

# Refining the scientific needs to observe small-scale ocean surface dynamics and vertical ocean processes in coastal, shelf and polar seas from space

Christine Gommenginger et al.,

# Motivation

Why have a session on “small-scale ocean dynamics at the interfaces of the Earth System” ?

This talk is ...

A way to start a dialogue with the wider community about scientific needs, opportunities and challenges linked to small scale ocean dynamics, to inform SEASTAR EE11 Phase 0 activities.

This talk is not...

A promise that the SEASTAR mission will change dramatically to satisfy all requests.

# SEASTAR Science drivers

Wednesday 15:40pm B2.01.1 The Earth Explorer 11 Candidate Missions  
Gommenginger et al., Small-scale ocean surface dynamics from space: the Earth Explorer 11 candidate mission SEASTAR

High-resolution satellite images often show small ocean eddies, swirls and filaments at scales below 10 km

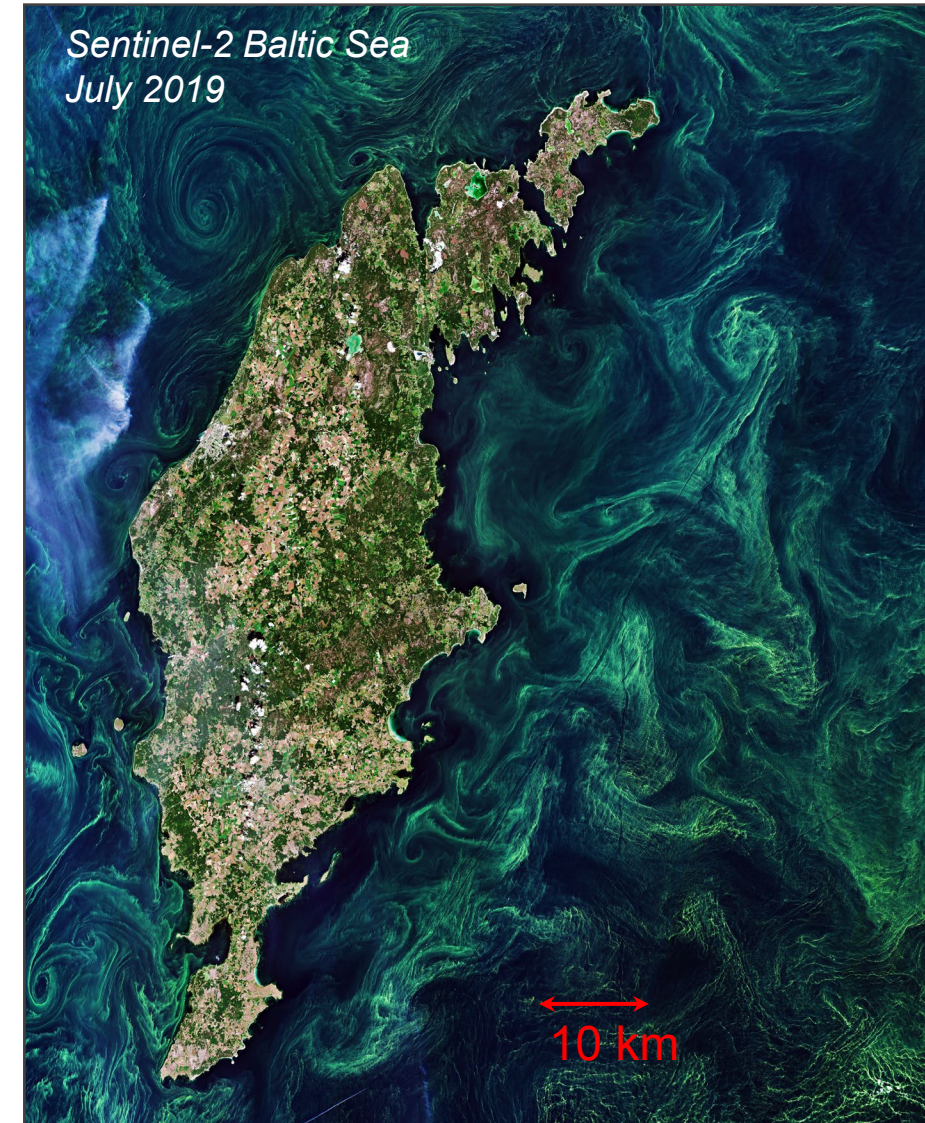
Frequent near jets, large eddies and in coastal and polar seas  
Fingerprints of dynamic vertical exchanges at the sea surface

Numerical models indicate these small-scale phenomena play a critical role on ocean circulation and the global climate system

Impact on vertical exchanges e.g. heat, CO<sub>2</sub>, nutrients...  
Impact on horizontal dispersion & pathways e.g. debris, oil...

There are very few observations of ocean dynamics at these scales

Challenging & expensive with traditional means  
No existing or planned spaceborne capability to quantify their magnitude, spatial distribution and temporal variability.



# Phase 0 Consolidating requirements

Expressed in MATER

MATER v1.2 now issued

input to system studies by industry

e.g. requirements on swath width, performance, sampling...

MD-130 The L2 TSCV and OSVW images shall be obtained for an **extended swath**  $\geq 150$  km TBC (Goal for extended swath:  $\geq 200$  km), including a **minimum swath**  $\geq 100$  km TBC (Goal for minimum swath:  $\geq 150$  km) over which accuracy requirements for TSCV and OSVW are satisfied (see MD-110 and MD-115)

*Note 1: A minimum swath width of 100km where accuracy requirements for TSCV and OSVW are satisfied is needed to observe the wider mesoscale, coastal or MIZ context to support the interpretation of the high-resolution observations.*

*Note 2: The instrument has to satisfy LIB accuracy requirements on radial velocity, backscatter and coherence at VV polarisation over the full range of the minimum swath.*

*Note 3: The extended swath would provide greater overlap between neighbouring overpasses during the drifting phase of the mission, see also requirement MD-160.*

*Note 4: The width of the minimum swath over which the accuracy requirement can be satisfied should be maximised, and will be used as a key performance indicator to differentiate different concepts.*

## EE11 SEASTAR CANDIDATE MISSION MISSION ASSUMPTIONS AND TECHNICAL REQUIREMENTS (MATER)

Prepared by	ESA
Document Type	Requirement Document / Specification (System, Subsystem, Unit, Equipment level)
Reference	EOP-ΦMP/2021-11-2315
Issue/Revision	1.2
Date of Issue	29/04/2022
Status	Issued

# SEASTAR Coverage & revisit



SEASTAR is **NOT** a global monitoring mission !

Focus on coastal, shelf-seas & Marginal Ice Zones  
+ Open-ocean regions of special interest (ORSSI)

Two mission phases:

**Fast-repeat phase (6 months)**

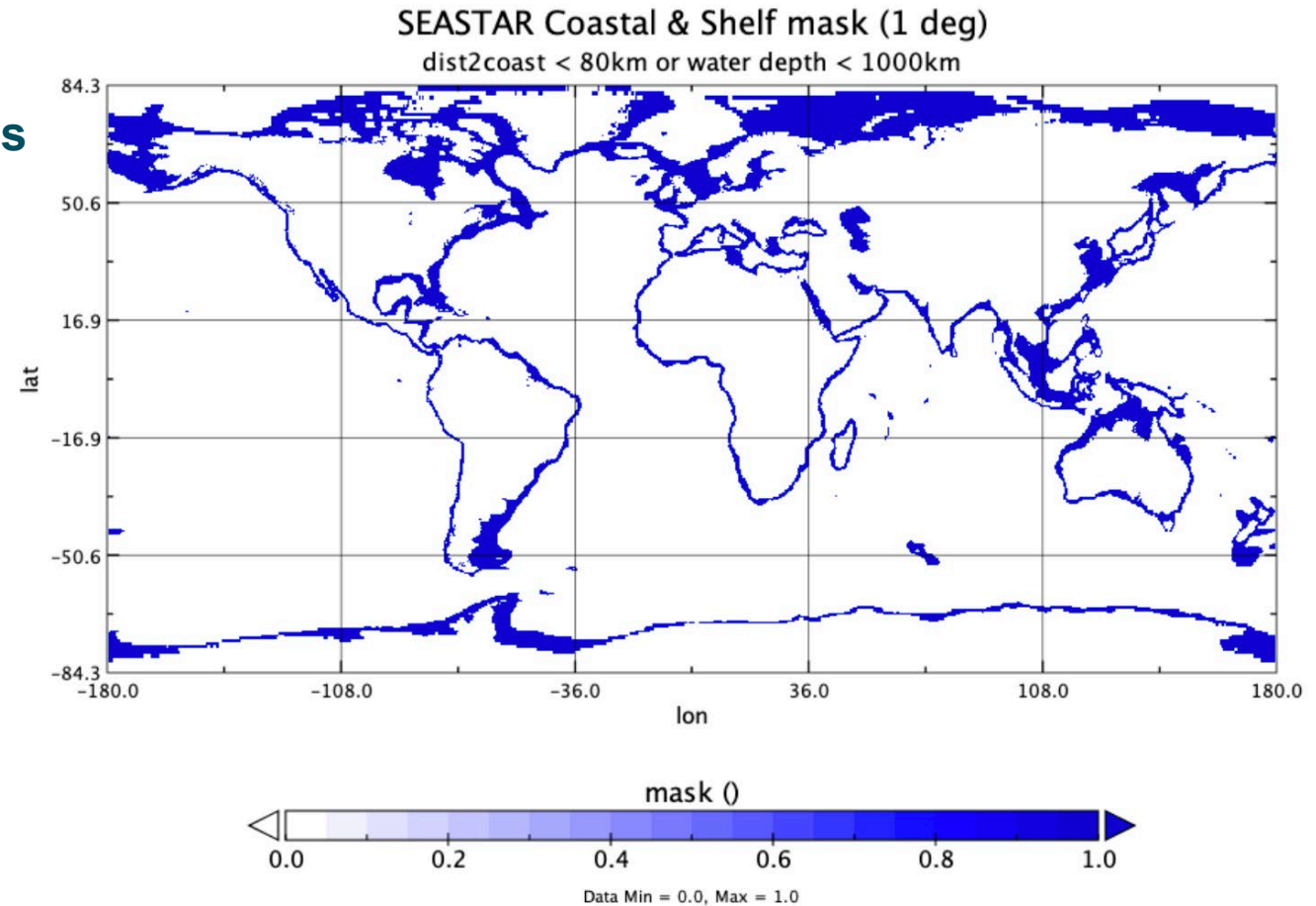
1 day repeat

150 scenes every day, each 250 km long

**30-days drifting orbit (4 years)**

1-day sub-cycle

50% swath overlap at the Equator



Feedback & Comments welcome

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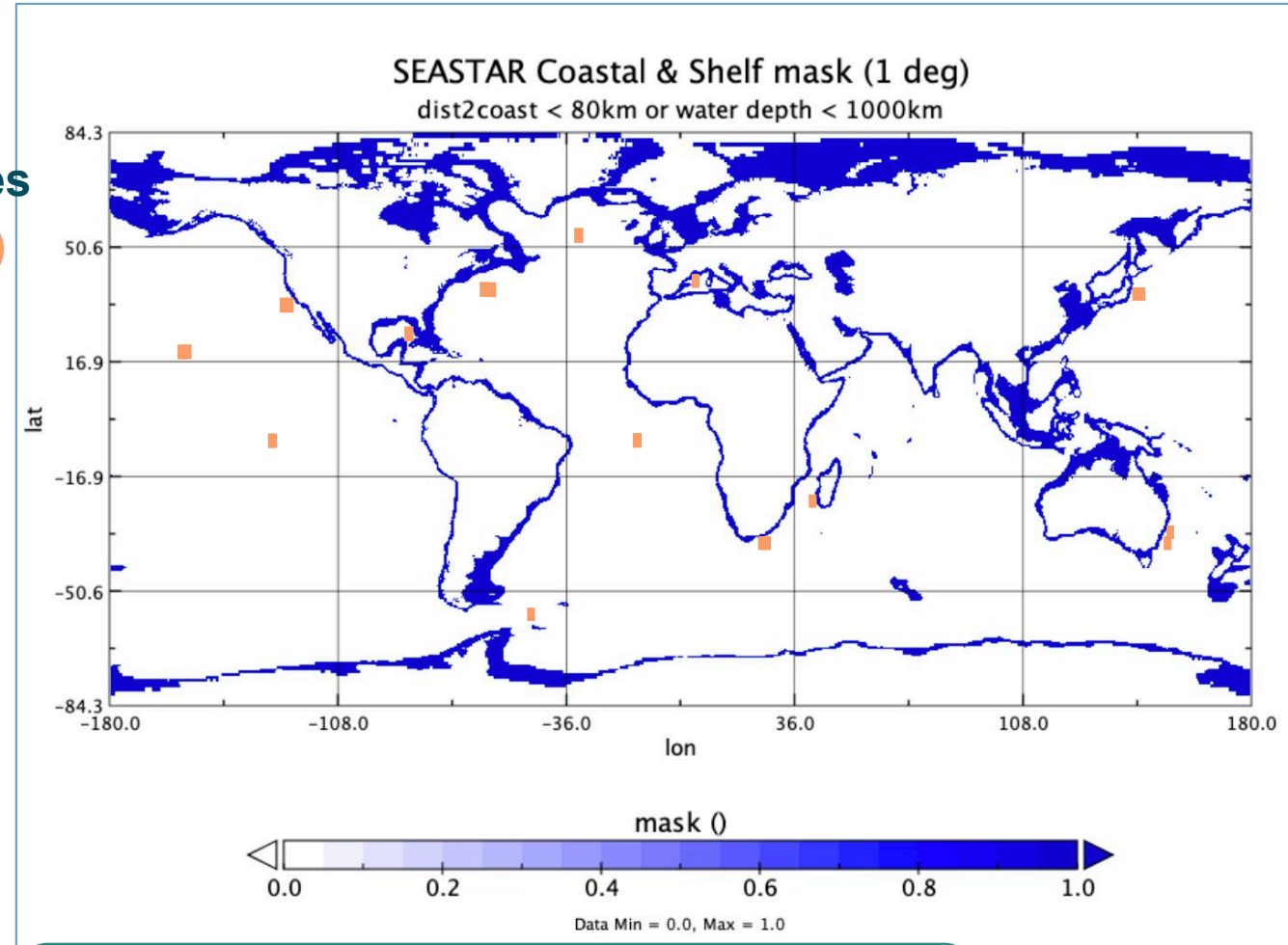
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Where would you place the ORSSI ?  
Why ?

## SEASTAR Primary Products (Level 2)

### Total Surface Current Vector (L2-TSCV)

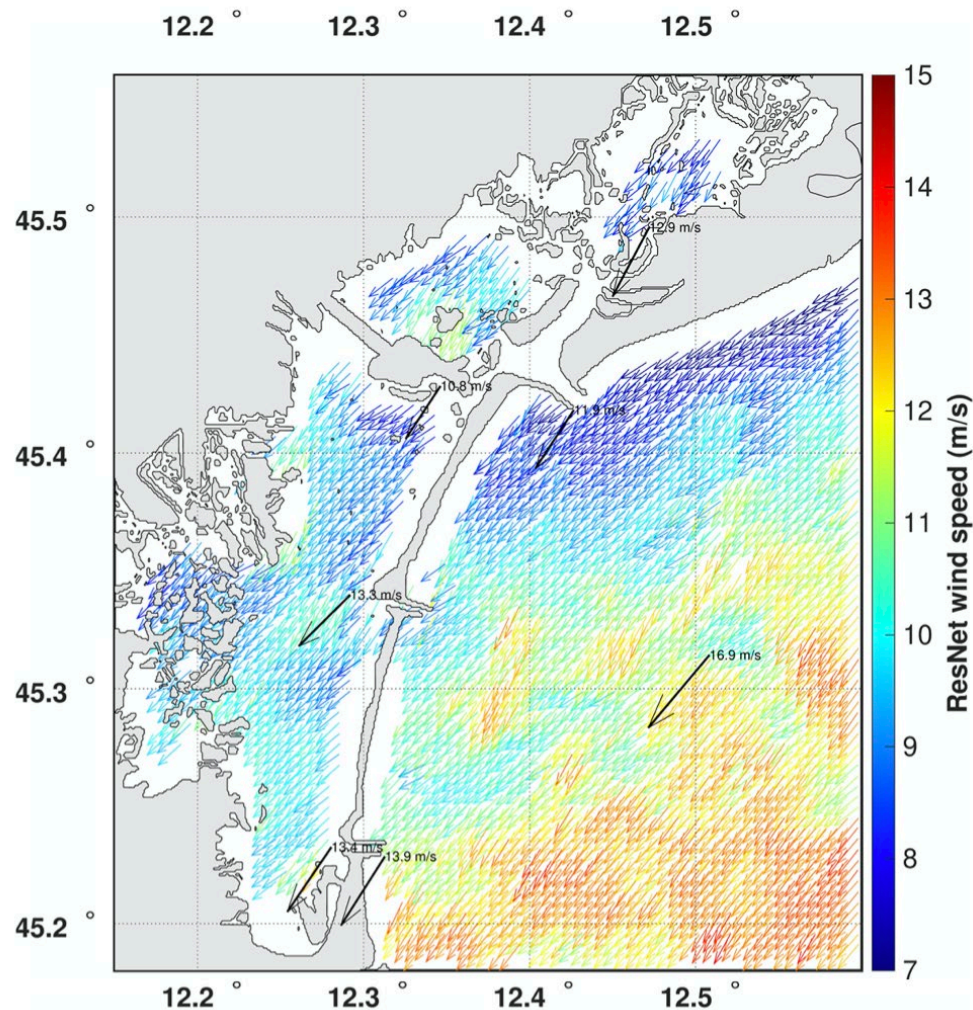
One continuous swath:	$\geq 100$ (minimum) $\geq 150$ km (extended)
Horizontal posting (resolution):	$\leq 1$ km
TSCV RMSE @ 1km resolution:	$\leq 0.1$ m/s or 10%



### Ocean Surface Vector Wind (L2-OSVW)

Same swath and posting as TSCV
OSVW RMSE @ 5km resolution: $\leq 1$ m/s or 10%

Why 5km and not 1km ?



IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING, VOL. 60, 2022

## Structure of High-Resolution SAR Winds Over the Venice Lagoon Area

Stefano Zecchetto <sup>ID</sup> and Andrea Zanchetta <sup>ID</sup>

Can we reliably validate OSVW  
at 1km resolution ?

At 5km ?

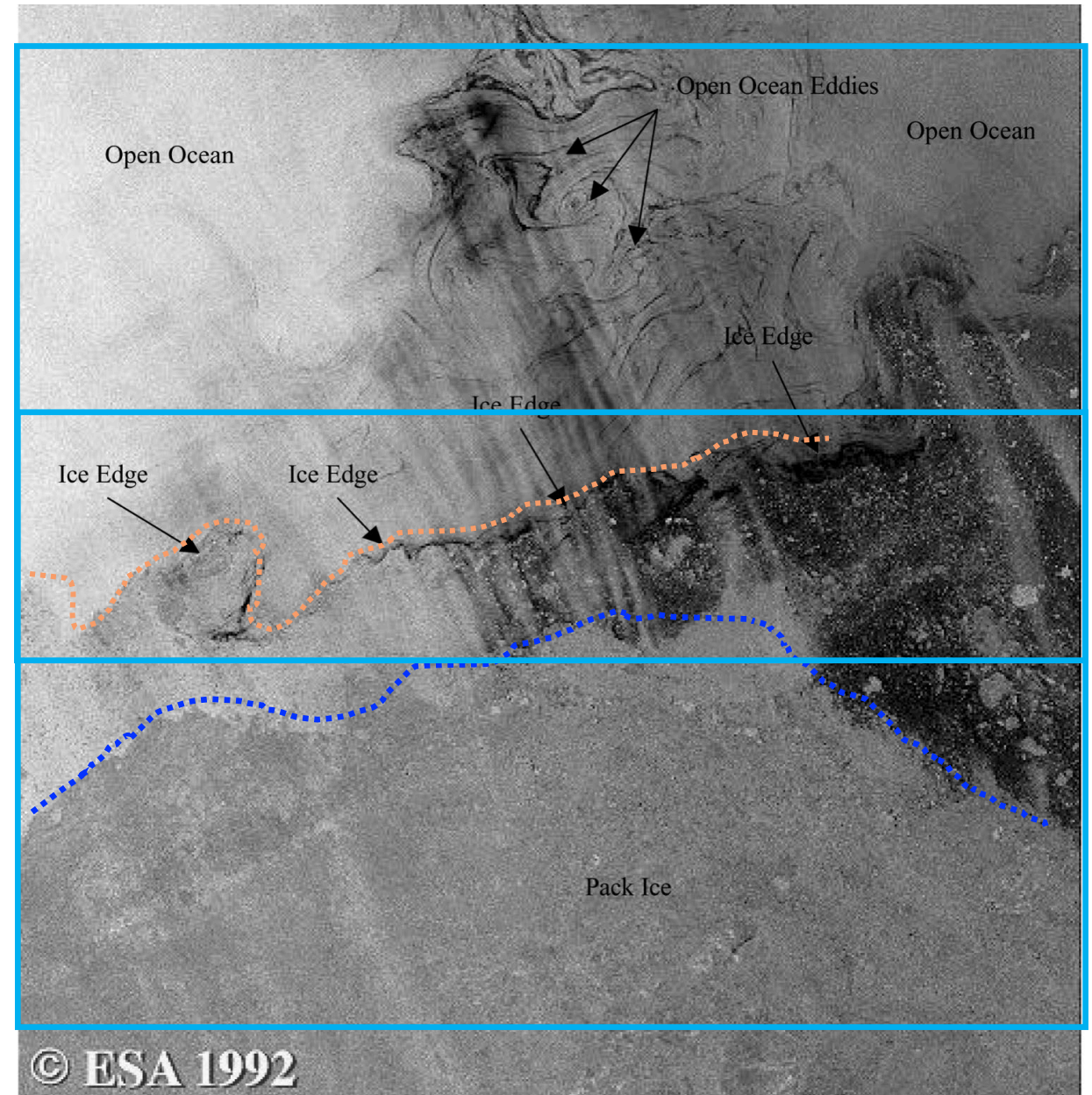


# Observing the MIZ

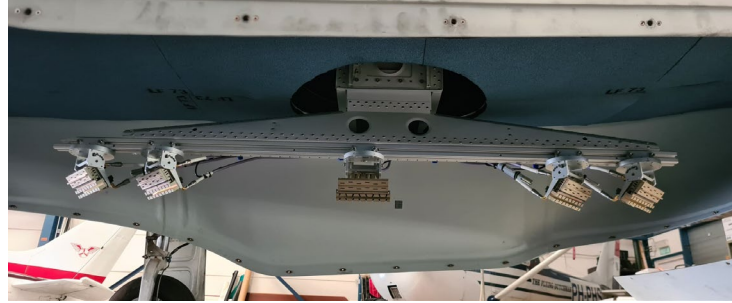
SEASTAR  
150km swath

Where would you position the  
SEASTAR swath?

Shuchman et al., 2004

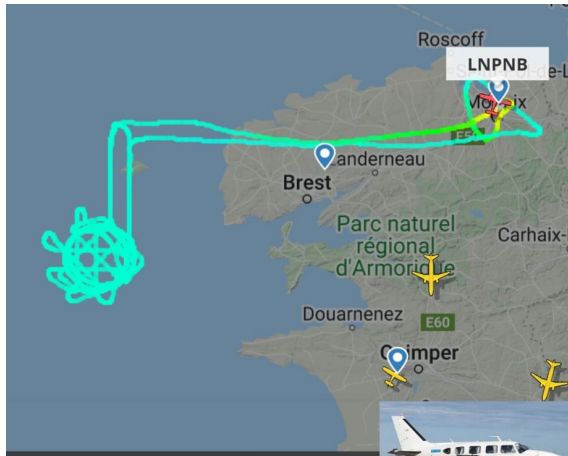


# OSCAR airborne campaigns



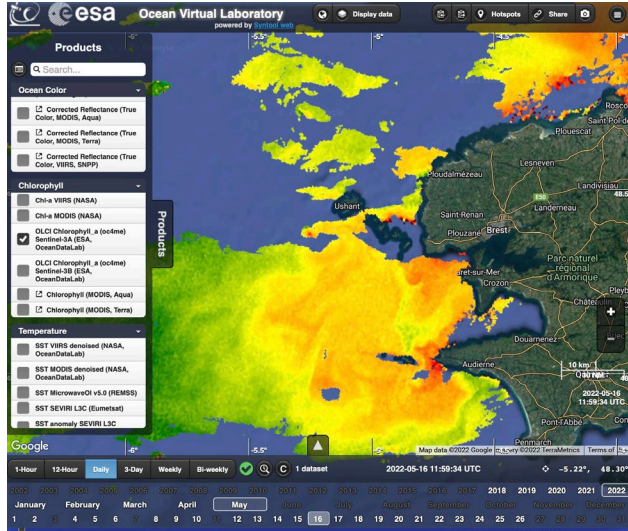
OSCAR  
Airborne campaign  
Iroise Sea  
17+ 22 + 26 May 2022

Thank  
You Team!

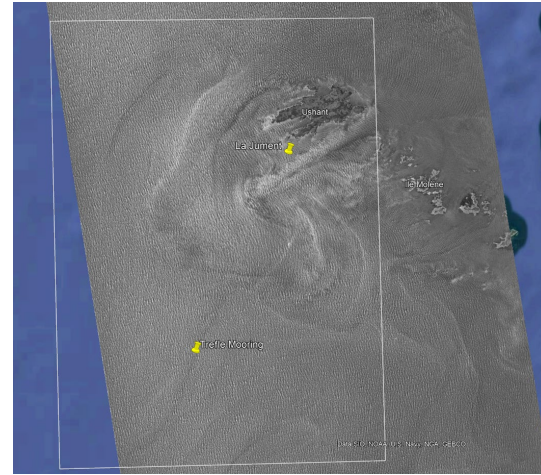


Where next?

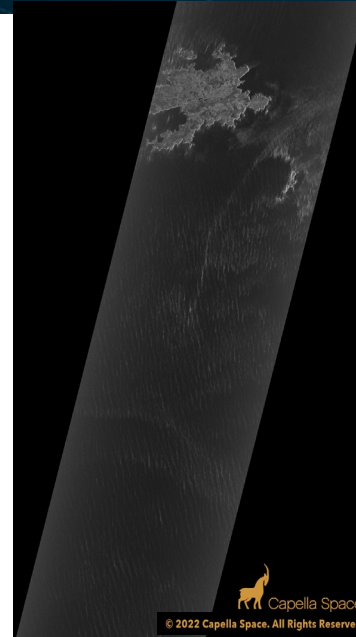
# Synergetic studies of small scale processes



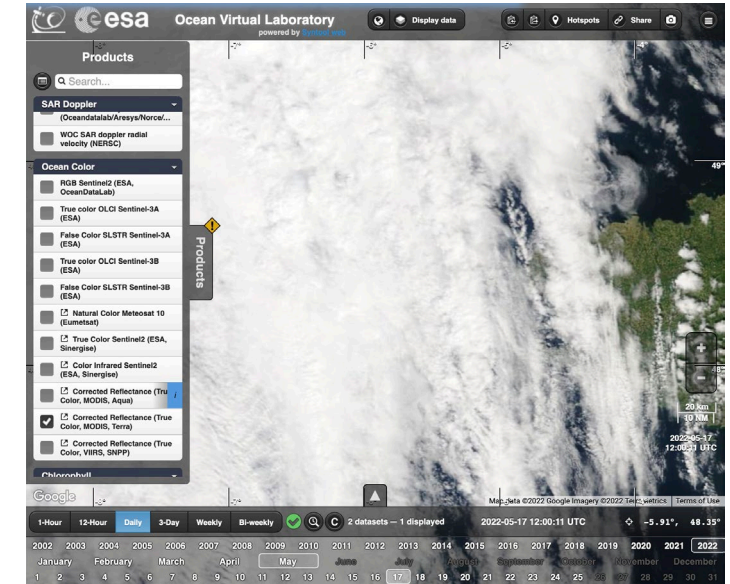
S3A-OLCI 2022-05-16



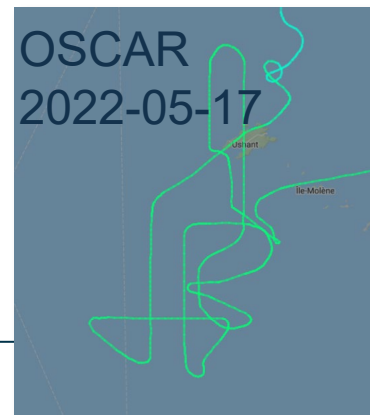
NovaSAR S-band  
2022-05-17



Capella X-band  
2022-05-17



MODIS Terra  
2022-05-17



OSCAR  
2022-05-17

# Summary & Take-home message

Science requirements for the SEASTAR are currently being consolidated to provide input to industry system studies

We may need to make trade-offs in future to ensure SEASTAR satisfies EE11 constraints

Now is the time to compile a wish list to make sure we maximise scientific return and community engagement.

A number of points are currently under discussion

We welcome feedback/comments in person or by email to [cg1@noc.ac.uk](mailto:cg1@noc.ac.uk) and/or Adrien [adm@noc.ac.uk](mailto:adm@noc.ac.uk) or through any of the MAG members

<https://projects.noc.ac.uk/seastar/>

Two hurdles (Autumn 2023, July 2025) before launch in 2031/32 but ...

There are plenty of opportunities to make progress on small scale ocean dynamics

e.g. airborne campaigns, ocean campaigns, modelling