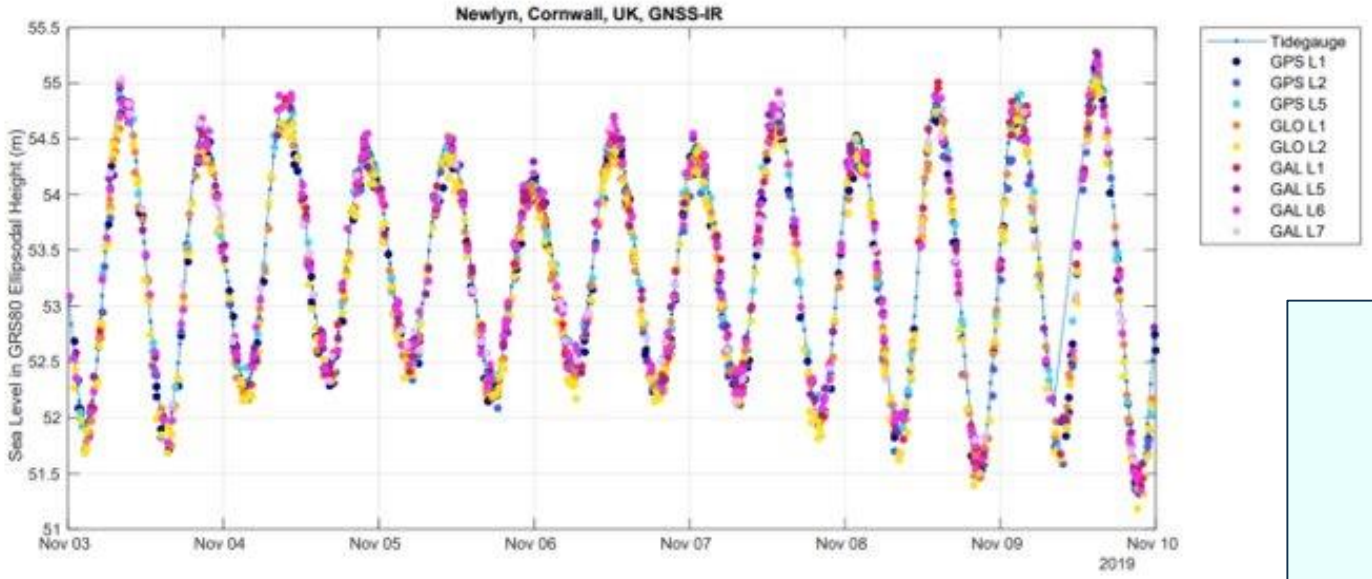
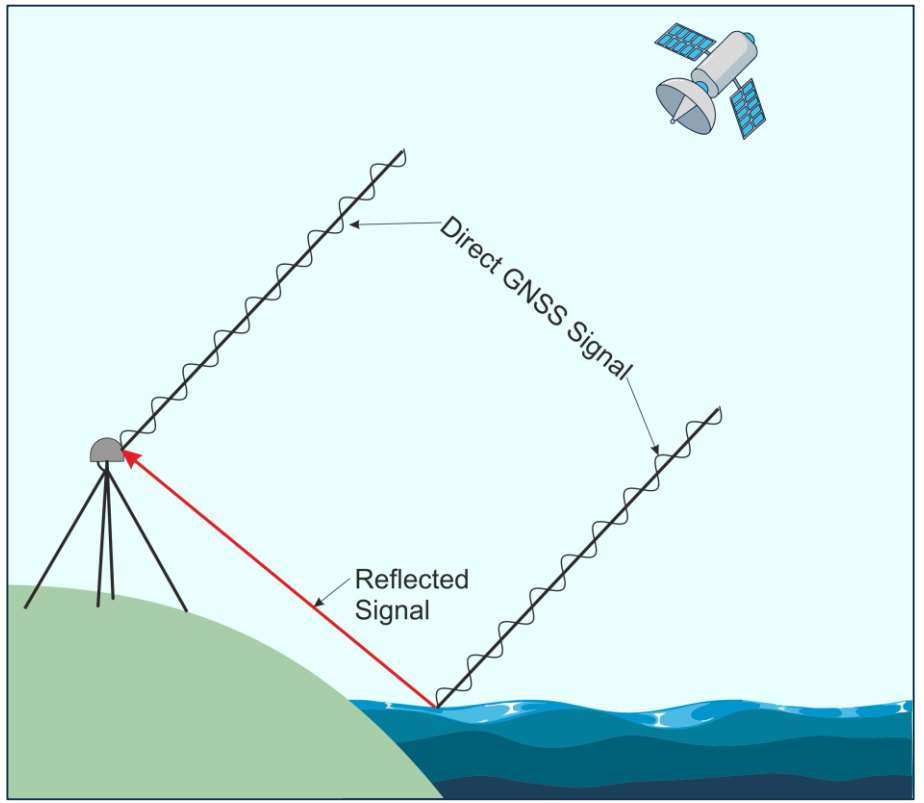
# What is GNSS Interferometric Reflectometry (GNSS-IR)?




The emerging technology of GNSS-IR gives us the opportunity to measure sea levels without getting out feet wet

This technique allows sea level to be measured using only a GNSS receiver.

As well as a receiving a direct signal from a GNSS satellite, the GNSS receiver detects a reflected signal off the surface of the water. The phase delay between the direct and reflected signal will vary as the height of the water changes.



# Short course on Friday afternoon

## SC5.5

**EDI**

**gnssrefl: an open source GNSS reflections software package for measuring snow accumulation and water levels**

We have developed an open source software package in python for ground-based GNSS reflections – gnssrefl (https://github.com/kristinemlarson/gnssrefl). This new software supports geoscientists wishing to measure in situ snow accumulation, permafrost melt, firn density, tides, and lake/river levels. We have developed videos (hosted on youtube) to help new users understand both the basic concepts of GNSS reflections and how to install and run the gnssrefl code. More than a dozen use cases are available online; Jupyter Notebooks have been developed as well. We envision the EGU tutorial session to be hands-on and interactive, with a focus on demonstrating the gnssrefl software and online tools (https://gnss-reflections.org), examining and discussing environmental results derived from GNSS data taken from public archives, and analyzing new datasets suggested by the students.

**Share:** https://meetingorganizer.copernicus.org/EGU22/session/43170

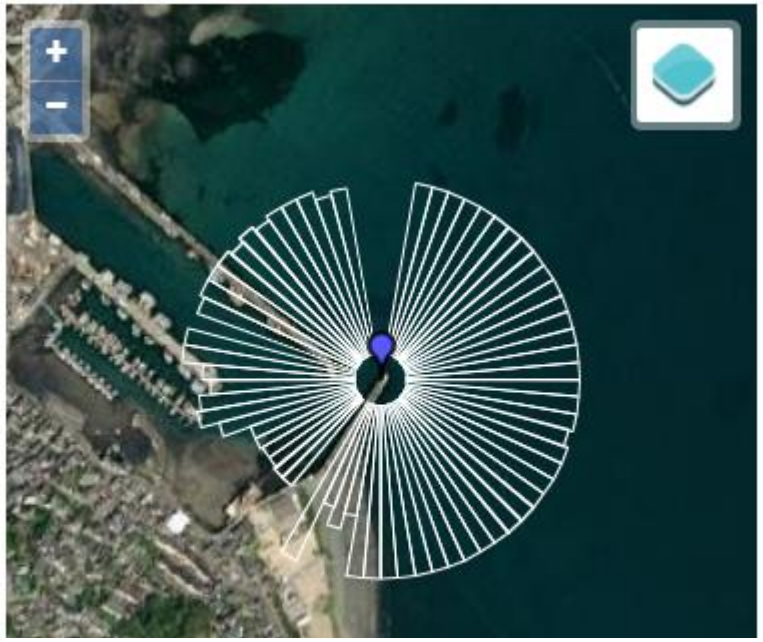
Co-organized by CR8/G7/GI2/HS11/OS5

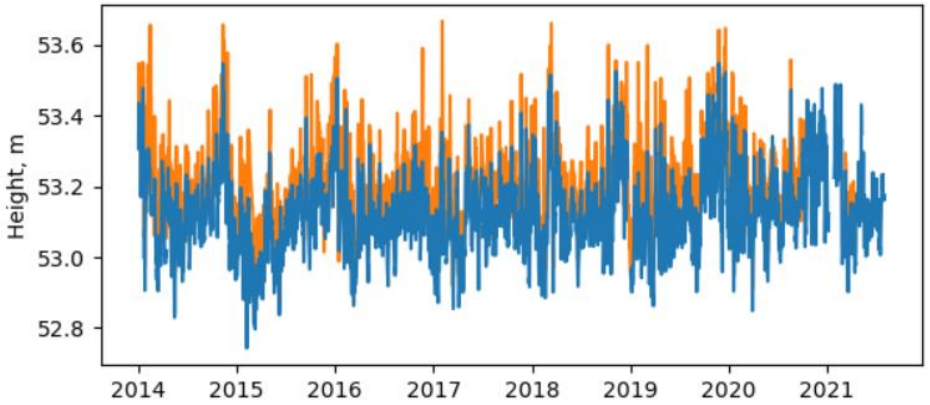
Convener: Kristine Larson | Co-conveners: Makan Karegar[ECS], Kelly Enloe[ECS]

Fri, 27 May, 15:10–16:40 (CEST) Room -2.85/86

See also these links to Kristine's code, YouTube videos and web app

# Data portal at https://psmsl.org/data/gnssir






Blue: GNSS-IR Data, Orange: Nearby tide gauge data


Good site - reflectometry works well and data is available

Decommissioned - reflectometry works well, data is available, but site is no longer operating

Questionable - reflectometry works sometimes or the signal is very weak probably due to location

Bad - no data available at the site, either due to positioning of the sensor, lack of signal to noise ratio data, or data sampling is inadequate for the height of the sensor

# Things to know about the data

Example notebook: https://psmsl.org/data/gnssir/gnssir_example.html

Simple csv format – one liner to read in Python (Pandas), Matlab, perhaps R?

| time | raw_height | adjusted_height | fitted_tide | prn | signal | azimuth | elevation |
|---|---|---|---|---|---|---|---|
| 2014-01-01 00:24:30 | 51.435 | 52.065 | 51.953 | 107 | 1 | 250.881 | 12.907 |
| 2014-01-01 00:34:45 | 51.373 | 52.363 | 52.159 | 219 | 1 | 258.202 | 12.845 |
| 2014-01-01 00:34:45 | 51.415 | 52.405 | 52.159 | 219 | 5 | 258.202 | 12.845 |
| 2014-01-01 00:34:45 | 51.218 | 52.208 | 52.159 | 219 | 7 | 258.202 | 12.845 |
| 2014-01-01 02:44:29 | 54.251 | 54.878 | 54.795 | 2 | 2 | 37.505 | 12.921 |

Time steps are irregular – observations represent one passing of a GNSS satellite overhead

# Things to know about the data

Example notebook: https://psmsl.org/data/gnssir/gnssir_example.html

Simple csv format – one liner to read in Python (Pandas), Matlab, perhaps R?

Which Satellite?
1-99: GPS
101-199: GLONASS
201-299: Galileo
301-400: BeiDou

| time | raw_height | adjusted_height | fitted_tide | prn | signal | azimuth | elevation |
|---|---|---|---|---|---|---|---|
| 2014-01-01 00:24:30 | 51.435 | 52.065 | 51.953 | 107 | 1 | 250.881 | 12.907 |
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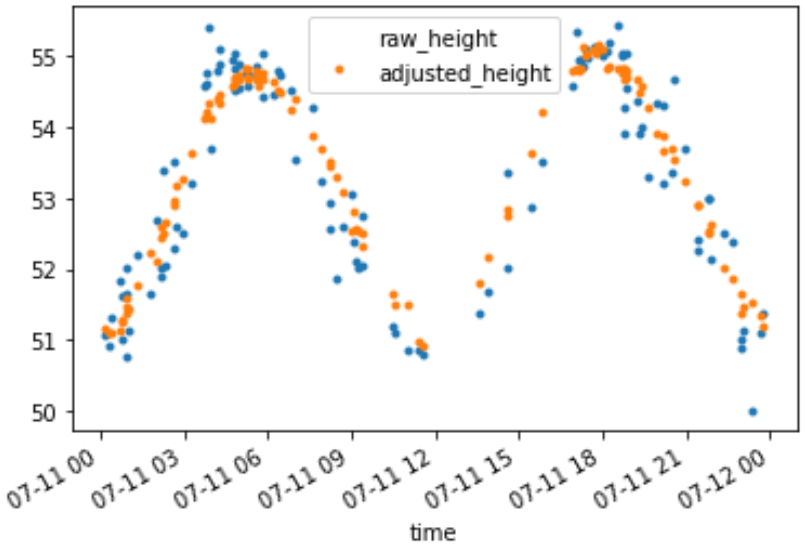
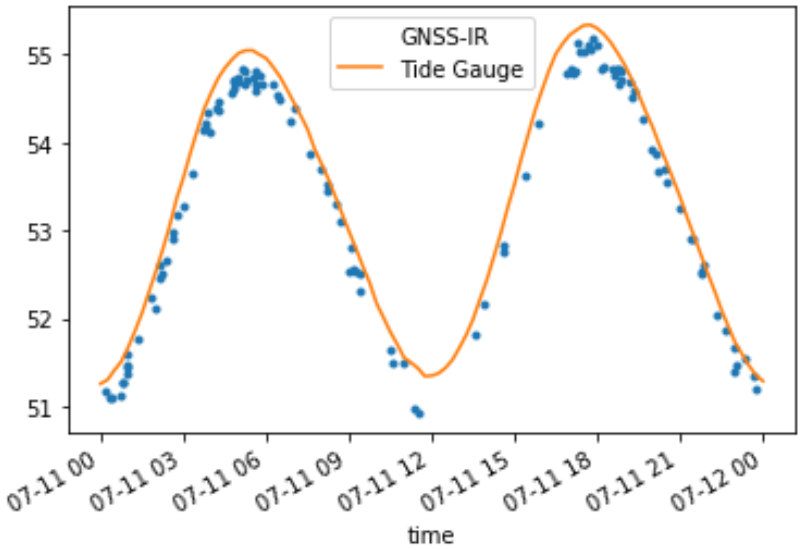
Time steps are not unique
Satellites transmit multiple frequencies, which are processed separately
Different channels may have different biases

Which channel?

# More things to know about the data

- We provide two heights: **“raw”** and **“adjusted”**
  **adjusted** accounts for the horizontal movement of the sea as the satellite passes overhead.
- GNSS measurements are geocentric, but!
  These data are **relative sea levels**
- We’ve used **approximate ellipsoidal height** as a datum, but if you’re comparing with geocentric data (e.g. satellite altimetry), you’ll need to account for land movement (using direct GNSS observations)
- This is delayed mode processing (although we have proof of concept it can be done in near real time)



# Our plans for the future

- Still in beta! We'll add more documentation and explanations
- This is a first attempt – many improvements can be made
- Needs better integration with the traditional tide gauge network and GNSS data sources
- Delivery through ERDDAP data servers
- Near real time delivery

If you have a GNSS receiver you'd like to include that isn't there, please let us know!

(Ensure SNR, signal-to-noise ratio, is recorded in your RINEX file, and for best results use RINEX 3 or 4, and record all constellations and frequencies possible, and ideally increase sampling rate – 5 seconds is a good compromise between rate and file size).

You can find the portal at https://psmsl.org/data/gnssir/

Please send your questions and feedback to psmsl@noc.ac.uk

# Thanks for listening!