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Research excellence supporting a sustainable ocean

Machine Learning in Marine Research at PML, UK

David Moffat

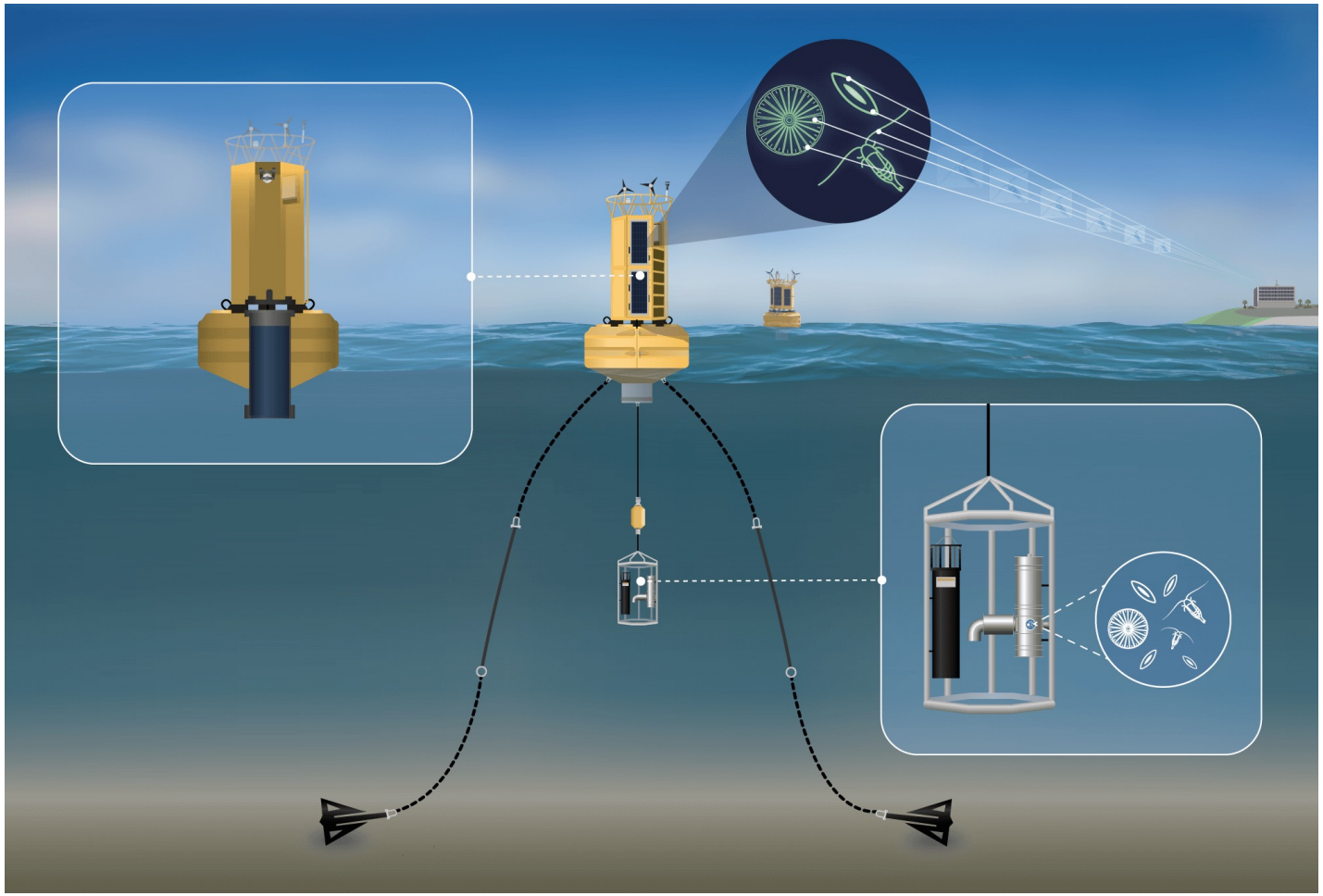
National Centre for Earth Observation
NATURAL ENVIRONMENT RESEARCH COUNCIL

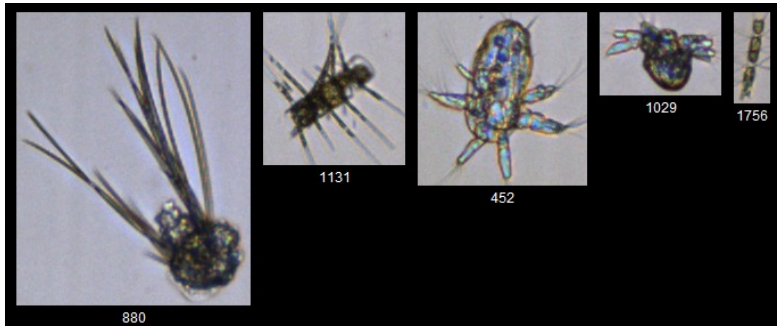
NEODAAS
NERC Earth Observation Data Acquisition and Analysis Service

UKRI Natural Environment Research Council

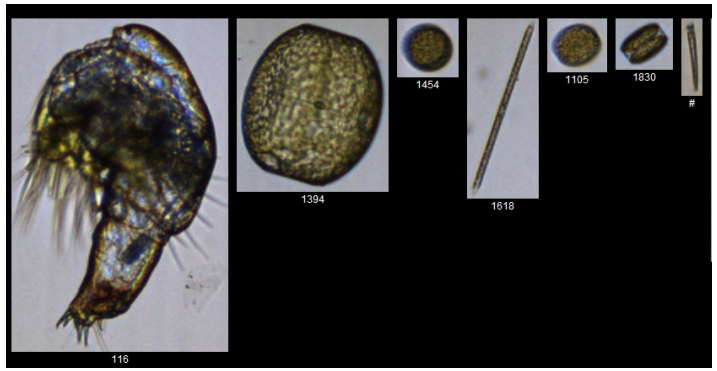
Few-Shot learning for the identification of FlowCam plankton images

Elaine Fileman, Jim Clark, Anjan Dutta, Oliver Fawcett





APICS project performing on the fly classification of plankton taxa
Using **few shot learning** approach
Building pipelines for measuring plankton quantity and matching up with Satellite Imagery



Detection and Classification of Floating Plastic Litter Using a Vessel-Mounted Video Camera and Deep Learning

- Detect floating plastic litter
- Apply to ship mounted camera
- Scale to range of different platforms
- Investigate embedded system, for real time classification
- Using YOLO algorithm – Convolutional Neural Network

Armitage, S., Awty-Carroll, K., Clewley, D., & Martinez-Vicente, V. (2022). Detection and Classification of Floating Plastic Litter Using a Vessel-Mounted Video Camera and Deep Learning. *Remote Sensing*, 14(14), 3425.

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Pacific Oysters Detection Using Drones

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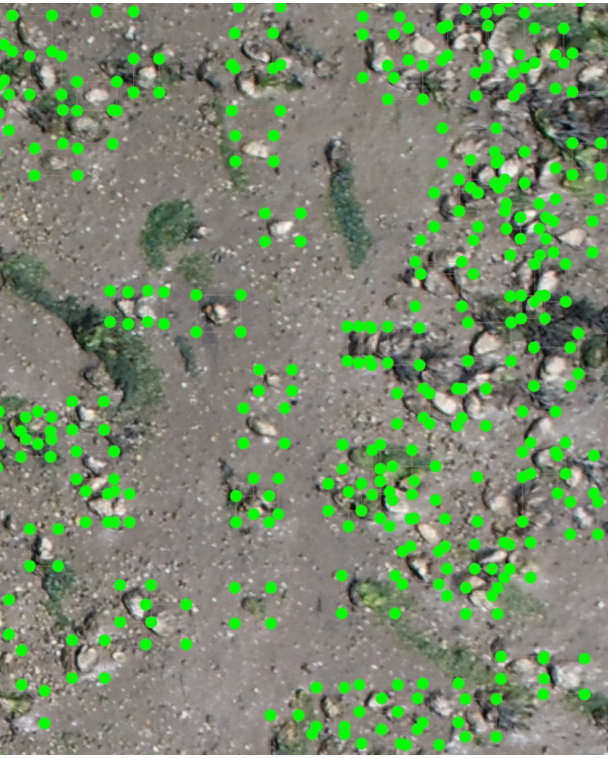
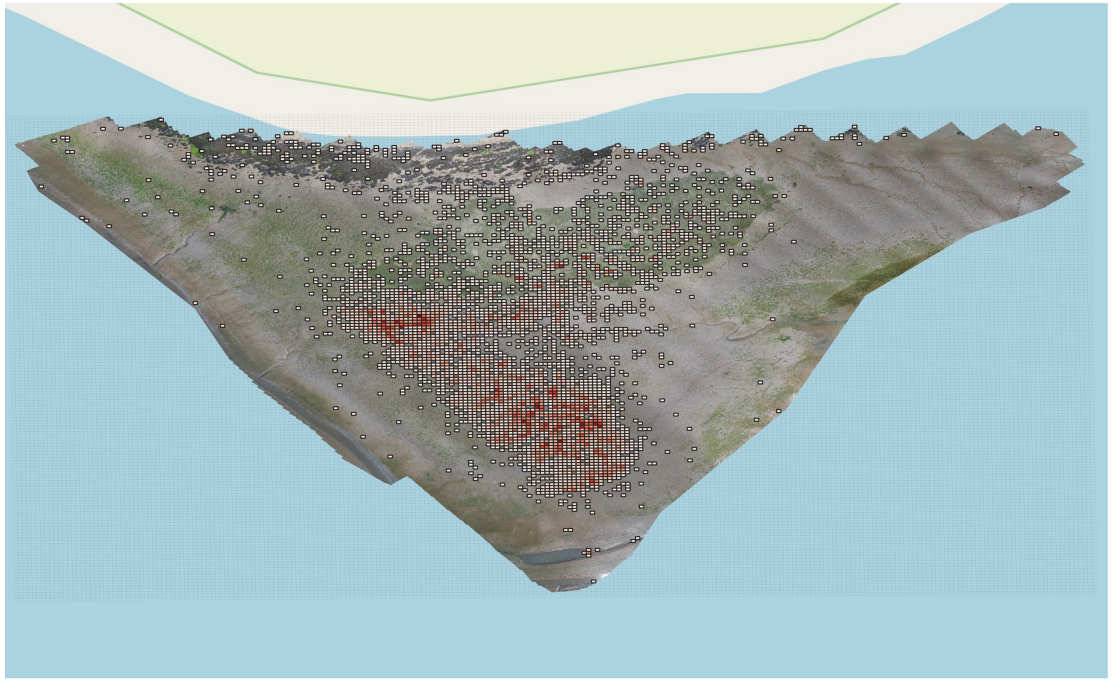
Aser Mata, William Jay, Katie Awty-Carroll, Ollie Thomas, David Moffat, Silvia Almeida and Nigel Mortimer

Several sites have been reported in unfavourable condition, due to the alteration of the biotopes, and therefore the loss of original species and biotopes which make up the protected habitat features. If unmanaged the expansion of dense Pacific oyster populations will most likely reduce the extent of the sites and could reduce species richness and change community composition, as well as their diversity.

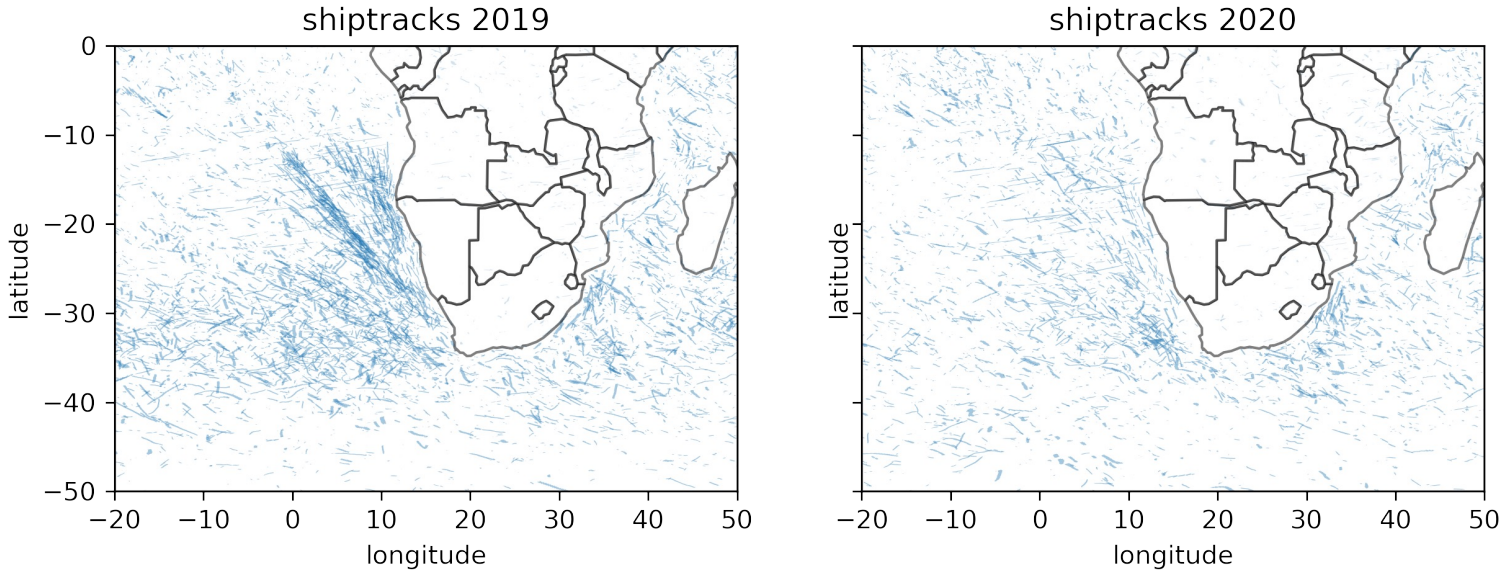


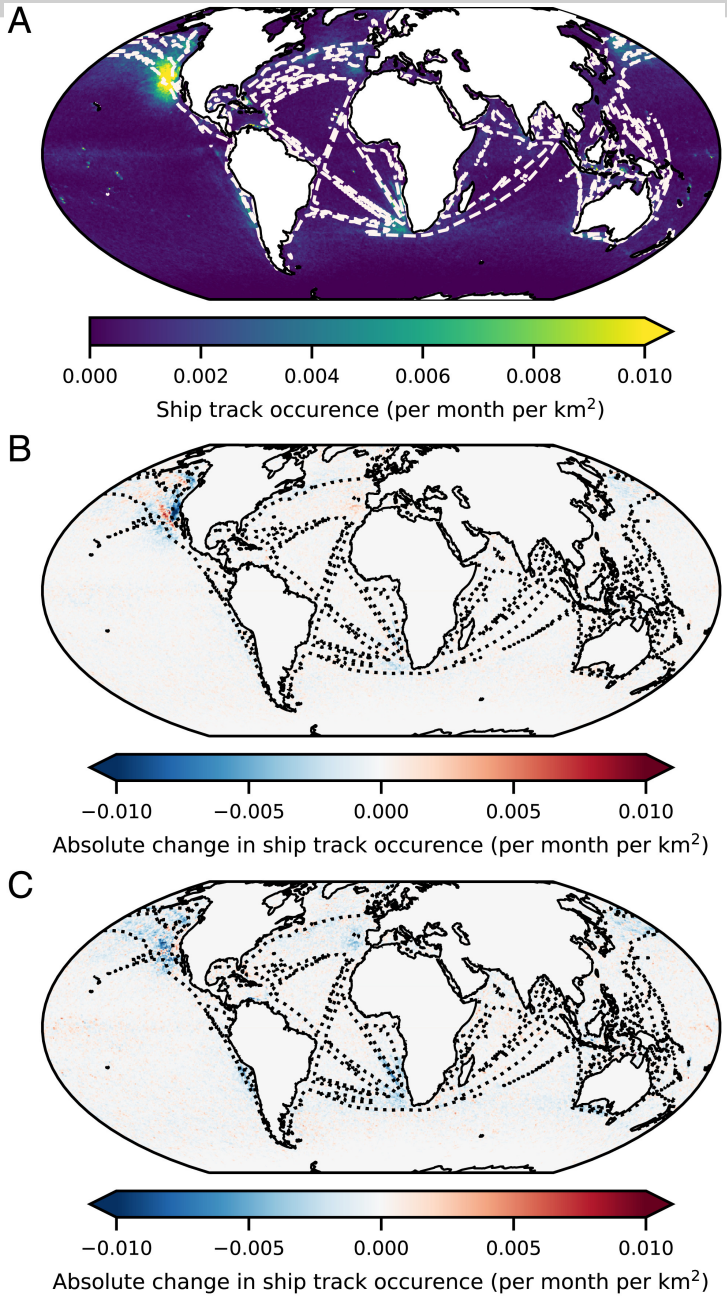
Collapit Creek, Pacific Oysters population (1m x 1m grid)



Detection of ship tracks

Duncan Watson-Parris, Angus Laurenson, Dan Clewley





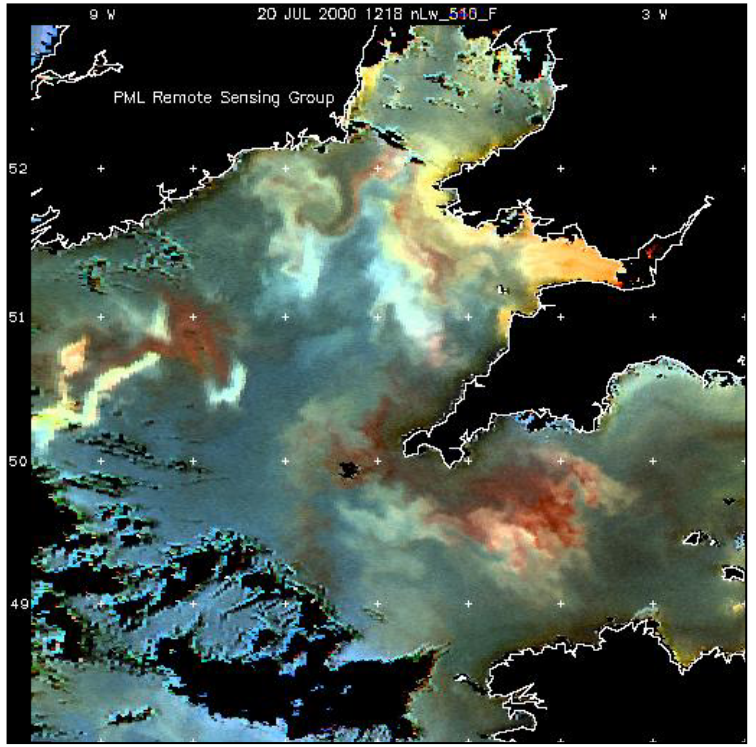
Nitrate aerosols are release from ship exhausts every day. Under certain conditions, they can seed bright clouds that trail from the ship, known as "shiptracks". We measured these clouds using satellite imagery and discovered that there is a visible drop from 2019 to 2020, due to a change in ship fuel regulations that reduced the nitrogen content allowed in fuel world-wide.

Watson-Parris, Duncan, Matthew W. Christensen, Angus Laurenson, Daniel Clewley, Edward Gryspeerdt, and Philip Stier. "Shipping regulations lead to large reduction in cloud perturbations." *Proceedings of the National Academy of Sciences* 119, no. 41 (2022): e2206885119.

Deep learning detection of Harmful Algal Blooms

Silvia Pardo, David Moffat, and Gavin Tilstone

- Harmful algal blooms are rare but distinct events
- We use a **contrastive learning** approach to compare two images and measure how similar they are.
- Learn general images of the ocean (OLCI 2017 – 2021)
- Identify unique signature of each image
- Compare two images and measure how similar they are
- Approach works with limited data and rare events



Karenia mikimotoi & *Noctiluca scintillans* in English Channel (20 Jul 2000)

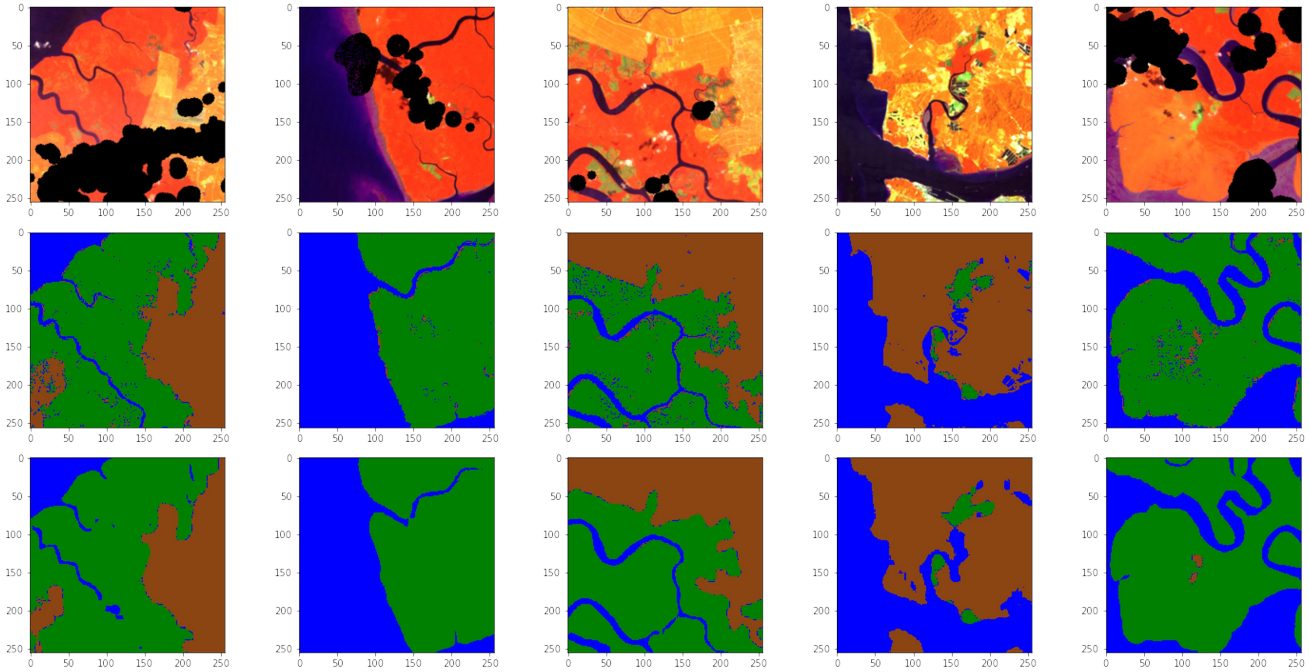
Global Mangrove Monitoring

Bunting, Awty-Carroll, Clewley

False colour image

GMW (training)

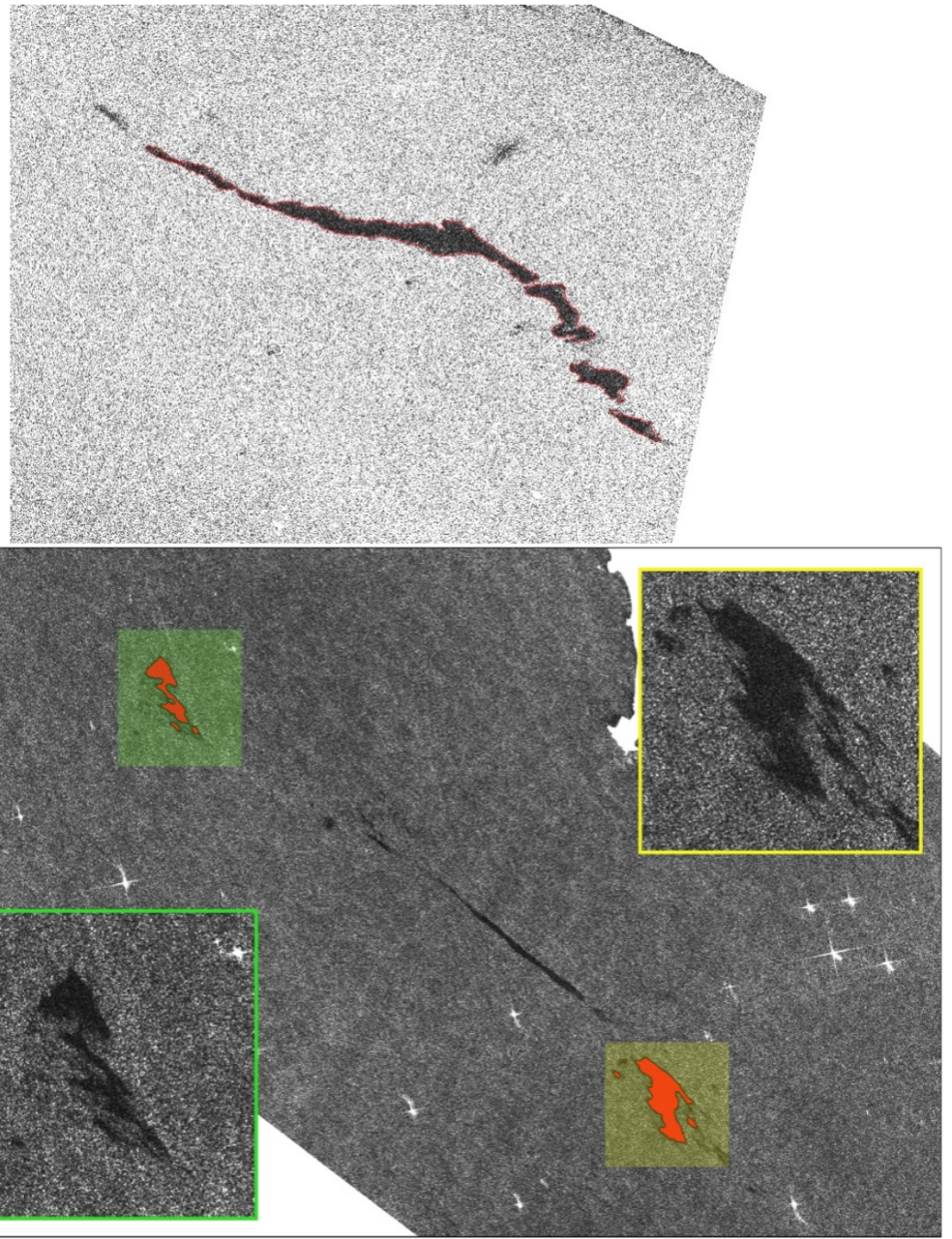
U-Net Classification



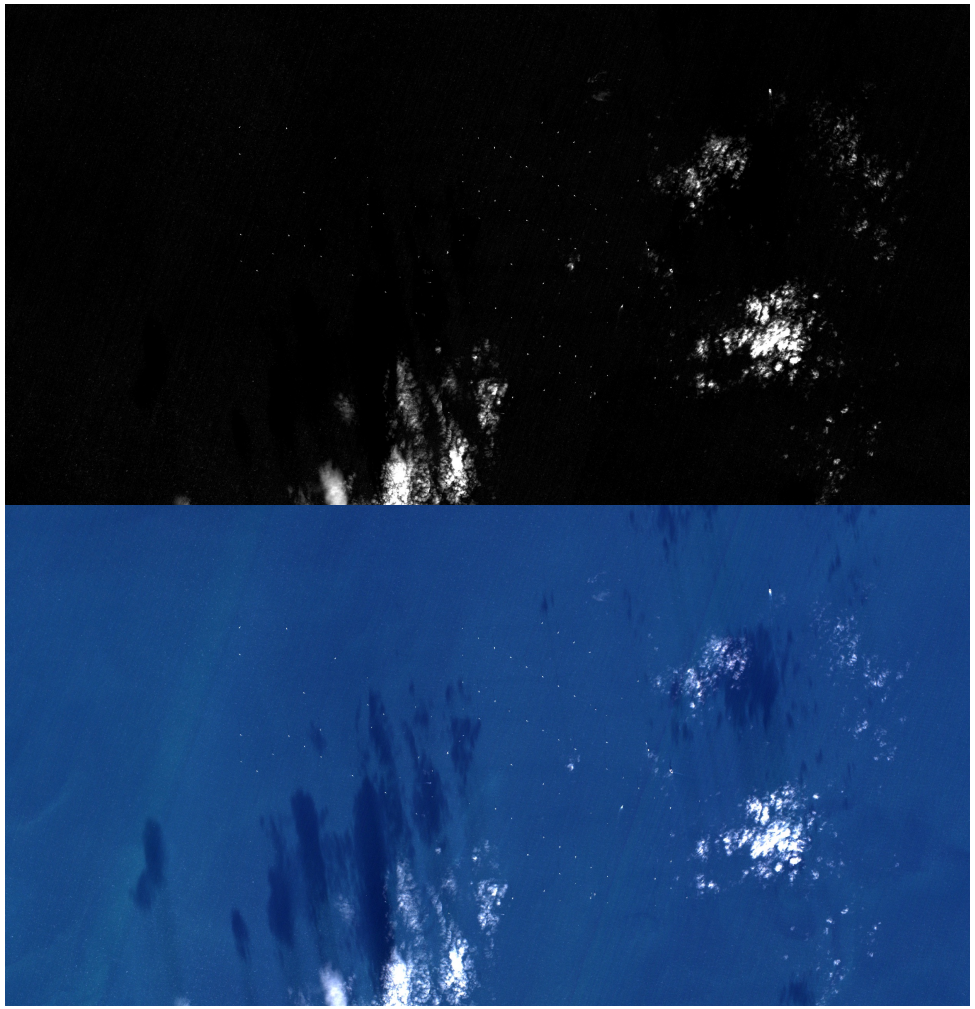
Developing deep learning approaches to classify and track mangroves, globally. Using training data from Global Mangrove Watch, the AI approach allows higher spatial and temporal resolution tracking of mangroves, particularly in challenging areas.

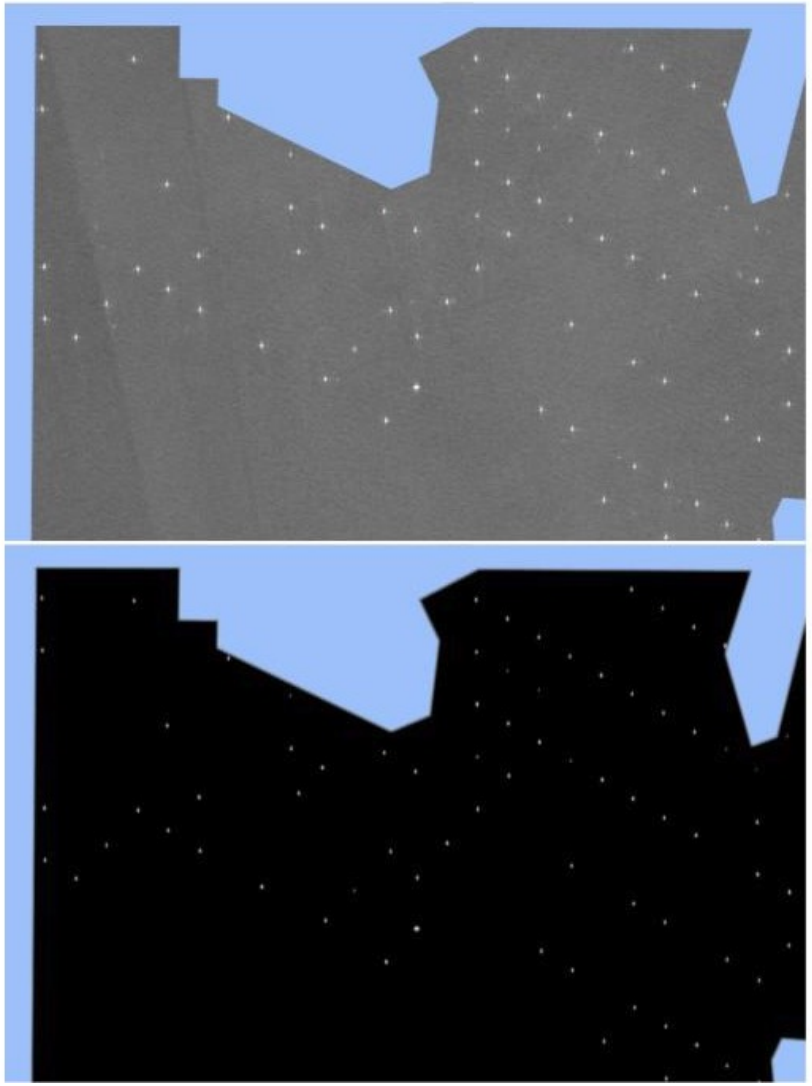
Oil Spill Detection

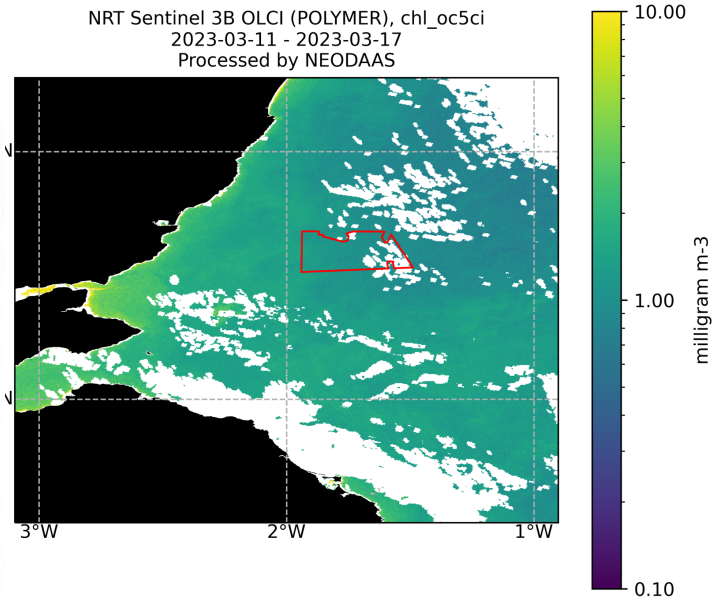
Plymouth Marine Laboratory have developed a ML approach to automatically detect oil spills in SAR satellite data, which we have tested out for operational use off the west coast of Africa.



Offshore Windfarm Monitoring





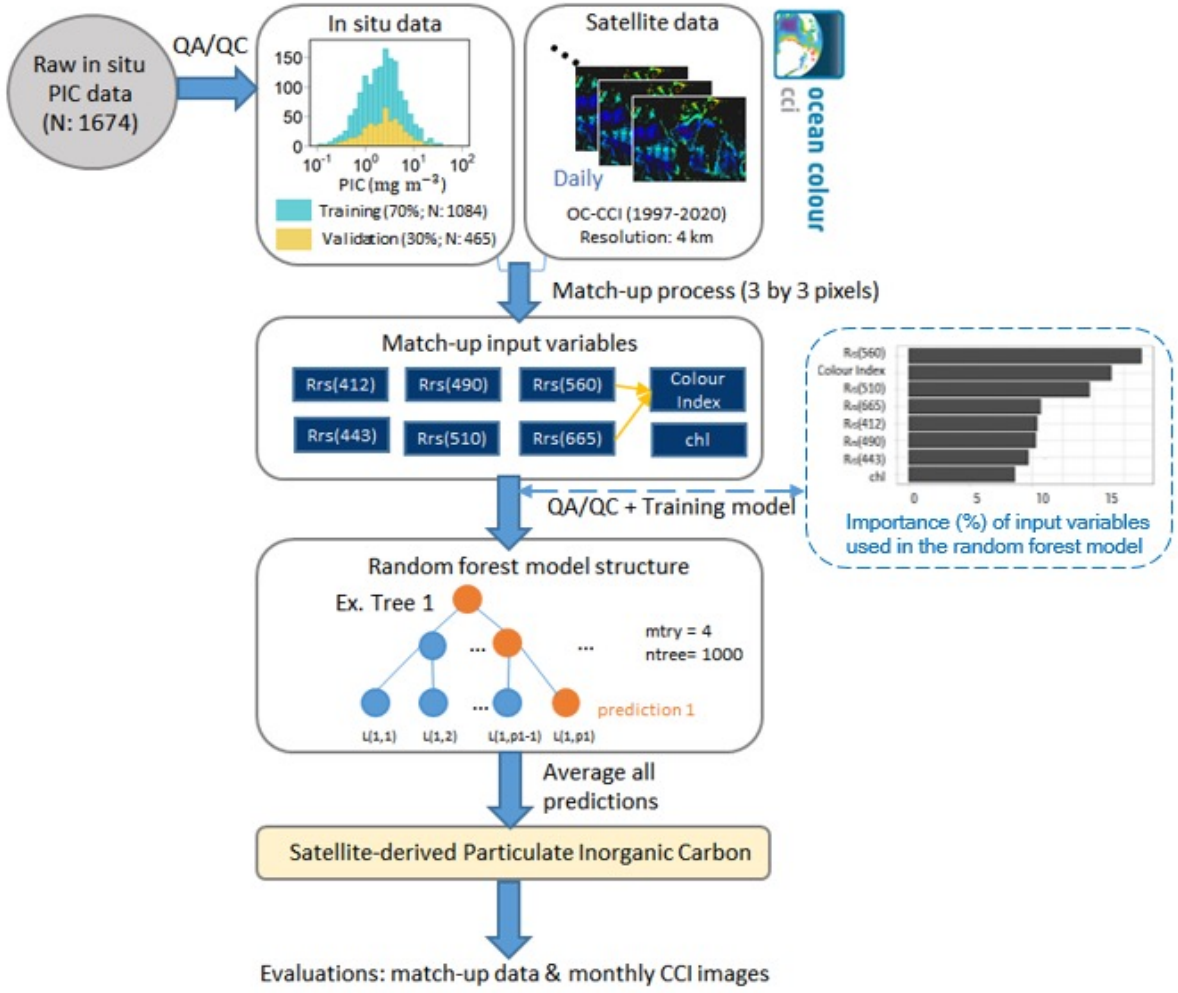


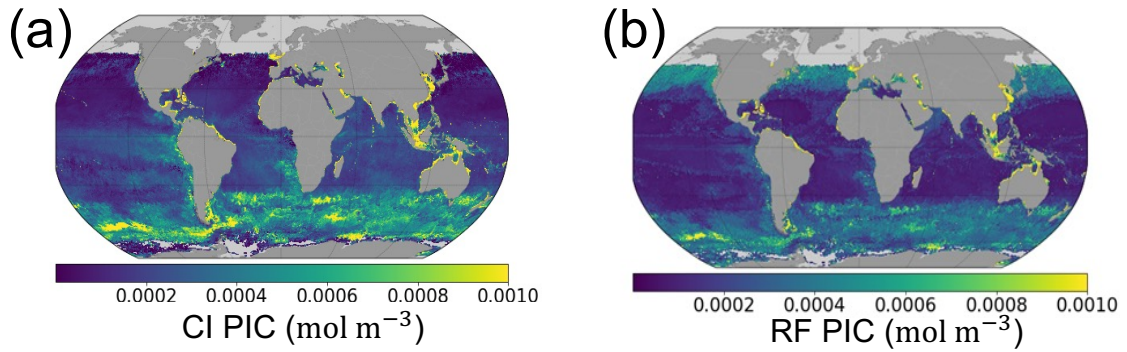
Monitoring the development of windfarms over time around UK Coast

Develop ESA product of Particulate Inorganic Carbon

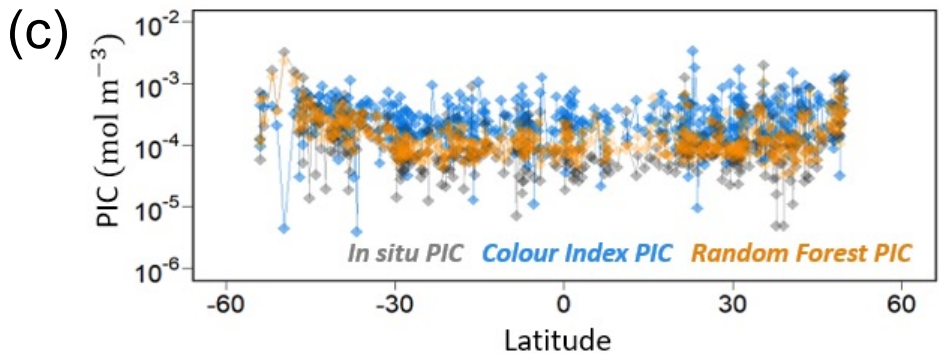
https://oceancarbonfromspace2022.esa.int/

ML Derived PIC





Spatial maps of (a) colour-index-derived PIC, and (b) random-forest-derived PIC using a monthly OC-CCIv5 data (Dec. 2020).

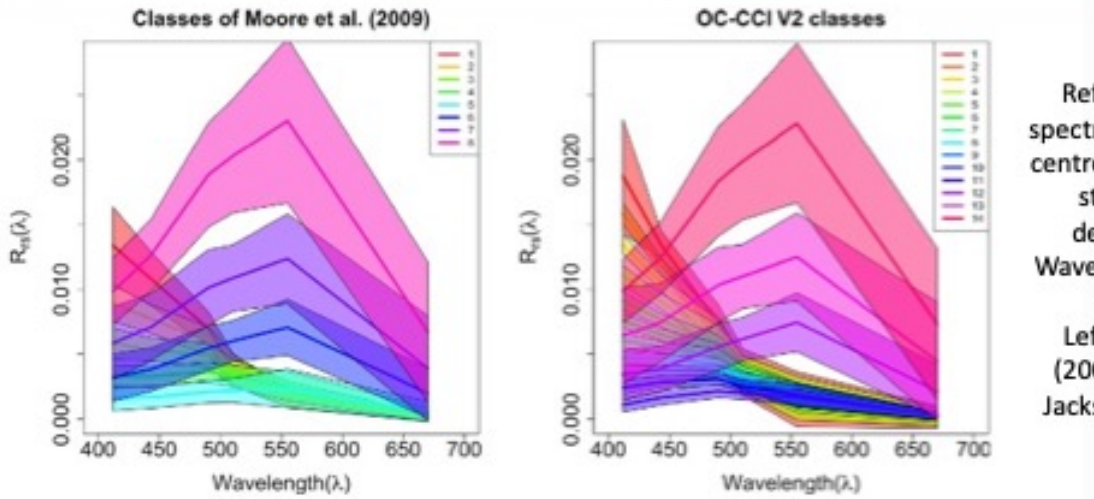


Scatter plot of in situ PIC, colour index-derived PIC (Mitchell et al., 2017), and random-forest–derived PIC match-up data versus latitude of mean AMT cruise tracks.

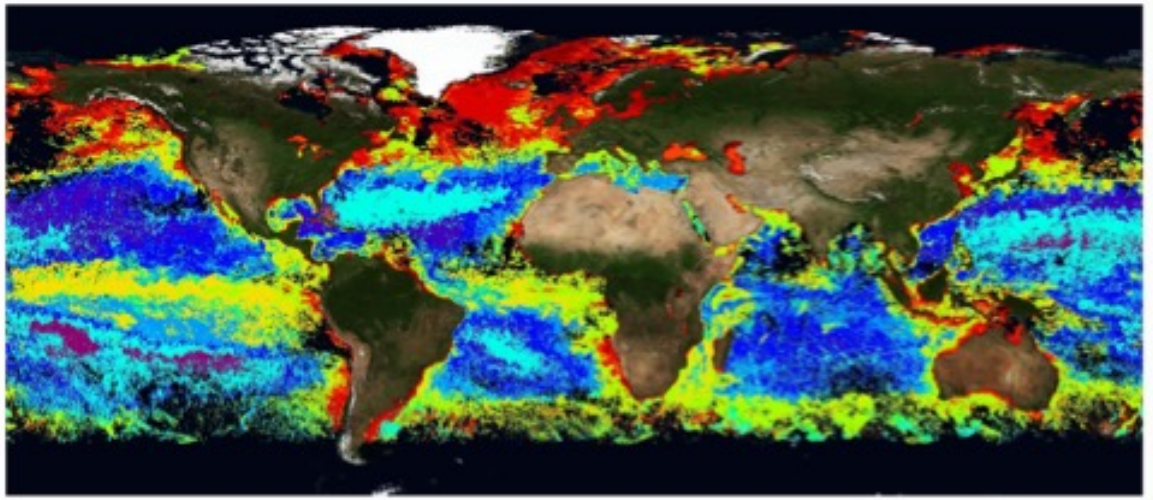
BOOMS - Biodiversity in the Open Ocean: Mapping, Monitoring and Modelling

Optical Water Type (OWT)

- Fuzzy clustering (c-means)
- Fitted (automated) to a representative sample of ocean colour reflectance data
- Applied to reflectance data at global scale
- Each spectrum has a degree of membership to every cluster
- Dominant cluster loosely segments the ocean into regions with similar reflectance



Reflectance spectra of cluster centres and their standard deviation. Wavelength is in nm.
Left) Moore (2009) Right) Jackson (2017)



Dominant optical waterclass per pixel, OC-CCI v5.0 data. 8-day composite image of June 2nd to June 10th 2019.

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Are there any questions?

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