7th Sentinel-3 Validation Team Meeting 2022

18-20 October 2022 | ESA-ESRIN | Frascati (Rm), Italy

Evaluation of results from Fully Focused SAR processing as a potential contribution to Coastal Monitoring

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→ THE EUROPEAN SPACE AGENCY

FFSAR - Coastal

The FFSAR-Coastal Project is applying the SMAP Fully Focused SAR (FFSAR) altimetry processor on Sentinel-3A and Sentinel 3B data in order to evaluate the potential of FFSAR altimeter data to contribute to coastal and estuarine monitoring.

Two different environments :

- The Severn Estuary : Highly dynamic mixed tidal estuary environment, confluence between a river and its estuary experiencing large tidal range and strong tidal currents.

- The lower Rhone Delta and Camargue: A low lying, flat river delta and wetland environment, susceptible to inundation and rising water levels.
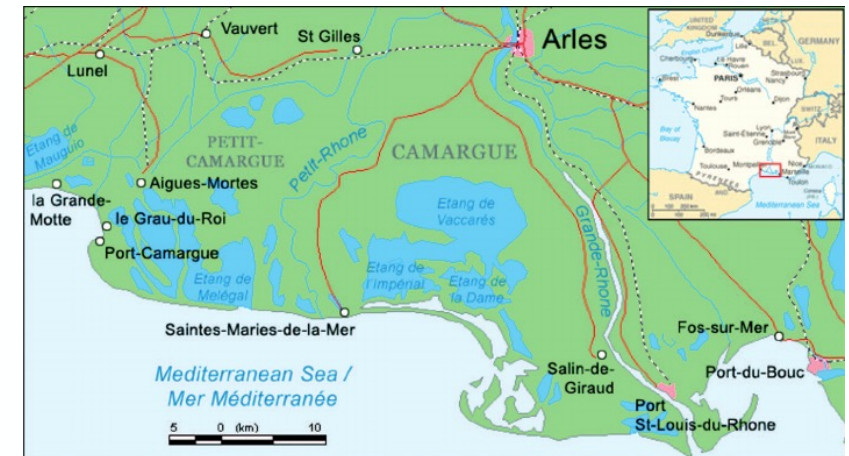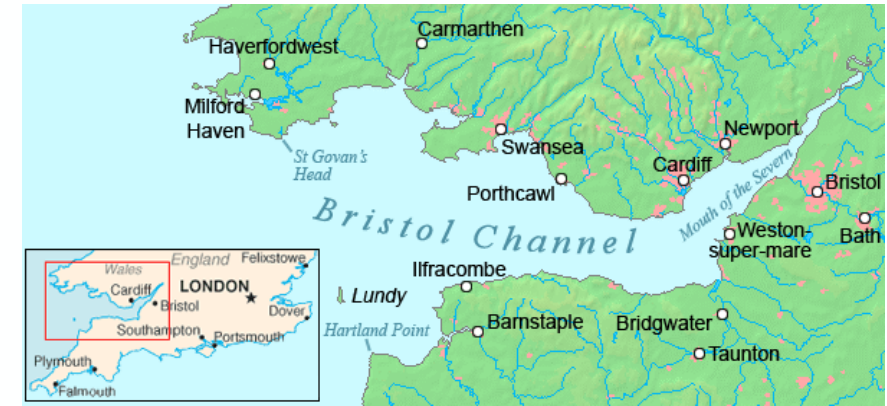
Funded by **ESA** through the EO4Society Open Call

https://www.satoc.eu/projects/ffsar/

FFSAR – Coastal –Project Overview

- Fully Focussed SAR processing (DTU)
  - Apply SMAP FFSAR processor for S3A, S3B data in Severn and Rhône areas
  - Validate against in-situ data, evaluate ability to map key features
  - Identify optimum processing choices
- vortex.io micro-gauges
  - Install 4 μgauges (2 per region) for in situ validation
  - Drone campaigns to map water level from in situ sites to satellite track
- User Engagement / Application Road Map (NOC, CCO)
  - Workshops > Roadmap for use of FFSAR processing in Coastal Monitoring Systems
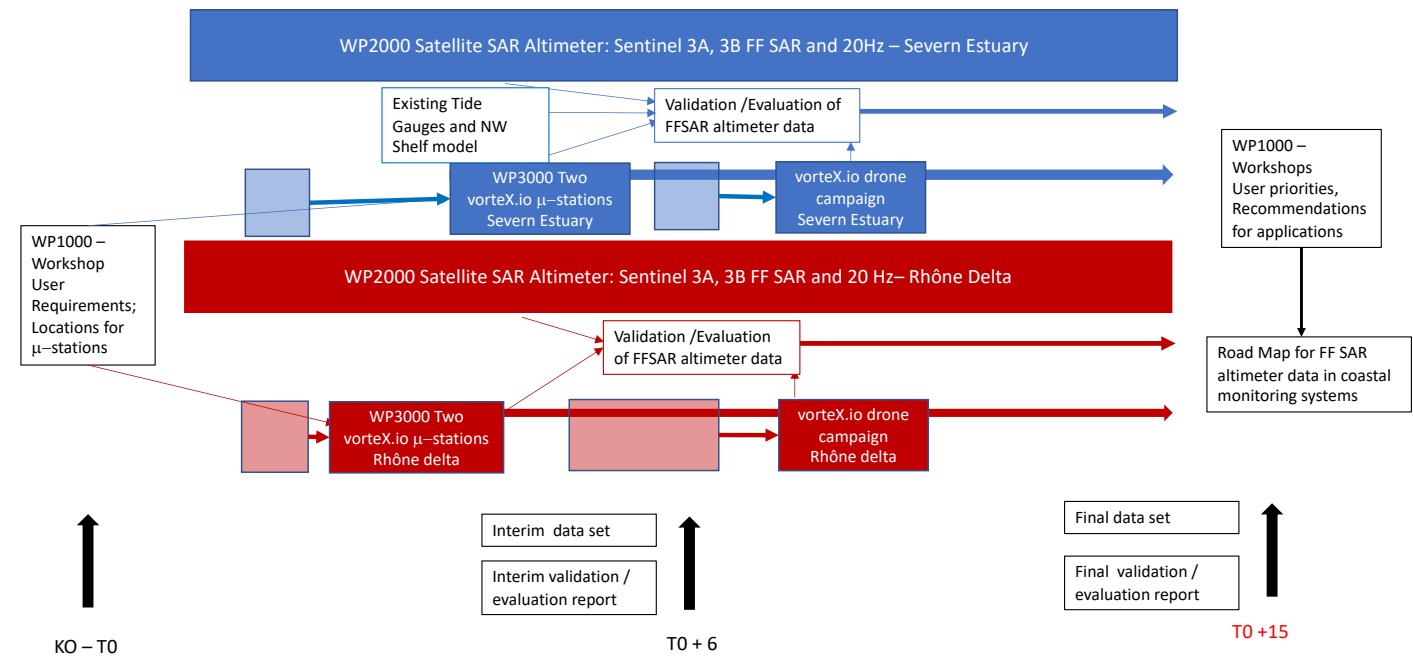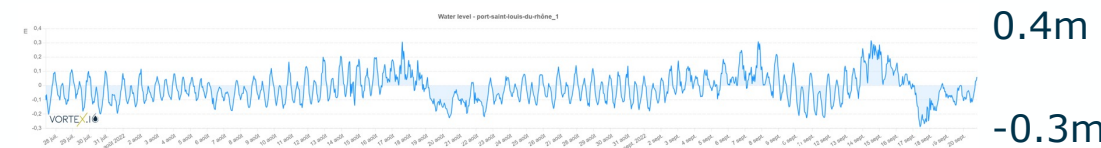
vortex.io in-situ Gauges

Vortex.io "micro" Gauges

- liDAR, 8Mpx camera
- Real Time data
- Remote management
- Lightweight, small and easy to install
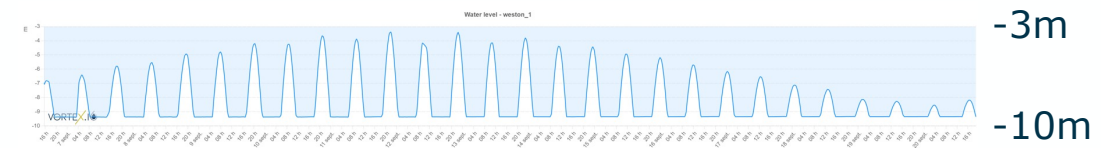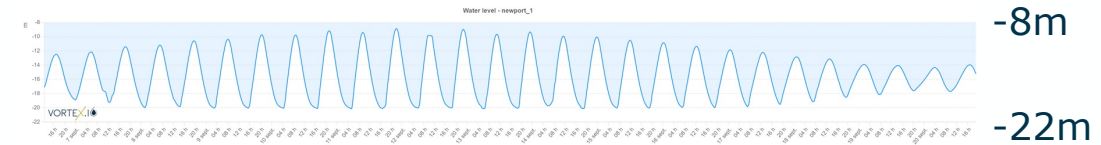
FFSAR Coastal Installations

- Severn Estuary: Newport & Weston Super Mare (06/09/22)
- Rhône delta: Port St Louis du Rhône & Fos sur Mer (27/07/22)
- To be deployed until June 2023

Drone Campaigns

Connect water level at gauge to satellite track at the time of overpass.

- liDAR: cm level accuracy, 50cm to 90m range
- 8Mpx camera: water mask, orthophotos
- 900g

Flight planning

- Deployment from river banks or boat, depends on respective locations of gauges and satellite tracks
- Regulations for flying near airports
- Rhône flights in Q4 2022, Severn flights Q1 2023

WSH measured by vorteX.io VTX-1 Saône 21/05/2020
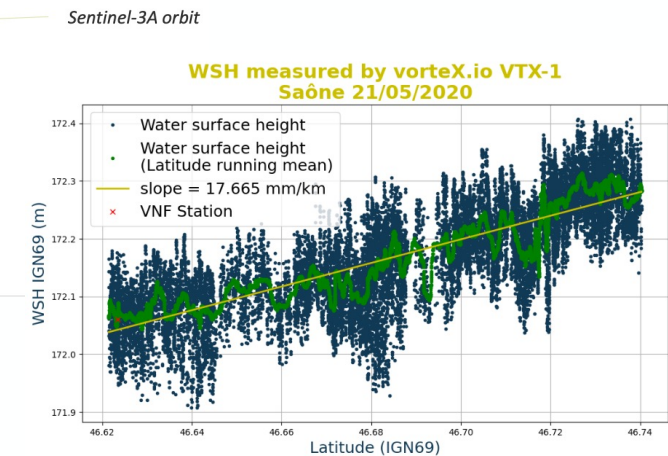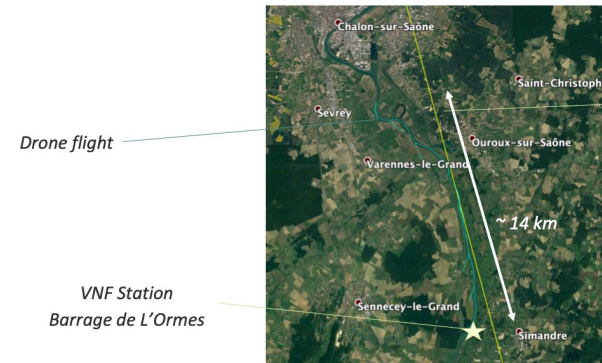
Fully Focussed SAR Altimeter Processing

- Apply SMAP (Standalone Multi-Mission Altimetry Processor) to Sentinel 3A and 3B data

- Initial results to identify the optimum processing choices, then applied to generate time series of data for selected tracks.

- Validation against in-situ data and models.

- Evaluate how well FFSAR altimeter data can resolve fine scale features in two different environments.

- Severn Estuary: Ability to capture small scale physical signals (surface gradients, currents, roughness signatures) in highly tidal regions and to detect and measure tidal asymmetry/gradients

- Rhône delta: Ability of FFSAR data to accurately map different low lying channels and filaments.

Fully Focussed Processing – Severn Estuary

The Severn Estuary, UK

- Input files downloaded for RONs 265, 299, and 208 for both S3A and S3B

- All cycles from 265B have been processed using the SMAP with different settings to find the most appropriate setup.

- Water levels are found by combining SMAP output with L2 files from ESA/scihub.
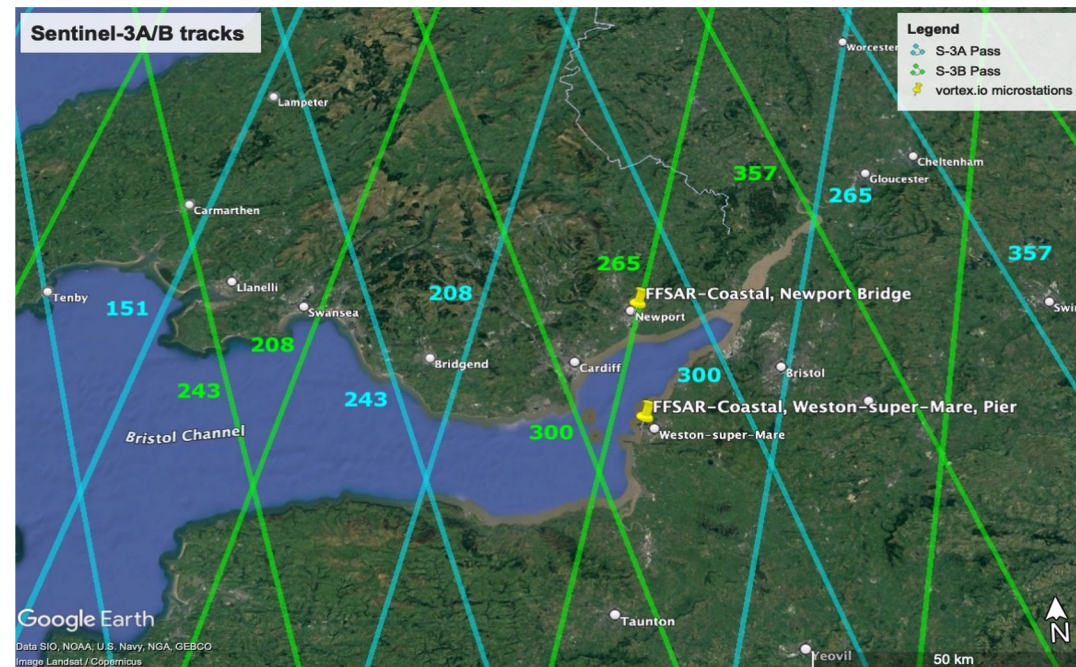
RON	Sentinel-3A period (cycles)	Sentinel-3B period (cycles)
265	Apr 2016 (cycle 3) – May 2022 (cycle 85)	**Dec 2018 (cycle 19) -May 2022 (cycle 65)**
299(300)	Apr 2016 (cycle 3) – May 2022 (cycle 85)	Feb 2018 (cycle 21) – June 2022 (cycle 66)
208	May 2016 (cycle 4) – June 2022 (cycle 86)	Dec-2018 (cycle 19) – June 2022 (cycle 66)
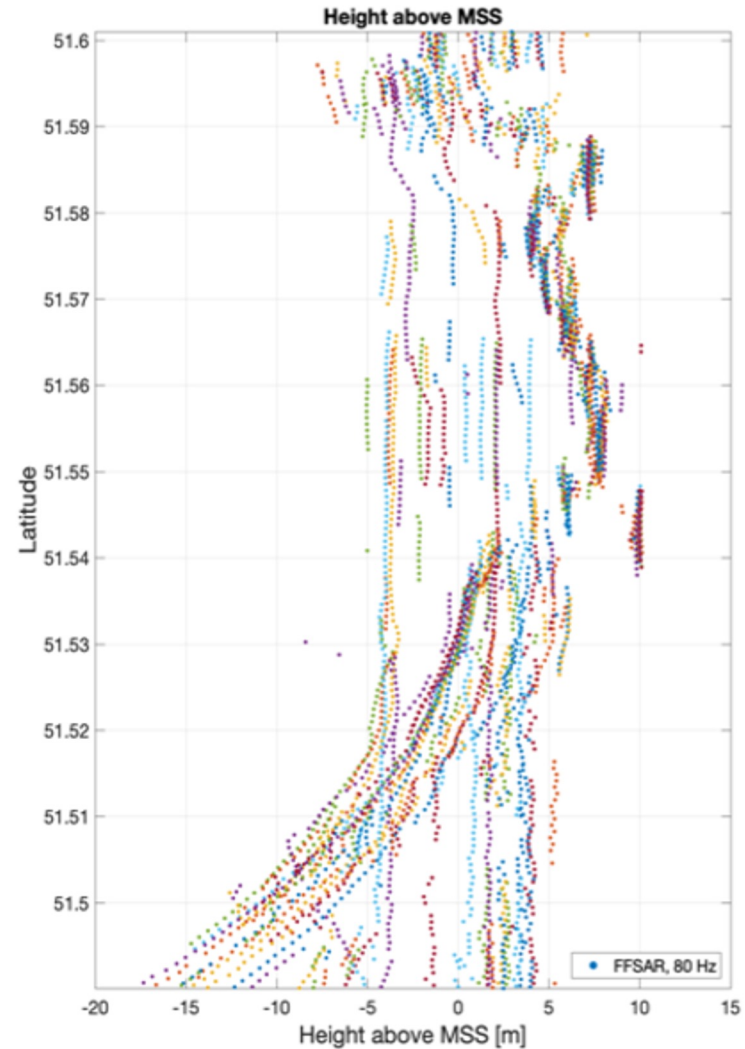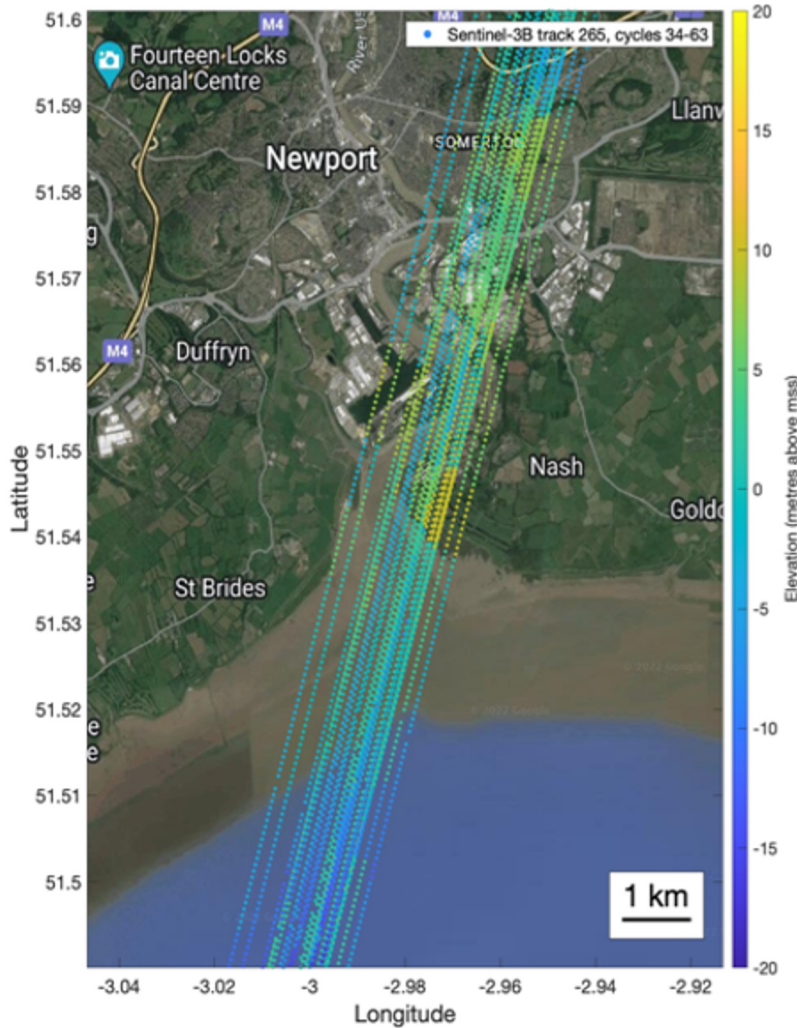
Q: Are we seeing bathymetry at low tide?
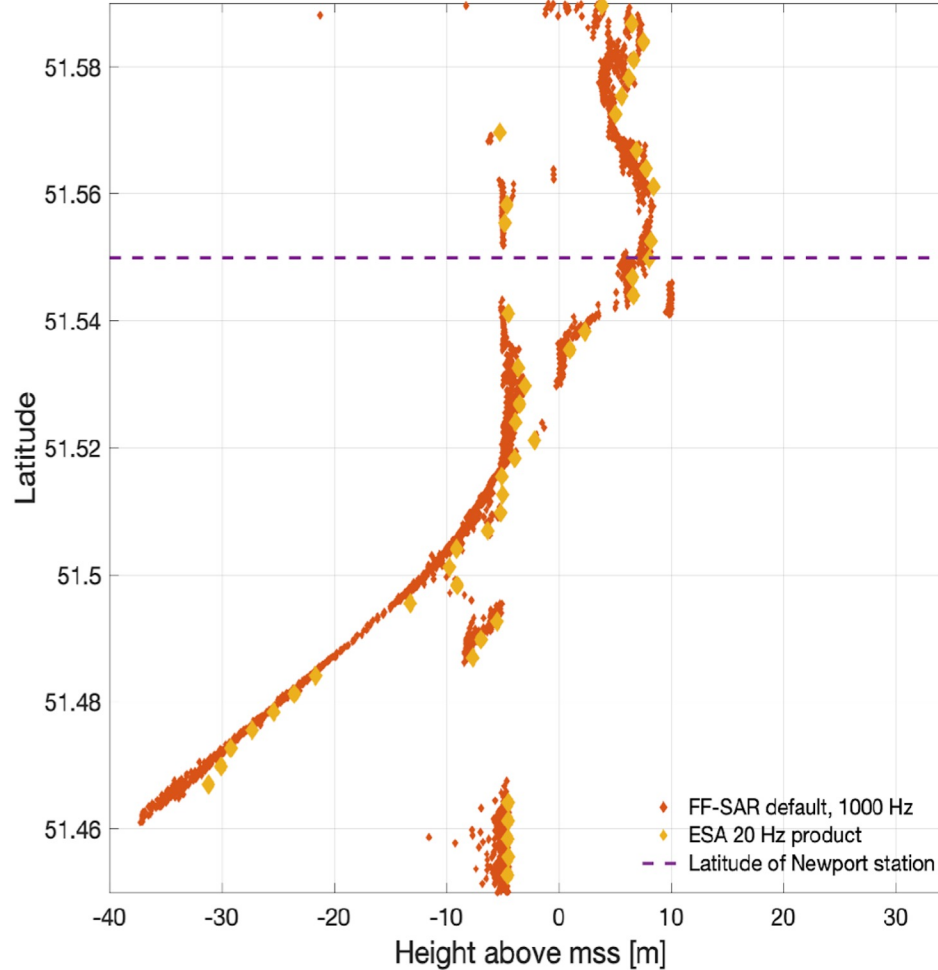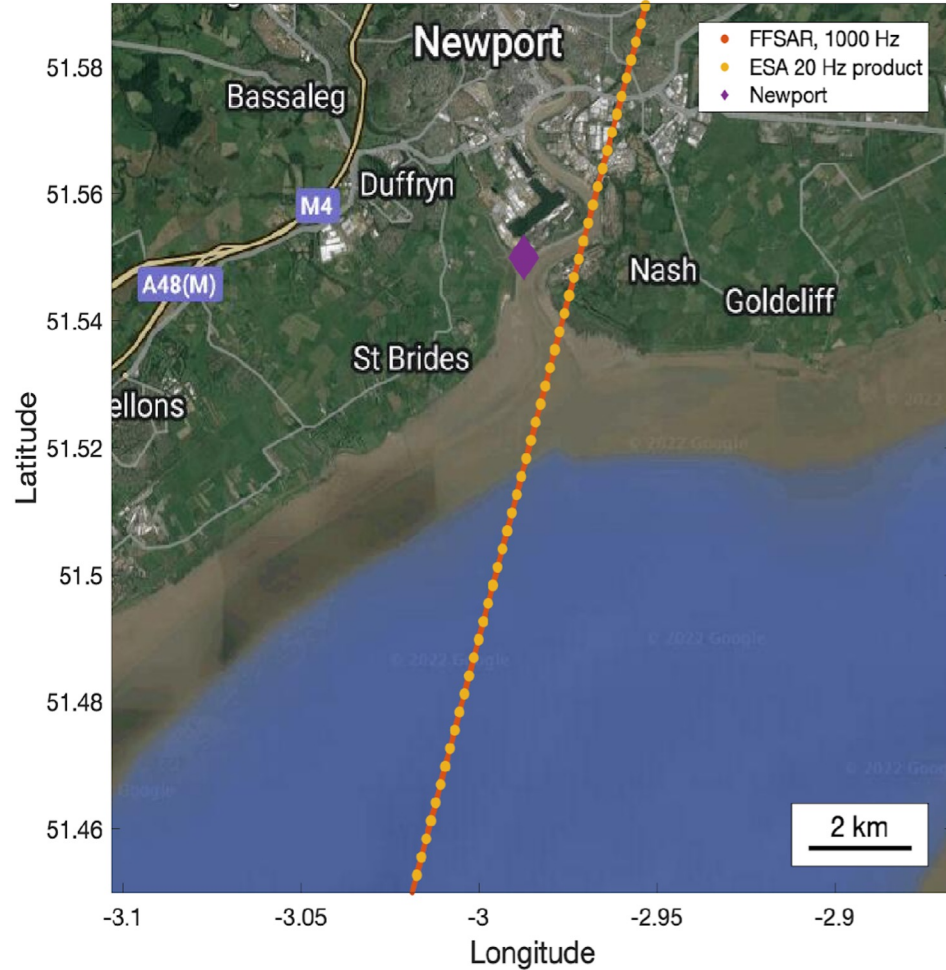
Or is it snagging?
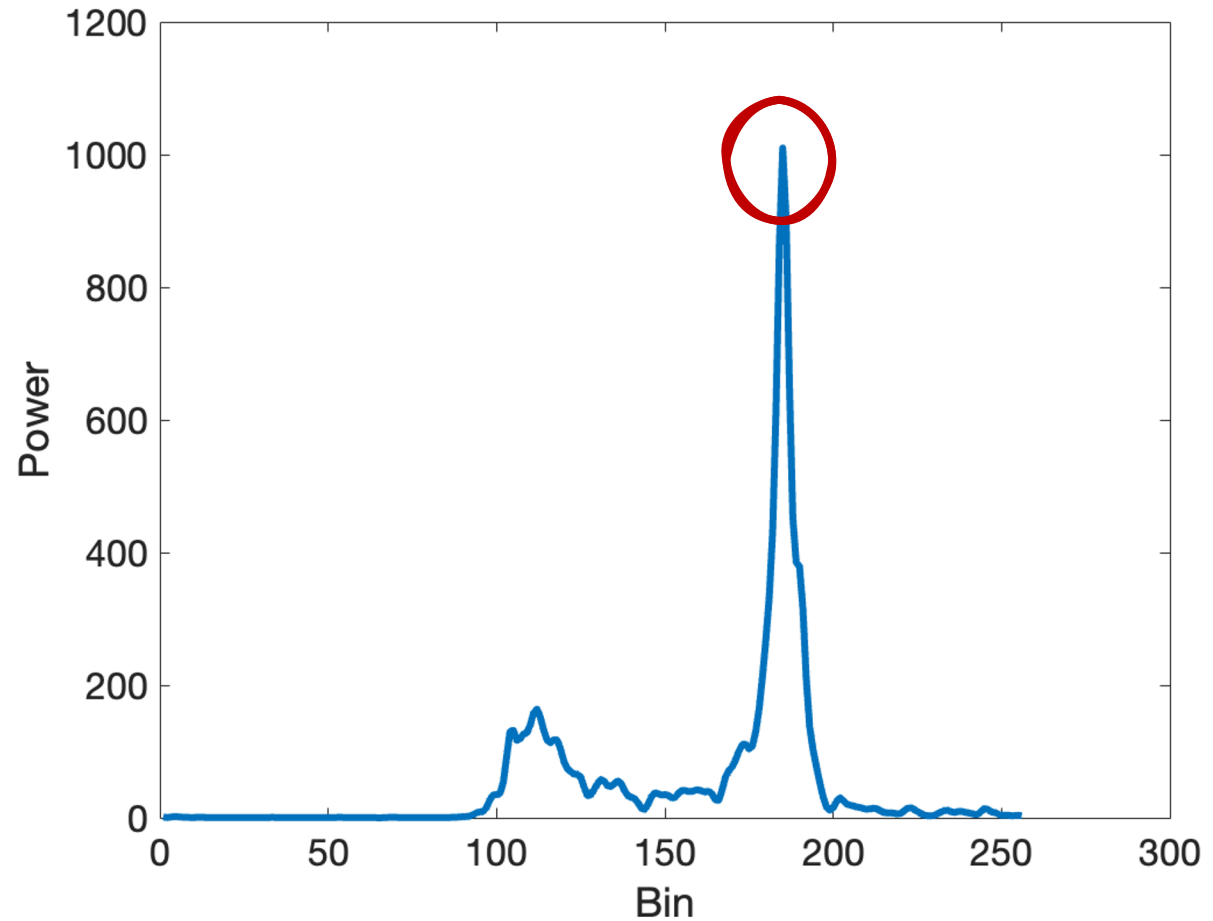
SMAP retracker options:

- PTR
- OCOG (can adjust parameters)
- Multi-PTR (10 main peaks)

OR

Could use another retracker (e.g. DTU)
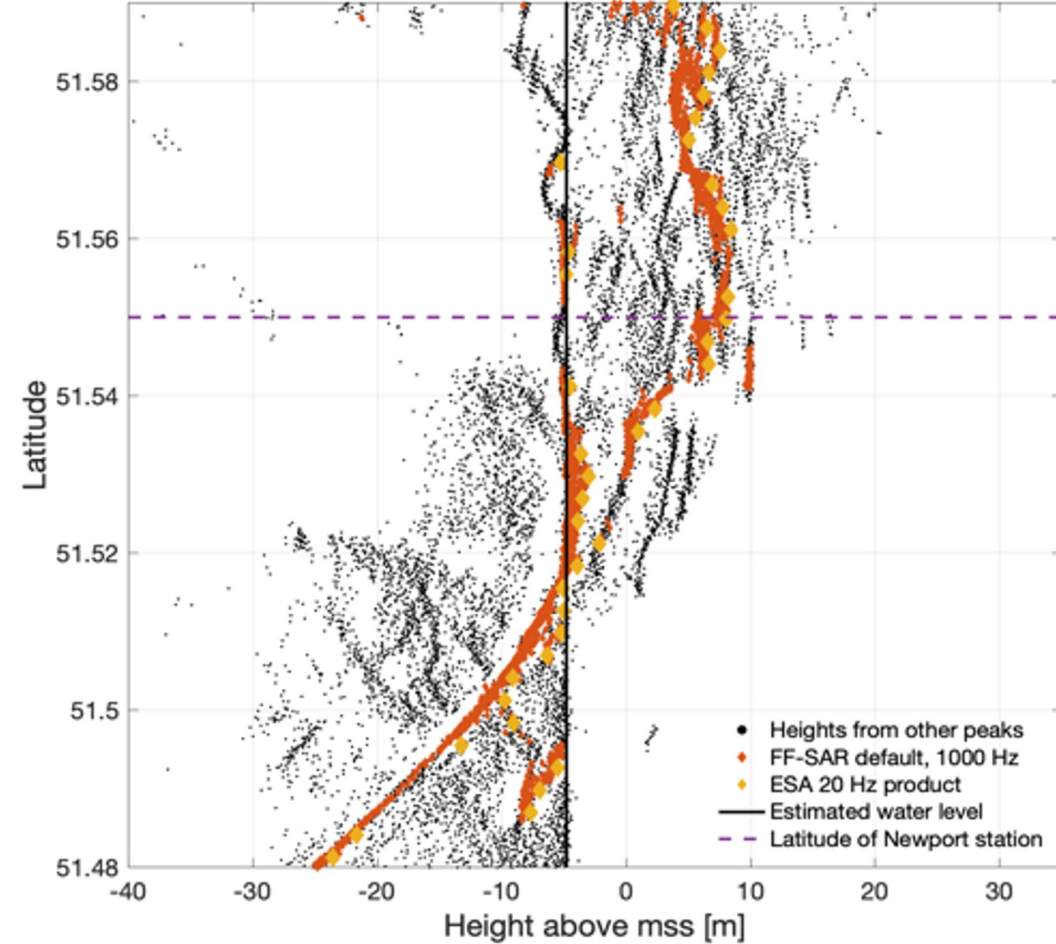
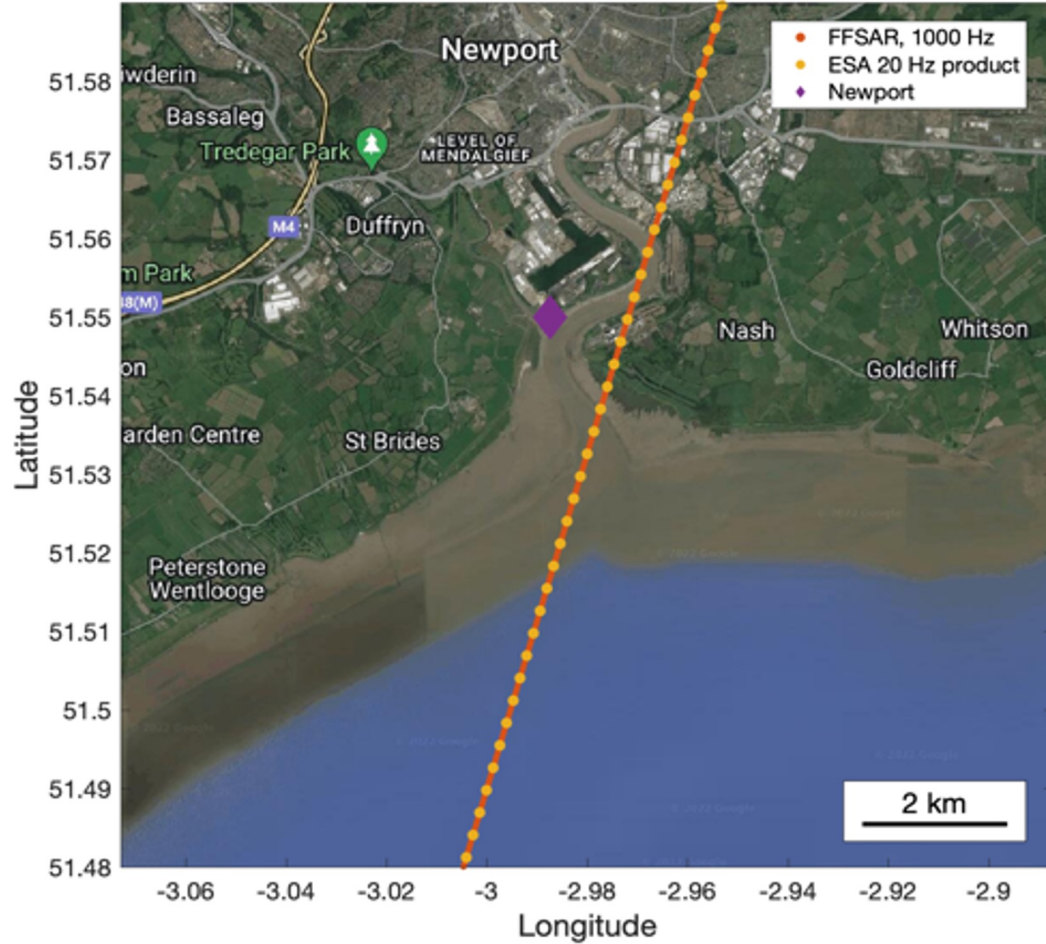04-May-2020 10:55:43

RON 265 from Sentinel-3B is close to several tide gauges and to the micro-stations

Tide gauges used for validation of FFSAR data:
Newport
Hinkley Point
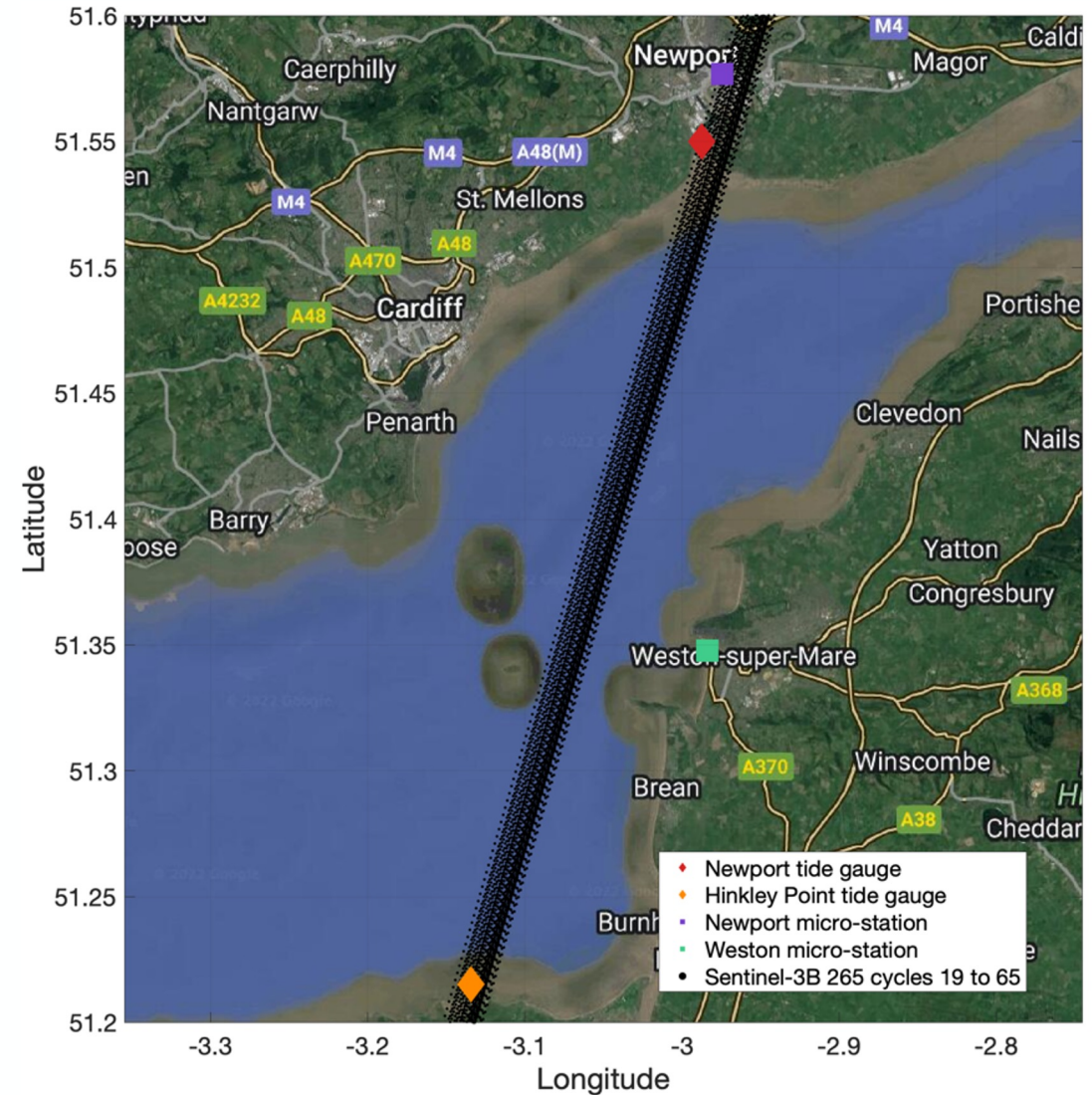
All time series at 0 mean because of different reference systems.

Many tide gauge measurements are flagged

Generally good agreement but a high RMSE of 1.2 m!
(RMSE was ~3m from ESA OCOG retracker.

Newport

All time series at 0 mean because of different reference systems.

Most tide gauge measurements after 2020 are flagged

Also a high RMSE of 1.1 m!

Rhône Delta

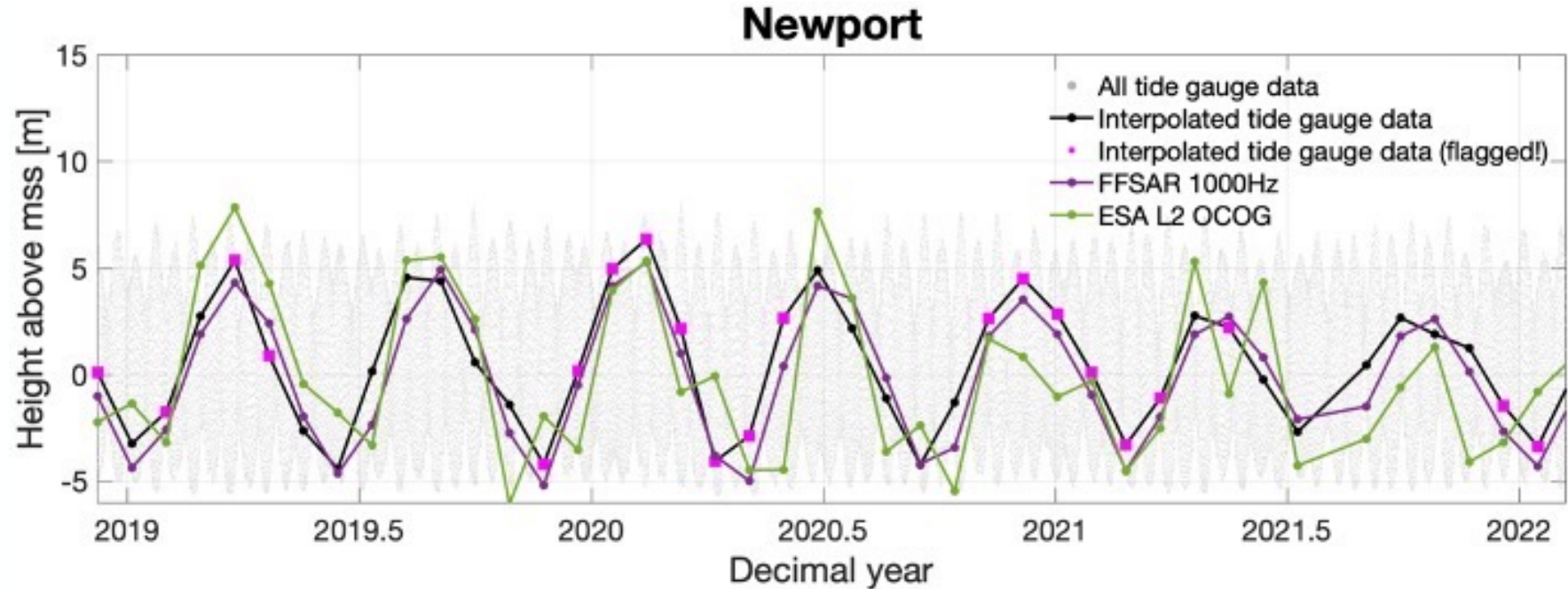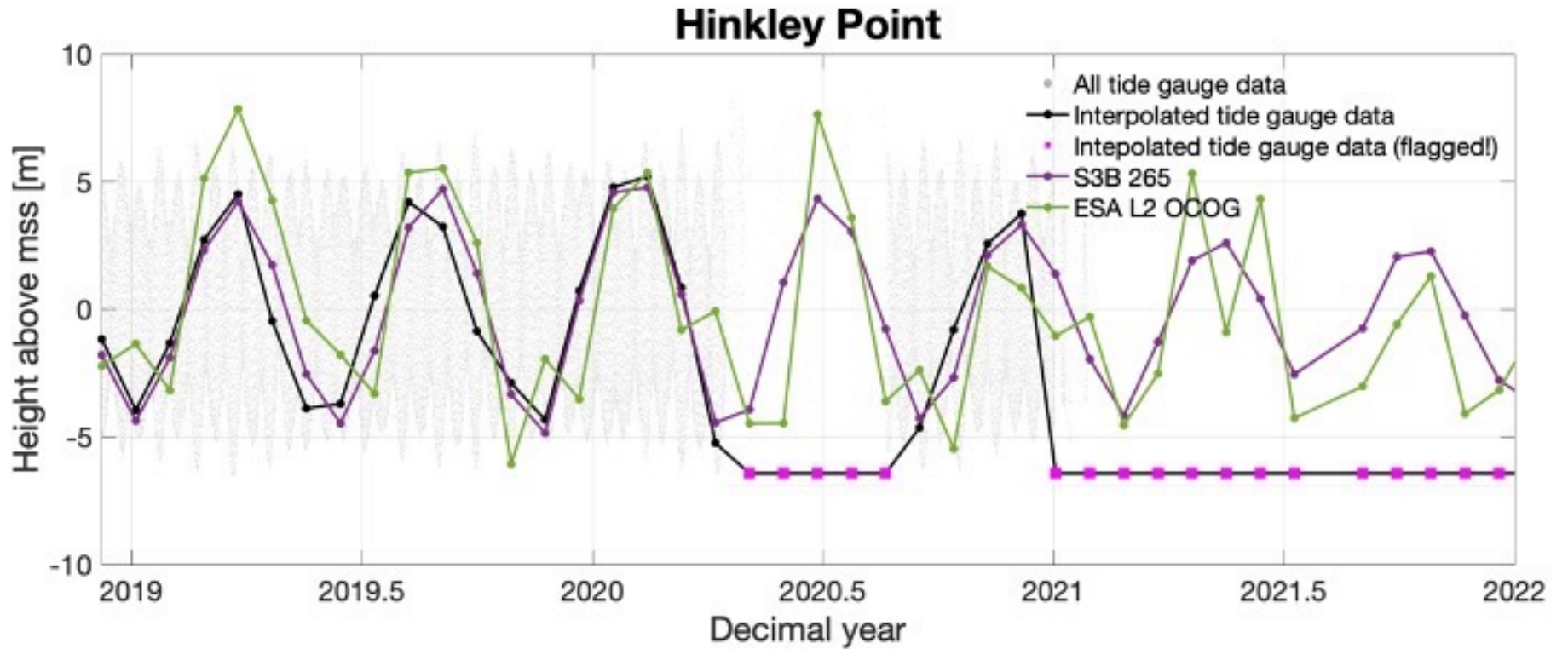- Input files downloaded for RONs 179 and 199 from S3B, cycles 19-68.

- All data has been processed, but best setup will be made clear once proper validation data is acquired.

- Best source for high frequency Tide Gauge data nearby?

RON	Sentinel-3B period (cycles)
179	March 2019 (cycle 23) – August 2022 (cycle 69)
199	Dec 2018 (cycle 19) – July 2022 (cycle 68)
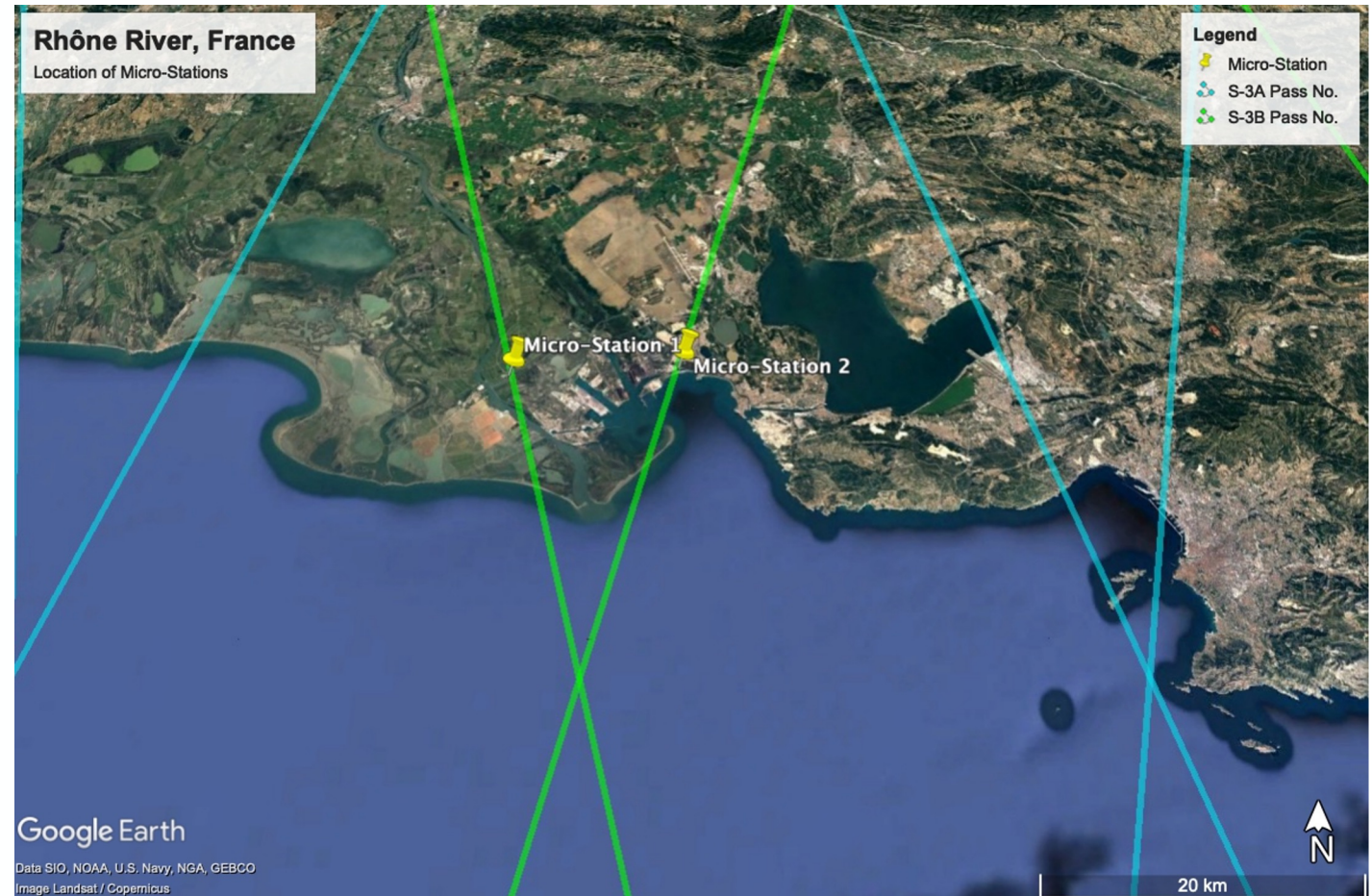
Further Work

Severn Estuary

- Investigate re-tracker options
  - Apply multi peak re-tracker
  - Different parameters on OCOG re-tracker
  - Use DTU re-tracker

- Process other tracks one at a time to confirm optimum processor options

- Get reference from micro-stations and compare absolute heights.

- Validate against drone campaign data

Rhône Delta

- Closer analysis of FFSAR data, similar or different behaviour to Severn?

- Identify best processing options and complete processing.

- Identify source of nearby high frequency in-situ sea level data.

- Validate against drone campaign data.

FFSAR Coastal – Final Outputs

Data Sets

- FFSAR S3A and S3B data sets: Severn Estuary and Rhône delta
  - Along track data and time series
  - Vortex.io micro-station time series data
- Drone campaign data
- Will be available at: www.coastalmonitoring.org

Product Validation and Evaluation

- Validation against in-situ and model data

- Evaluation:
  - Small scale physical signals in highly tidal regions
  - Tidal asymmetry/gradients across estuaries
  - Understanding interaction of tides and river discharge

Application Road Map

- Key requirements from User Groups
- Recommendations for application of FFSAR in coastal monitoring systems.
- Recommendations for use of "micro" gauges as part of coastal monitoring systems

https://eo4society.esa.int/projects/ffsar-coastal/