COASTAL EROSION webinar

Coastal Change Consortium

22 January 2021

THE PROBLEM

- Increasing storms
- More investment in coastal margins as populations grow and urbanization increases.

THE TEAM

ARCTUS UQAR

British Geological Survey

Geological Survey
Suirbhéireacht Gheolaíochta
Ireland | Éireann

IH cantabria
INSTITUTO DE HIDRÁULICA AMBIENTAL
UNIVERSIDAD DE CANTABRIA

GOBIERNO DE ESPAÑA
VICEPRESIDENCIA CUARTA DEL GOBIERNO
MINISTERIO PARA LA TRANSICIÓN ECOLÓGICA Y EL RETO DEMOGRÁFICO

isardSAT

ARGANS

adwäisEO

DEFINITION

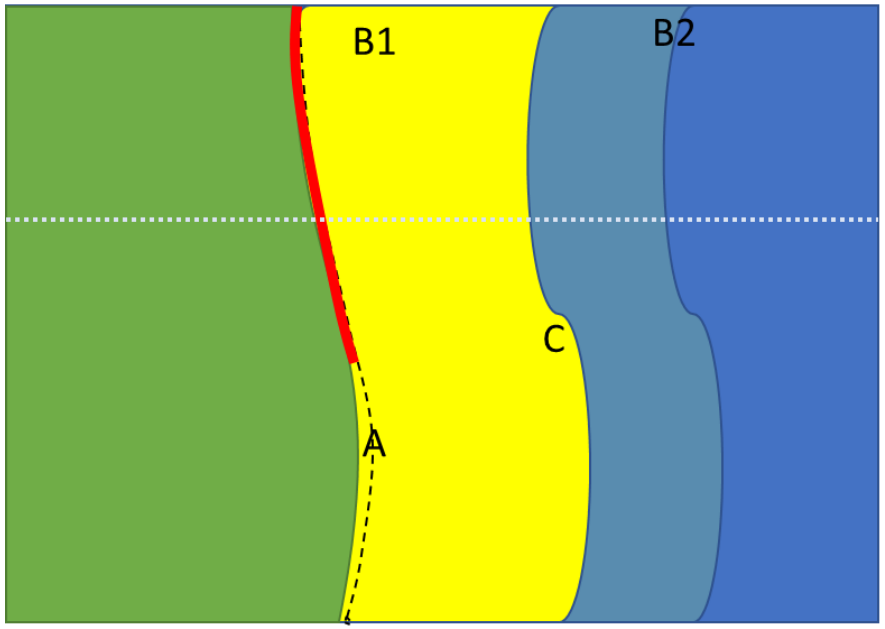
Waterline *– the edge of the sea at a snapshot in time*

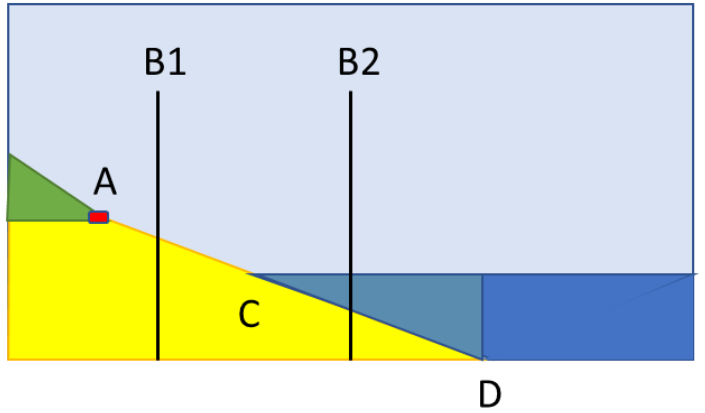
Shoreline *– the prediction of where the tidal waterline would be at a determined time*

Littoral Line *– a highwater line depicting a hard boundary where a fixed object*

Time Series *– a derived product based on a series of different shorelines or waterlines.*

Depth of Closure *– the depth beneath which erosion is not significant*





Vegetation
Beach
Nearshore
Offshore
Seawall
Littoral Line
A Shoreline
C Waterline
B1. MHWS
B2. MLWS
D Depth of Closure

HEADLINES

This chapter is part of

Eighth International Symposium "Monitoring of Mediterranean Coastal Areas. Problems and Measurement Techniques"

Edited by: Bonora, L.; Carboni, D.; De Vincenzi, M.

esa ARGANS Geological Survey Suirbhéireacht Gheolaíochta Ireland | Éireann 175 years | bliain 1845-2020

Please come and join the MONITORING COASTAL EROSION FROM SPACE Workshop
10 Dec 2020 | 9:45 – 13:00 GMT

EO from space is mature enough to provide valuable information over the coastal region to support the community whose mission is to manage the risk and effects of coastal erosion.

The European Space Agency (ESA) funded "Coastal Erosion from Space" project has developed new innovative methods to produce highly spatially accurate products going back 25 years.

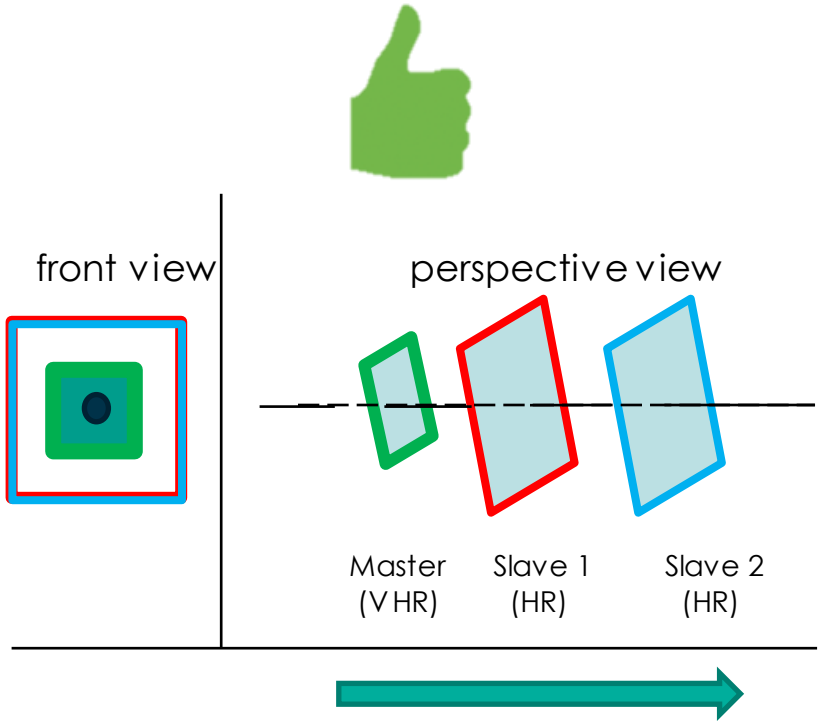
AGENDA

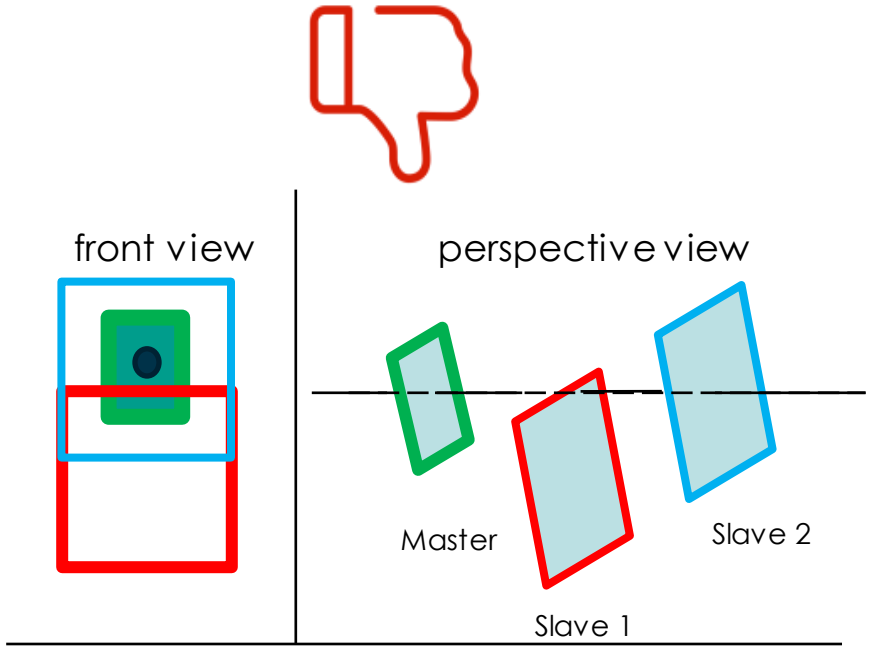
1	What is feasible to observe from space with existing EO civil technology? (ARGANS Ltd and isardSAT)
2	How confident are we on the coastal changes detected from space? (Geological Survey Ireland)
3	A Panel discussion on whether this information may be useful to build more resilient coastal management in Ireland?

The Eventbrite registration is here

Our Processors and Products

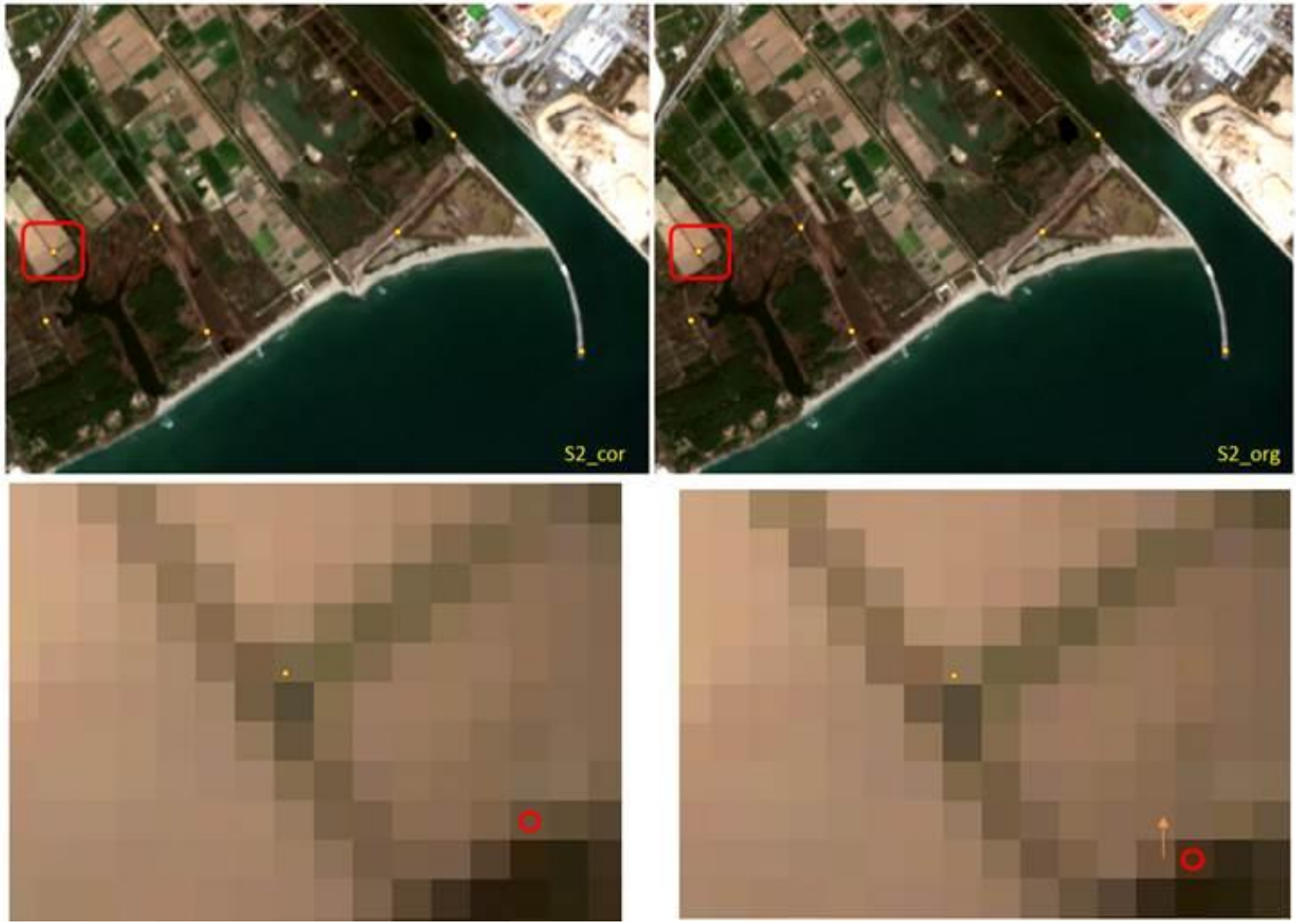
Geolocation



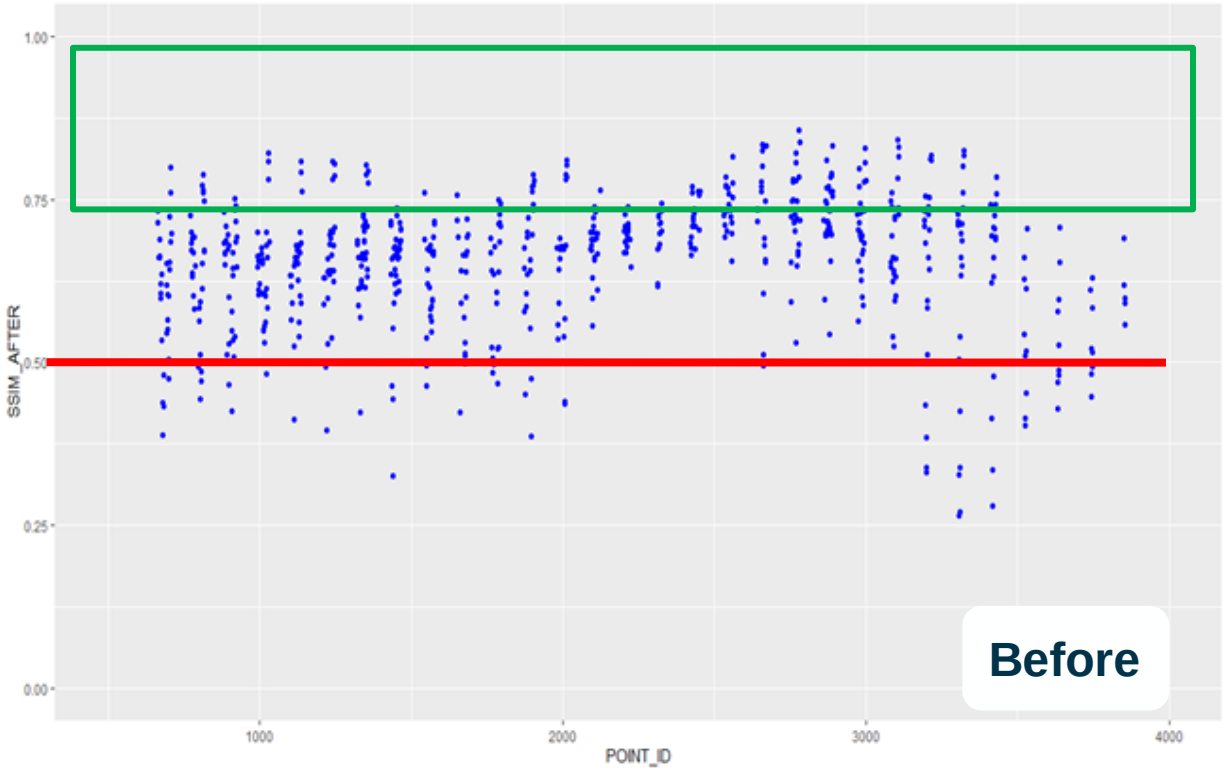


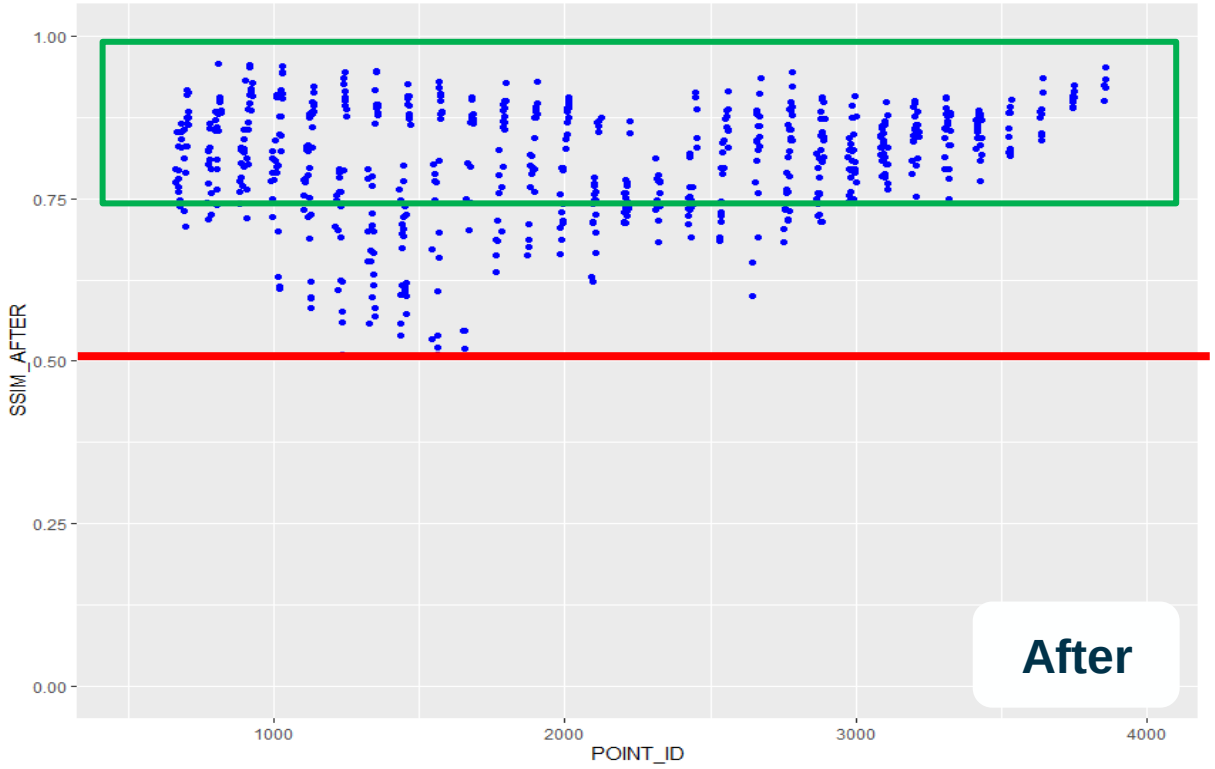
real case (different sensor)

Geolocation



Geolocation

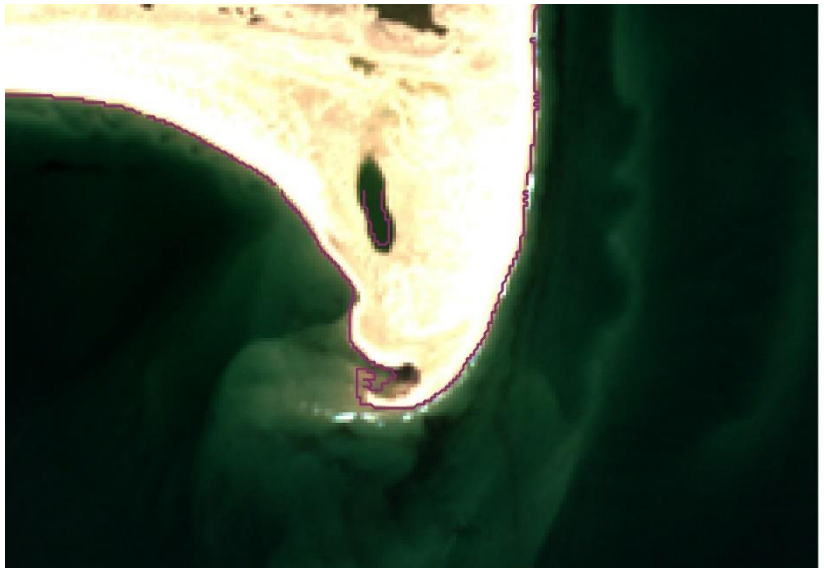




Optical Waterlines

Optical Waterlines

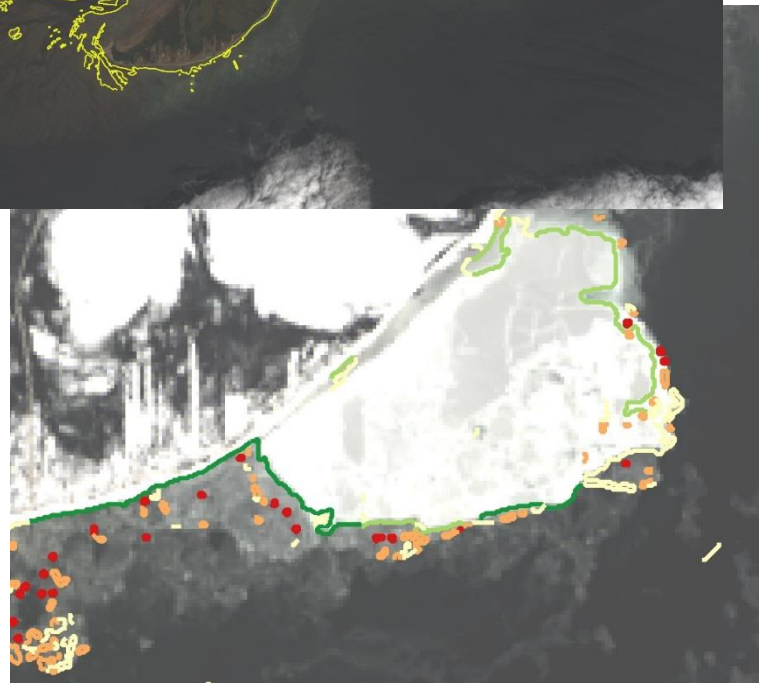
29 Mai 2016

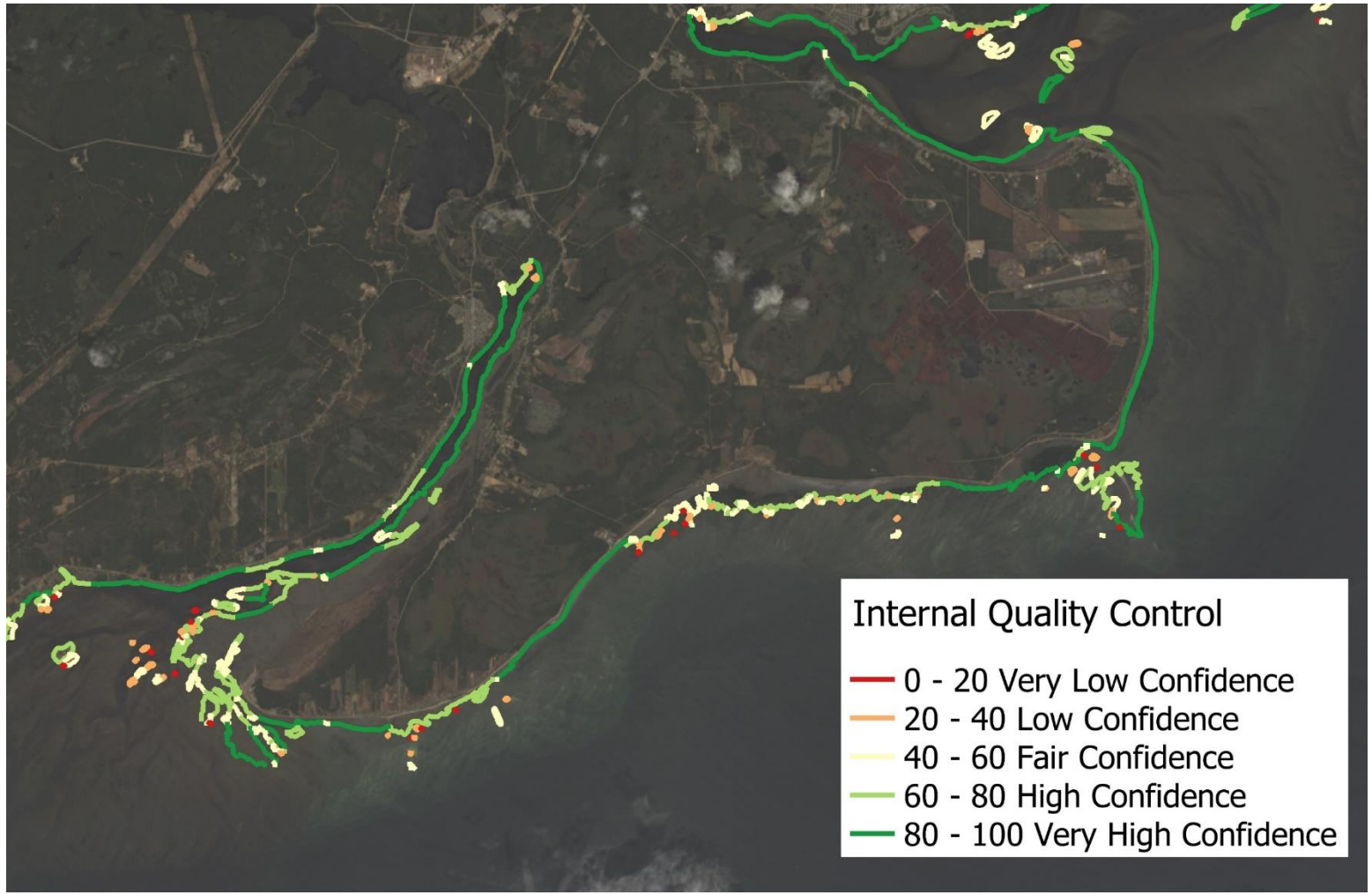


30 July 2017

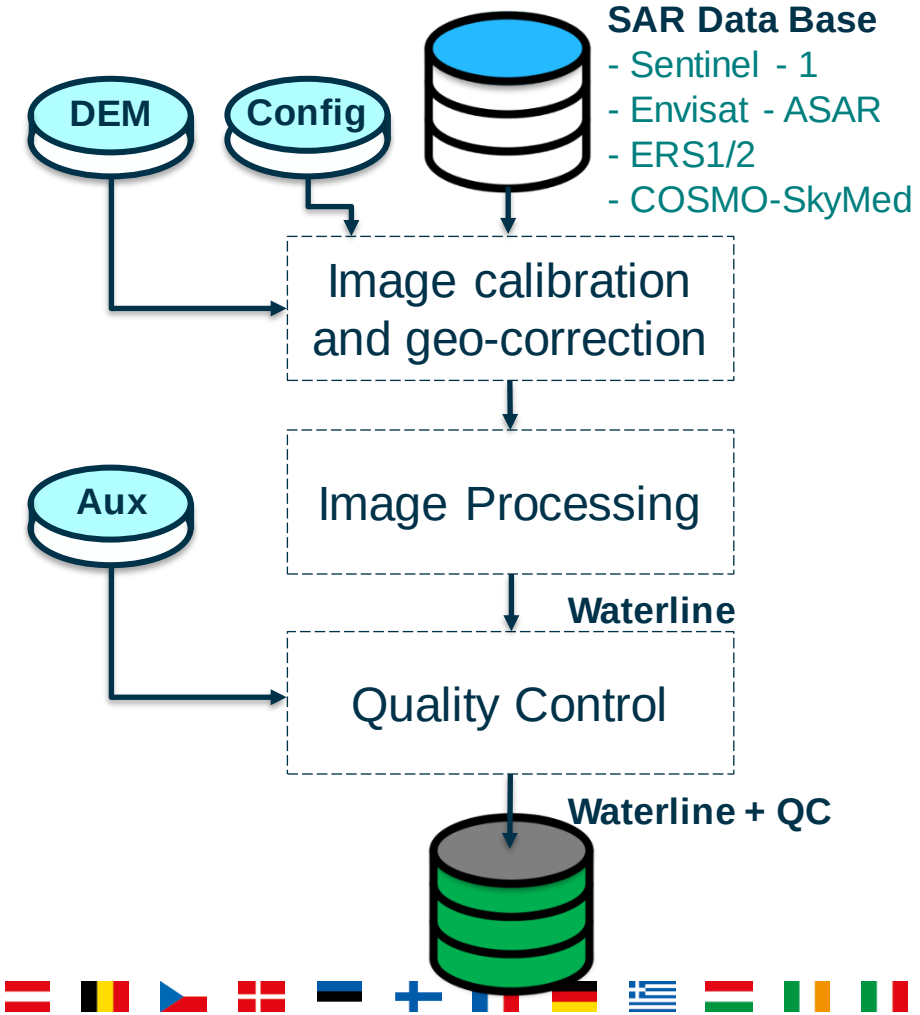
14 August 2018

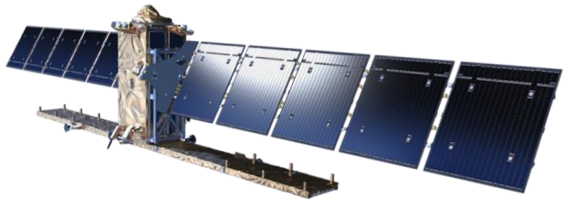
Optical Waterlines

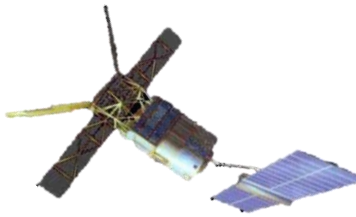


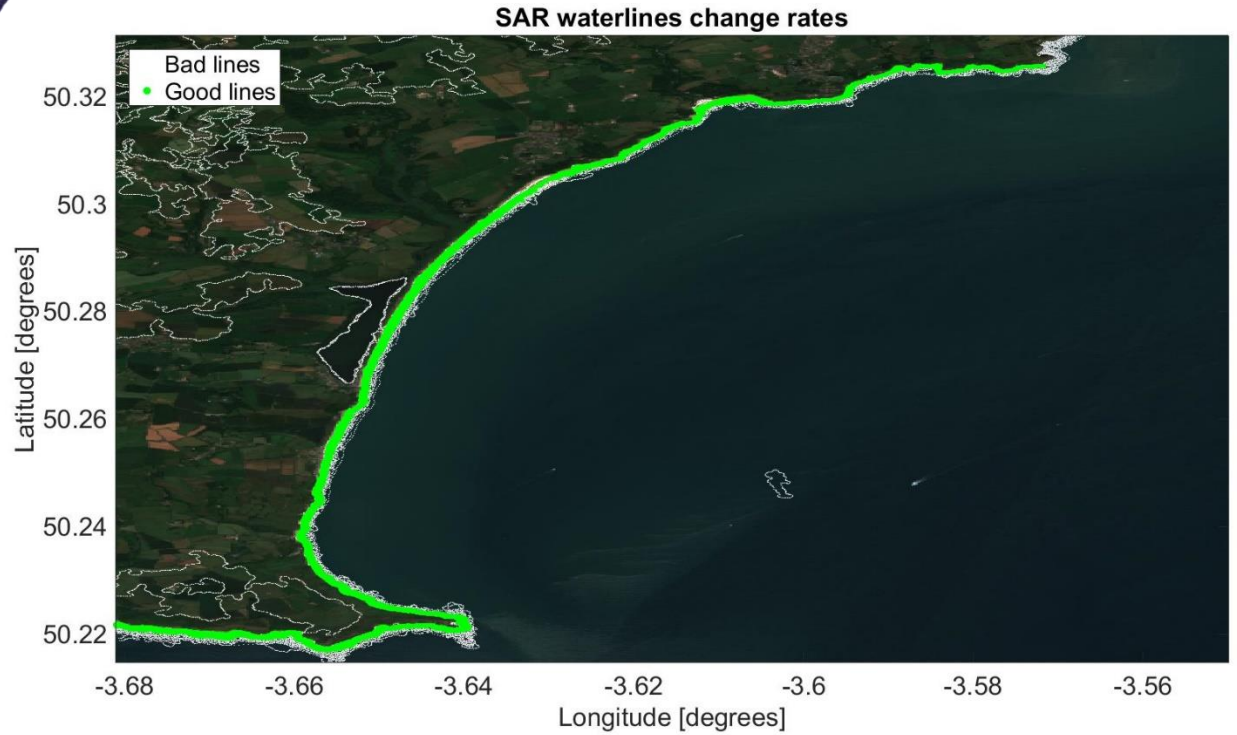


SAR Waterlines

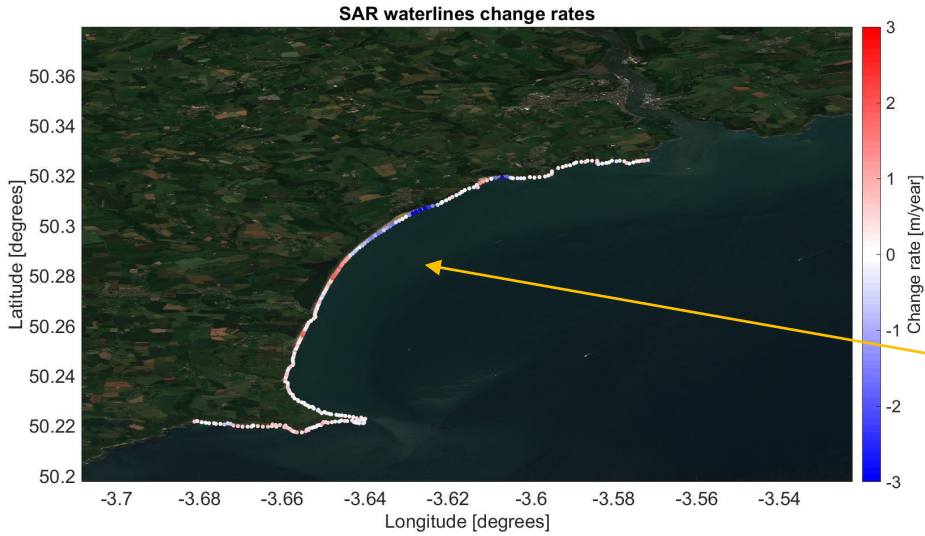


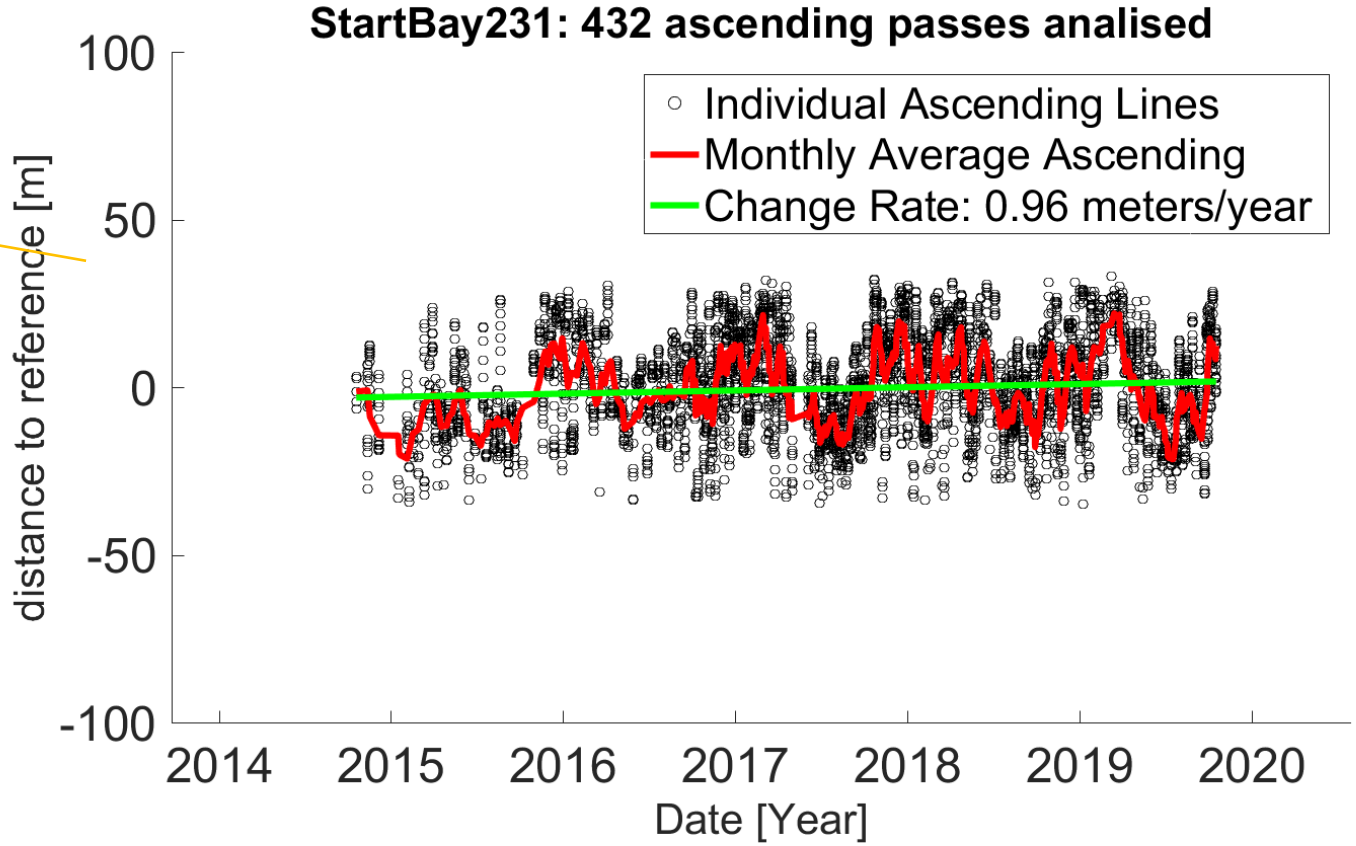




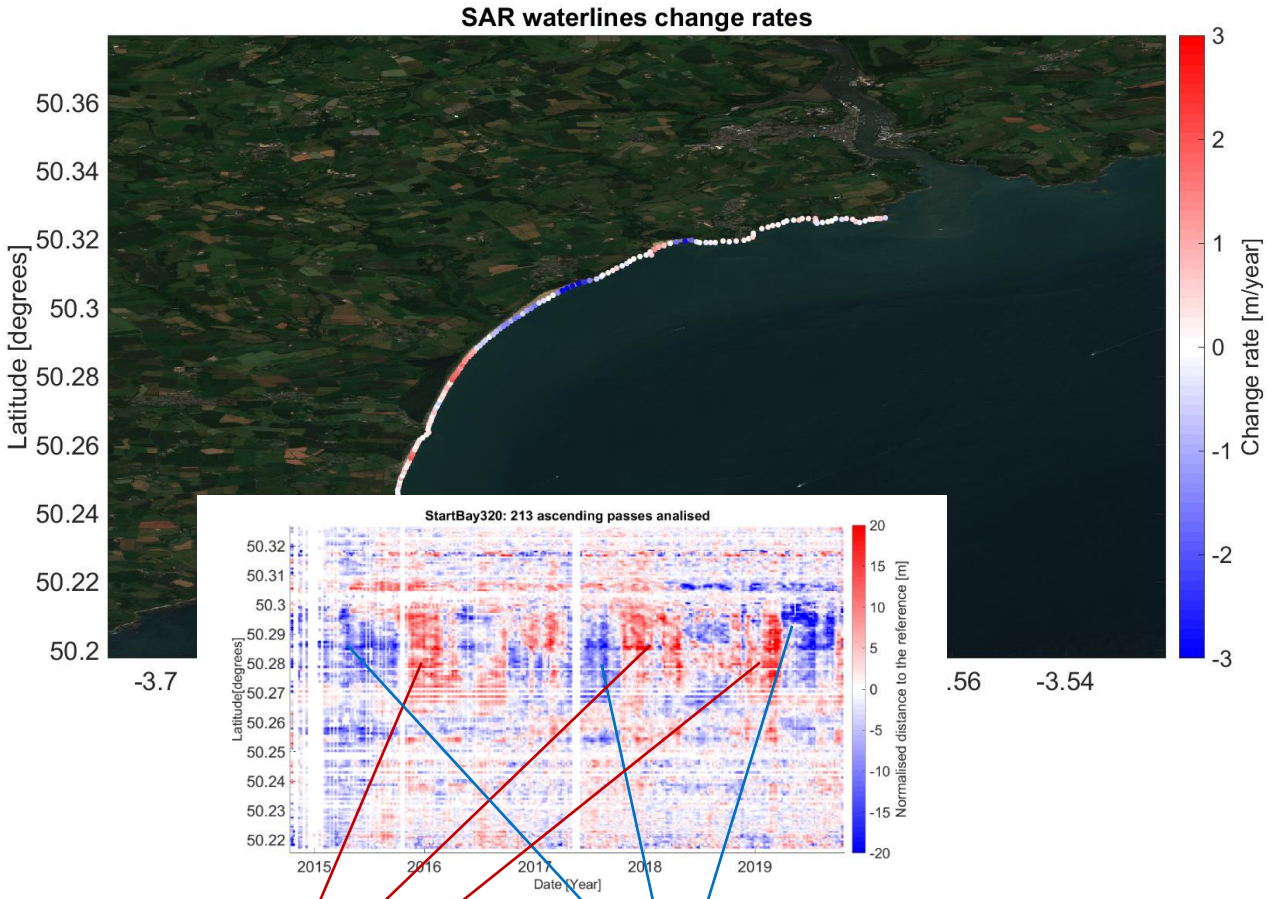


SAR Waterlines

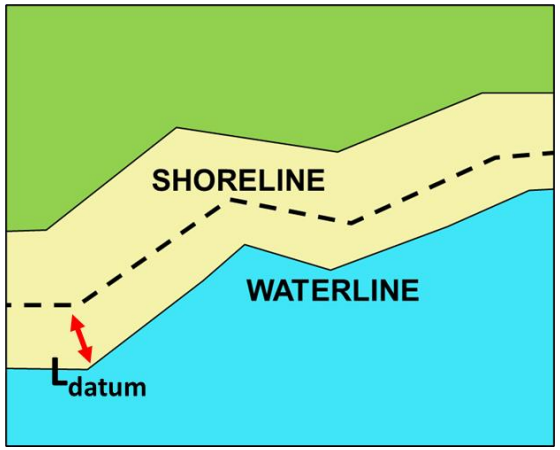


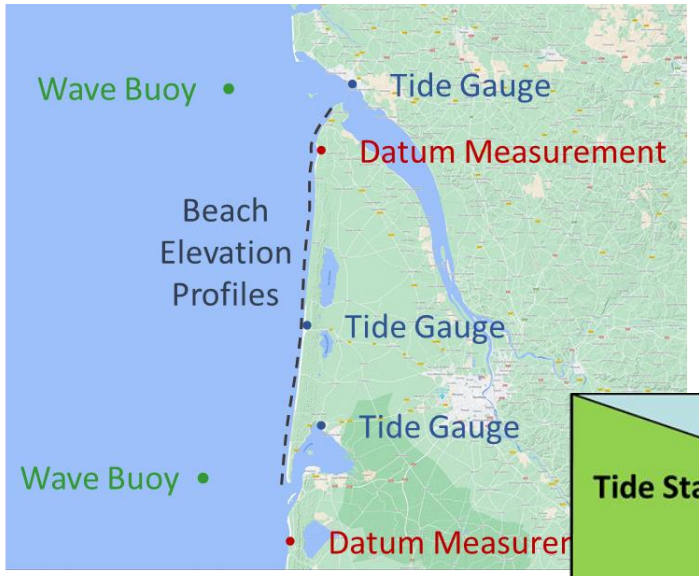


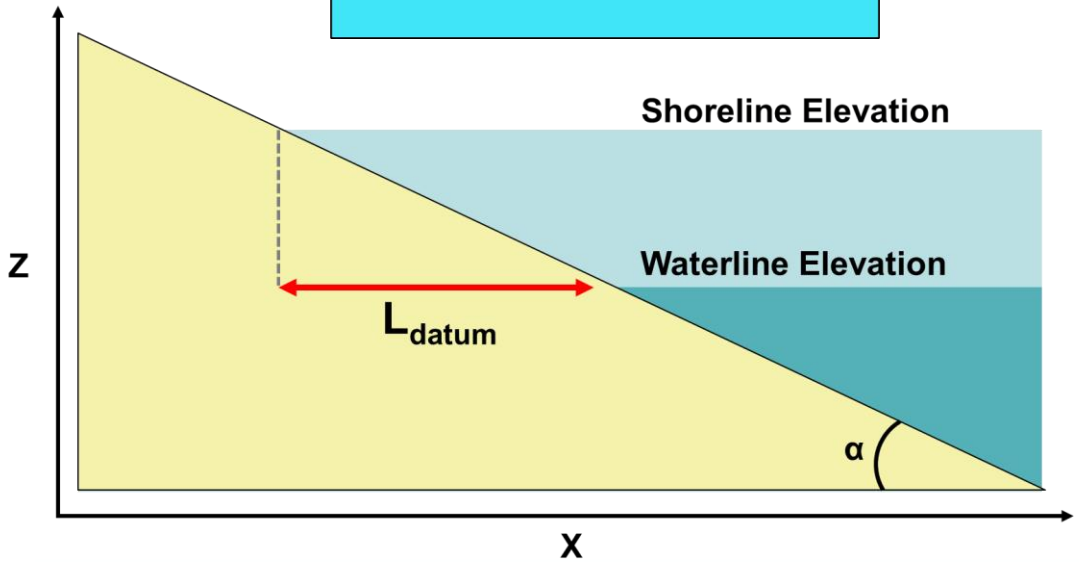
SAR Waterlines

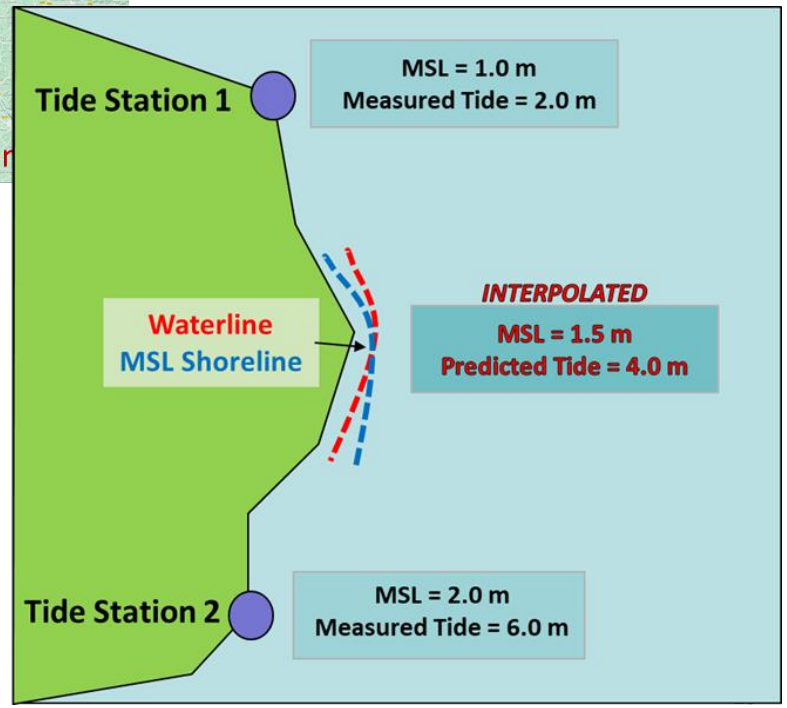


Shorelines


SHORELINE
WATERLINE
L datum

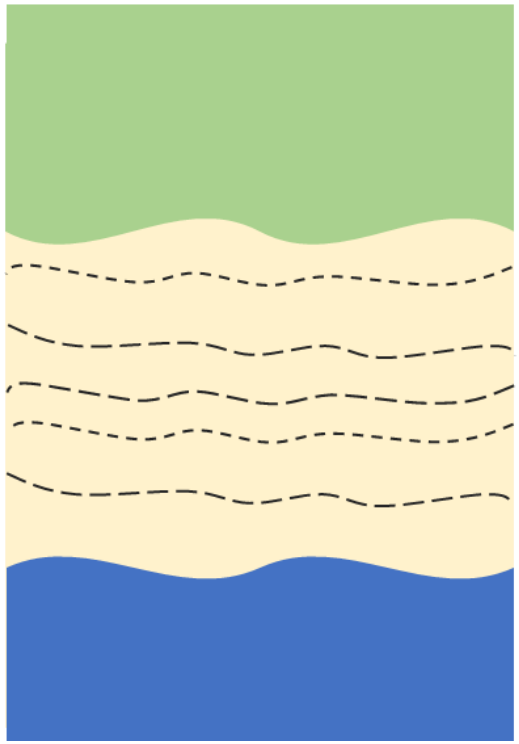

Wave Buoy
Tide Gauge
Datum Measurement
Beach
Elevation
Profiles
Tide Gauge
Tide Gauge
Wave Buoy
Datum Measurer


Shoreline Elevation
Waterline Elevation
Z
L datum
α
X


Tide Station 1
MSL = 1.0 m
Measured Tide = 2.0 m
INTERPOLATED
Waterline
MSL Shoreline
MSL = 1.5 m
Predicted Tide = 4.0 m
Tide Station 2
MSL = 2.0 m
Measured Tide = 6.0 m

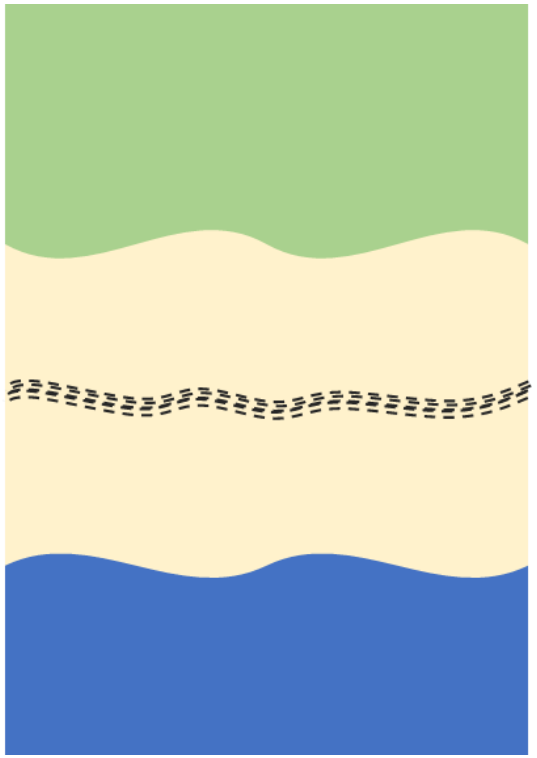
Shorelines

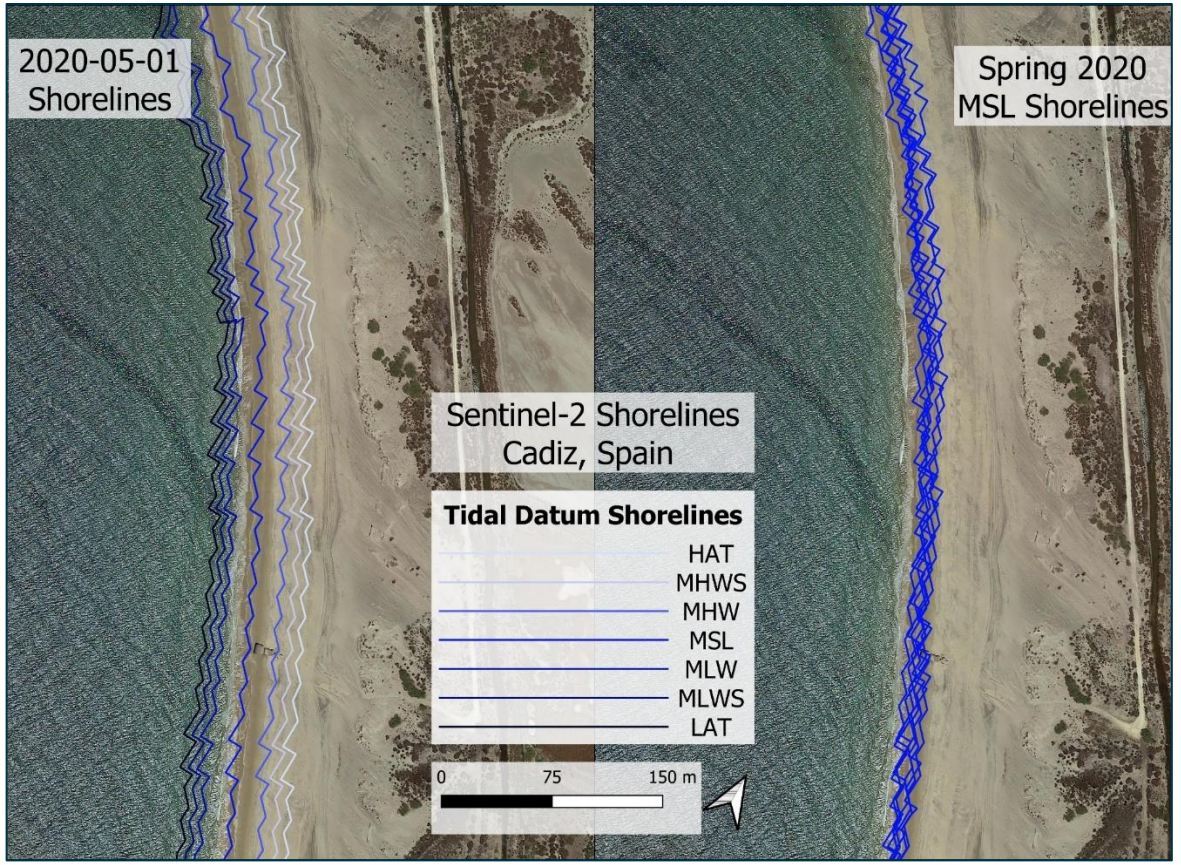
Instantaneous Waterline



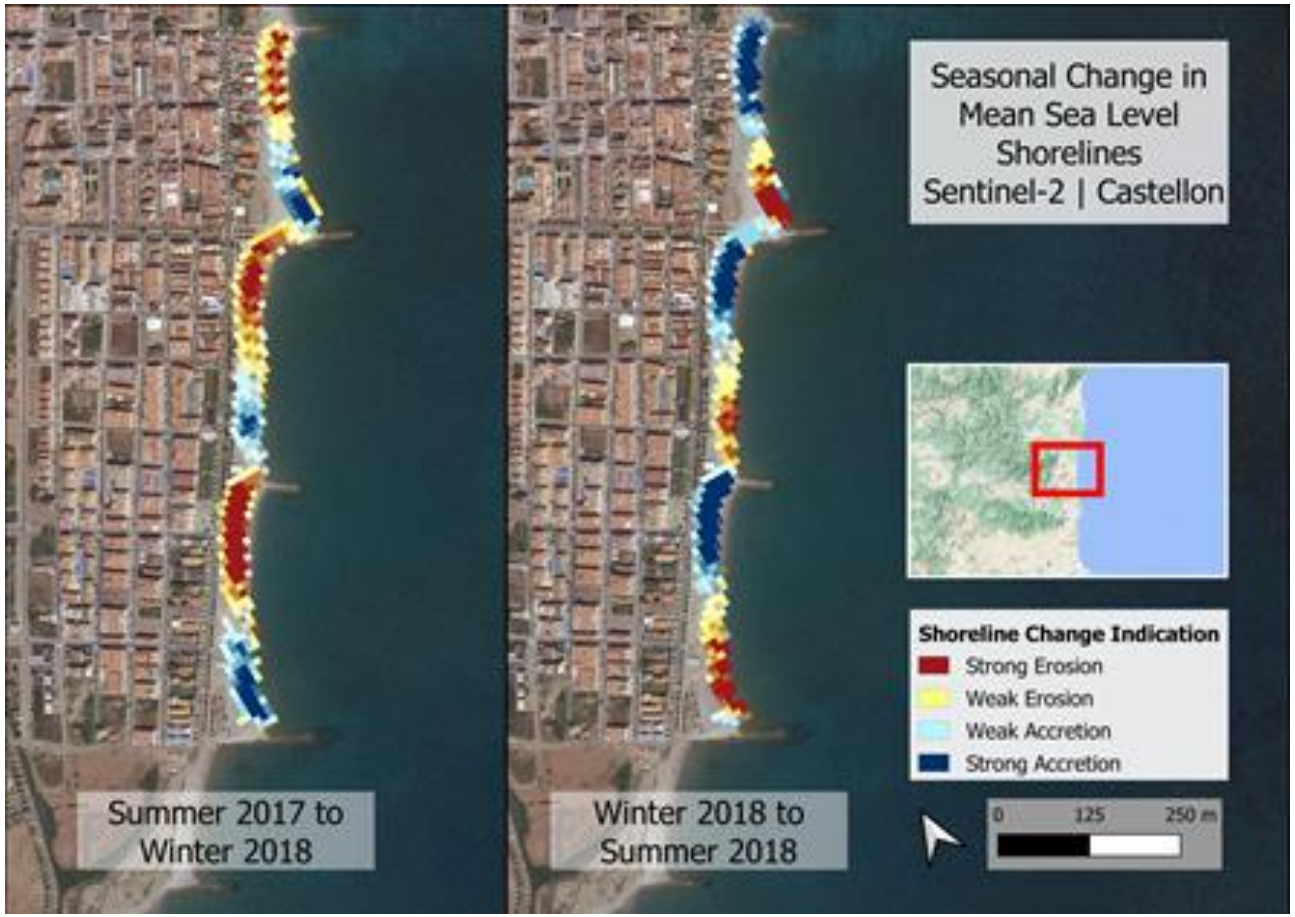
SHORELINE PROCESSOR

MSL Shorelines



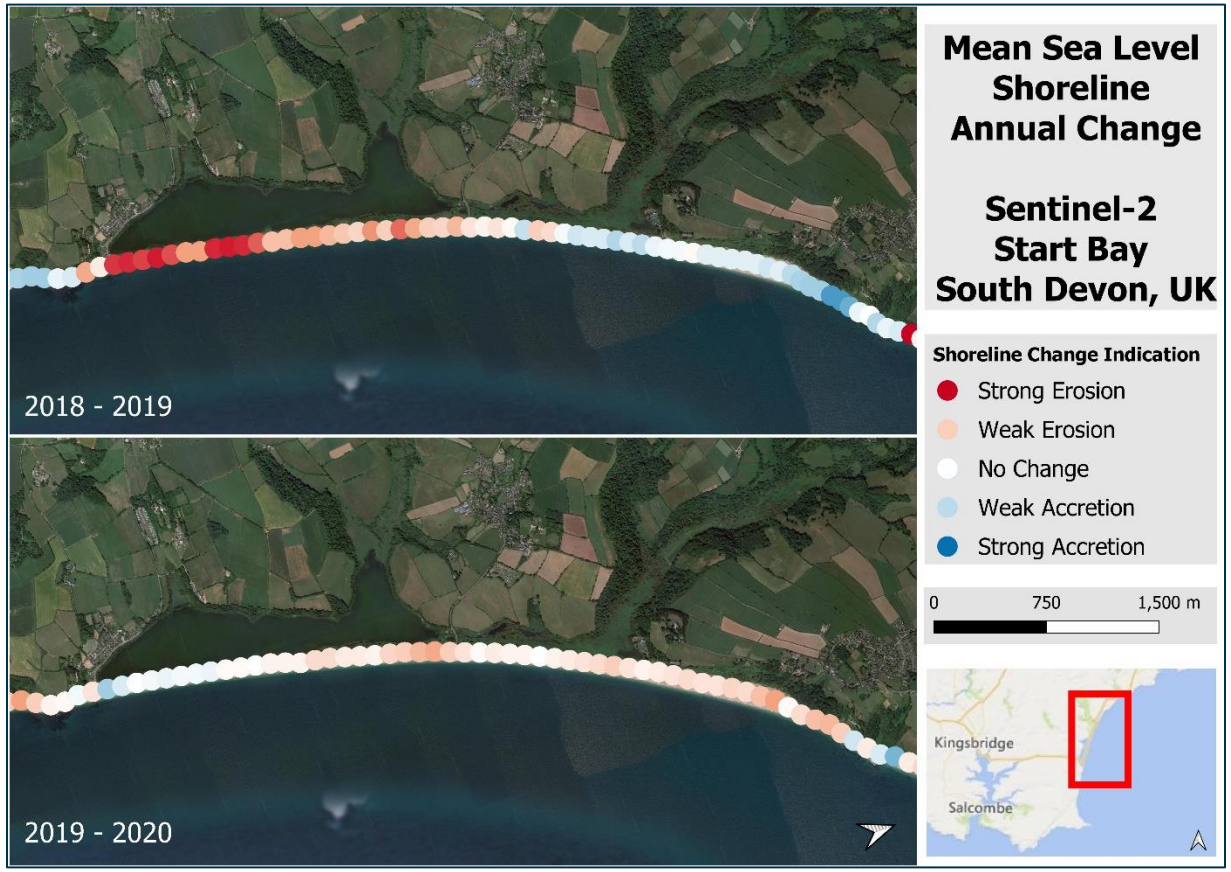


Shorelines


Seasonal Change in Mean Sea Level Shorelines Sentinel-2 | Castellon
Shoreline Change Indication
Strong Erosion
Weak Erosion
Weak Accretion
Strong Accretion
0 125 250 m
Summer 2017 to Winter 2018
Winter 2018 to Summer 2018

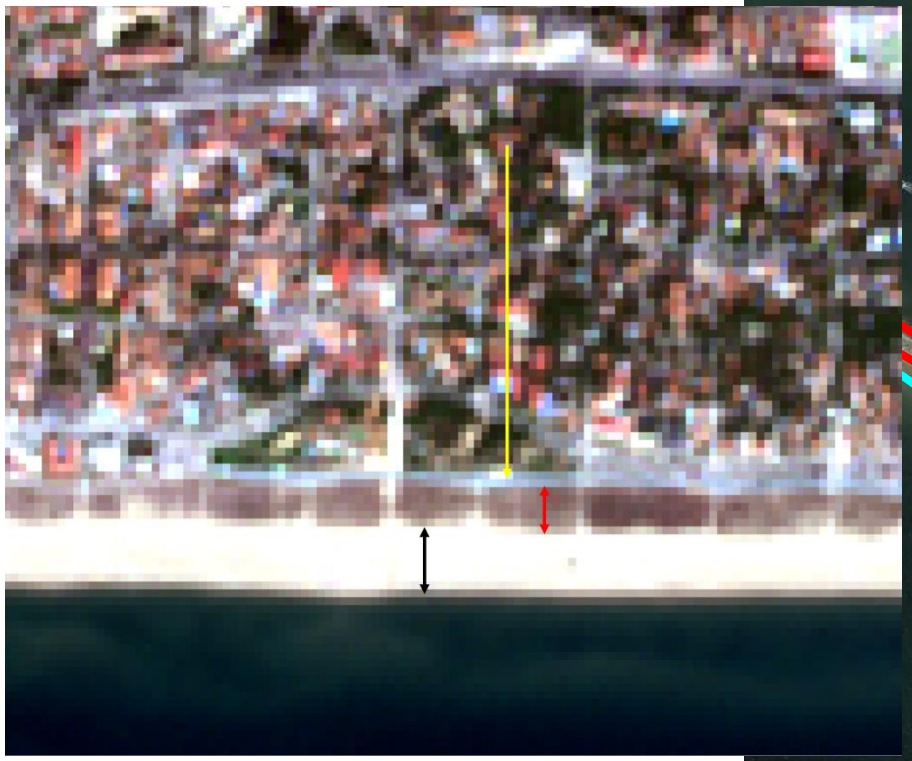

MSL Shoreline Change 2017 - 2019 | Castellon
0 250 500 m

Shorelines


2018 - 2019
2019 - 2020
Mean Sea Level Shoreline Annual Change
Sentinel-2 Start Bay South Devon, UK
Shoreline Change Indication
Strong Erosion
Weak Erosion
No Change
Weak Accretion
Strong Accretion
0
750
1,500 m
Kingsbridge
Salcombe

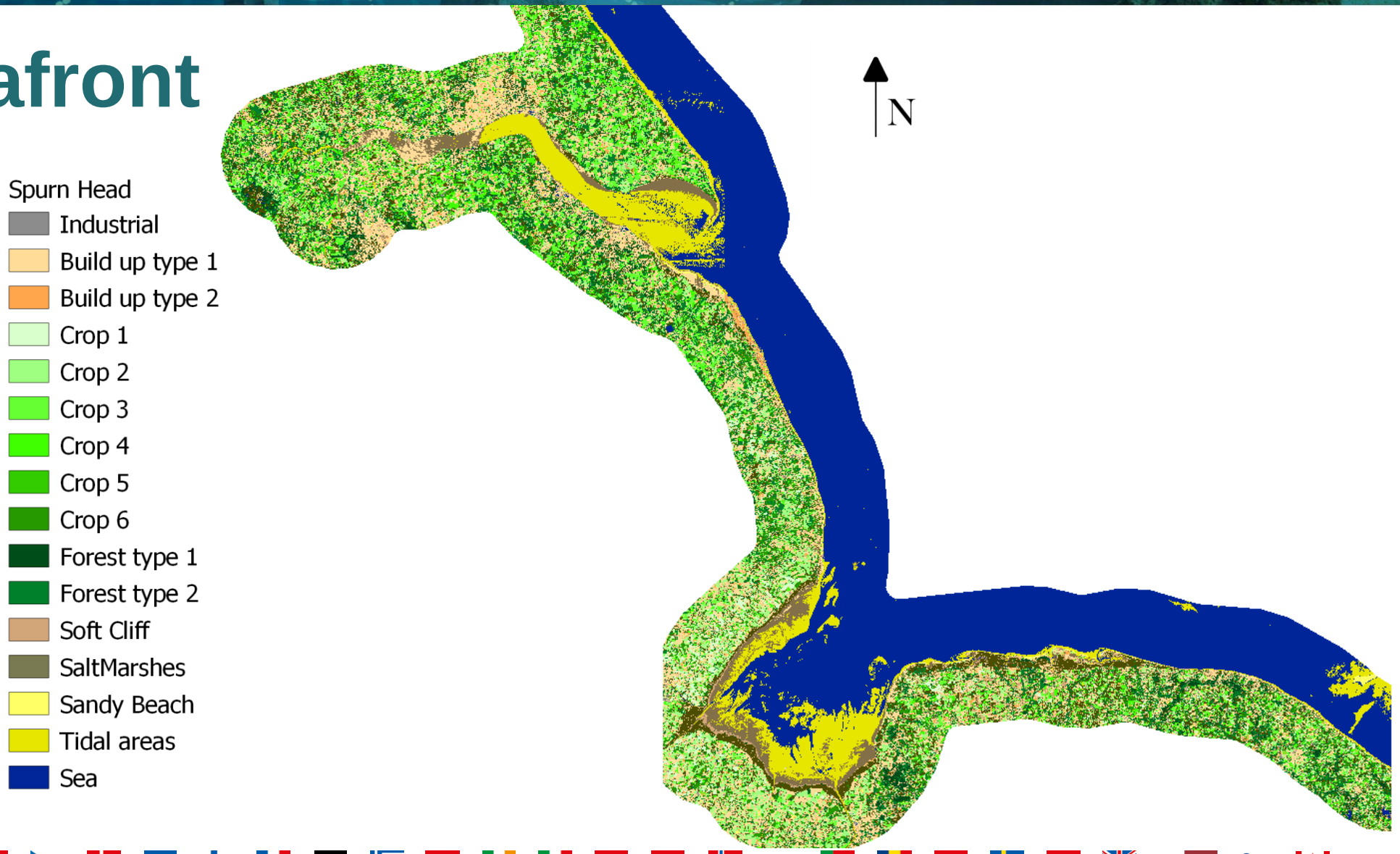

Mean Sea Level Shoreline
Average Erosion Rate 1994 - 2018
Tordera Delta, Spain
0
75
150 m
Average Erosion Rate (m/yr)
5 - 6.25
3.75 - 5
2.5 - 3.75
1.25 - 2.5
0 - 1.25

Seafront



OUR PRODUCTS

Seafront

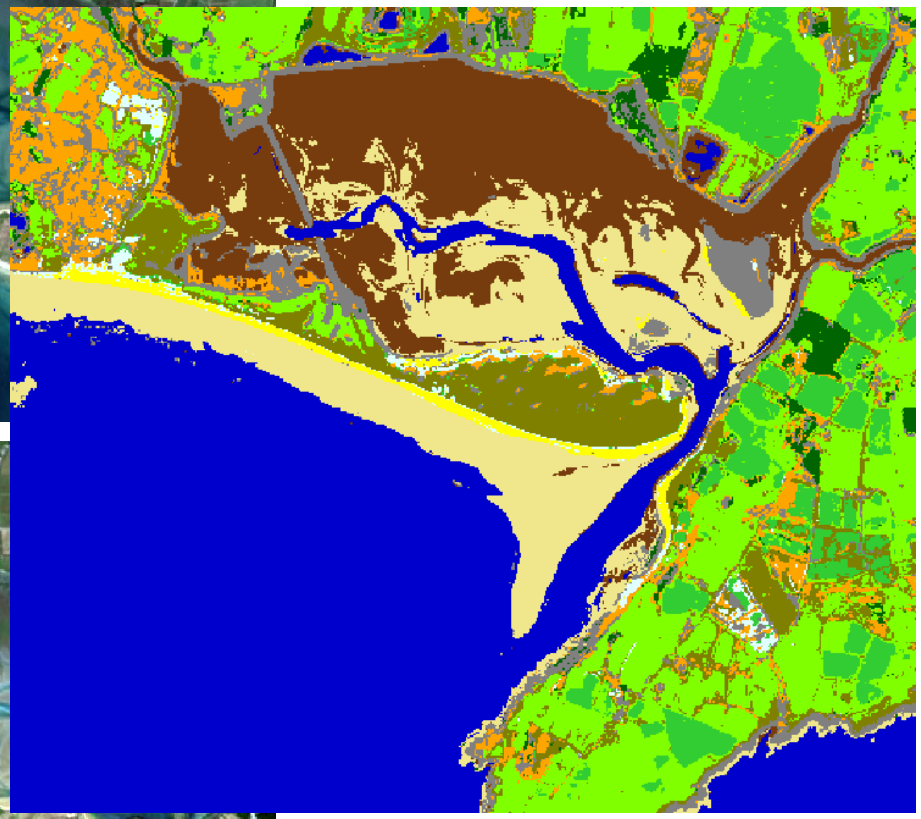


OUR PRODUCTS

Seafront

OUR PRODUCTS

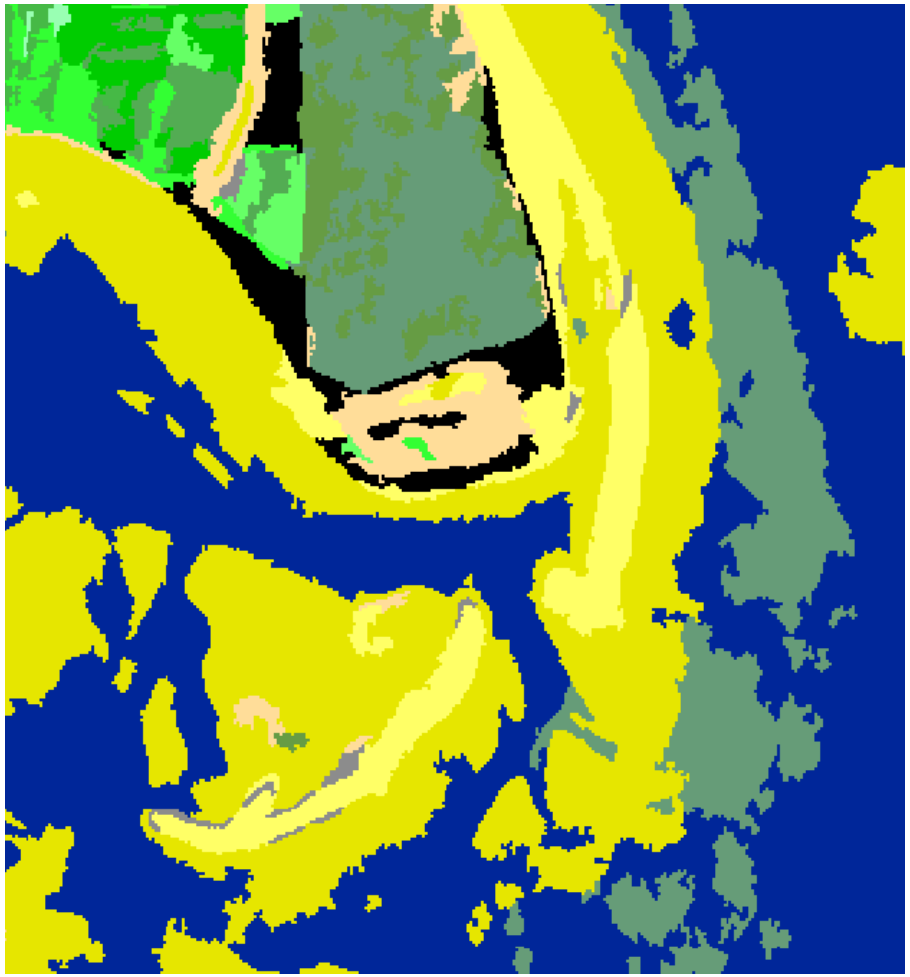
Seafront



Seafront

2017

2019



OUR PRODUCTS

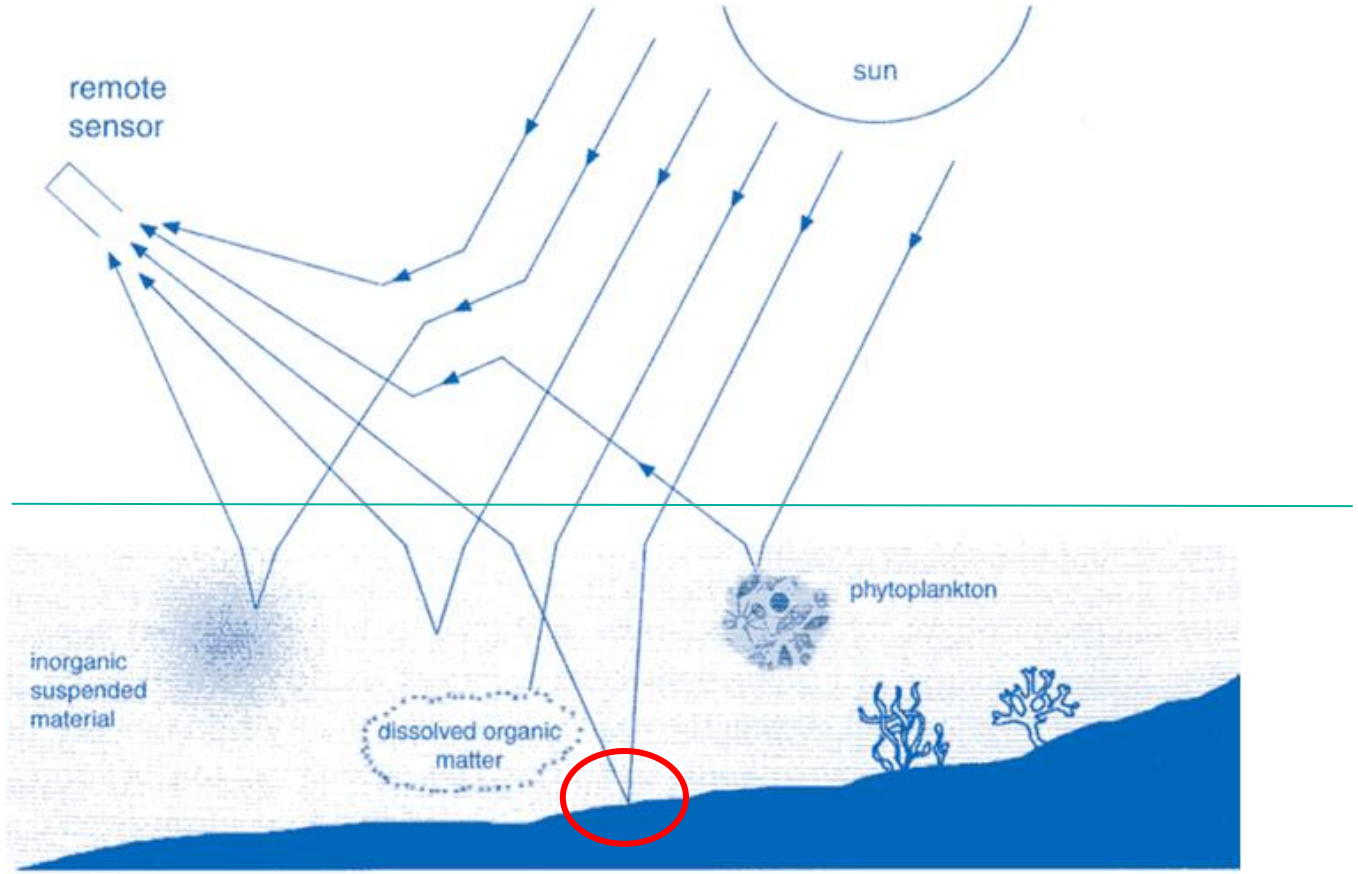
Seafront

2017

2019

Bathy-Morpho Terrain Models

Estimation of ocean morphology using multispectral sensors

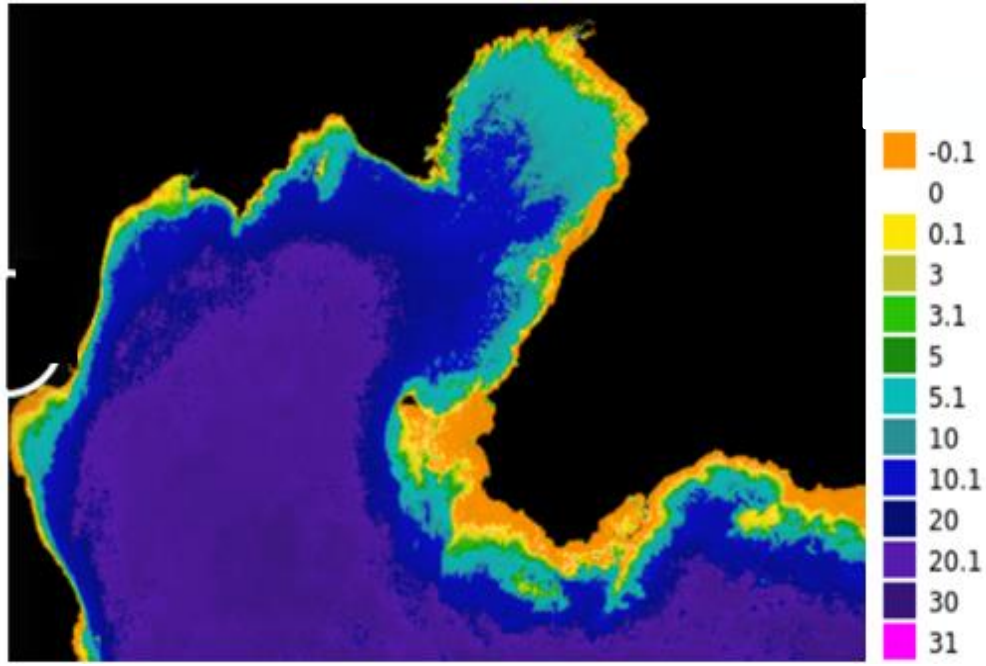


What we want :

Bathy-Morpho Terrain Models

- Physics-based model, Method of Hedley et al., 2009
- Different method from Satellite Derived Bathymetry

Coral Harbour, Canada

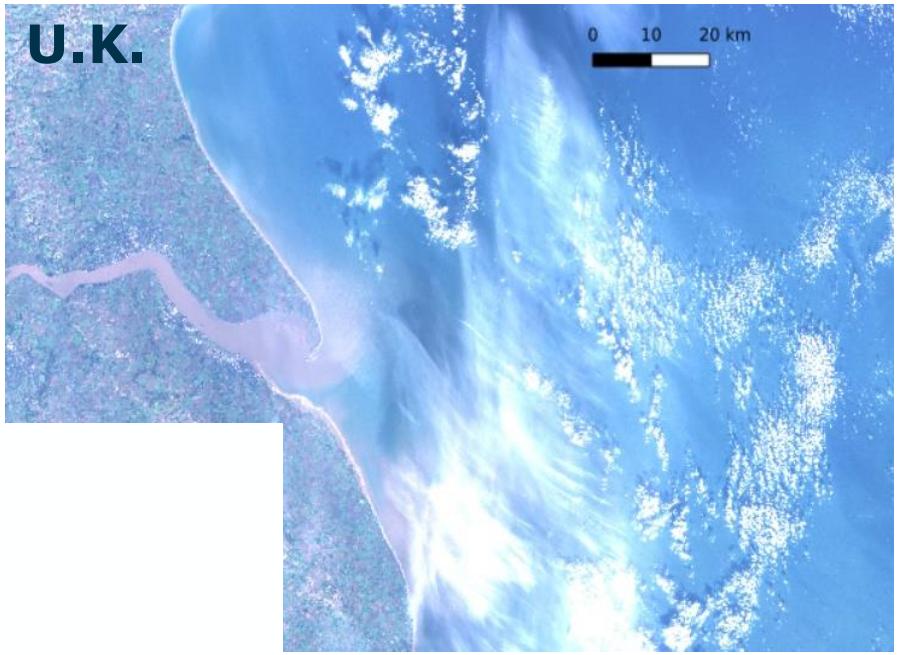


Coral Harbour SDB

Bathy-Morpho Terrain Models

1. Pre-Selection of images

One good single image – One Bathy-Morpho Terrain Model



Sediments and Clouds

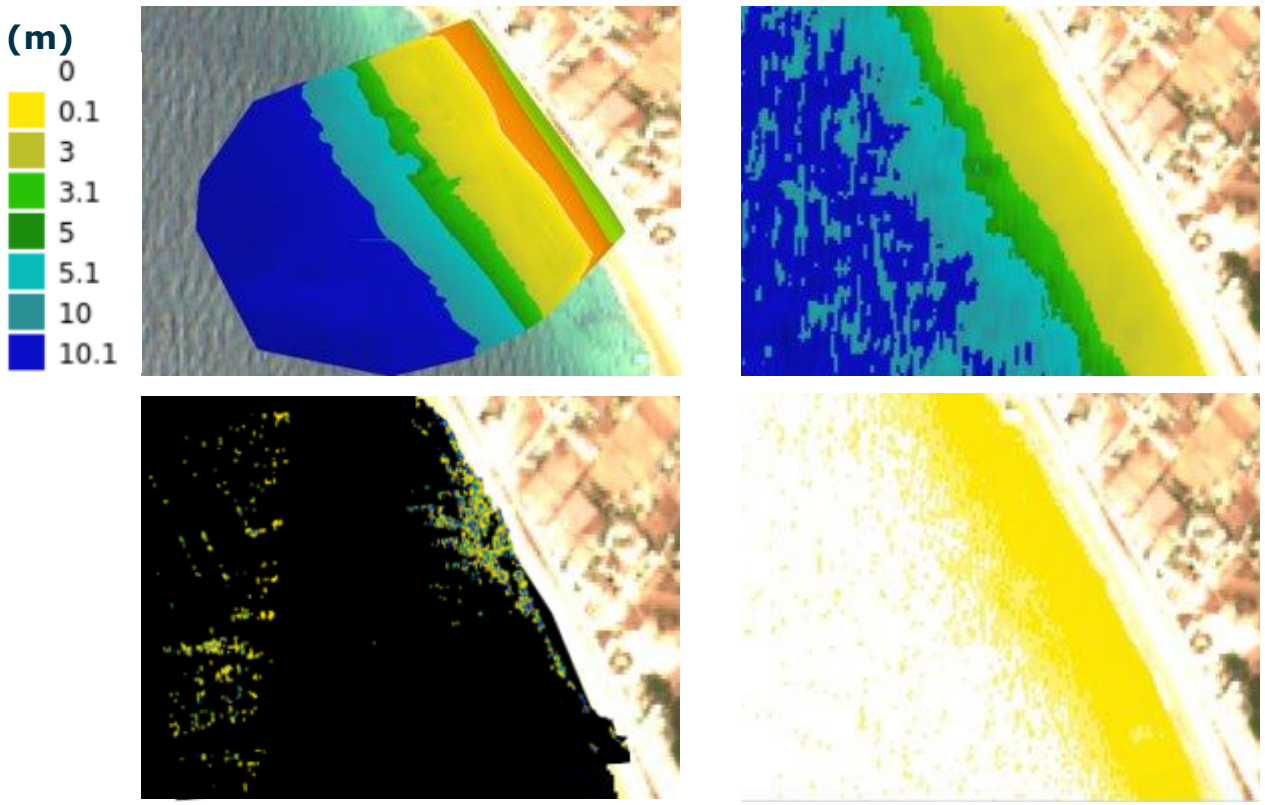
Sediments and Glint

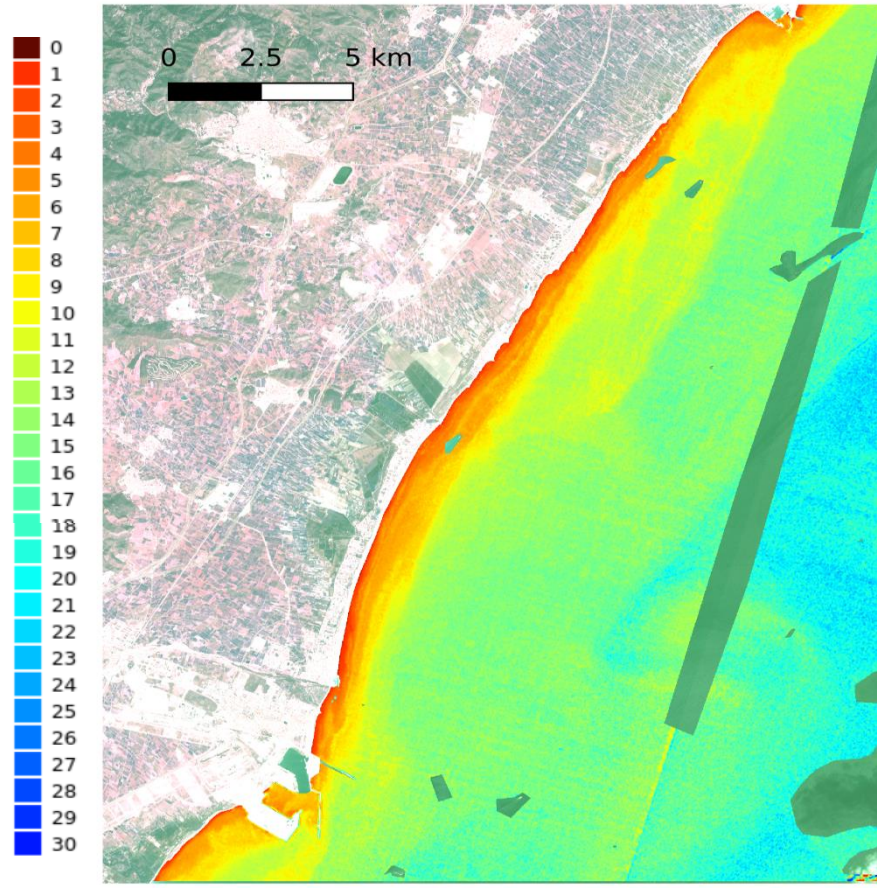
Ice

...and others

Bathy-Morpho Terrain Models

2. Atmospheric correction

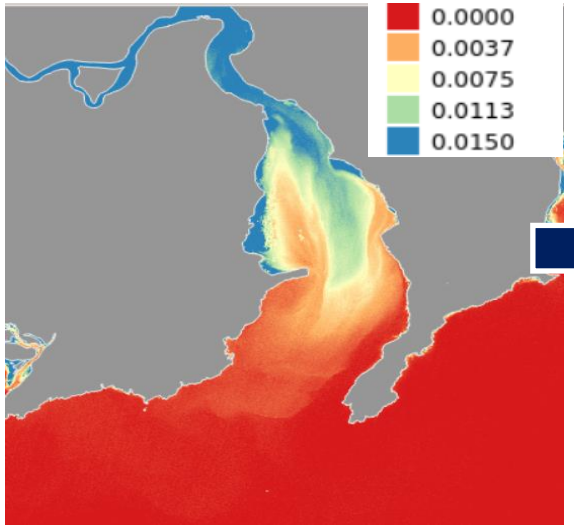




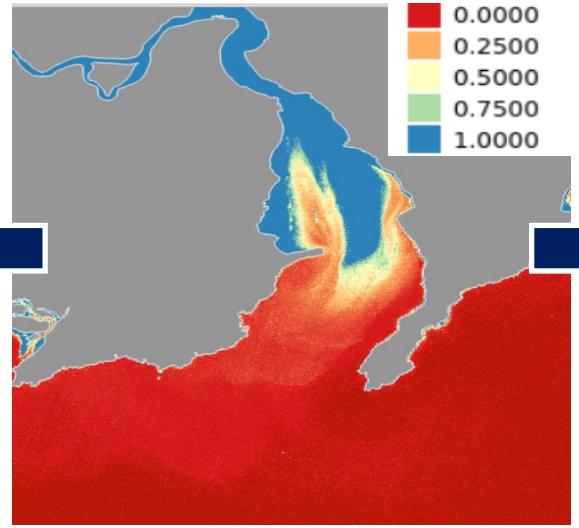
Cádiz, Spain

Bathy-Morpho Terrain Models

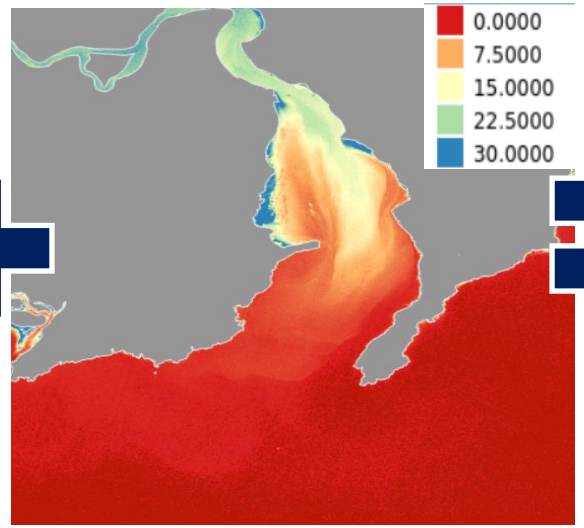
Reflectance



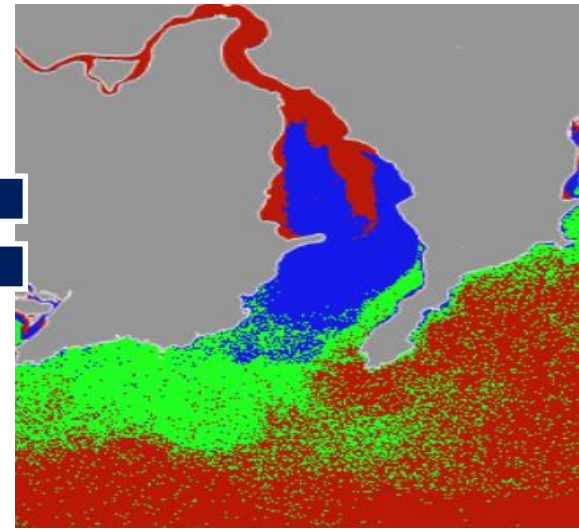
Coloured disolved organic matter



Suspended particulate matter



Confidence maps

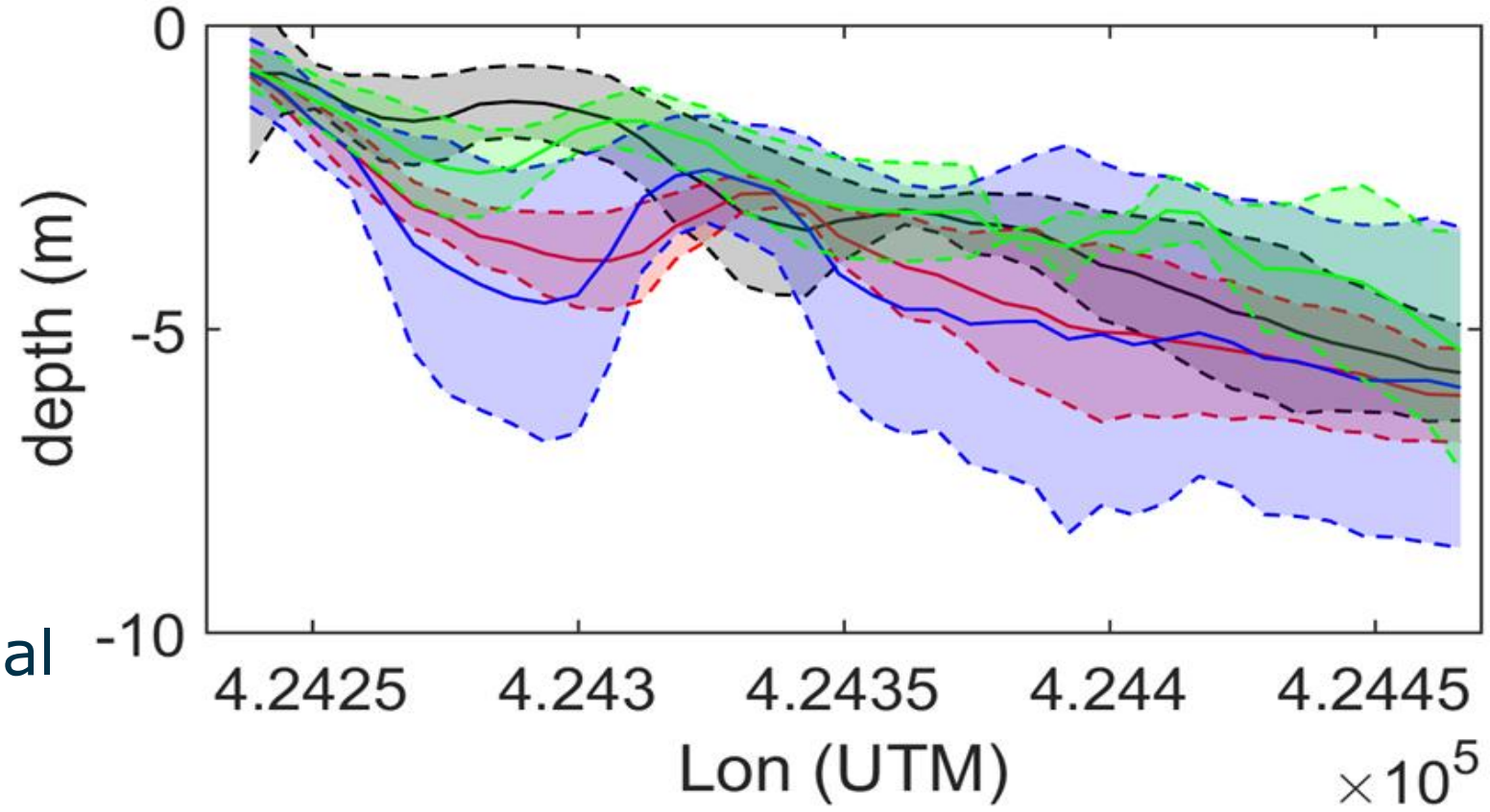


Good

Intermediate

Bad

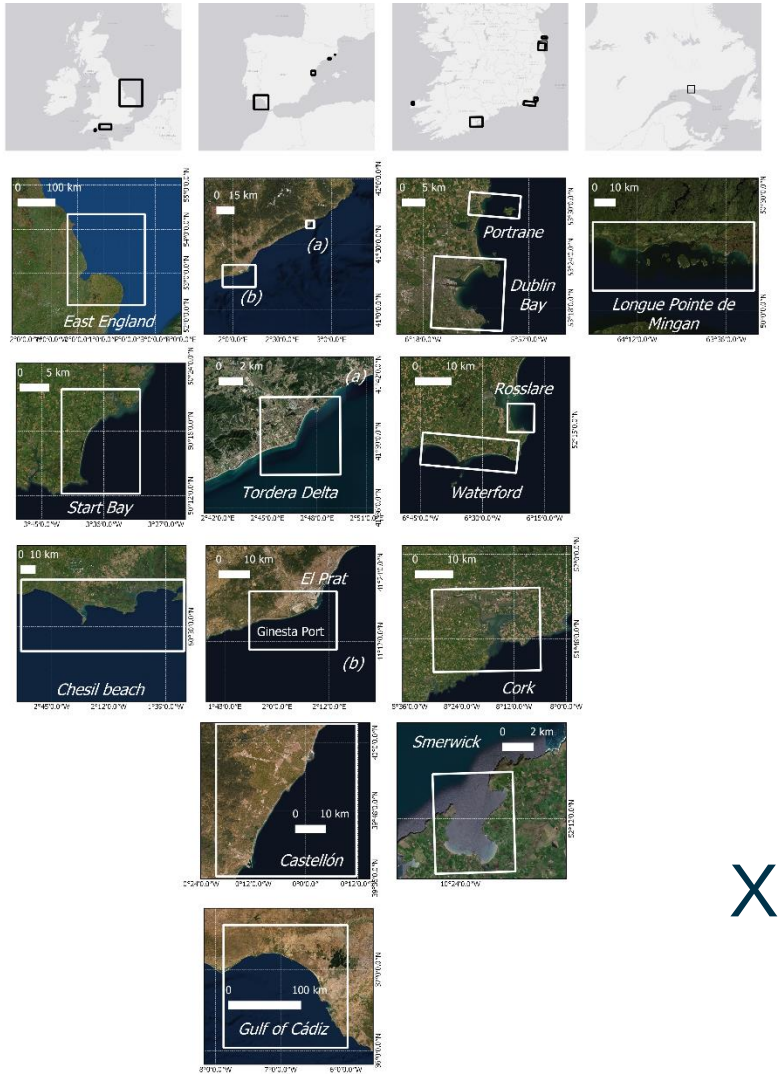
Bathy-Morpho Terrain Models



Potential time series analysis for the annual evolution 2016-2019

End Users
Product validation

Dr Andres Payo on behalf of End-Users team
Lead of Coast & Estuaries programme
British Geological Survey

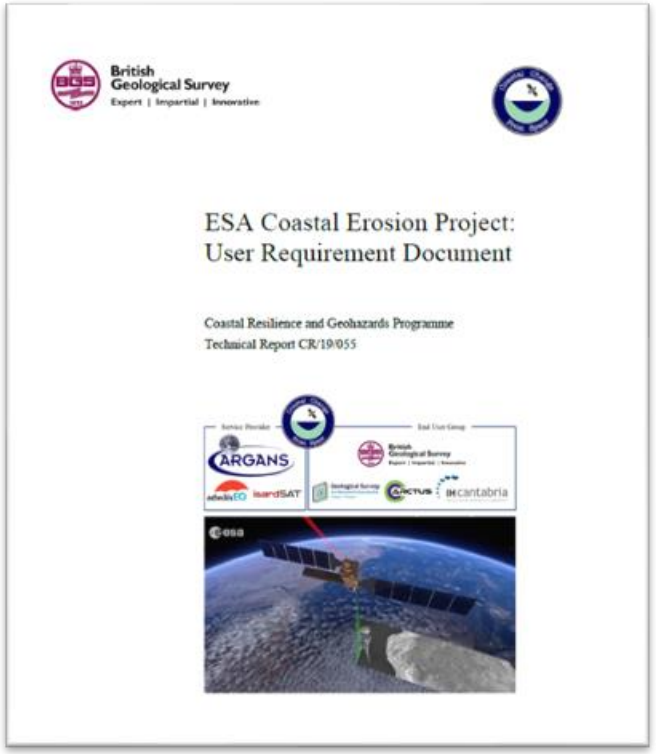


x 4 products

1D x 2 | 2D | 3D

This is a user's needs driven project

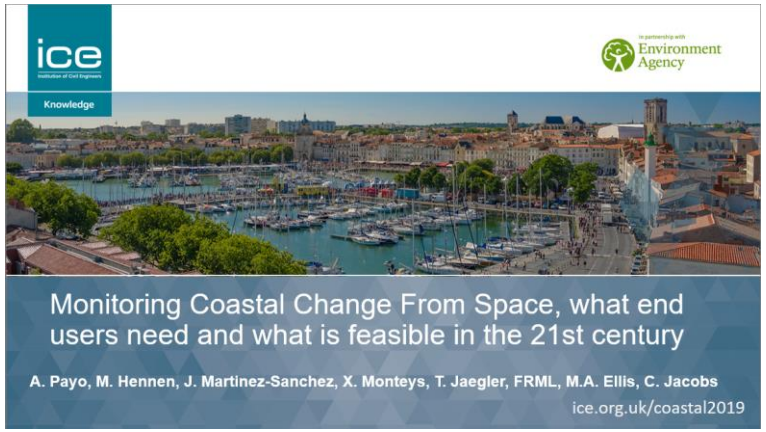
What are the end users requirements?



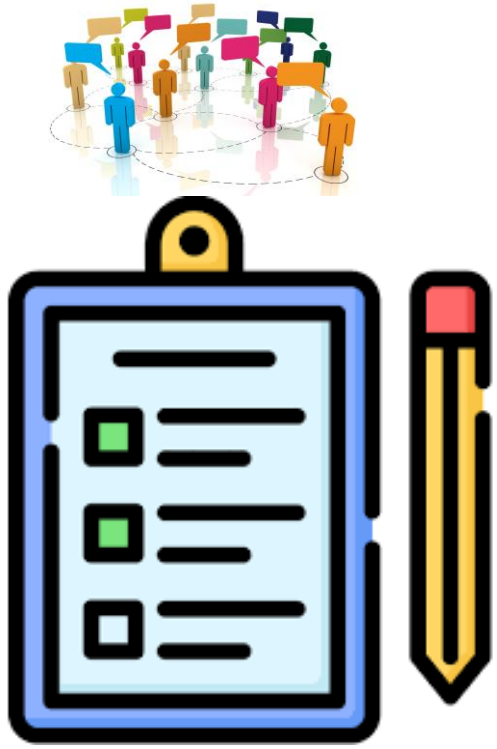
Full URD consolidated version (122 pp)
User Requirement Document_v2.pdf

PDF

Summary of URD & Feasibility study (10 pp)
Payo_et_al_ICE_2019_LaRochelle.pdf



Slides presented at ICE 2019



Broader end user community inputs

End Users overarching & specific requirements

"*Any policy for coastal erosion should increase coastal resilience by restoring the sediment balance and providing space for coastal processes*"
(EUROSION, 2004)

+ f(Country, site specific, End-User Type)

British Geological Survey

Geological Survey Suirbhéireacht Gheolaíochta Ireland | Éireann

ARCTUS

Gobierno de España — Vicepresidencia Cuarta del Gobierno — Ministerio para la Transición Ecológica y el Reto Demográfico

IH cantabria — Instituto de Hidráulica Ambiental

Thanks for your attention!

10th December 2020, recorded sessions here

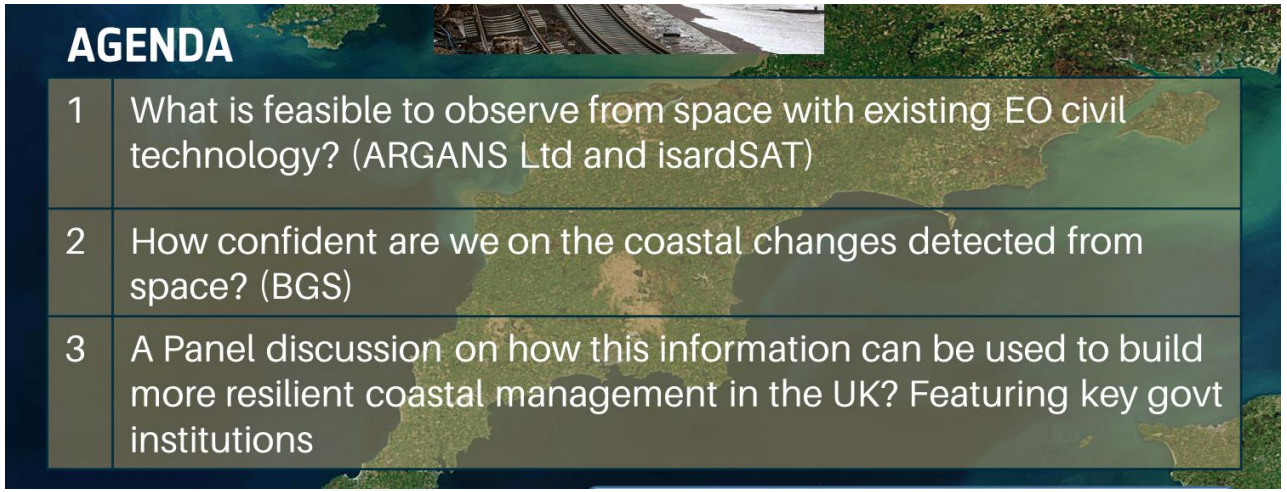
17th November 2020, recorded sessions here

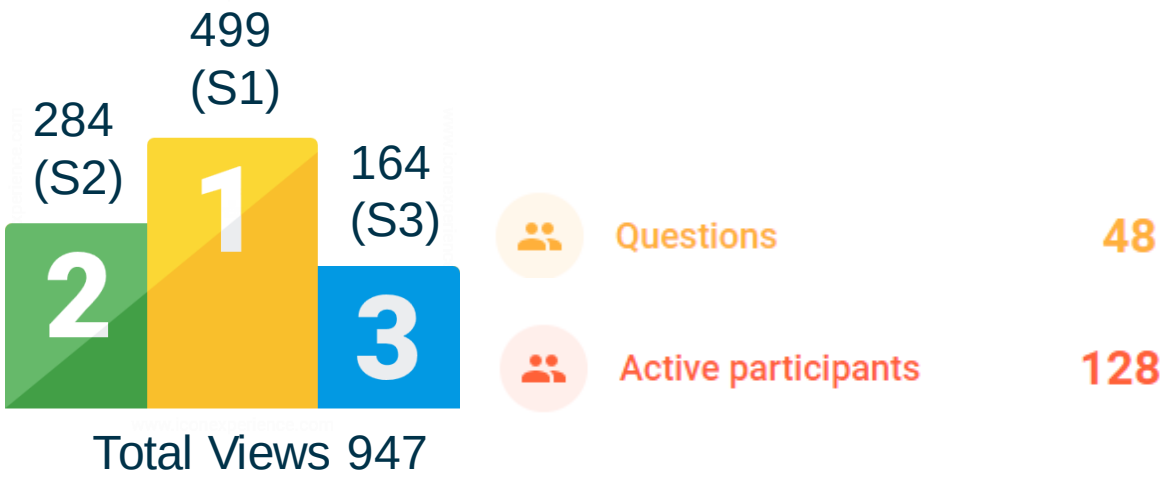
30th Nov, 14th December 2020, recorded sessions here

7th Dec 2020 recorded sessions here

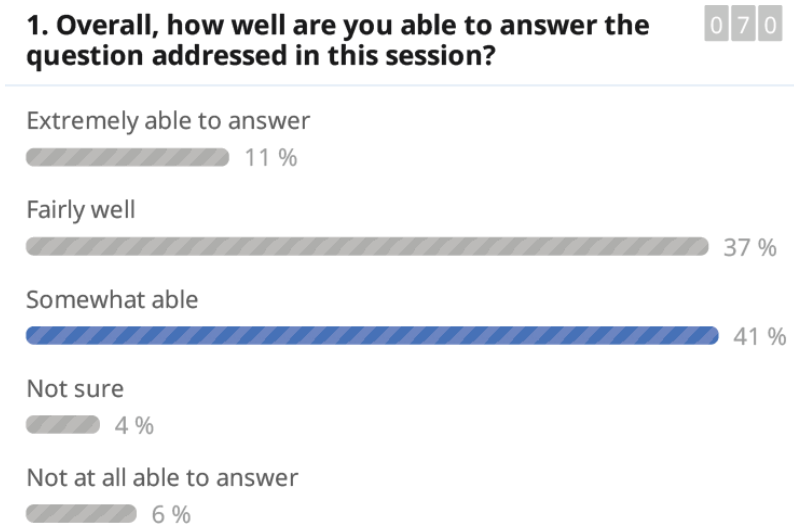
UK Coastal Erosion WS metrics

https://bgscoastalerosion.siteonsite.es/ OnSite

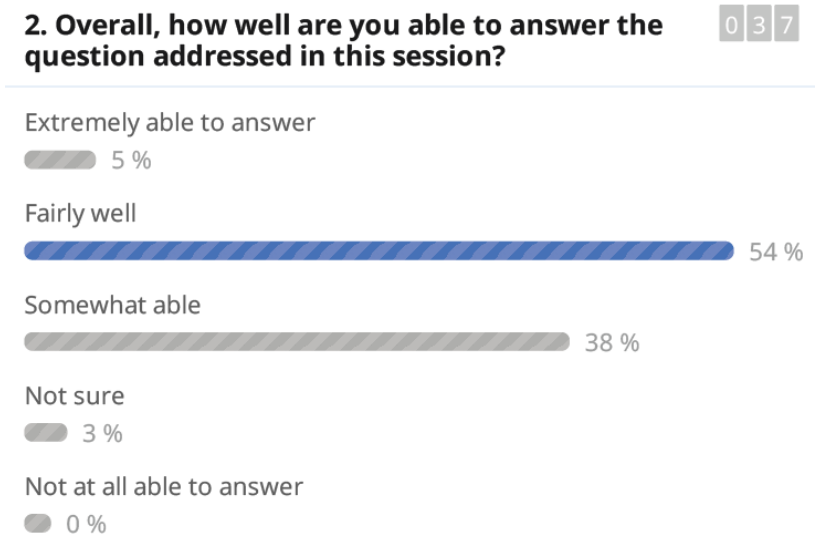




Before



After



R. Ireland Coastal Erosion WS metrics

450 registered attendees

10 Speakers

5 Irish key Stakeholders

10 Local authorites

30 Countries represented

Geological Survey IE
@GeolSurvIE

+ 2K

YouTube

+ 120

Spain Coastal Erosion WS metrics

Summary workshop report shared with registered participants

38 reads

73 downloads

5,180 direct
27,280 total impact

4,503 direct
7,313 total impact

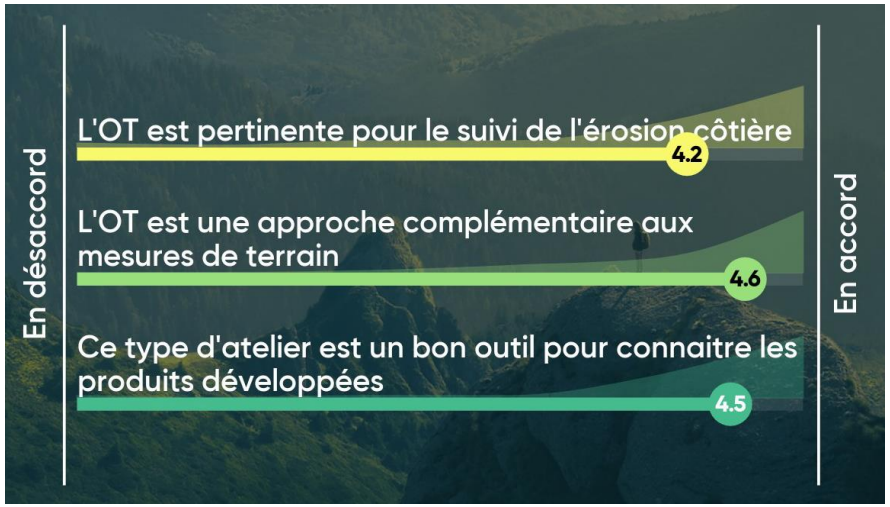
192 total

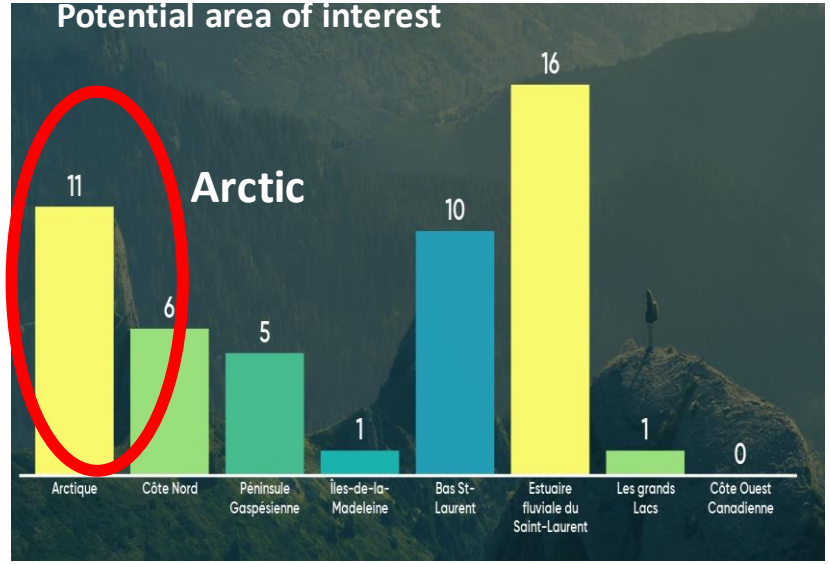
128 Morning session: https://vimeo.com/480714920

64 Afternnon session: https://vimeo.com/480717649

Quebec Coastal Erosion WS metrics

Two workshop 130 attendees.





Could specially fill the gap for coastal management, especially in remote area where in-situ measurement is cost and time consuming.

Various expertise and affiliations (gvt, academia, private, ONG)
45% less than 2 years experience
40% no or little EO knowledge

YouTube 98 views

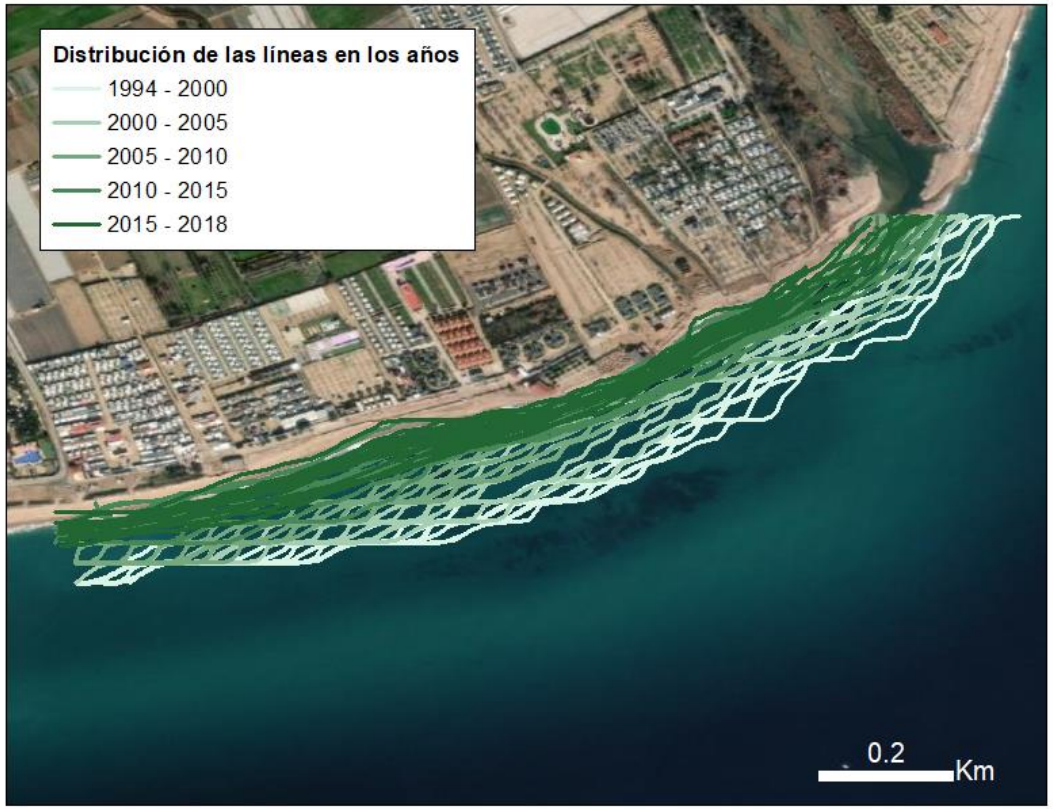
Next step :

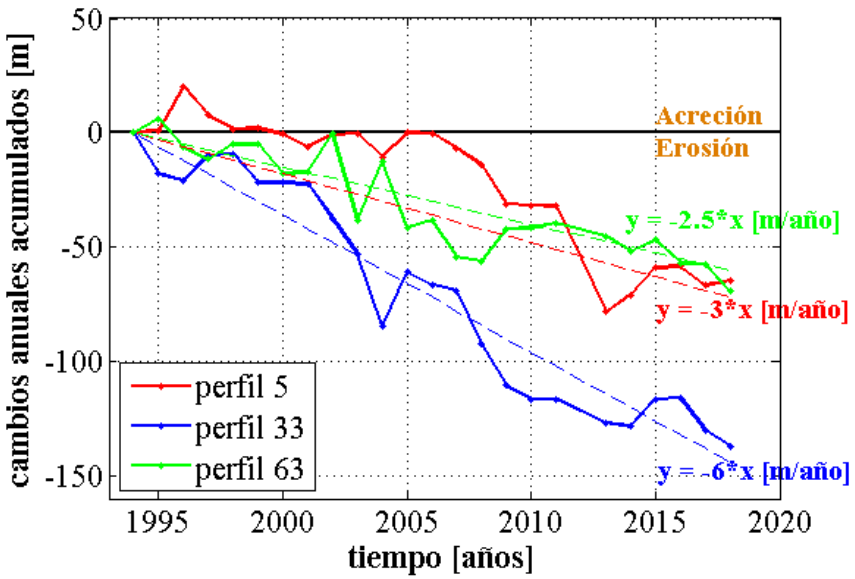
1. Data dissemination (web portal)
2. Operational products

Change over 25 years using SL | OPT

Process: **long-term shoreline evolution in Tordera**

184 shorelines (1994 a 2018 – 24 years)



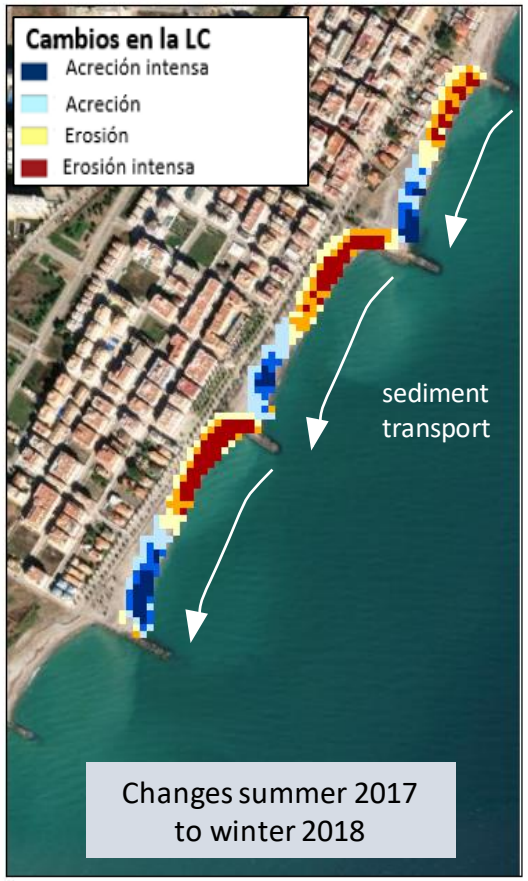


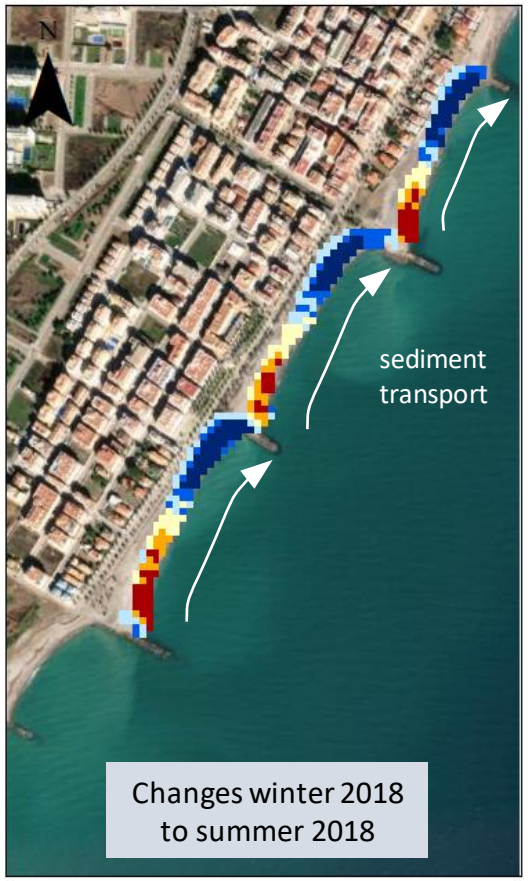
Source	Average erosion
Satellite	4.79 m/year
Aerial photogrametry	4.68 m/year

SL OPT able to detect seasonal change

Process: **seasonal beach rotation in Castellón**

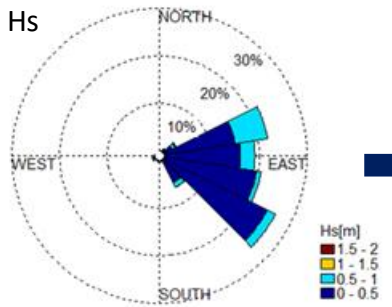
Analysis of Sentinel 2 shorelines:
Seasonal cheanges and beach rotation



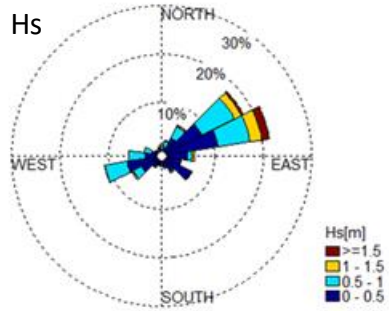


0.15 Km

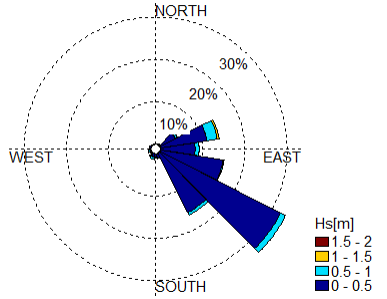
Summer 2017



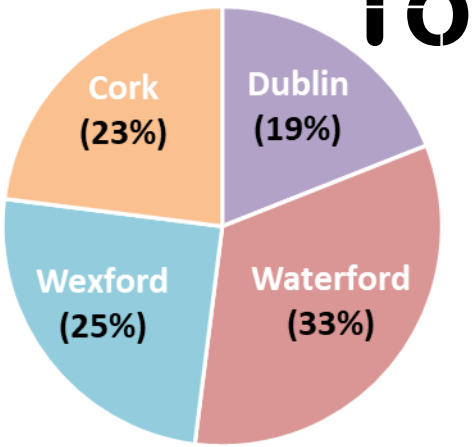
Winter 2018



Summer 2018

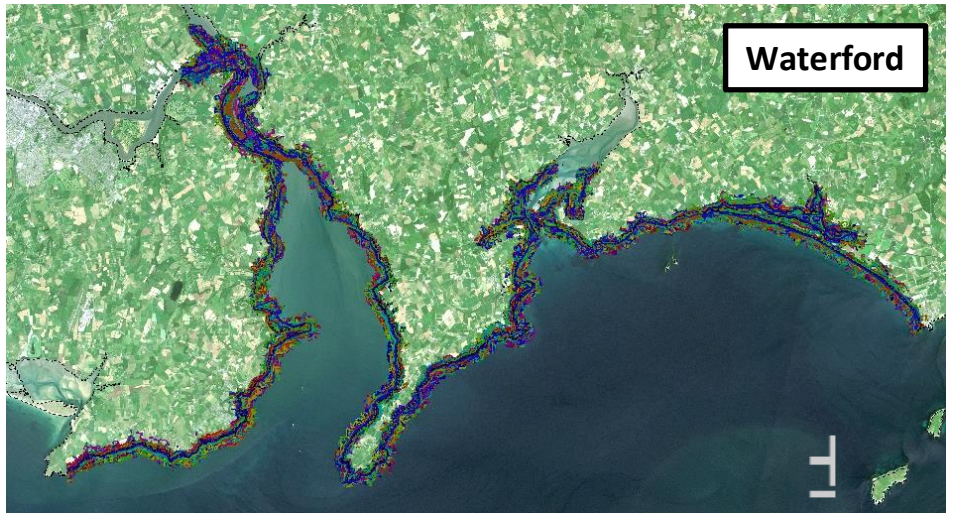


Total number of shorelines OPT



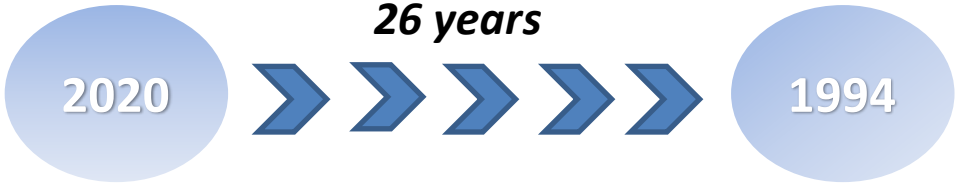
1760

Products

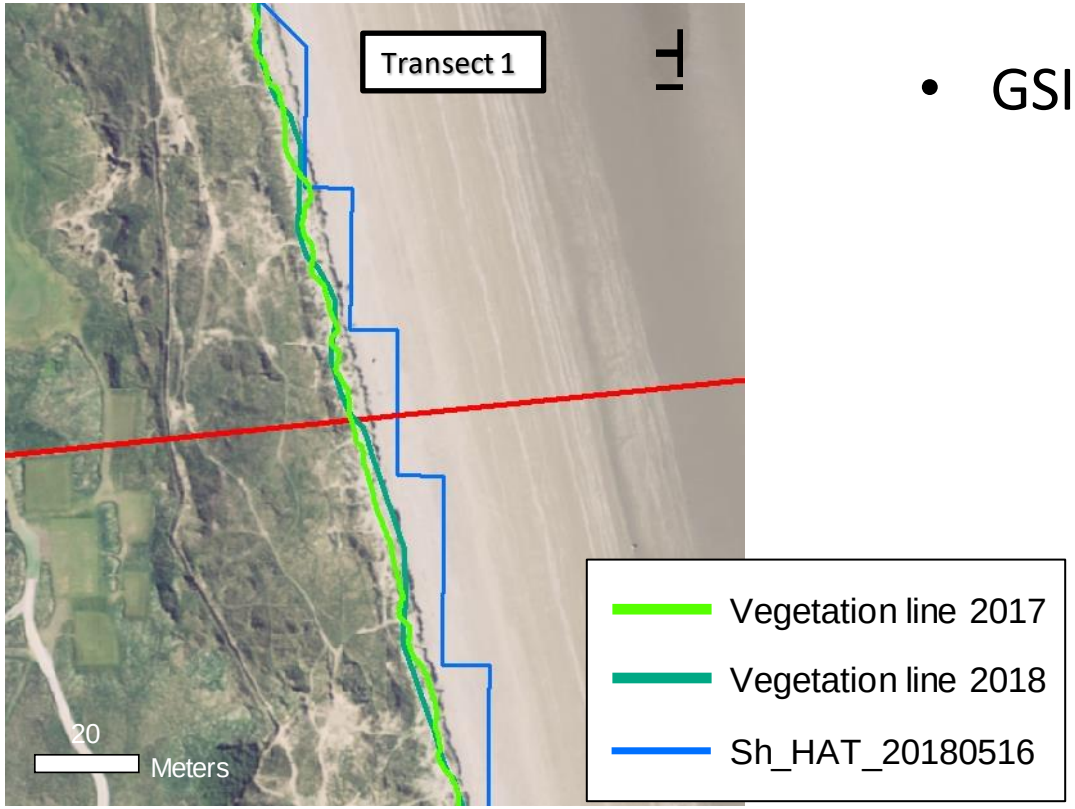


Missions

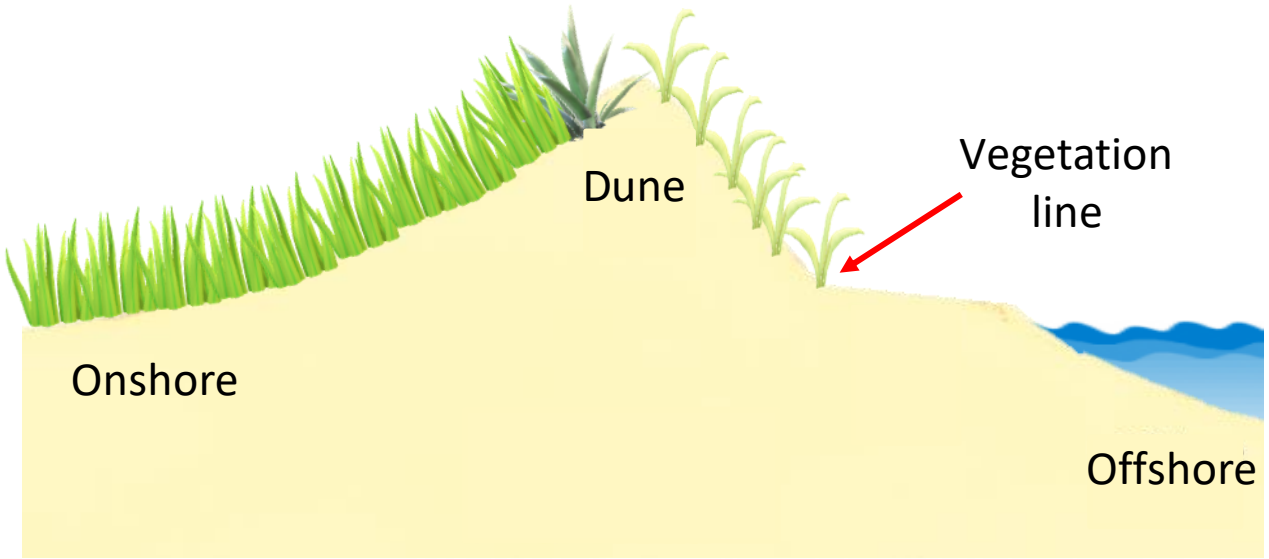
- Sentinel 2
- Landsat 8
- Landsat 5



Shoreline validation vs Vegetation lines



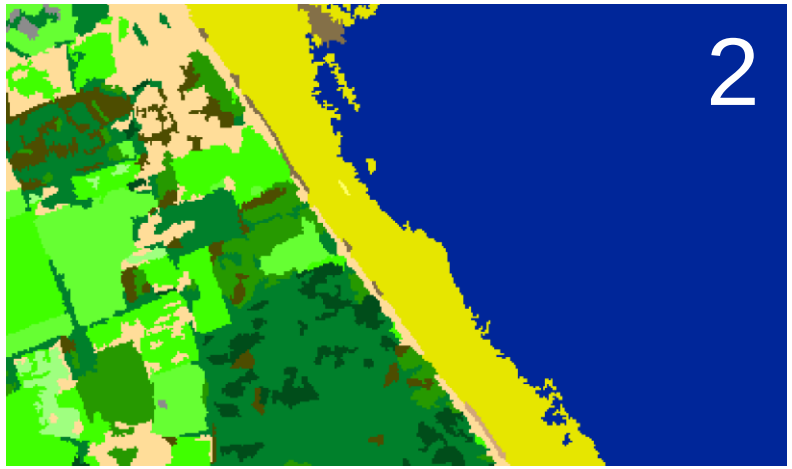
- GSI Vegetation line series from 1995 to 2020

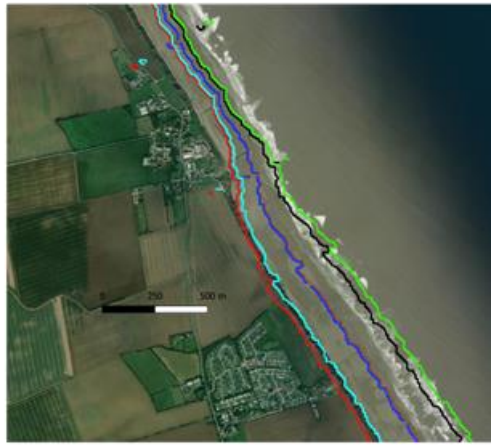


Littoral lines & backshore maps

2D backshore maps are used to delineate the littoral line which helps the QA of WL to SL transformations

Properties at risk at Aldborough, East, England.





S2 | WL | Spurn Head

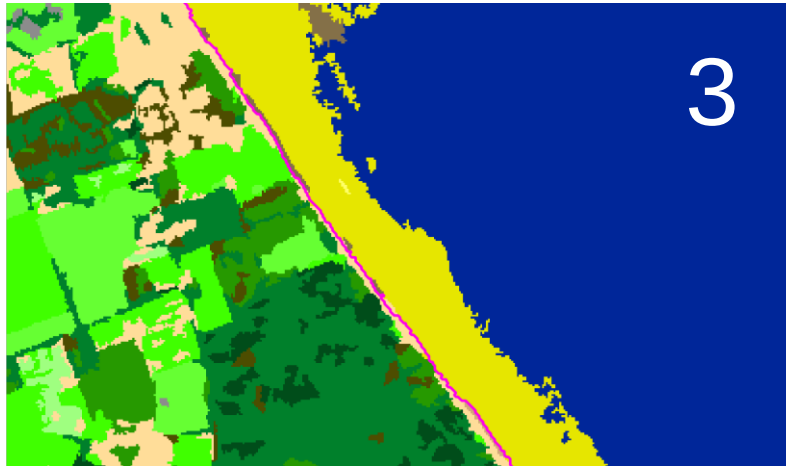
S2 | SL | HAT

S2 | SL | MHWS

S2 | SL | MSL

S2 | SL | MLWS

S2 | SL | LAT



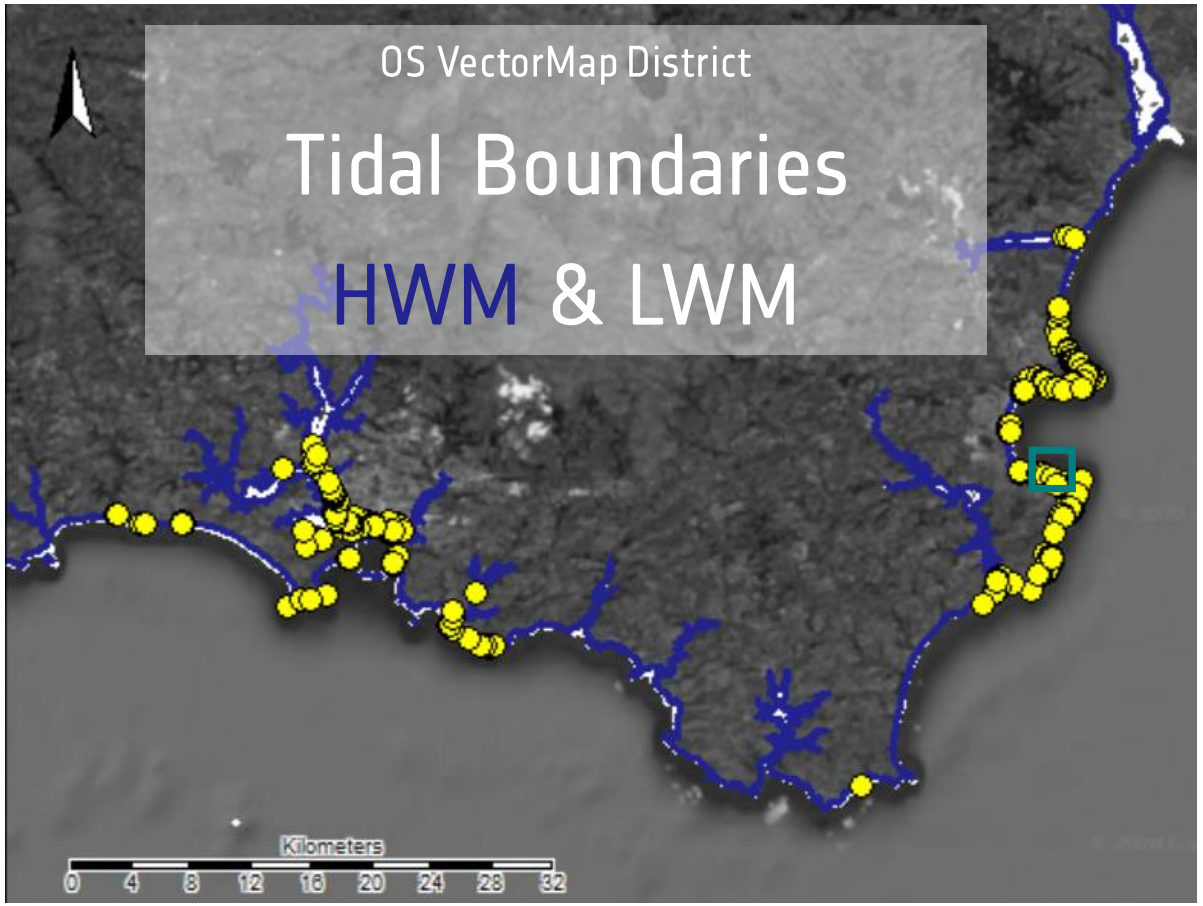
Old missions still require visual QA

Start Bay Area – OS data vs Landsat 8 WL 2016 - 2020

- OS HWM
- OS LWM
- Waterline is generally between the HWM and LWM.
  - Boats mapped as land
  - Pier /harbour breakwater = wider than it is

New methods developed for accuracy assessment: no foreshore approach

As no standard method exist to assess absolute accuracy of waterlines we have chosen points with no foreshore



Accuracy

absolute, relative, geometric fidelity

New methods developed for accuracy assessment: no foreshore approach

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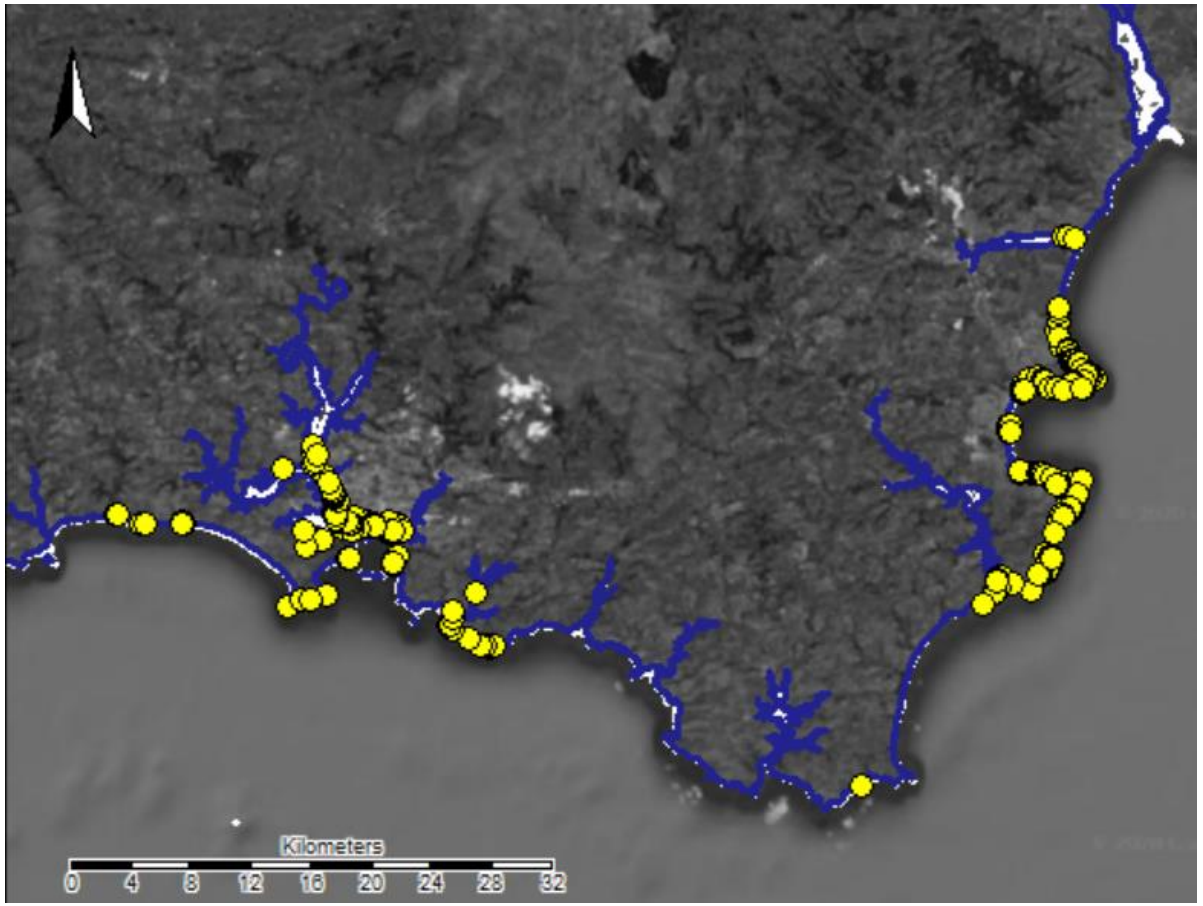
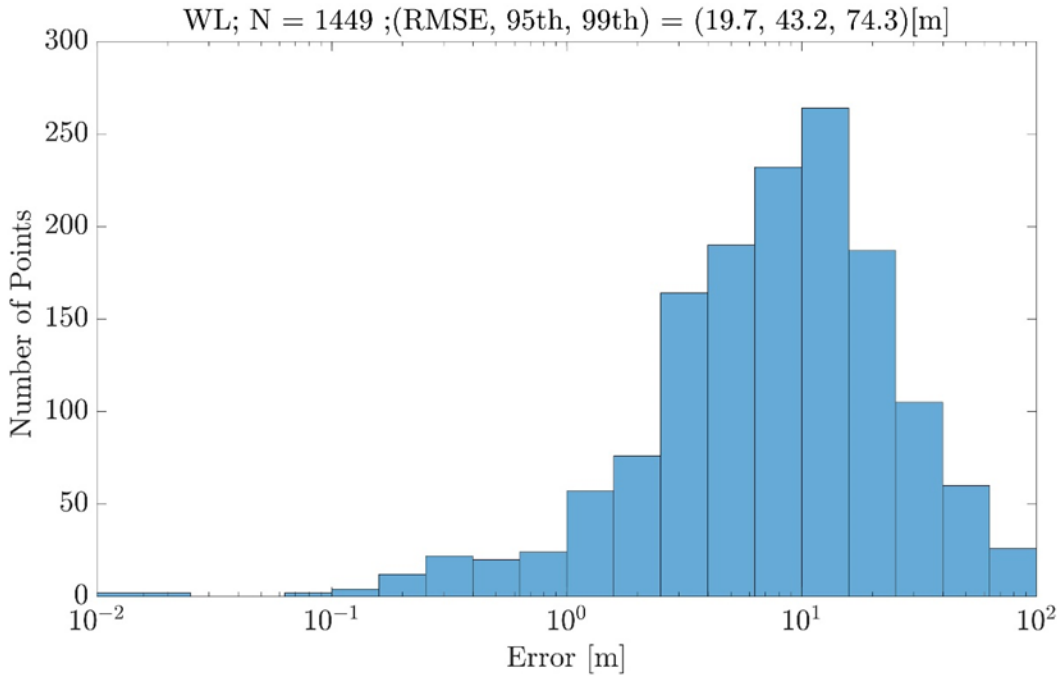


Absolute accuracy



S2 | Start Bay | 2019-10-02

New methods developed for accuracy assessment: no foreshore approach

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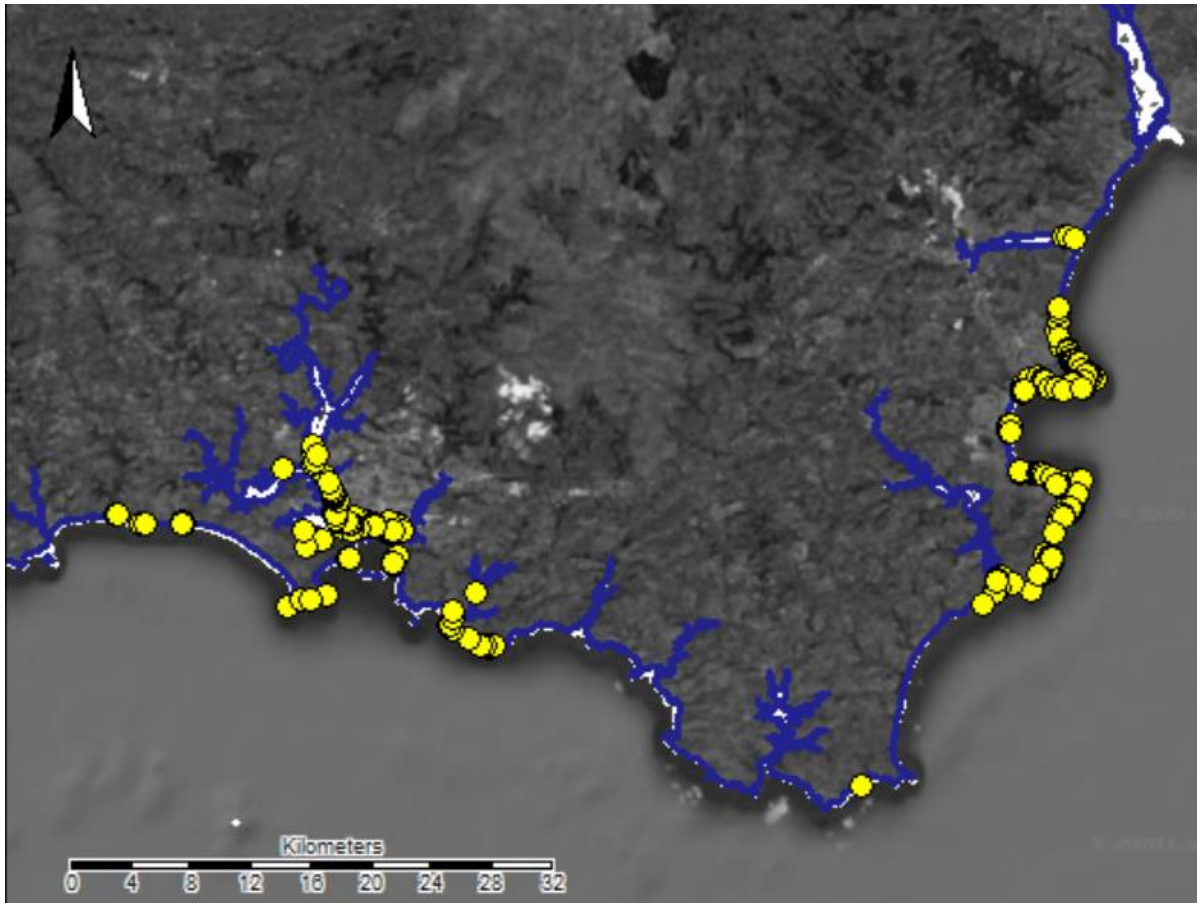
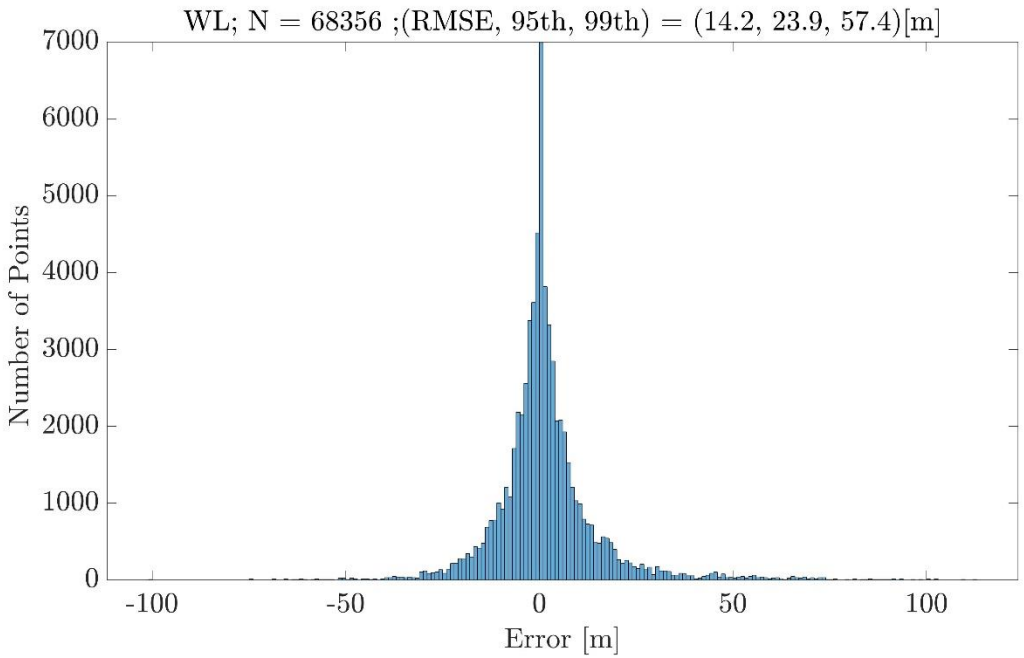
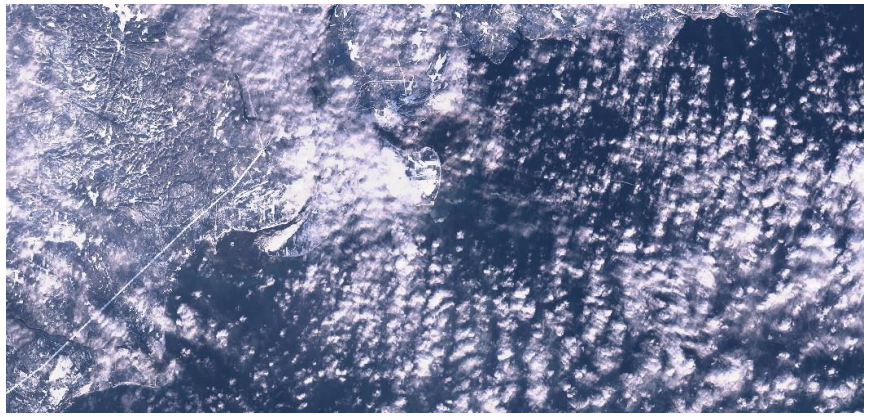


Relative accuracy



S2 | Start Bay | 2019-10-02

OPT WL extracted even in cloudy regions



Iles de la Madeleine:
122 Water lines
183 km

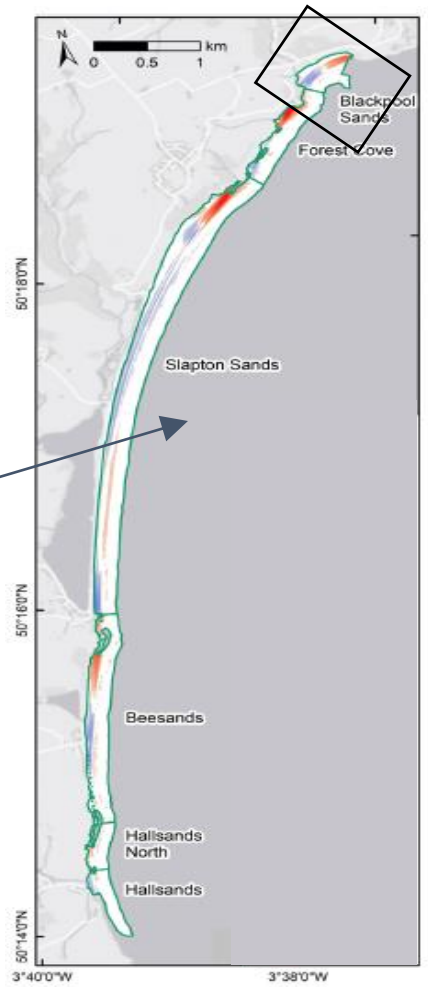
Mingan:
216 Water lines
112 kms

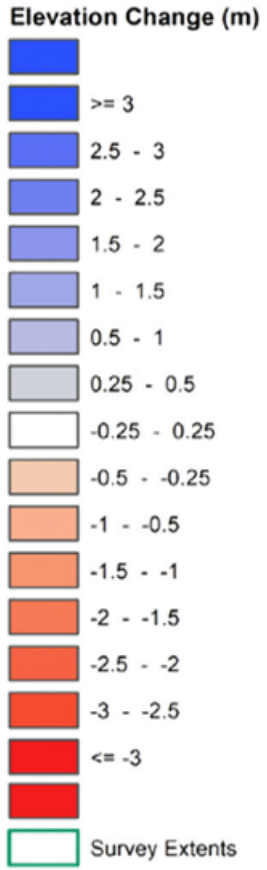
Manicouagan:
233 Water lines
163 kms

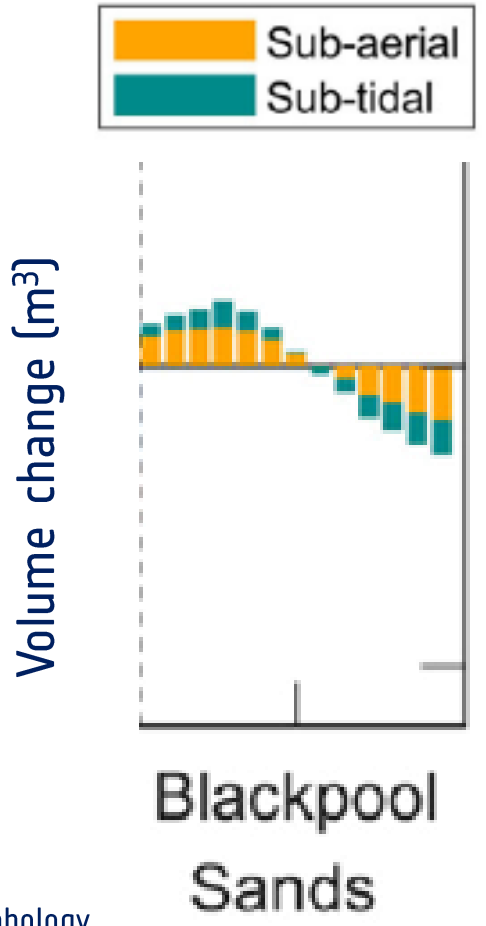
As SAR is transparent to clouds more WL can be extracted

Are SAR waterlines able to capture the observed beach rotation?

Slapton line Road damaged in 2018 causing local traffic disruption.



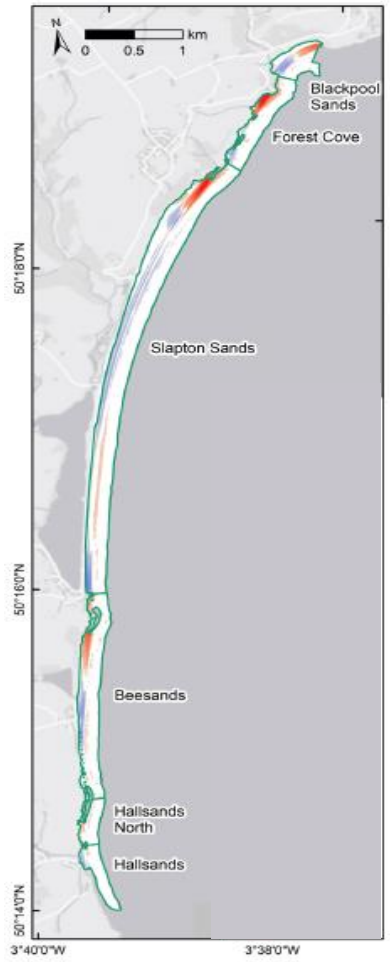


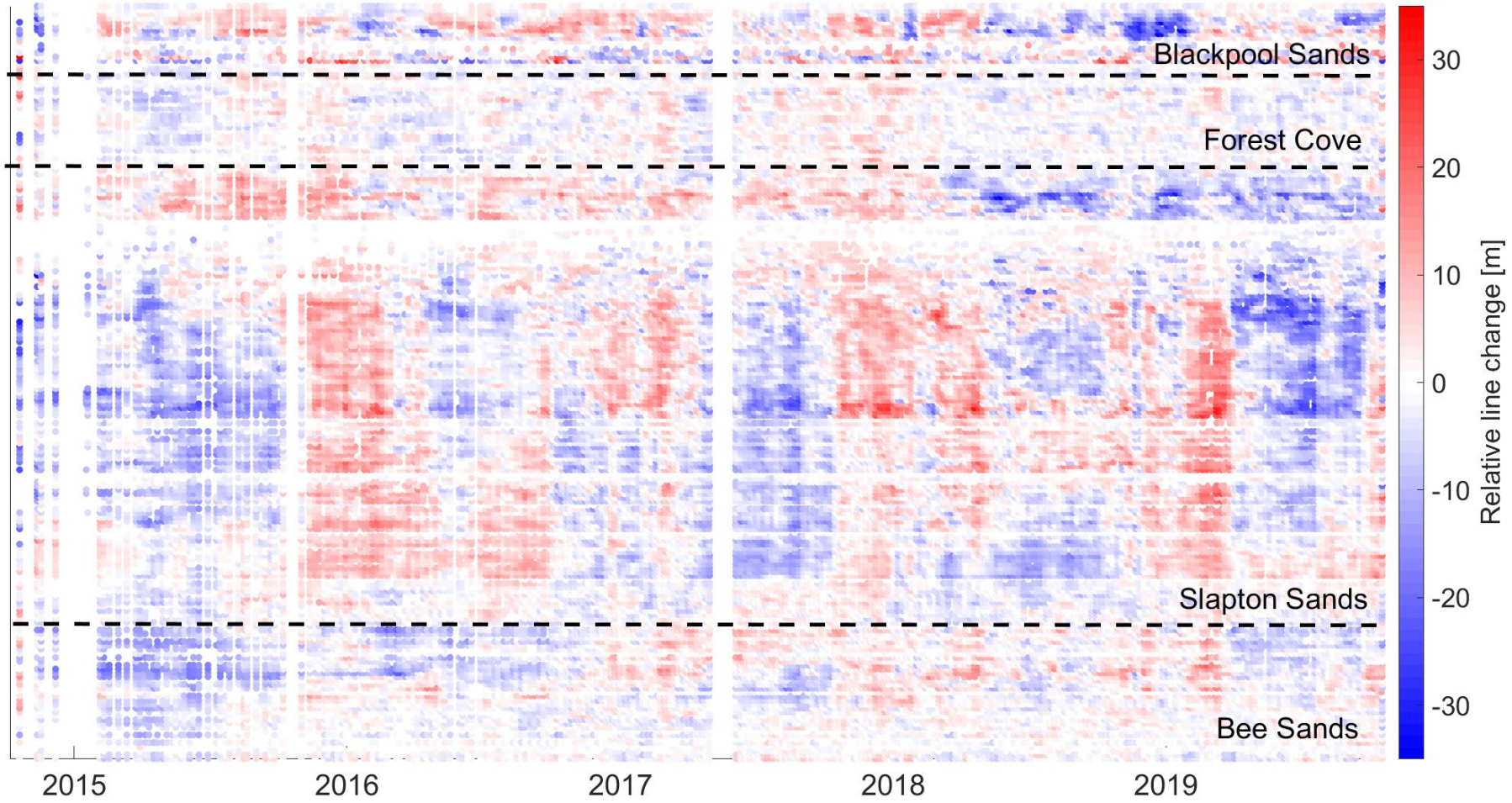


Wiggins et al. (2019) Geomorphology

Are WL SAR able to detect rotation?

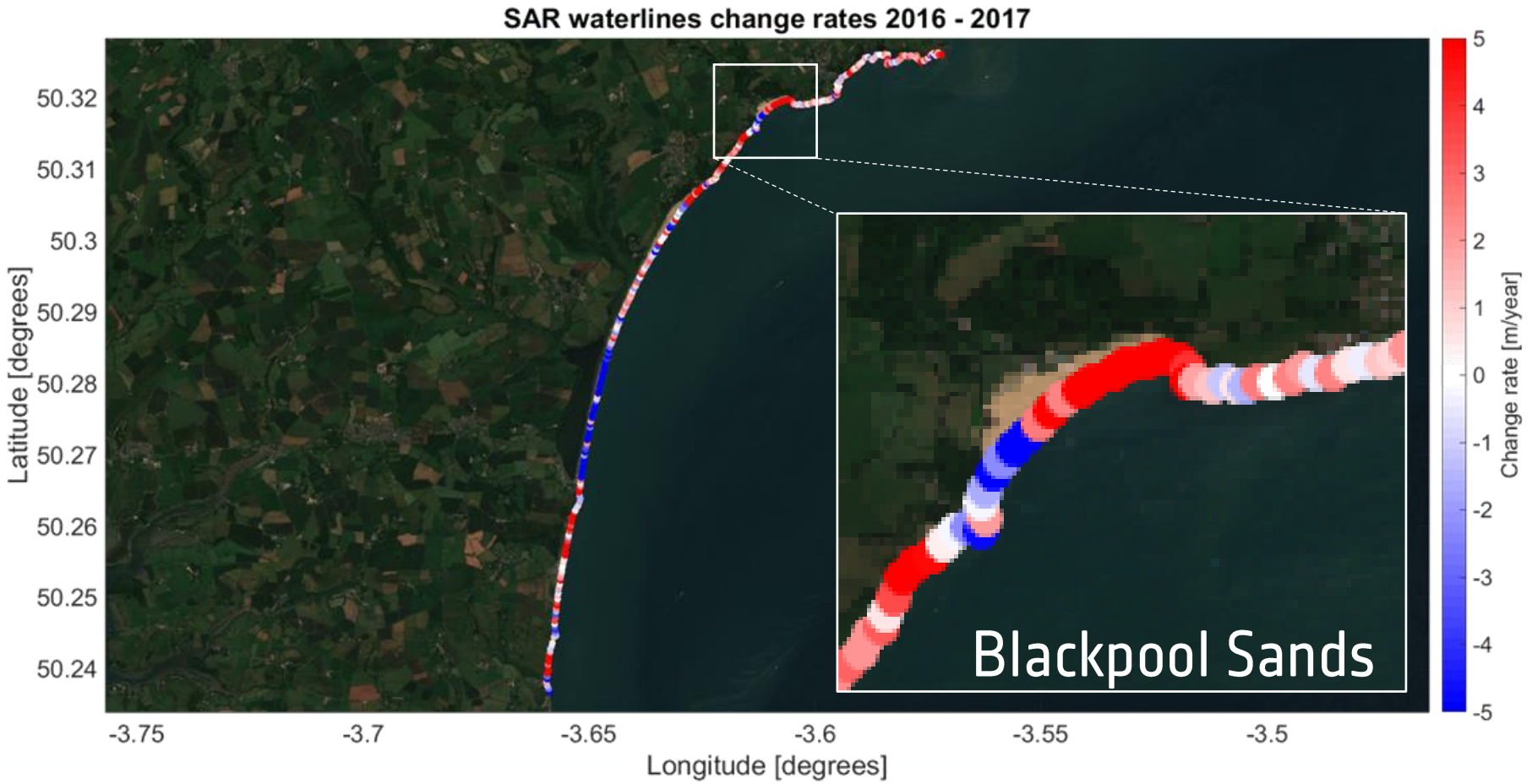
High frequency of SAR waterlines allows a more detailed analysis





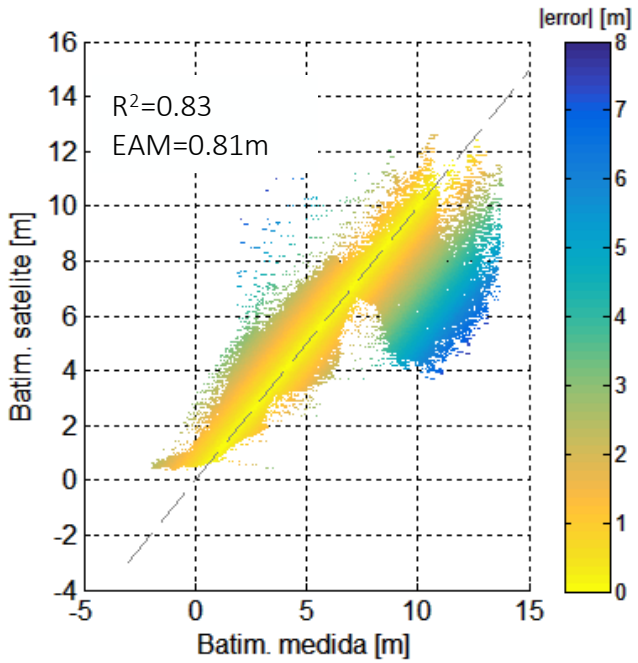
Are WL SAR able to detect rotation?

Rotation is clear when annual mean values of SAR WL for years 2016 and 2017 are used



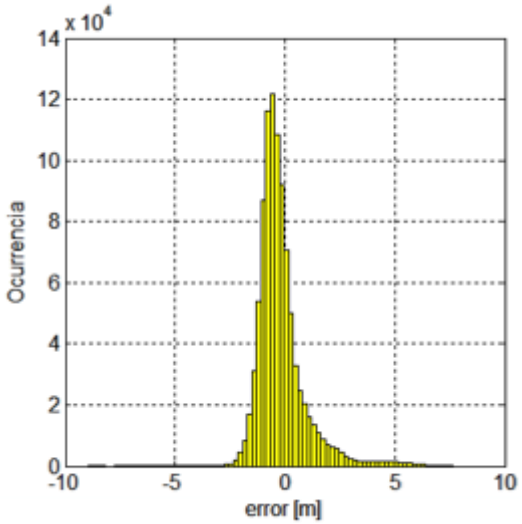
Validation Bathy-Morpho Terrain Model

Example of results from Barcelona



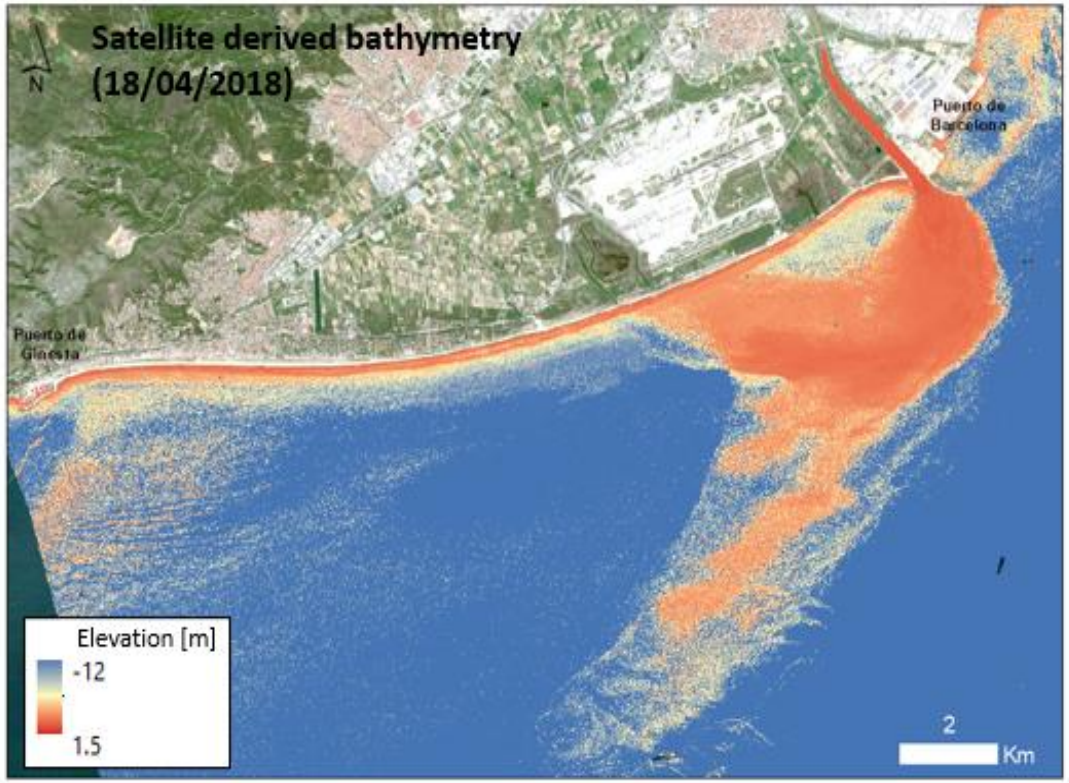
Mean absolute error:

$$MAE = 0.81\ m$$



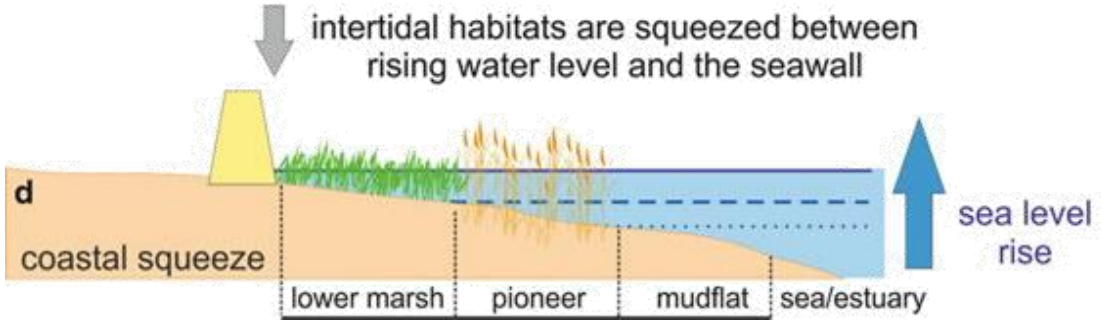
Confidence metadata prevent miss-interpretation: i.e. sediment plume

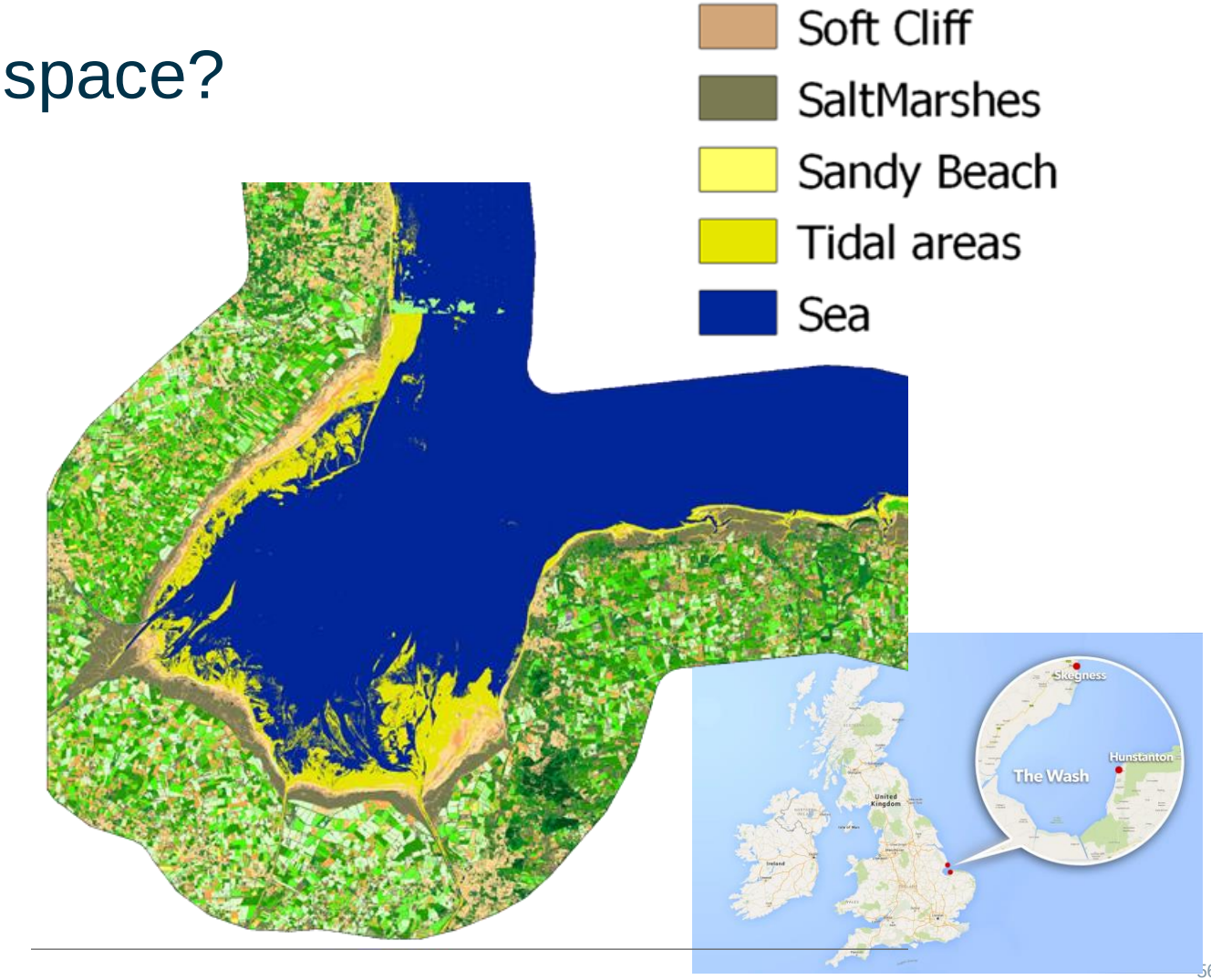
Confidence index



We are still exploring the potential of all EO products produced

Observing costal squeeze from space?





Thanks for your attention!

10th December 2020, recorded sessions here

17th November 2020, recorded sessions here

30th Nov, 14th December 2020, recorded sessions here

7th Dec 2020 recorded sessions here