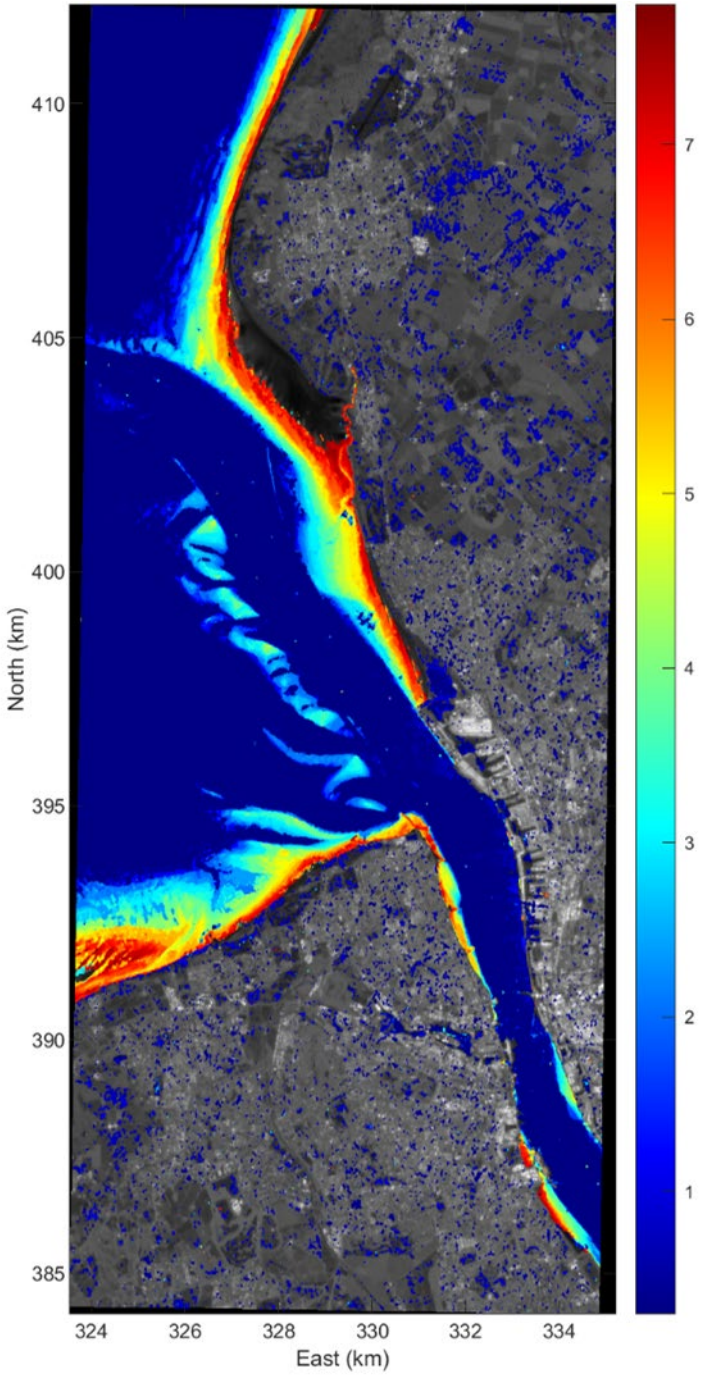
National Oceanography Centre

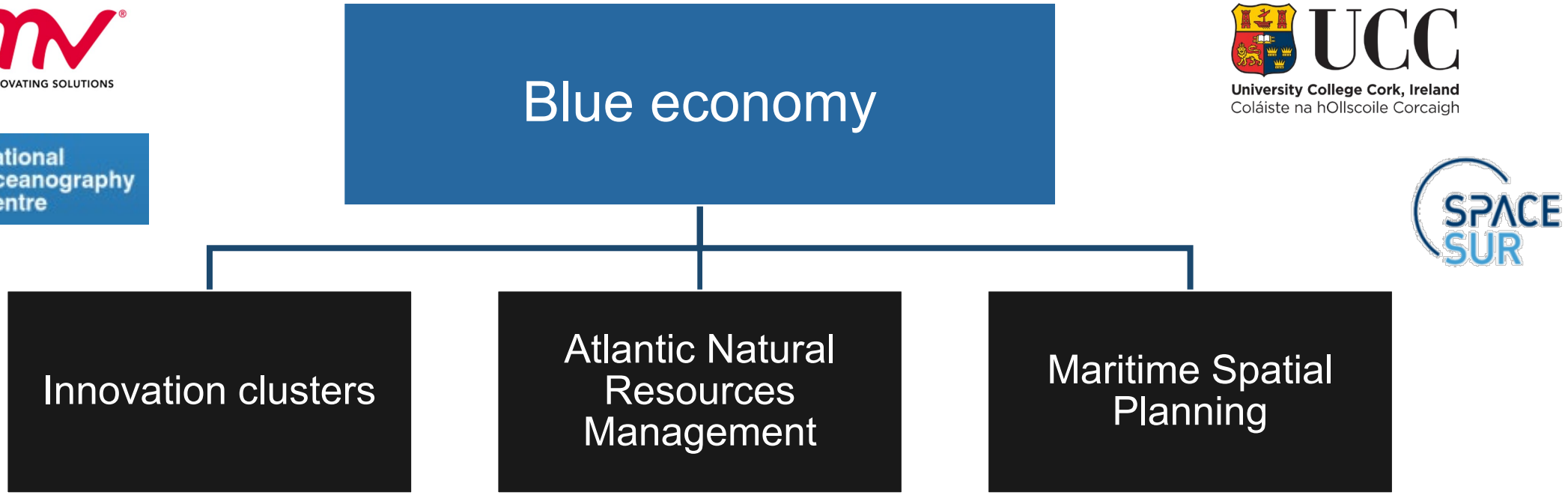
Inter-tidal bathymetry mapping from Sentinel-1 SAR using the temporal waterline method - UK case studies

Clive Neil, Paul Bell, Christine Sams

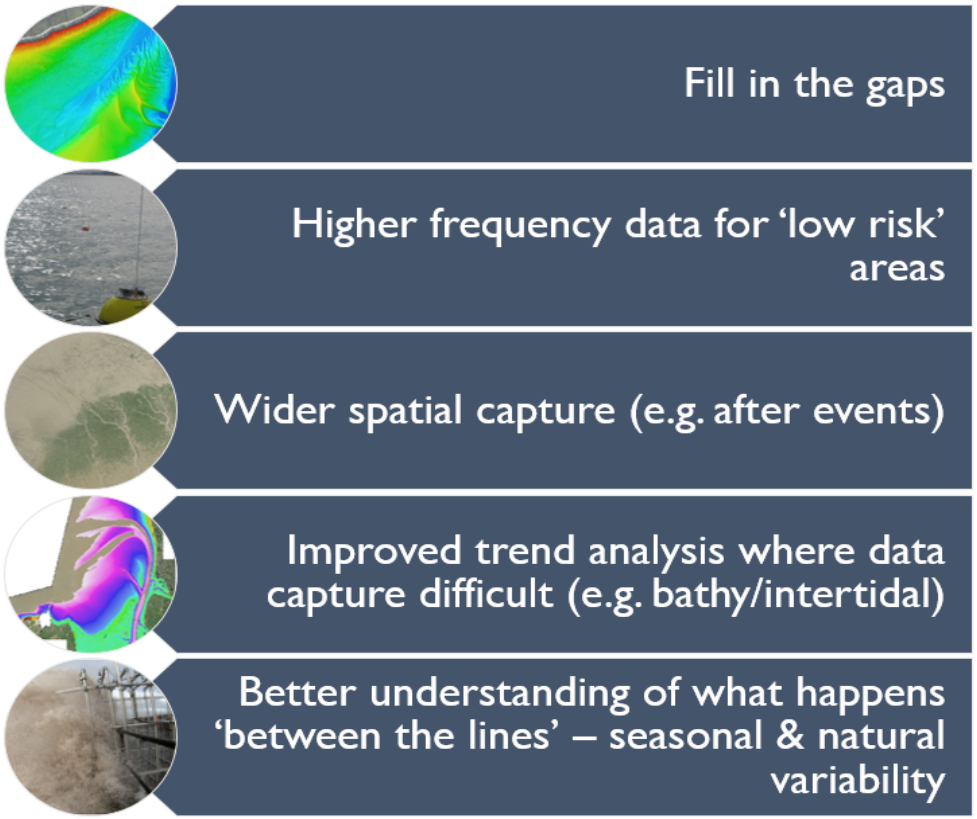


ESA Blue Economy: Innovation Clusters, Atlantic Natural Resources Management and Maritime Spatial Planning

Project is part of the **ESA Atlantic Regional initiative** providing insights and solutions in the **Blue Economy topic**

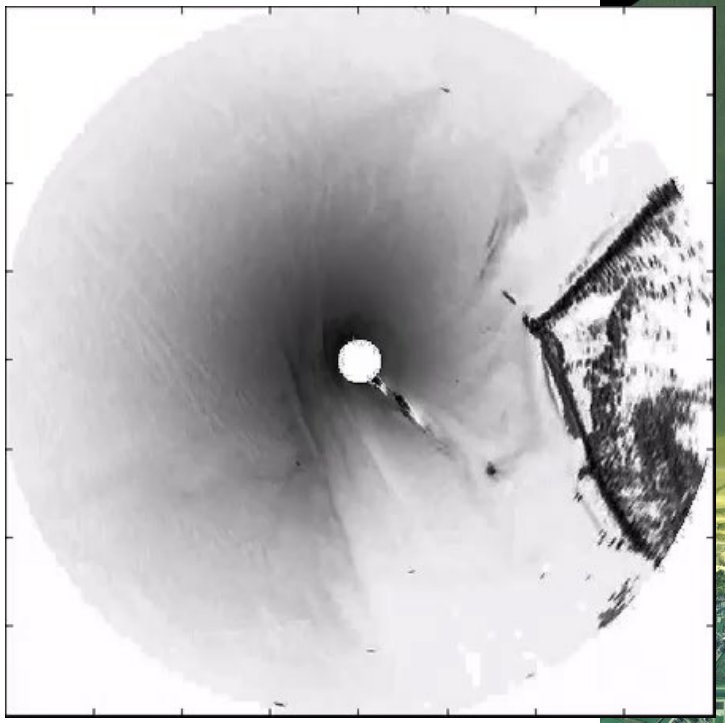


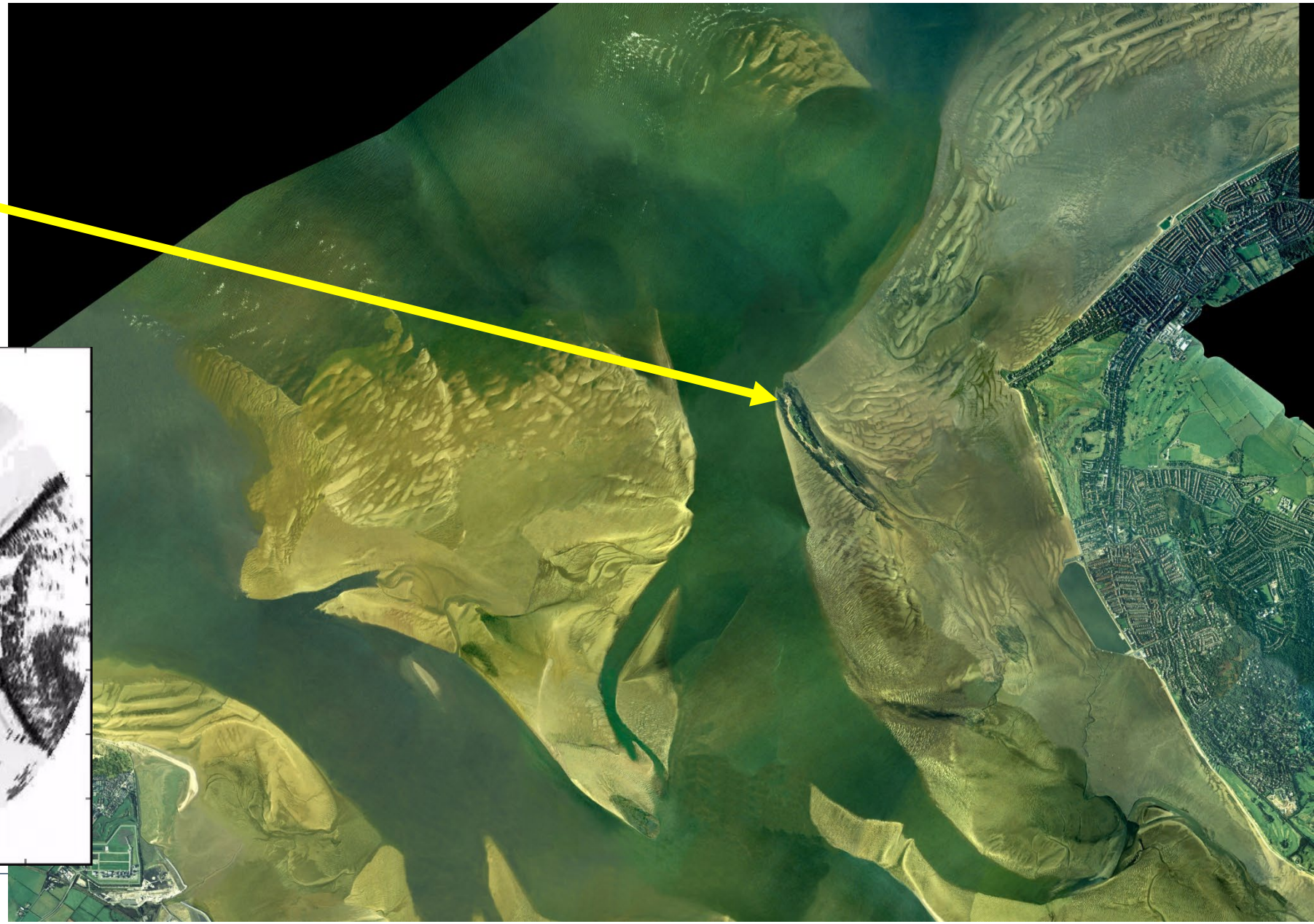
Context



We started with a question: *Is there a role for EO services in the coastal monitoring programmes of England and Wales ?*

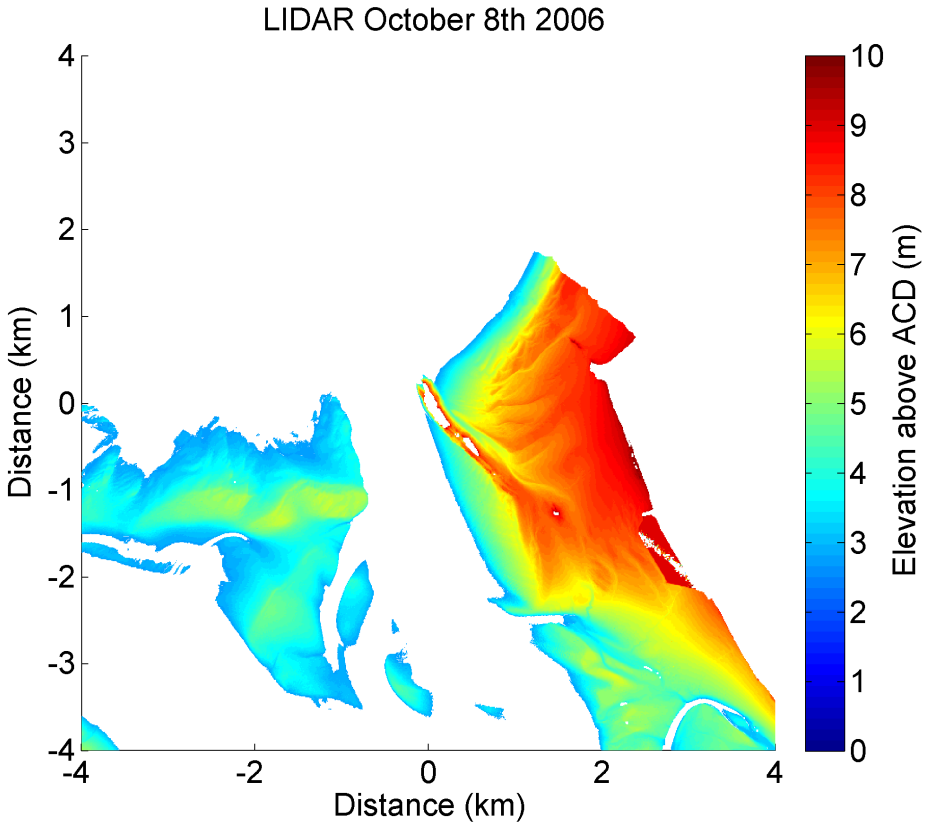
Radar Intertidal mapping - Dee Estuary, Hilbre Island

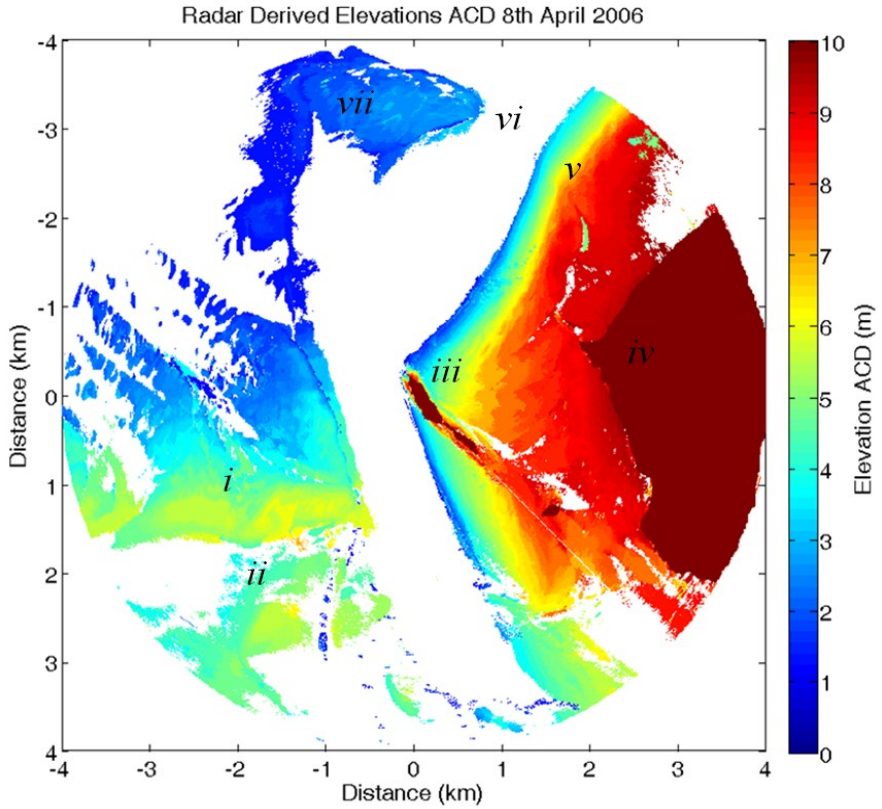




Intertidal Waterline Mapping Research

led by Dr Paul Bell in collaboration with Prof Andy Plater, U.Liverpool & Dr Cai Bird, Marlan Maritime ltd





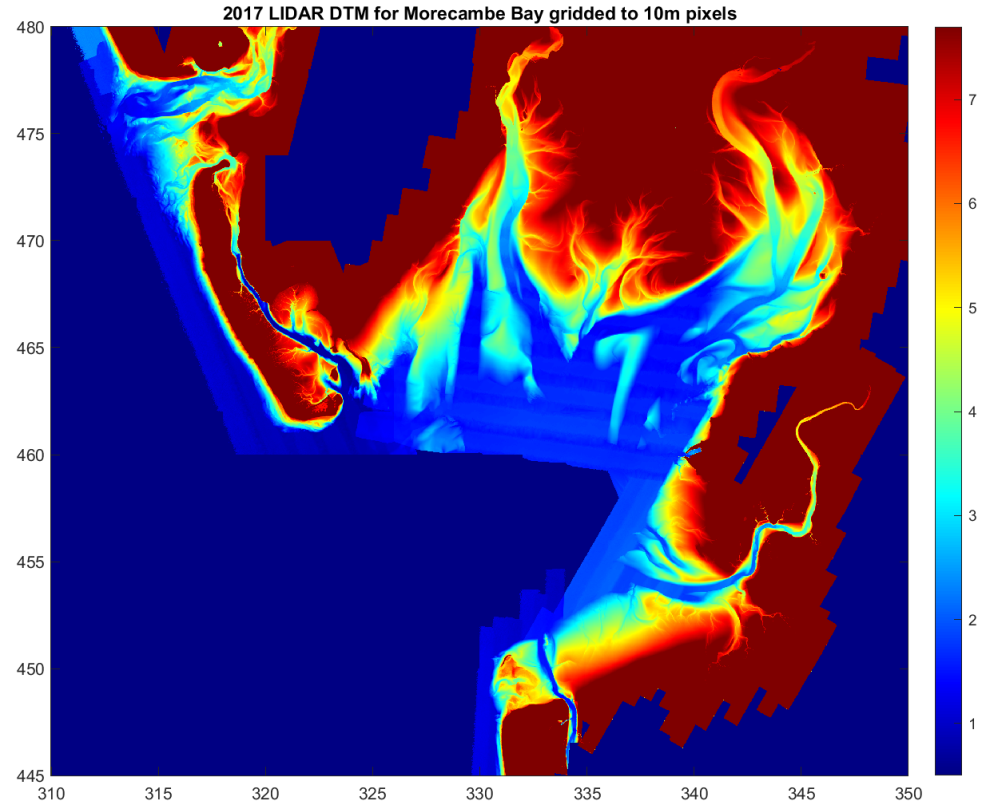
PCT/GB2014/050908 International patents granted

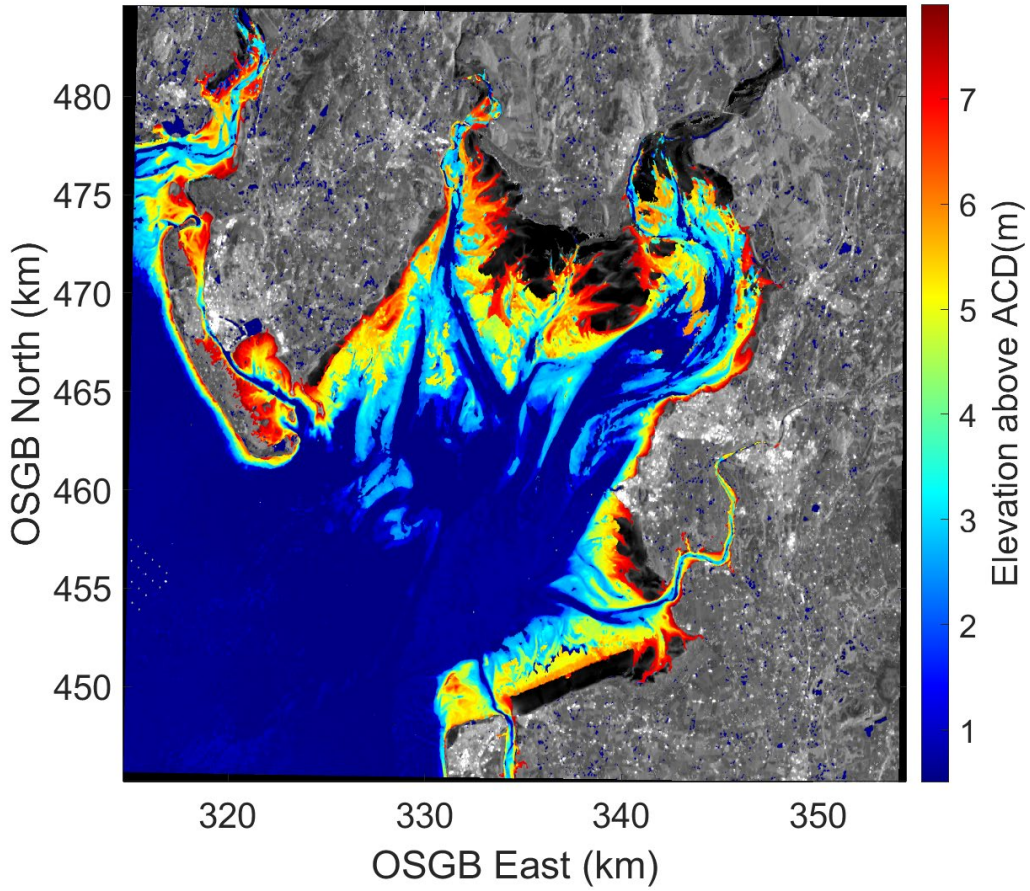
Bell, Bird & Plater, 2016, Coastal Engineering, DOI: 10.1016/j.coastaleng.2015.09.009

Bird, Bell & Plater, 2018, Marine Geology, DOI:10.1016/j.geomorph.2017.02.002

Method now being adapted for Satellite SAR (Synthetic Aperture Radar) data

Morecambe Bay: 2017 LiDAR & 2018 SAR Comparison

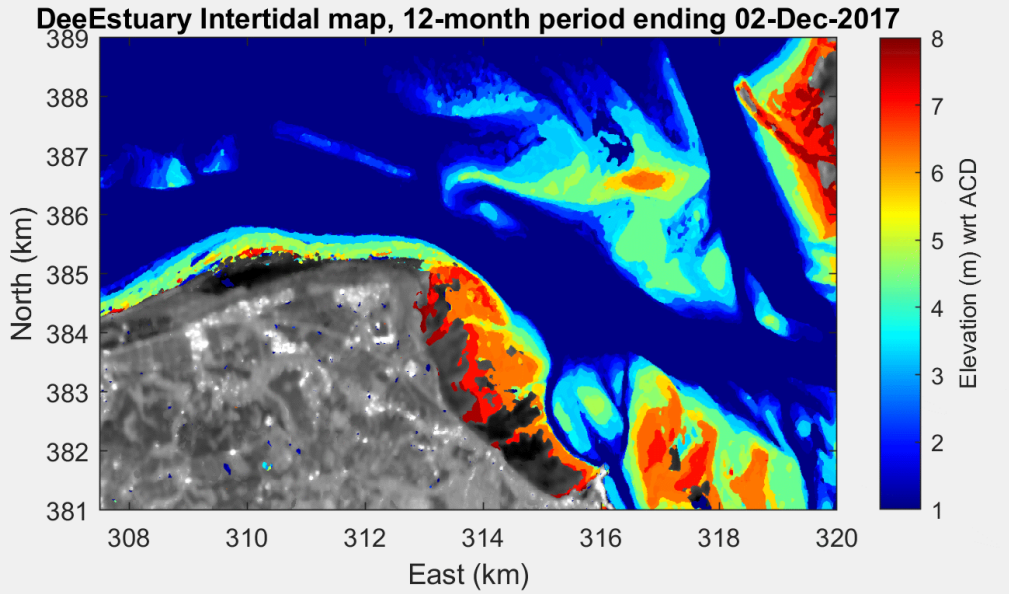


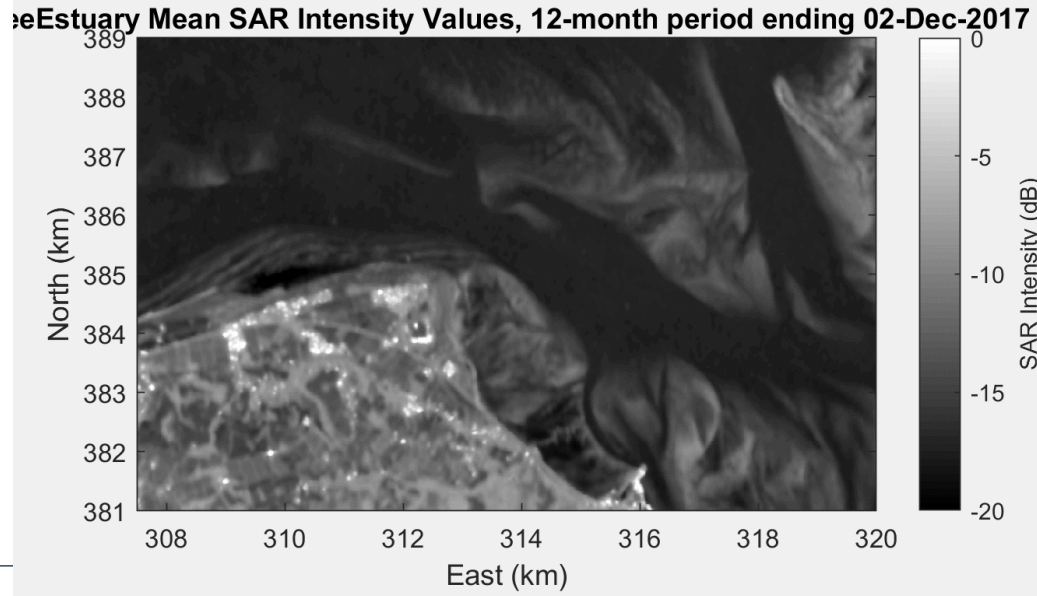


ACCORD Addressing Challenges of Coastal Communities through Ocean Research for Developing Economies

marine resources eo4sd

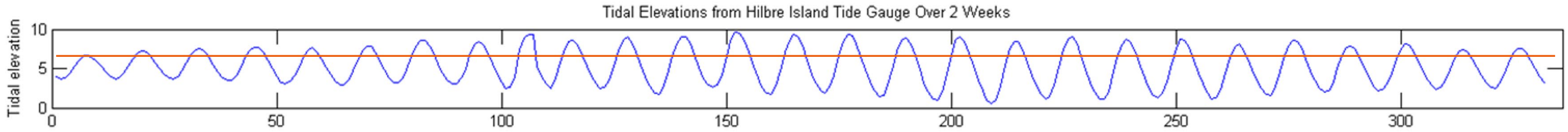
We know that we can see features of interest…



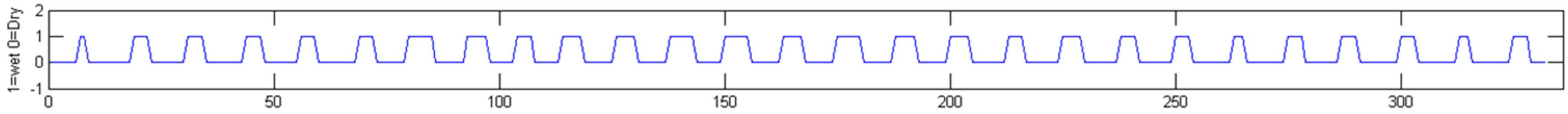


The Temporal Waterline Method – operates on sets of images

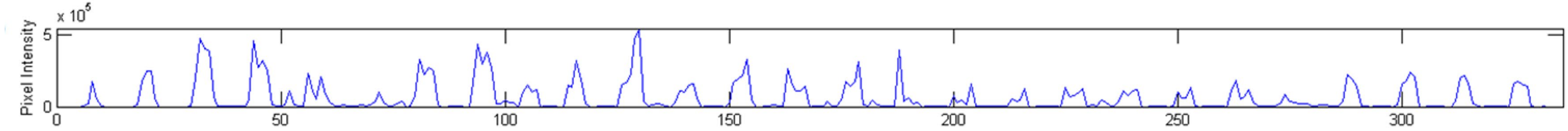
1. For any given intertidal pixel in an image we assume the wetting and drying is associated with the tide



2. We assume wetting and drying pattern based on the tidal curve and the pixel elevation



3. We extract a time series of image values that change between wet and dry



4. Look for the best match between the simulated wetting and drying signal and the image times series

Simplified processing chain..

Satellite data from Copernicus

L1 Sentinel 1, Synthetic Aperture Radar (SAR) Data

Sea Level data

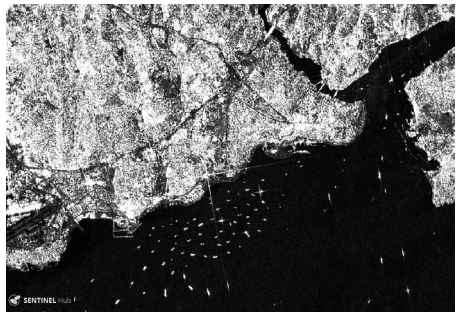
Tide Gauges
Tidal / hybrid models (altimetry)

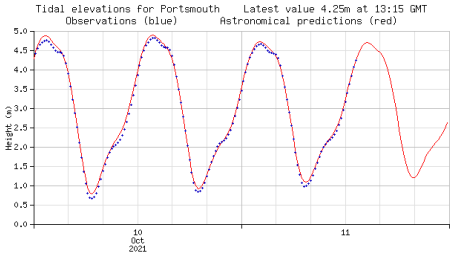
→

Apply Temporal Waterline Method 'TWL processor'

→

Intertidal Elevations

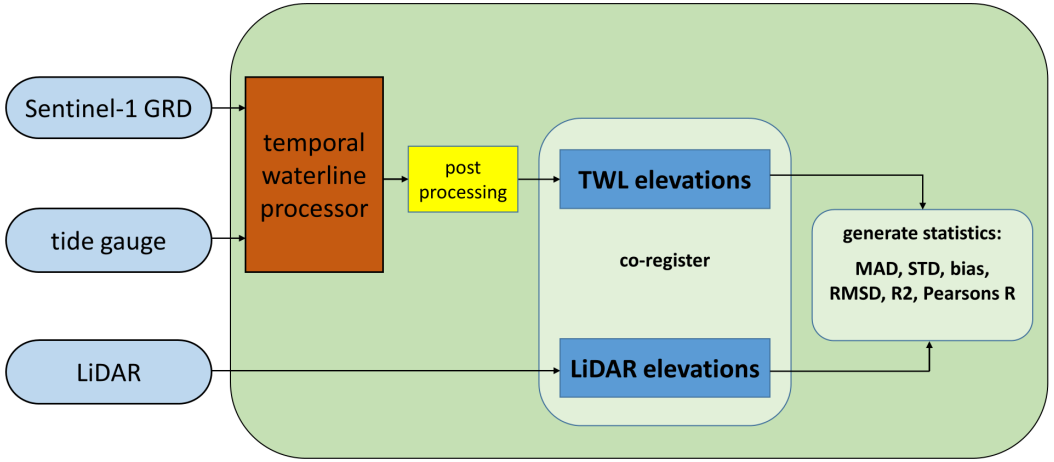




Makes a nice picture, but is any use for coastal management??

Validation Study using Portsmouth Harbour

A validation study has been completed comparing TWL results (4 month composites) against LiDAR survey data acquired in 2016, 2018 and 2020.



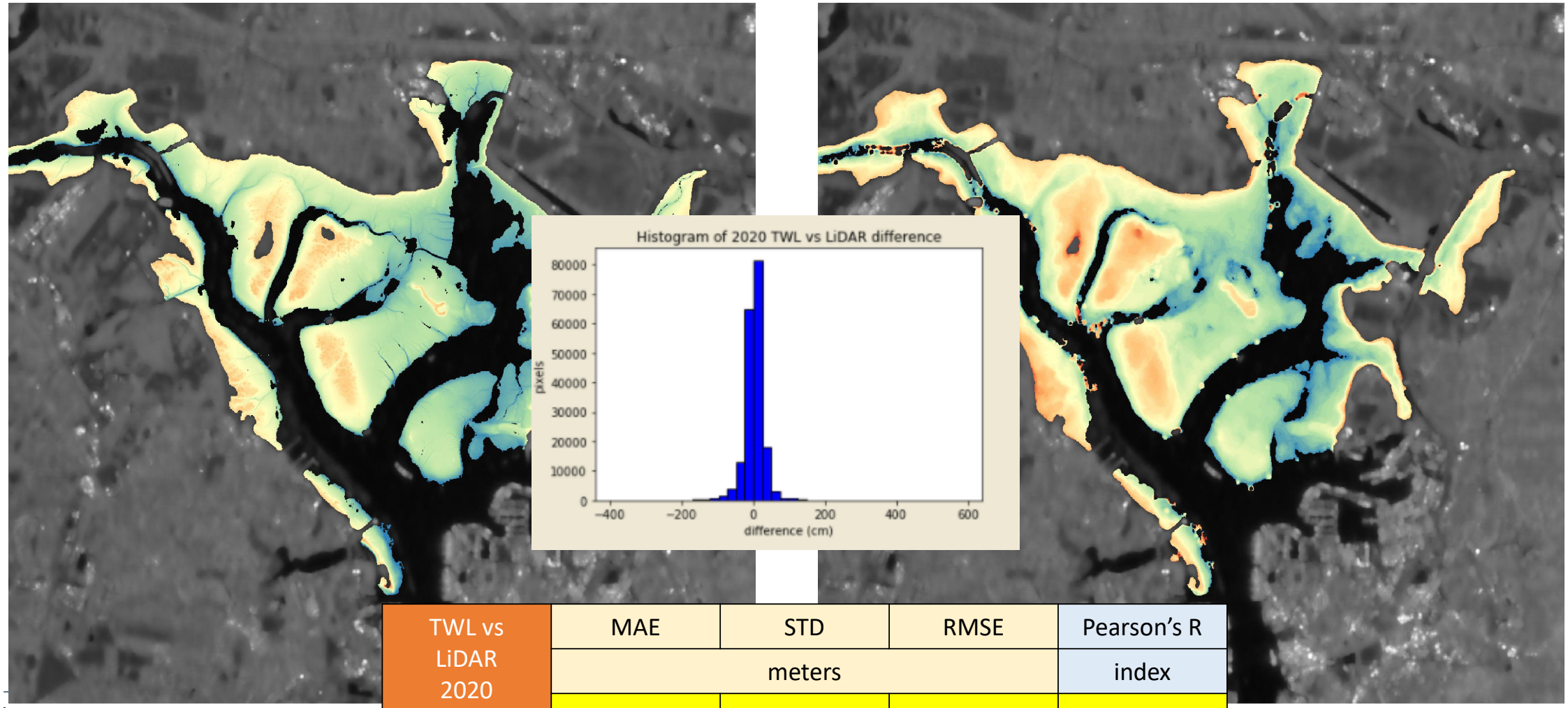
Validation - 2020 LiDAR vs TWL

LiDAR survey flown 19th September

1m spatial resolution resampled to match TWL

~3 month TWL composite 17th July - 21st Oct

6.4m spatial resolution

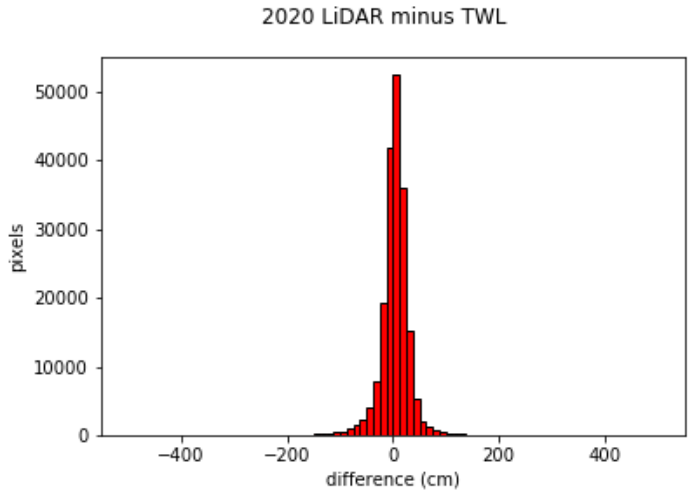


TWL vs LiDAR 2020	MAE	STD	RMSE	Pearson's R
	meters			index
	0.22	0.41	0.41	0.87

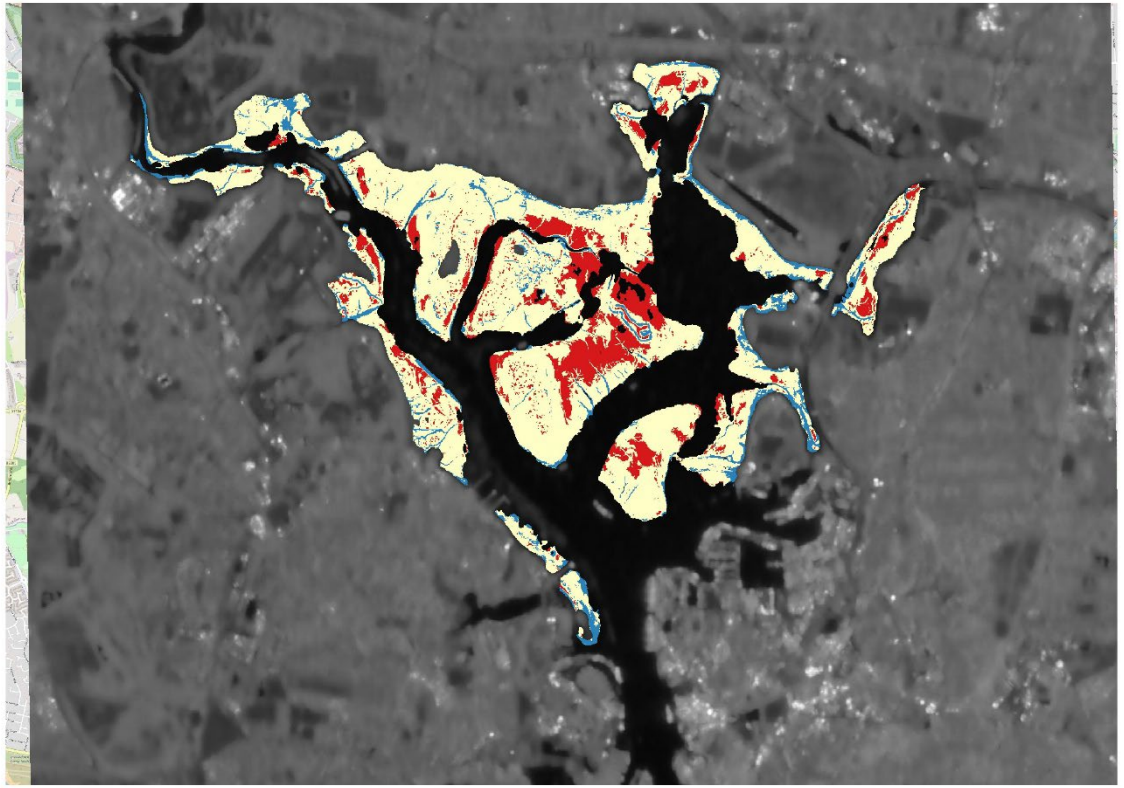
Validation Study using Portsmouth Harbour

A validation study has been completed comparing TWL results (4 month composites) against LiDAR survey data acquired in 2016, 2018 and 2020.

TWL vs LiDAR validation (using decluttering post processing)	MAD	STD	bias	RMSD	Pearsons R
	meters				index
2016 (77 images) – 91%pixels	0.25	0.33	0.12	0.35	0.89
2018 (139 images) – 87% pixels	0.25	0.32	0.10	0.34	0.90
2020 (83 images) – 93% pixels	0.20	0.31	0.05	0.31	0.92



Figures below: 2020 LiDAR-TWL showing spatial distribution of the differences. Blue areas show where TWL elevations are too high, yellow within +/-20cm and red where TWL elevations are too low. Histogram shows distribution of differences for 2020.



So, where are we?

- More questions than we started with
- Learnt a few things..
  - Sweet spot of 4 month composites - yet to test how that changes for very stable or very dynamic sites
  - Working on how to improve the sea level inputs – can we be smarter about how we construct the synthetic time series?
  - Gains in pre and post processing (removing clutter, only processing intertidal pixels) - not yet fully implemented
- Short term look ahead:
  - Sea Levels
  - Is there a calibration step needed?
  - How we present results – QA/QC, limitations etc.

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With many thanks to the Channel Coastal Observatory EO Working Group