ARCACHON - FRANCE

Palais des Congrès

2nd European Seagrass Restoration Workshop

8th-10th April 2025

A NEW EUROPEAN MAP FOR INTERTIDAL SEAGRASS USING DRONE & SATELLITE REMOTE SENSING

Nantes Université

Pierre GERNEZ & Laurent BARILLE

Arcachon, 9 April 2025

Introduction

Drones and satellites are increasingly used for seagrass mapping but paradoxically, seagrass distribution in Europe is not clearly established

Drones: now affordable tools
Free Satellite data: Sentinel 2 accessible worldwide

Machine learning approaches have improved classification accuracies

However: crucial to characterize optical fingerprint of seagrass and select the appropriate sensor

Remote sensing and seagrass restoration

Satellites: baseline information for future monitoring and looking back at seagrass trends through time

Build up solid scientific knowledge to determine the restoration needs

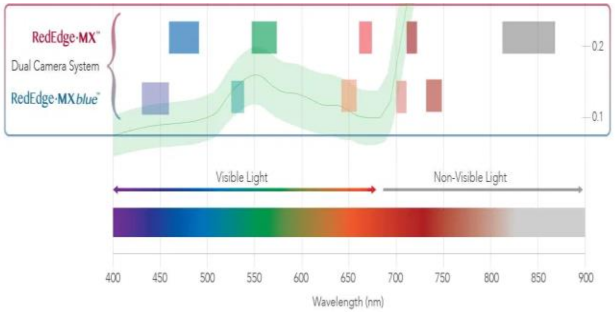
Drones: complementary very high-resolution data for real-time monitoring of restoration

Comparable sensors can be used on drones and satellites using similar algorithms and processing work-flow

Spectral reflectance up-scaling

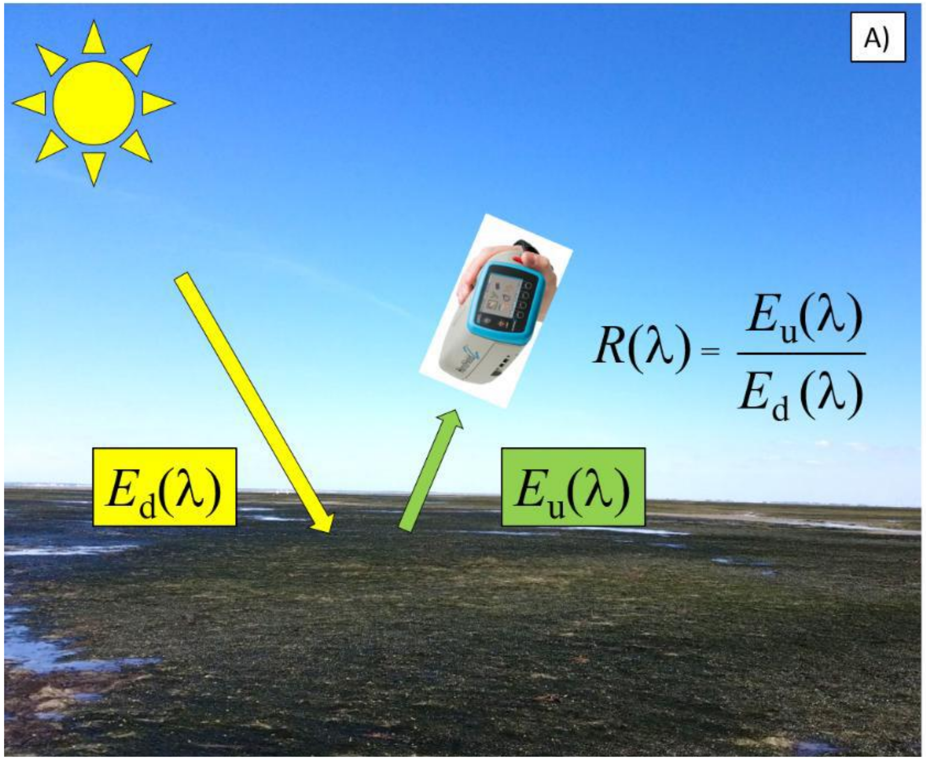
Field spectroradiometry

Drone with multispectral sensor

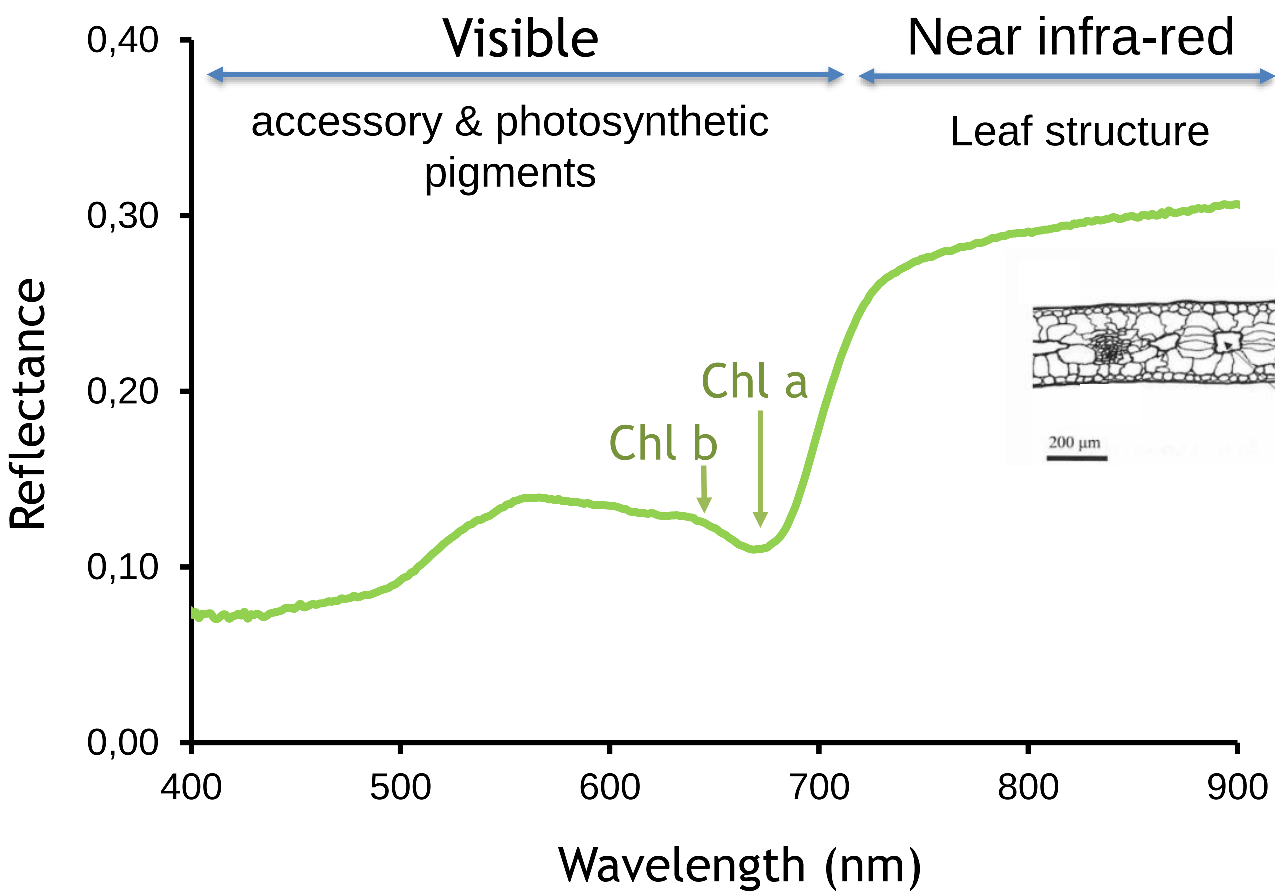


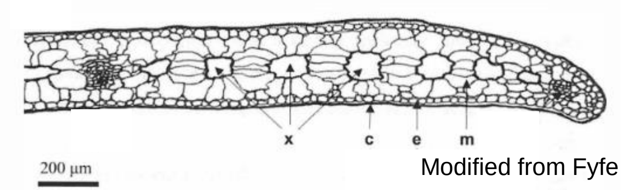
Sentinel 2 Satellite MSI multispectral sensor

Spectral reflectance $R(\lambda)$



Spectral reflectance (*Zostera noltei*)





Modified from Fyfe (2011)

Spectral library

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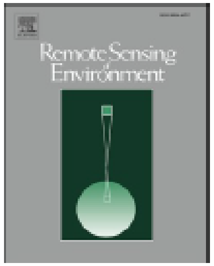
journal homepage: www.elsevier.com/locate/rse



Check for updates

Multi- and hyperspectral classification of soft-bottom intertidal vegetation using a spectral library for coastal biodiversity remote sensing

Bede Ffinian Rowe Davies [a,*], Pierre Gernez [a], Andréa Geraud [a], Simon Oiry [a], Philippe Rosa [a], Maria Laura Zoffoli [b], Laurent Barillé [a]

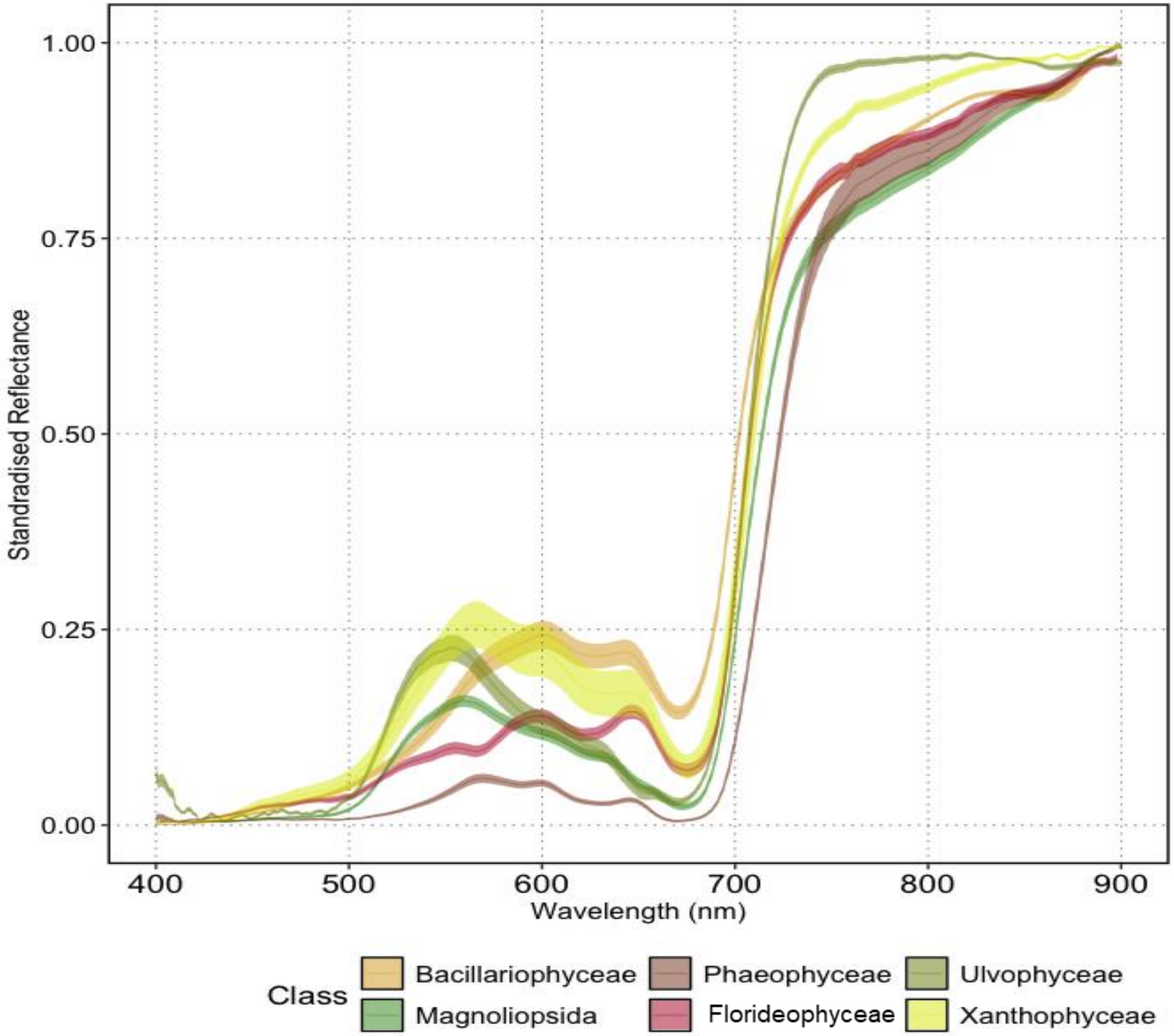
Spectral resolution

Multispectral sensors have a low number of large spectral bands

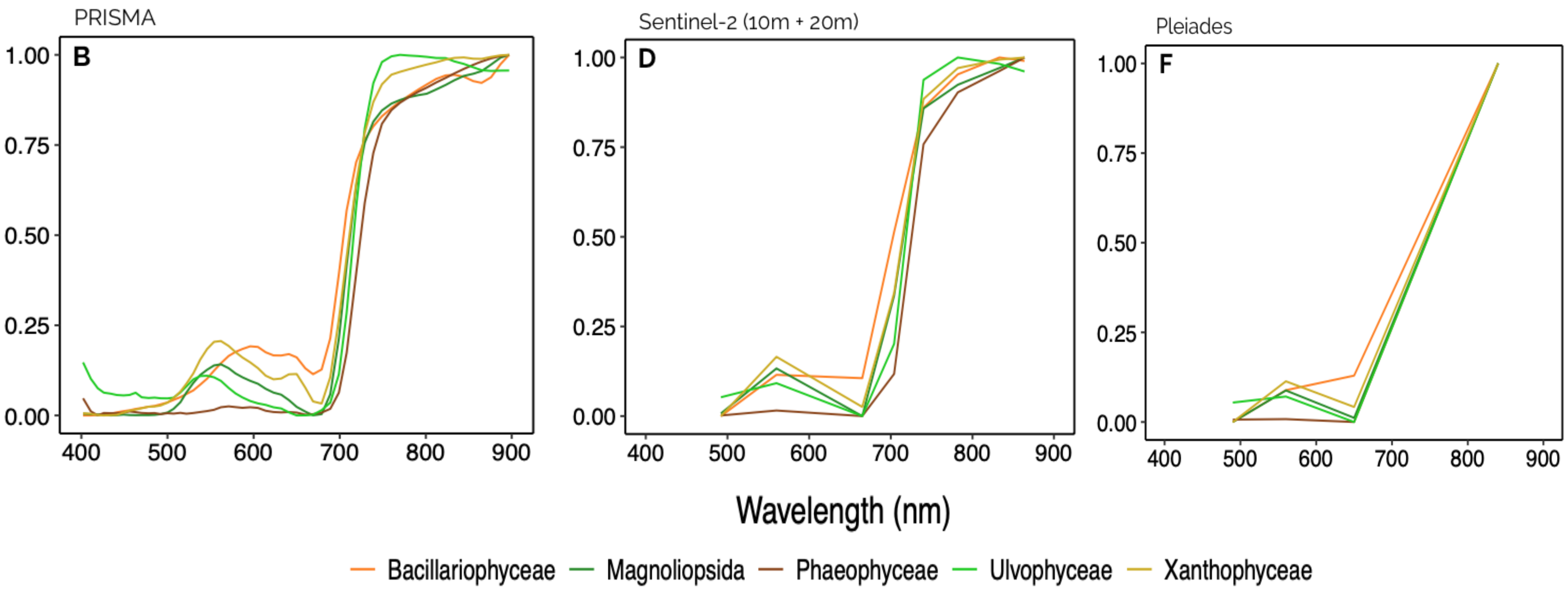
Hyperspectral sensors have a high number of narrow spectral bands

Satellite	Sensor	Number of bands	Spatial resolution
Pleïades	Multispectral	4	2 m
Sentinel-2	Multispectral	12	10 m (resampled)
PRISMA	Hyperspectral	66	30 m

Spectral biodiversity

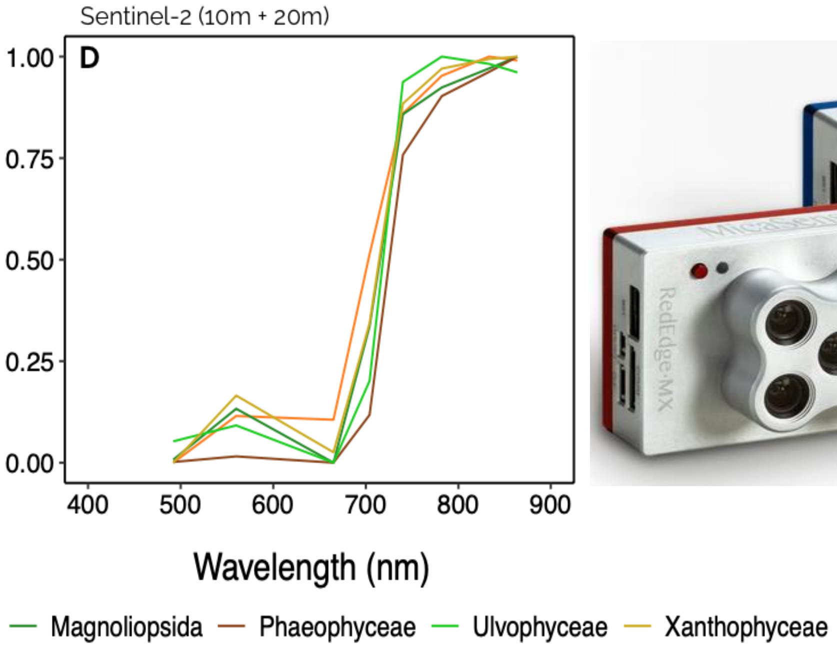


Spectral resolution



Multispectral resolution @ 10 bands

Matrix 300 DJI



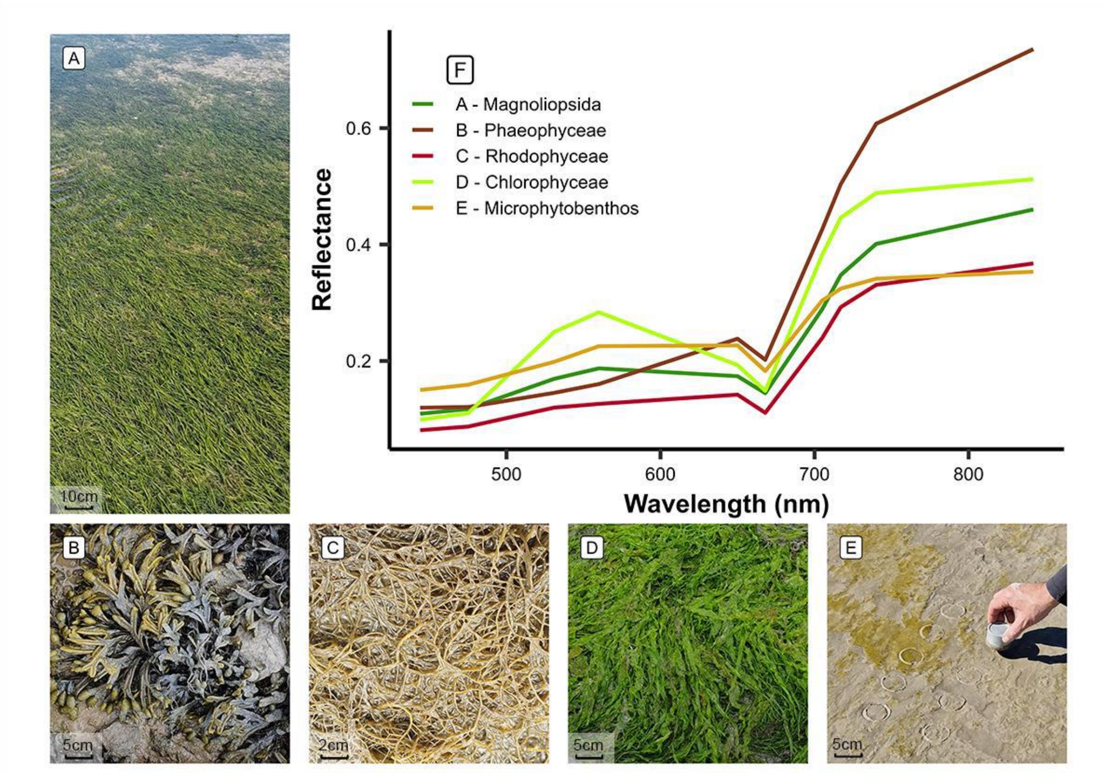
MicaSense Dual Sensor

remote sensing

Article

Discriminating Seagrasses from Green Macroalgae in European Intertidal Areas Using High-Resolution Multispectral Drone Imagery

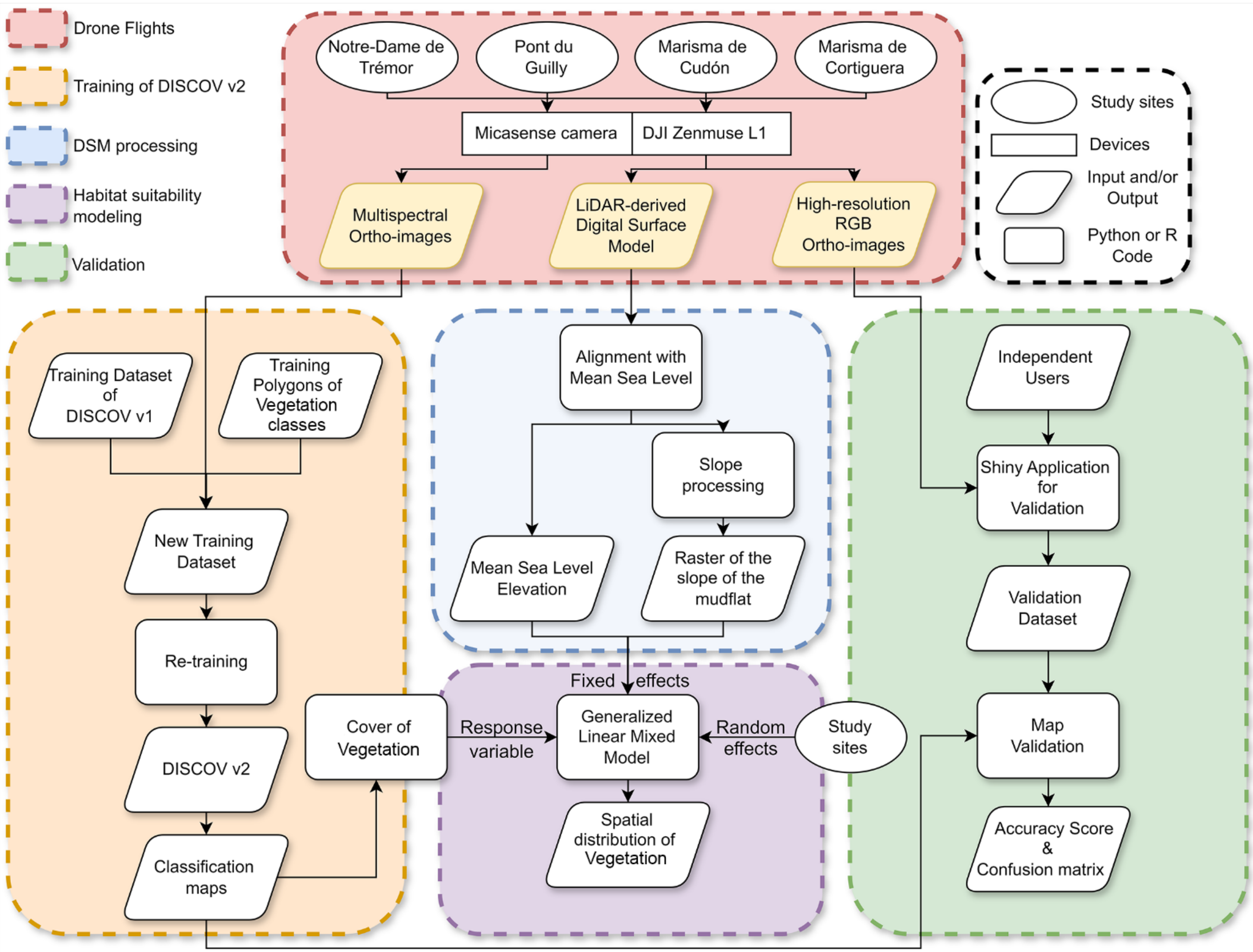
Simon Oiry [1], Bede Ffinian Rowe Davies [1], Ana I. Sousa [2], Philippe Rosa [1], Maria Laura Zoffoli [3], Guillaume Brunier [4], Pierre Gernez [1] and Laurent Barillé [1,*]



Spatial resolution

12 m pixel size 8 mm
120 m pixel size 8 cm

A drone-based Machine Learning algorithm



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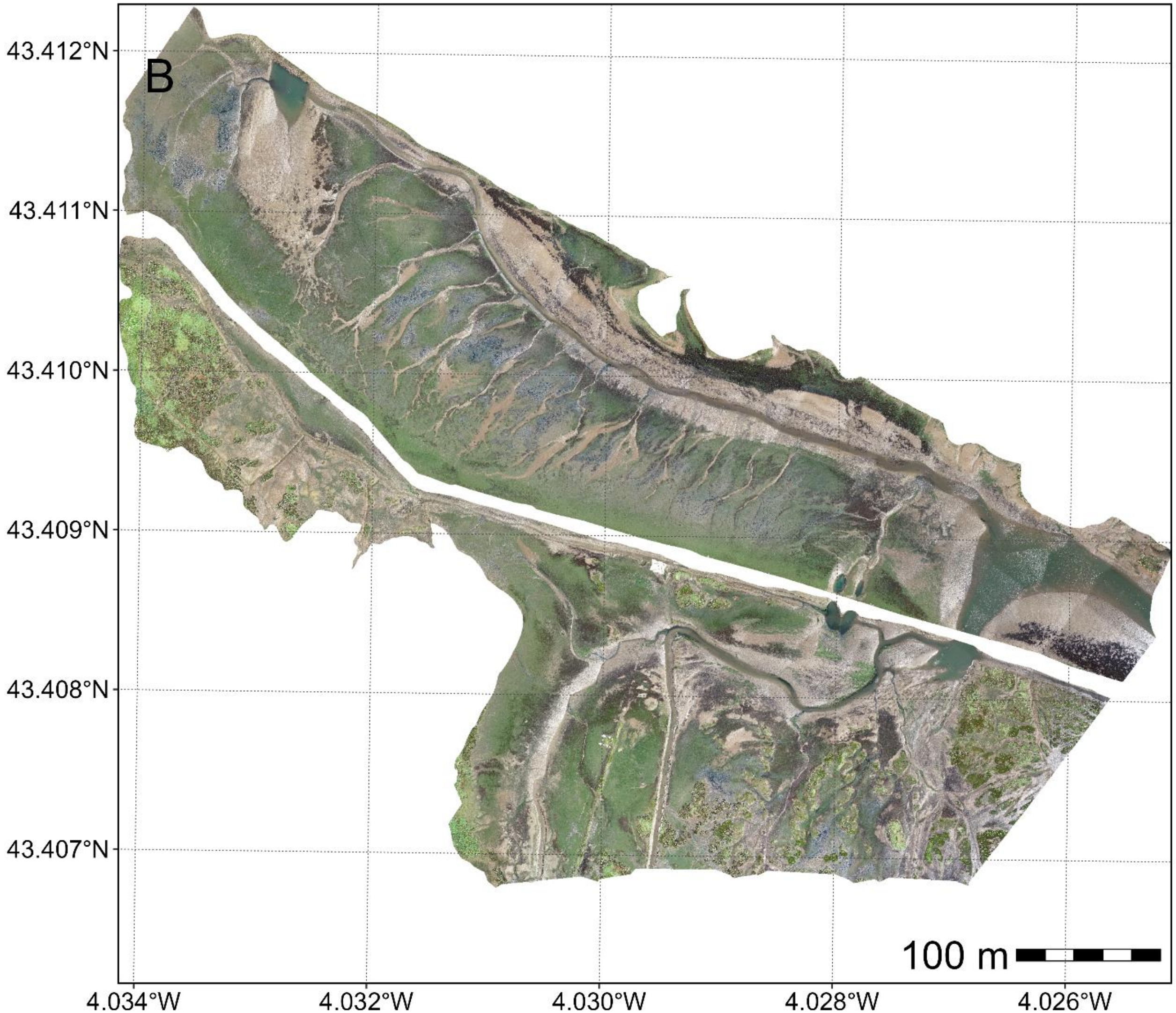
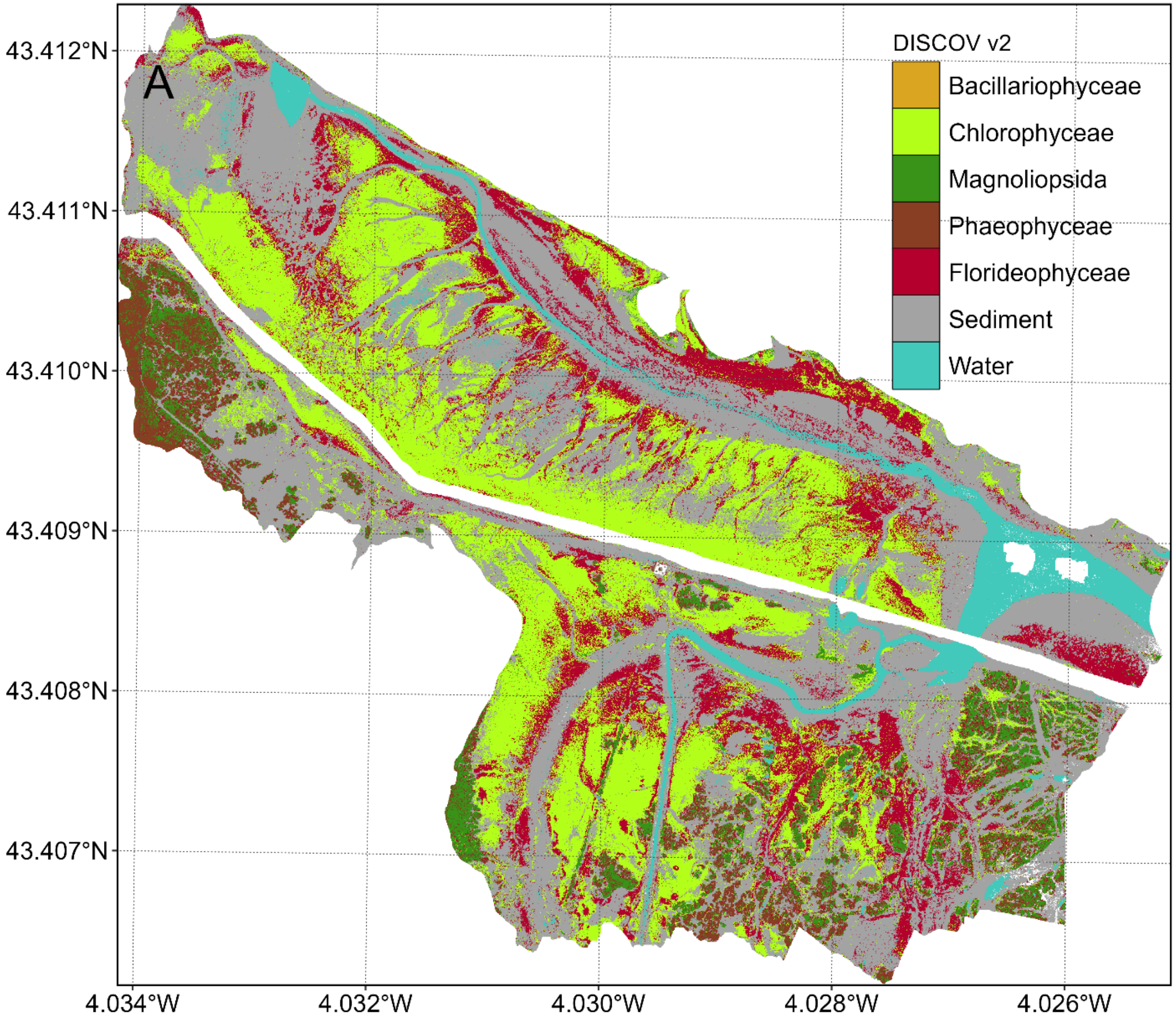
Map of soft-bottom vegetation Saja estuary



RGB image

Map of soft-bottom vegetation Saja estuary

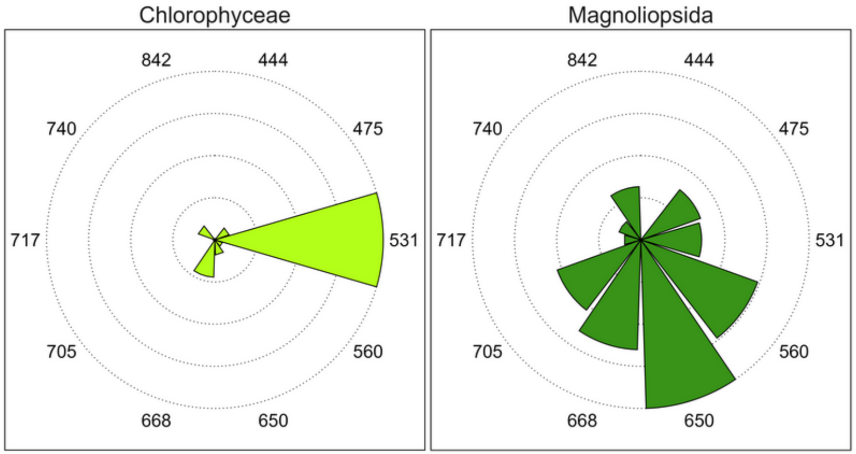


10 bands multispectral

DISCOV algorithm for drone

Drone Intertidal Substrate Classification Of Vegetation
Neural network classifier built on ~10 different sites
Overall accuracy 94%
Ca. 500,000 pixels of validation

Operational tool for high-resolution restoration monitoring



Wavelengths Importance of the Neural Network Classifier *Oiry et al. (2024)*

https://oirysimon.com/discov/

HOME PAPERS DISCOV ABOUT CONTACT

You want to participate to the validation of the Future version of DISCOV ?

Click here

On this page

Input and Output of the model

How to use DISCOV 1.0 on your data ?

DISCOV: The Intertidal Drone Classification Model for Micasense

The Drone Intertidal Substrats Classification Of Vegetation (**DISCOV**) is a Neural Network classification model trained on a **Micasense RedEdge-MX Dual** multispectral drone camera.

From drones to satellites

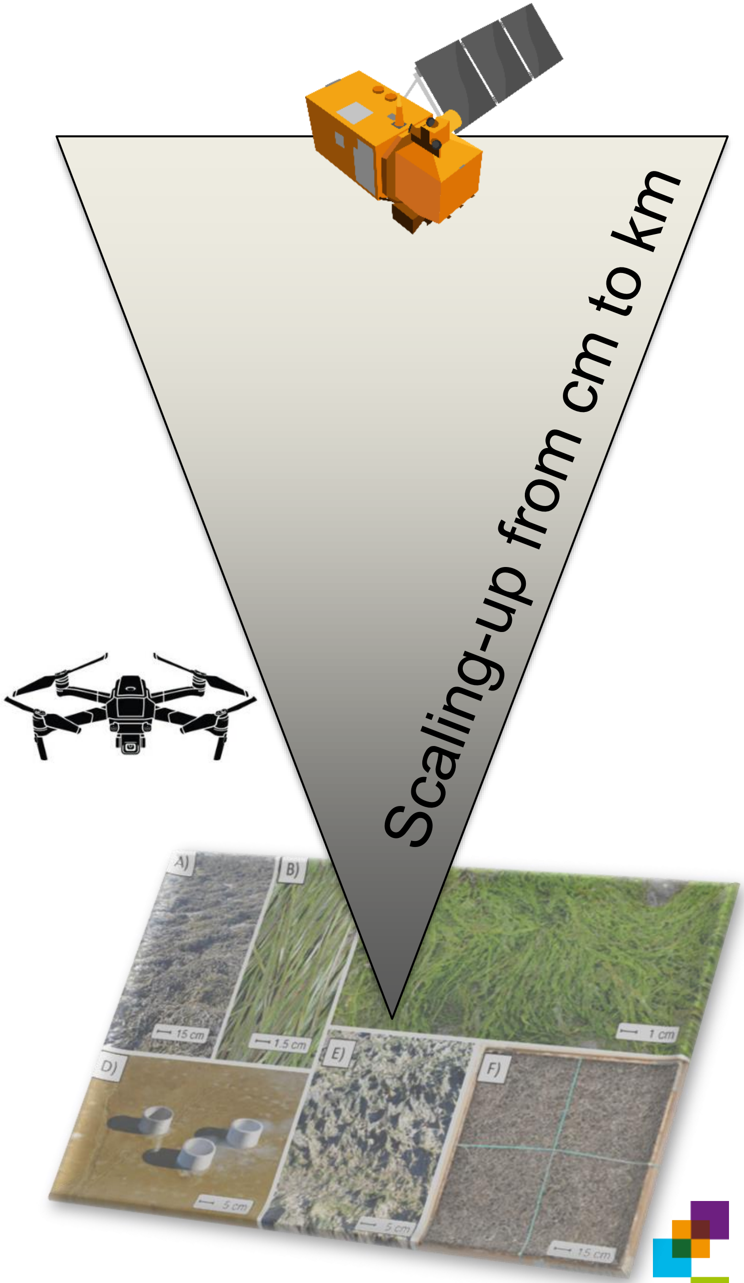
1) Drone: very high spatial resolution (< 1 cm)
→ accurate identification of taxonomic class

2) Resampe drone images at 10 m spatial resolution

3) Train a deep learning, neural network using thousands of labelled satellite pixels

4) Validate satellite-derived seagrass class

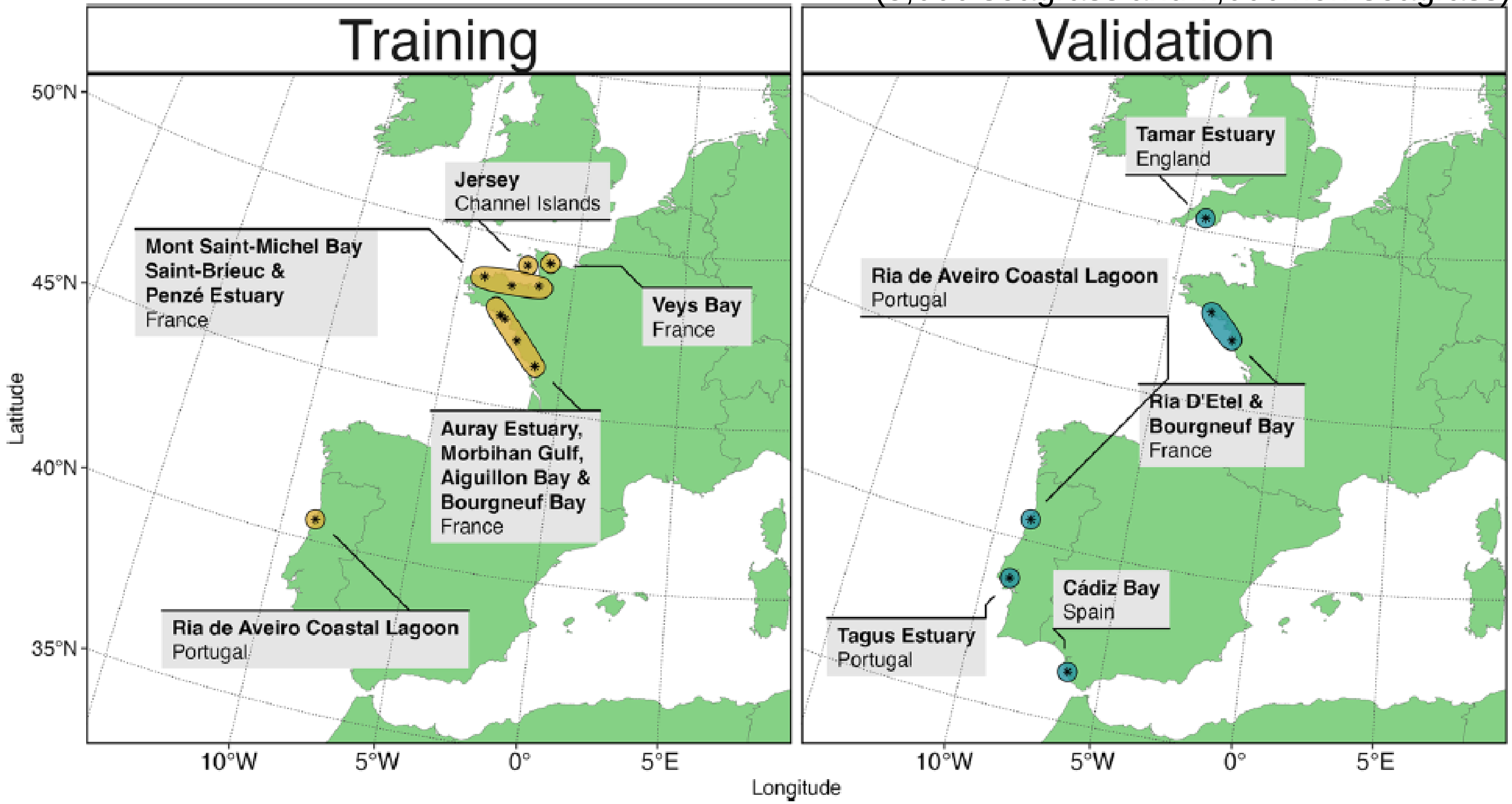
5) Apply model to study seagrass distribution & phenology at regional, national and continental scale



Model training and validation

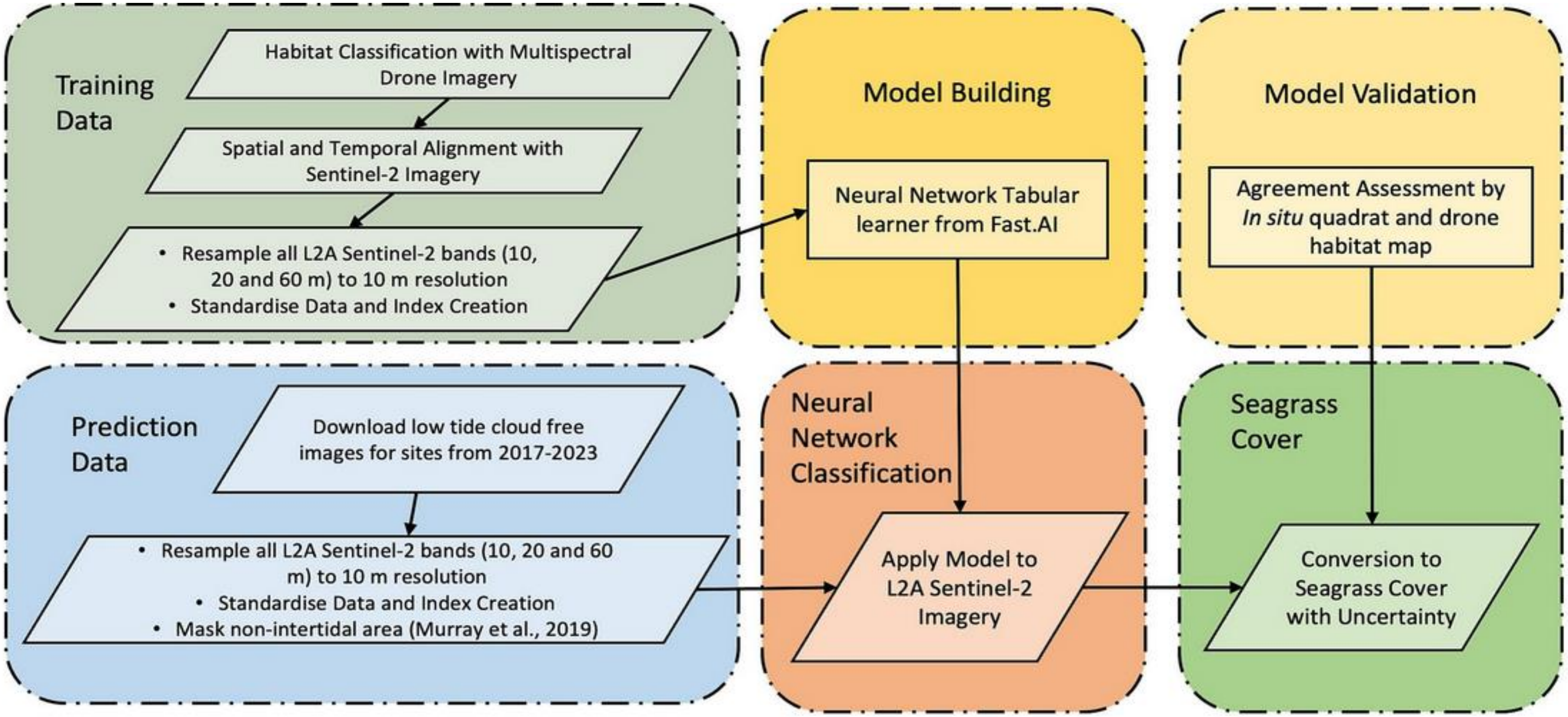
~374,000 labelled pixels

~12,000 pixels
(5,000 seagrass and 7,000 non-seagrass)



Neural network for intertidal seagrass classification with Sentinel-2

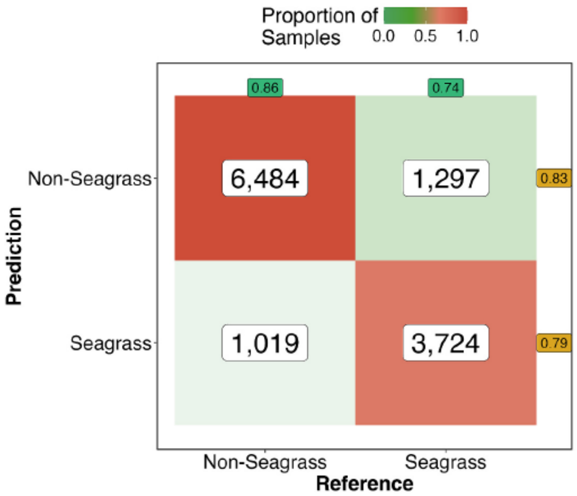
Intertidal **C**lassification of **E**urope:
Categorising **R**eflectance of **E**merged **A**reas of **M**arine vegetation with **S**entinel-2



ICE CREAMS model

Intertidal **C**lassification of **E**urope:
Categorising **R**eflectance of **E**merged **A**reas of **M**arine vegetation with **S**entinel-2

Davies et al. (2024a,b)

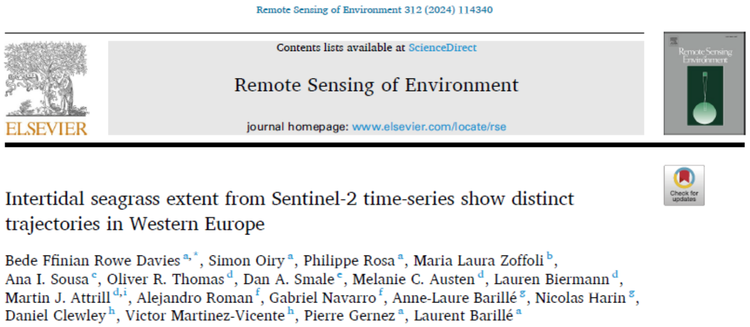


communications earth & environment
Article
https://doi.org/10.1038/s43247-024-01543-z

A sentinel watching over inter-tidal seagrass phenology across Western Europe and North Africa

Check for updates

Bede Ffinian Rowe Davies[1], Simon Oiry[1], Philippe Rosa[1], Maria Laura Zoffoli[2], Ana I. Sousa[3], Oliver R. Thomas[4], Dan A. Smale[5], Melanie C. Austen[4], Lauren Biermann[4], Martin J. Attrill[4,6], Alejandro Roman[7], Gabriel Navarro[7], Anne-Laure Barillé[8], Nicolas Harin[8], Daniel Clewley[9], Victor Martinez-Vicente[9], Pierre Gernez[1] & Laurent Barillé[1]



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Intertidal seagrass extent from Sentinel-2 time-series show distinct trajectories in Western Europe

Bede Ffinian Rowe Davies[a,*], Simon Oiry[a], Philippe Rosa[a], Maria Laura Zoffoli[b], Ana I. Sousa[c], Oliver R. Thomas[d], Dan A. Smale[e], Melanie C. Austen[d], Lauren Biermann[d], Martin J. Attrill[d,i], Alejandro Roman[f], Gabriel Navarro[f], Anne-Laure Barillé[g], Nicolas Harin[g], Daniel Clewley[h], Victor Martinez-Vicente[h], Pierre Gernez[a], Laurent Barillé[a]

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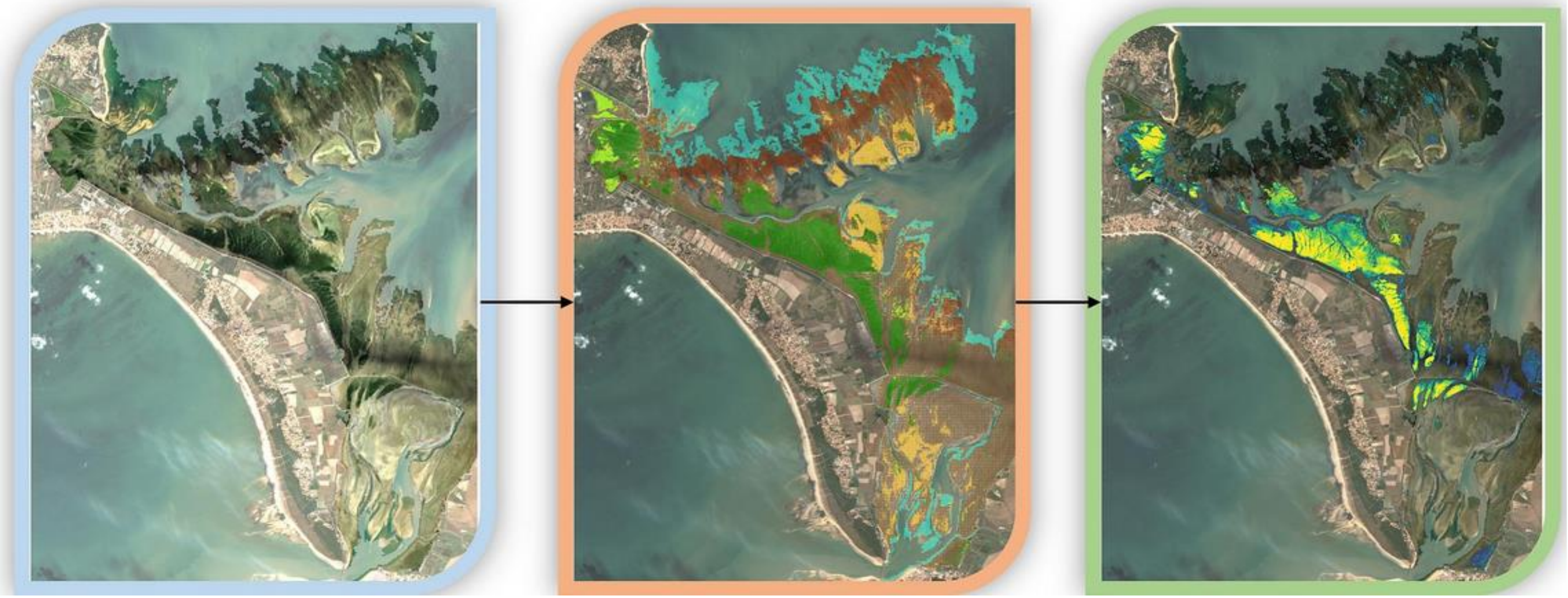
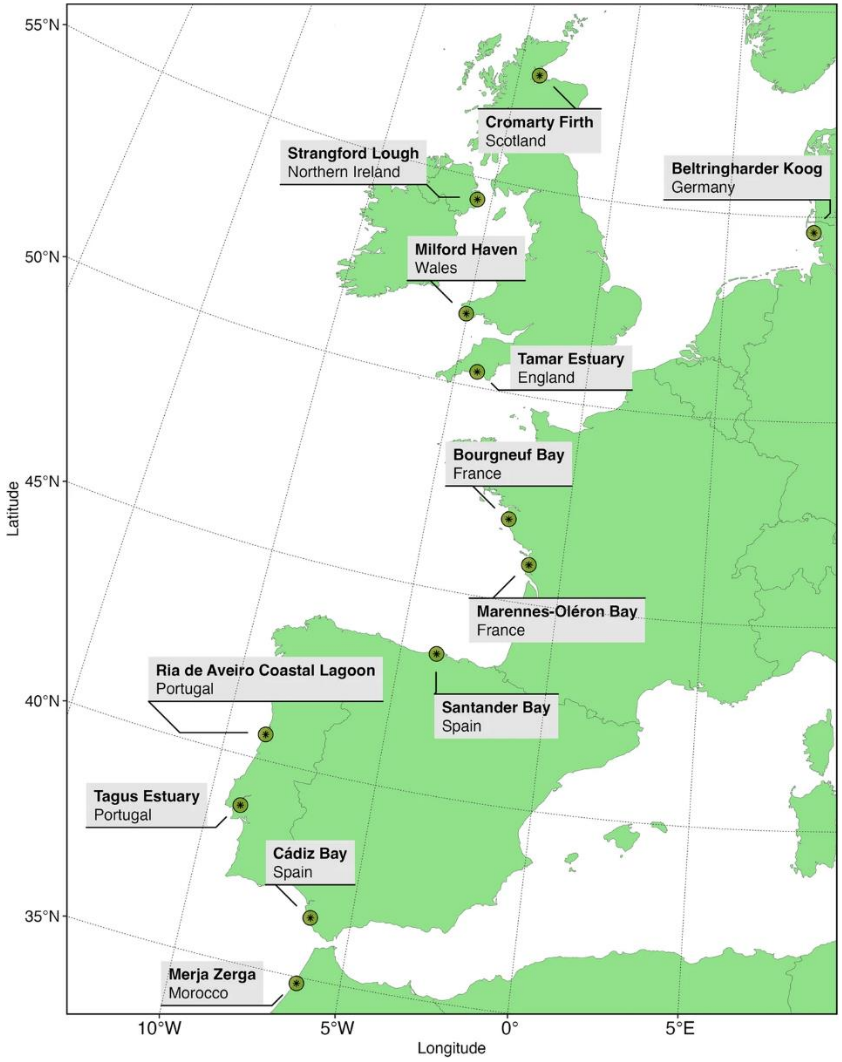
Performance metrics

Seagrass classification
82% accuracy

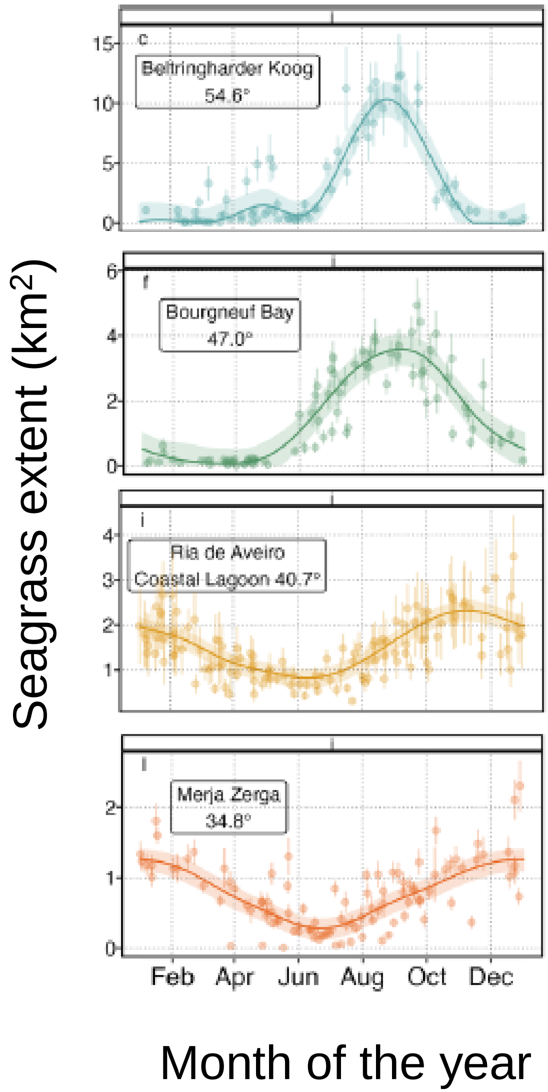


Seagrass cover estimation
19% RMSD

Intertidal seagrass phenology observed by Sentinel-2

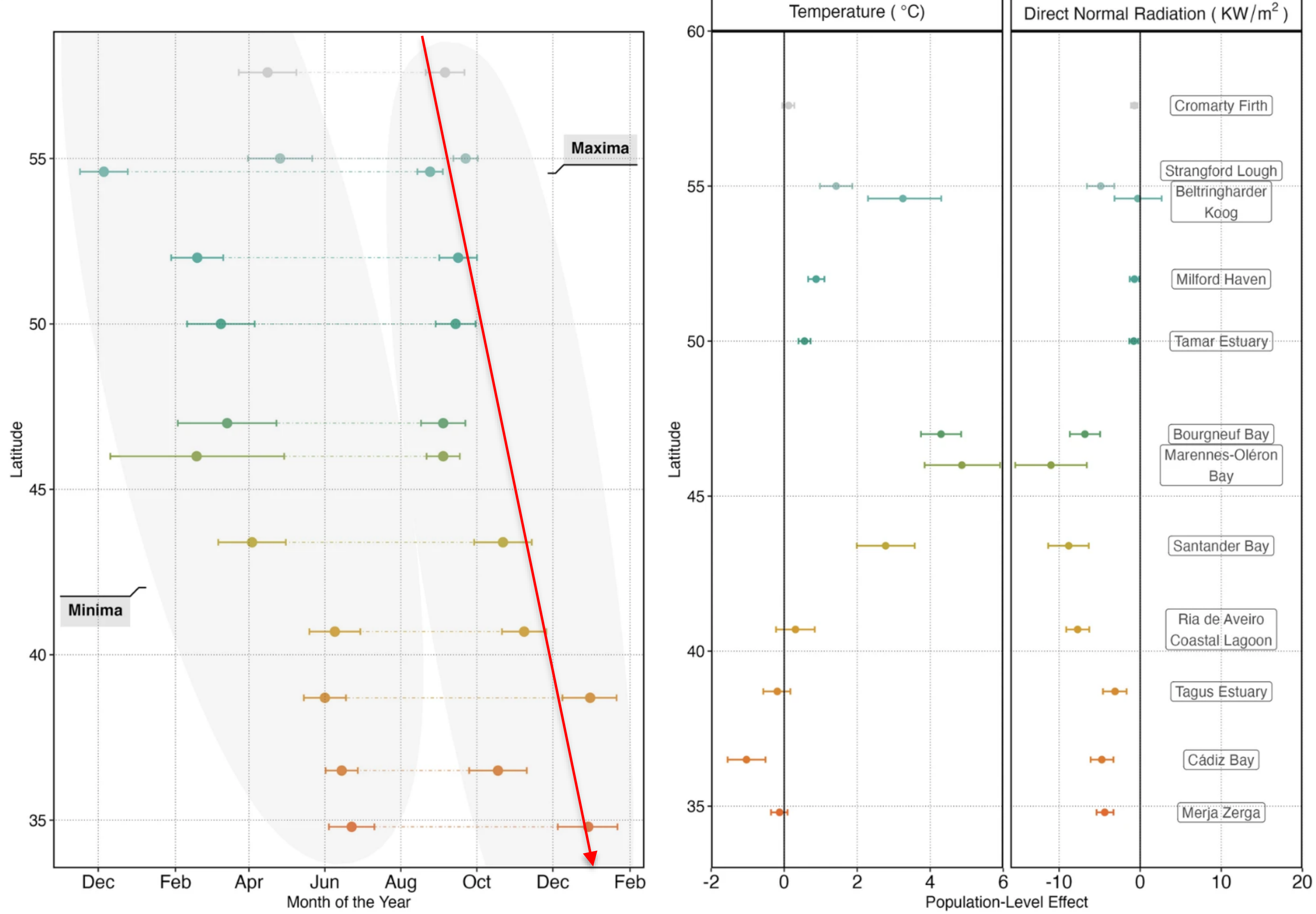


Composite year (2017-2023)



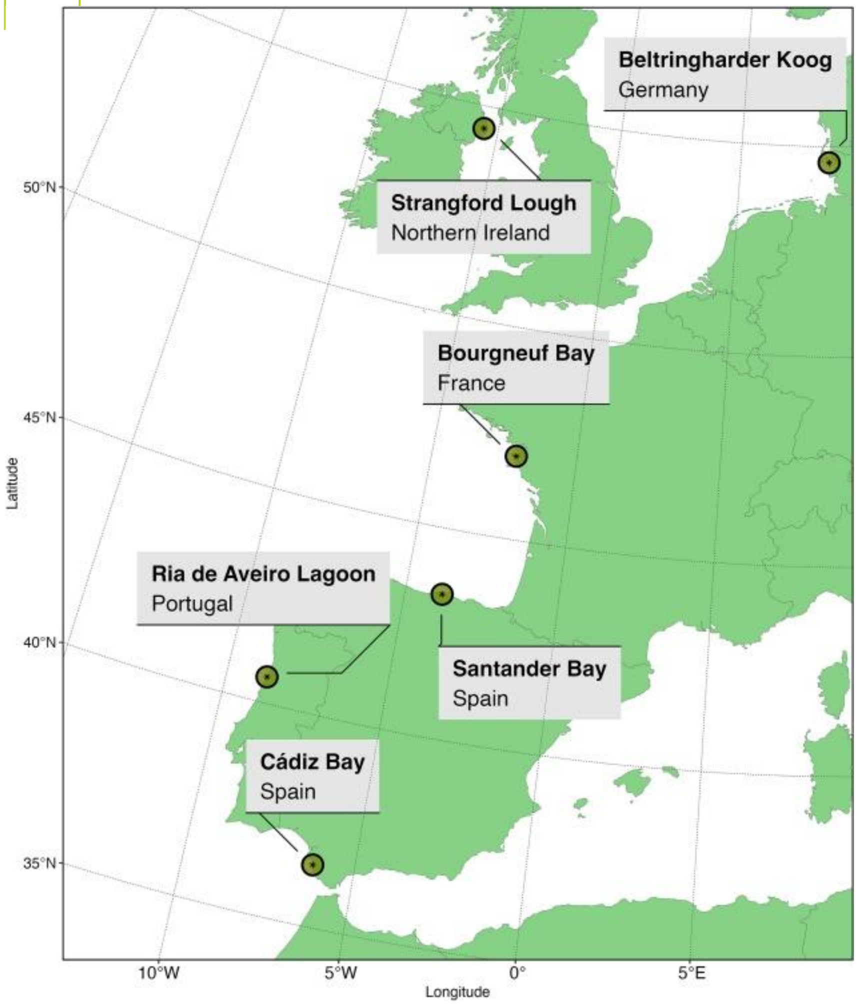
Latitudinal shift in month of maximal extent

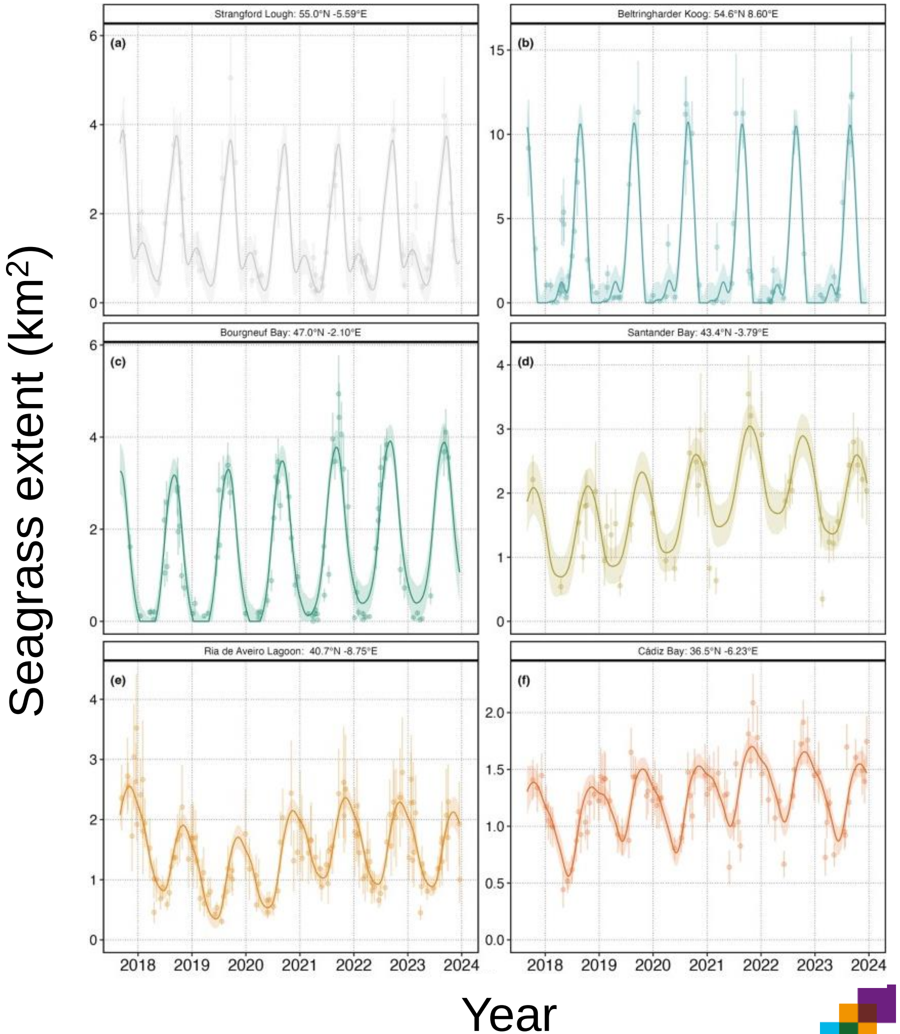
From late summer at 57°N…



… to mid winter at 35°N

Intertidal seagrass trajectory from 2018 – 2024





Site-specific, but overal stable or with increasing trend (good news)

Preliminary conclusions

- ✓ Intertidal seagrass can accurately be classified by Sentinel-2 satellite using ICE CREAMS model
- ✓ Methods provide an up-to-date intertidal seagrass assessment tool
- ✓ Latitudinal shift in phenology from Northern to Southern Europe (Atlantic)
- ✓ Intertidal seagrass meadow inter-annual variation is site specific

Preliminary conclusions

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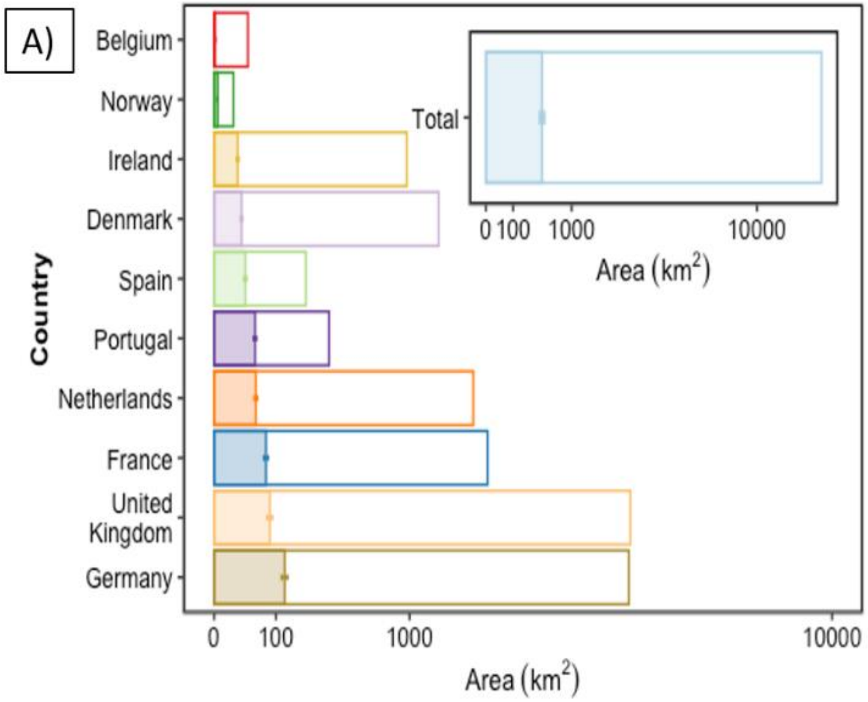
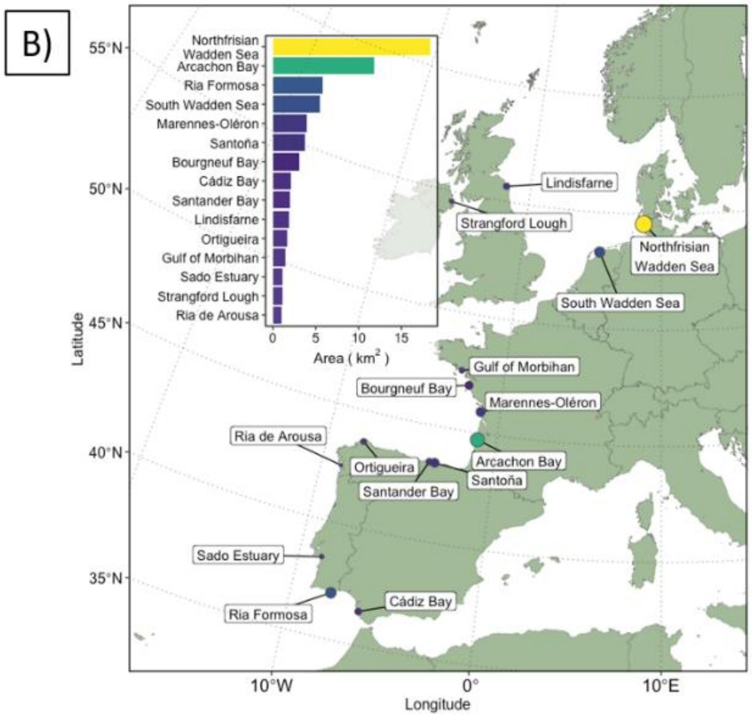
- ✓ Methods provide an up-to-date intertidal seagrass assessment tool
- ✓ Latitudinal shift in phenology from Northern to Southern Europe (Atlantic)
- ✓ Intertidal seagrass meadow inter-annual variation is site specific
- x Applied “only” to 12 intertidal meadows
- → Next step: continental scale intertidal seagrass mapping (RS workshop!)

First Map of European Intertidal Seagrass

Seagrass extent relative to whole intertidal zone

The top 15 intertidal seagrass sites



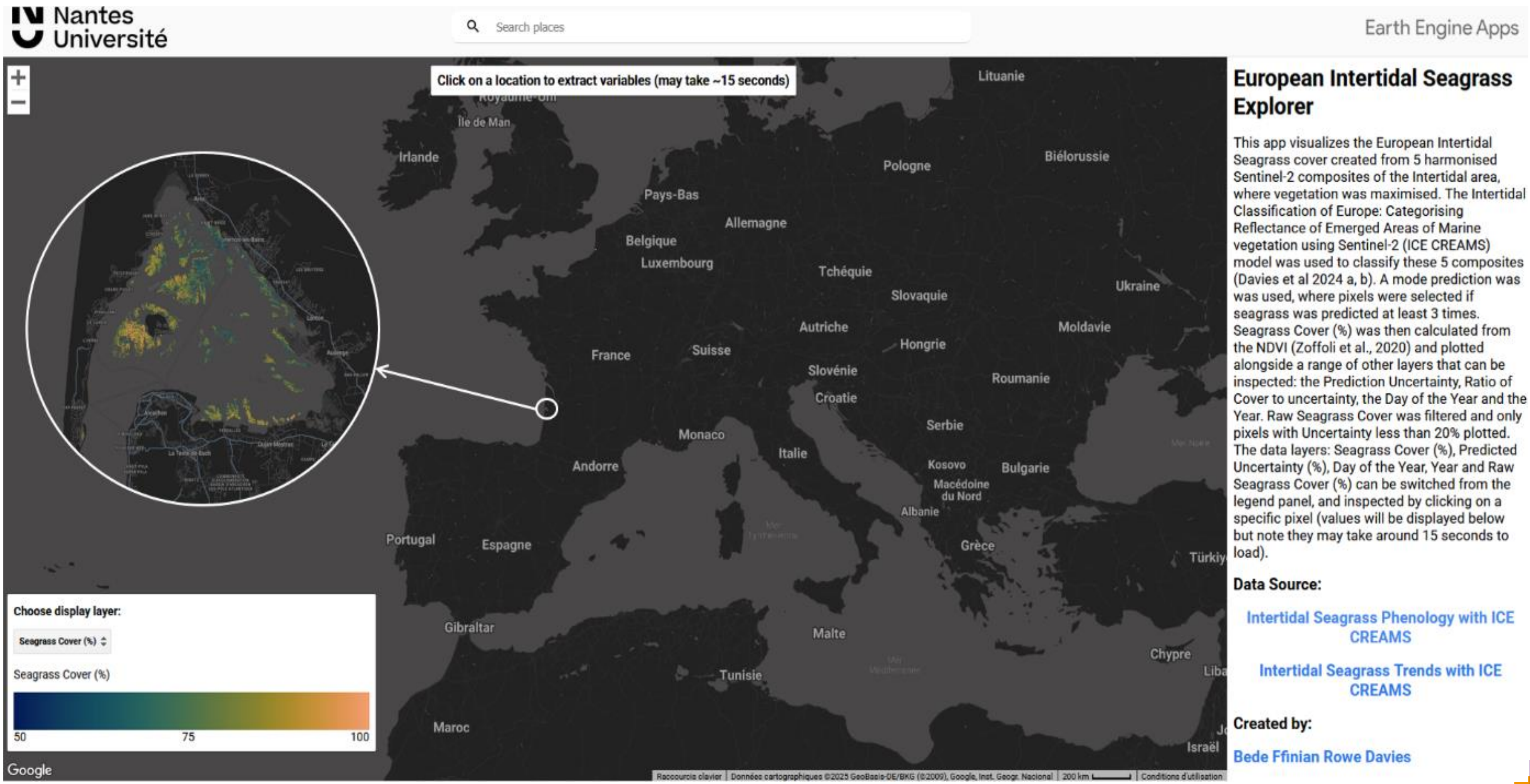


Intertidal seagrass meadow: only 3% of intertidal zone in Europe…

THERE IS ROOM FOR RESTORATION !!

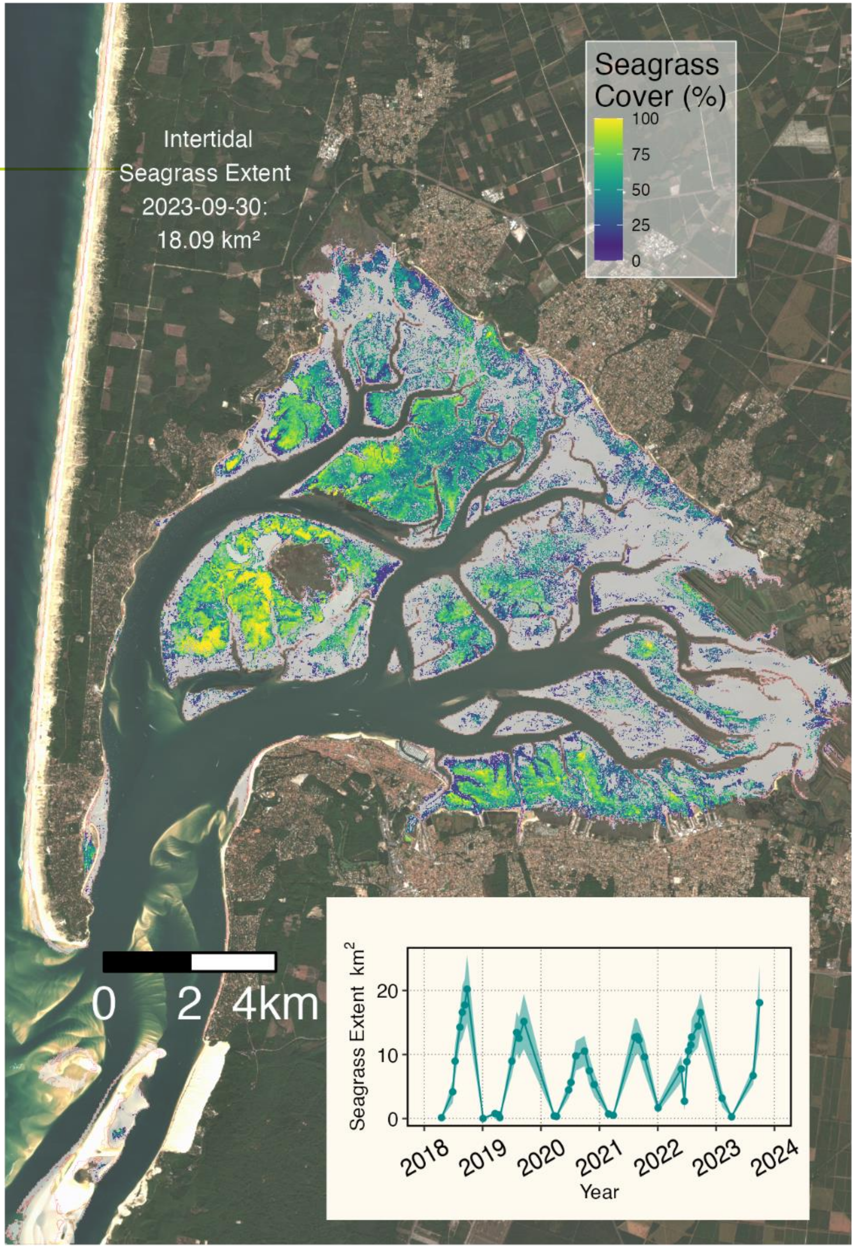
Open access interactive map

Work in progress…coming soon… stay tuned



and in Arcachon?

Preliminary results were obtained just in time for the:



Thank you!

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