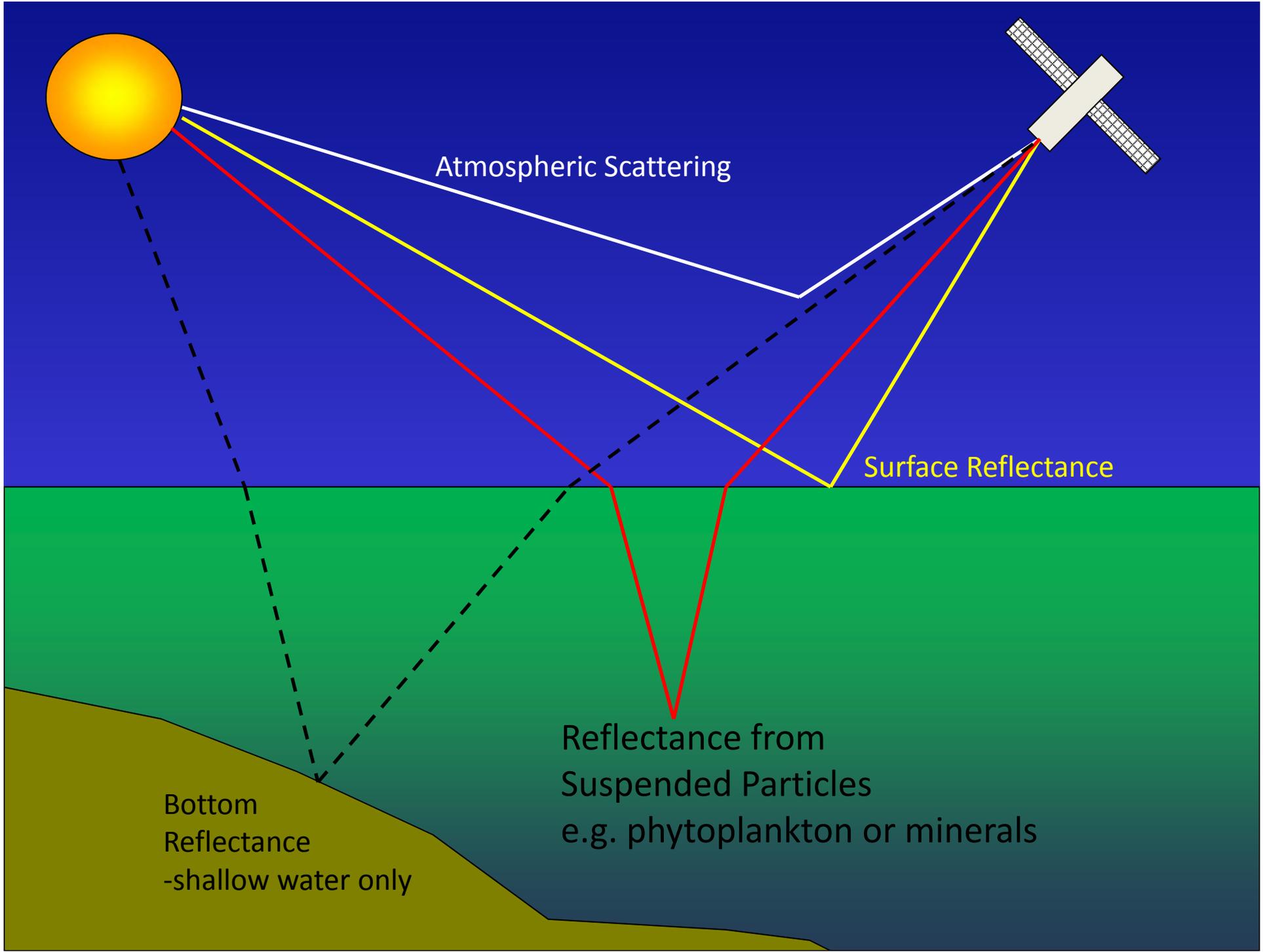


Ocean colour remote sensing for inshore and marine energy applications

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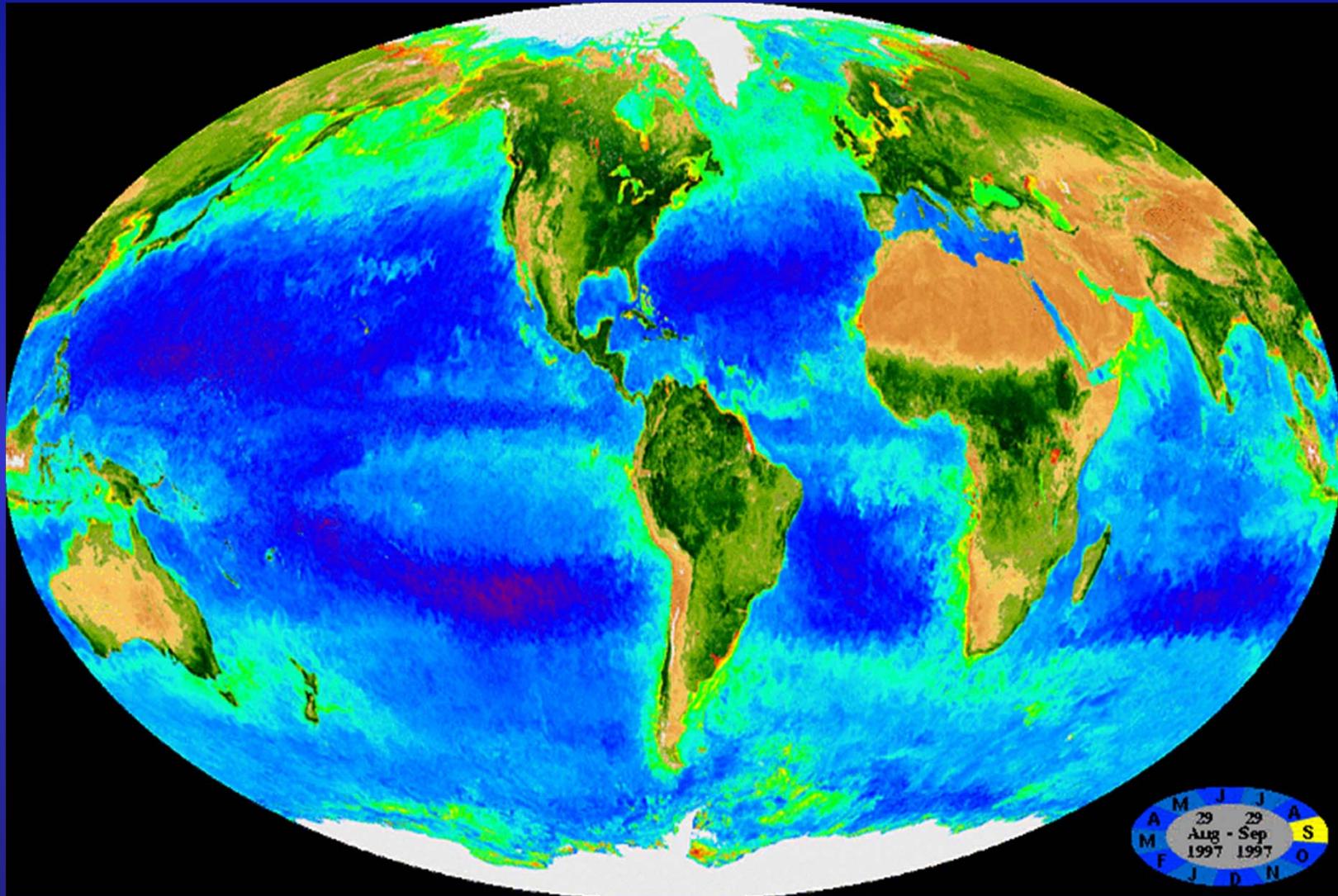
Atmospheric Scattering

Surface Reflectance

Bottom Reflectance
-shallow water only

Reflectance from
Suspended Particles
e.g. phytoplankton or minerals

Ocean Colour Remote Sensing: Unique Window onto Surface Biogeochemistry

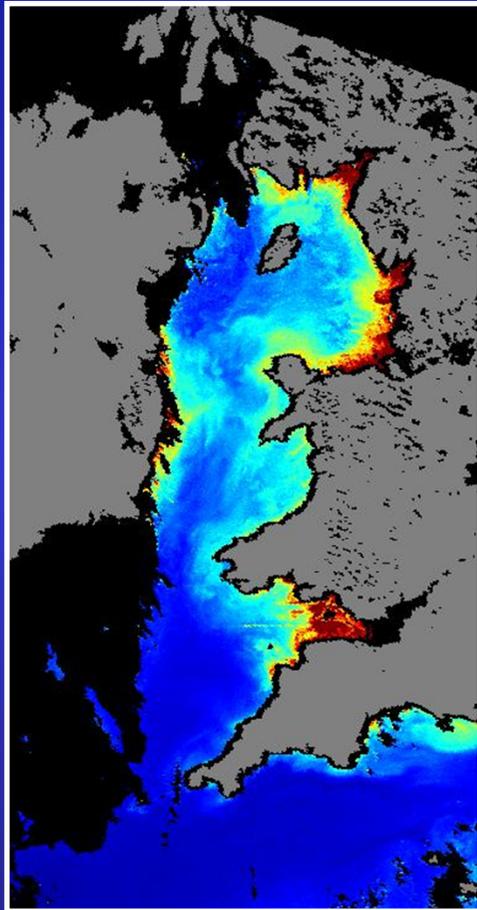


© NASA GSFC

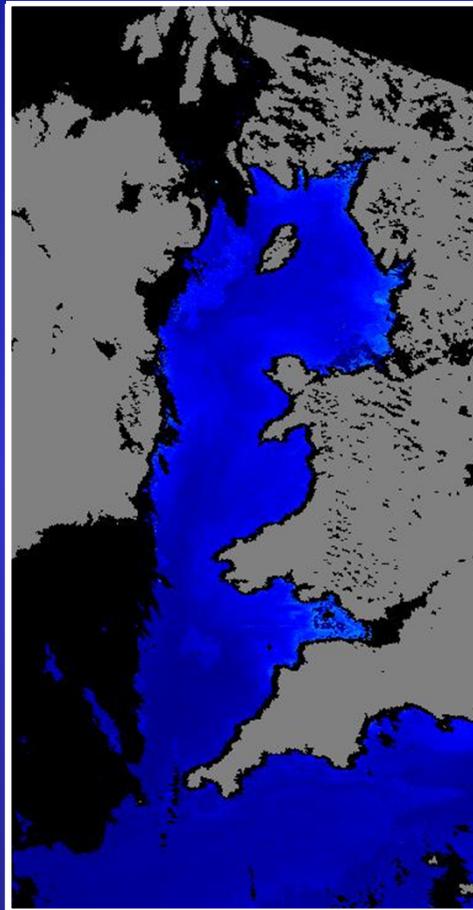
Unprecedented views of spatial and temporal patterns of coupled physical and biogeochemical processes

Ocean Colour Remote Sensing: Standard Products, Validation, New Algorithms

Chlorophyll a (mg m^{-3})

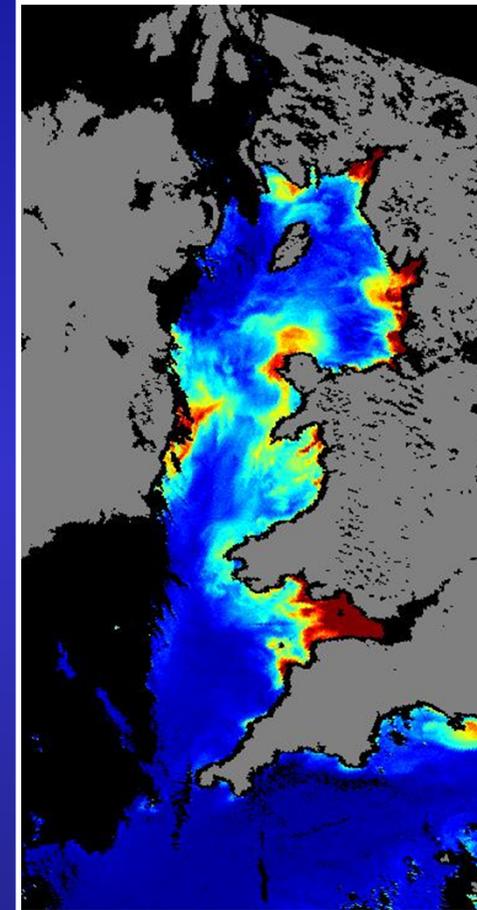


NASA Algorithm



Tuned Algorithm

Mineral Suspended Solids (mg l^{-1})



New Algorithm

Standard algorithm performs poorly in muddy coastal waters - new data products for UK seas...

Relationships between suspended mineral concentrations and red-waveband reflectances in moderately turbid shelf seas

Claire Neil, Alex Cunningham*, David McKee

Physics Department, University of Strathclyde, 107 Rottenrow, Glasgow G40NG, UK

Remote Sensing of Environment 115 (2011) 3719–3730

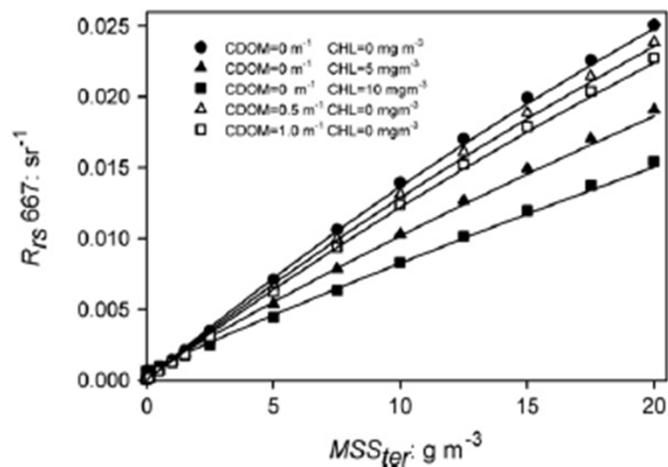


Fig. 12. Effect of the independent addition of CDOM and CHL on the relationship between $R_{rs,667}$ and MSS_{ter} . The symbols indicate results from radiative transfer modelling, and the lines are solutions to Eq. (12) with $\kappa=0.049$.

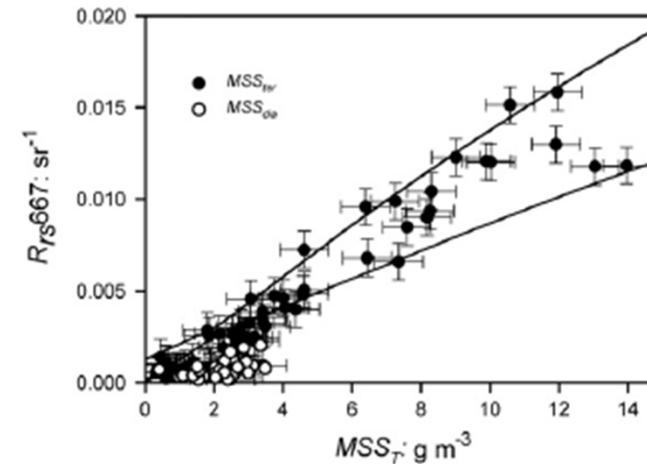


Fig. 13. Lines show the upper and lower boundaries calculated by radiative transfer modelling for CHL and CDOM varying independently in the range 0–10 mg m^{-3} and 0–1 m^{-1} respectively. Symbols indicate observations from 110 stations with reflectances calculated from radiometric profiles and MSS_r determined gravimetrically. The discrimination between diatomaceous and terrigenous MSS indicated by open and filled symbols is based on the classification of Fig. 3.

Red reflectance largely driven by sediment (MSS)

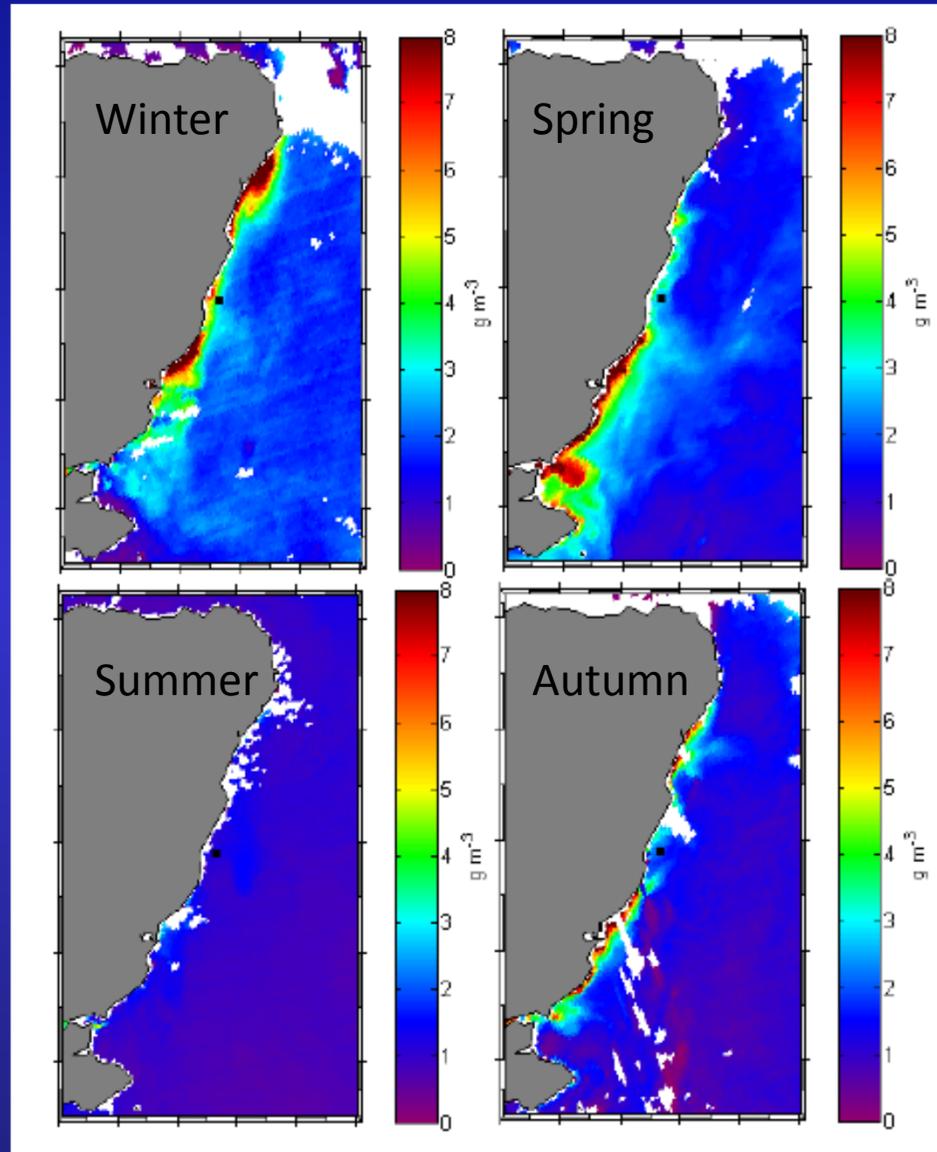
BUT also affected by phytoplankton and CDOM

Similar developments for diffuse attenuation, euphotic depth...

New algorithm gives MSS + uncertainty estimate

Also distinguishes contribution from diatoms.

Sediment Algorithm Validation: Stonehaven



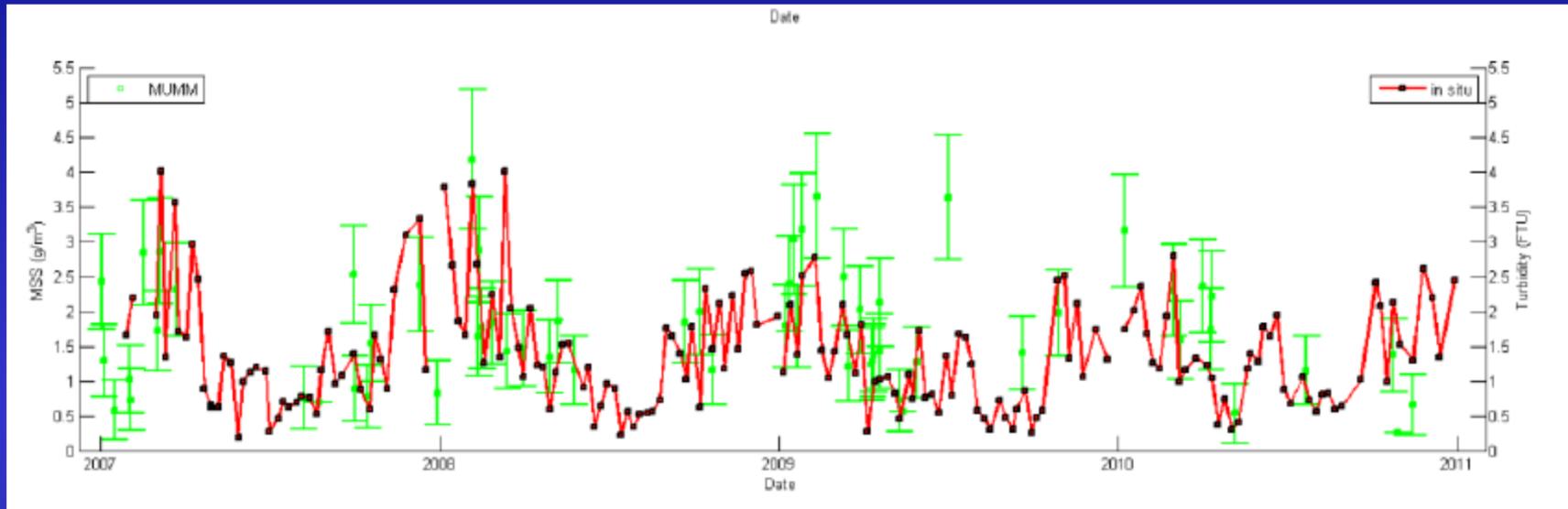
MODIS data processed for sediment at Stonehaven site 2007 – 2011.

Figure shows typical seasonal distributions.

OCRS data validated against weekly *in situ* data set collected by Prof Mike Heath (Maths and Statistics) at site marked with black square.

Contribution to Terawatt project funded under EPSRC SUPERGEN.

Sediment Algorithm Validation: Stonehaven

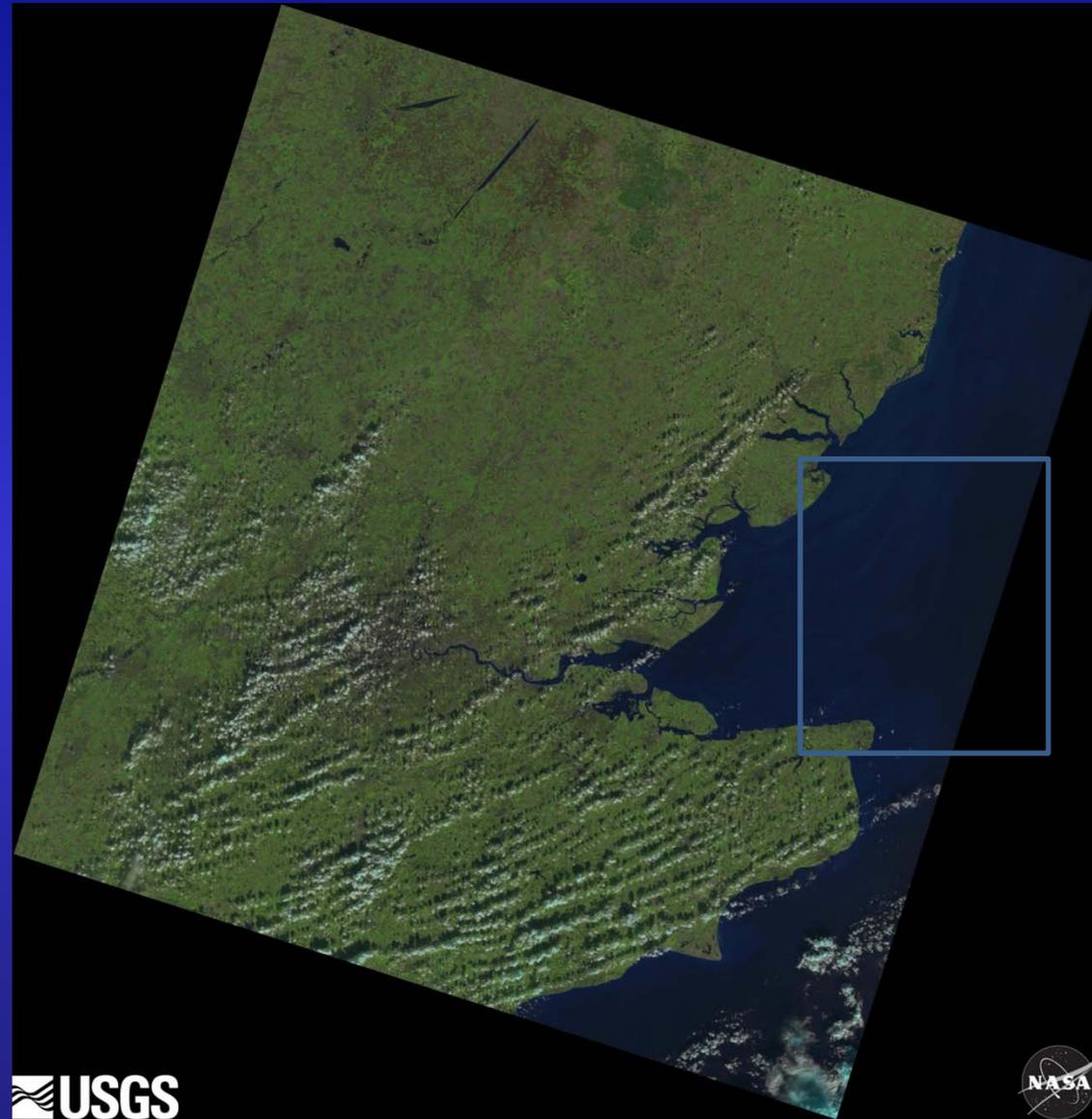


Good correlation between Strathclyde sediment algorithm (green symbols with max / min estimates) and in situ turbidity measurements (red line).

Algorithm will be applied to OCRS data set for Pentland Firth site for *in situ* renewables.

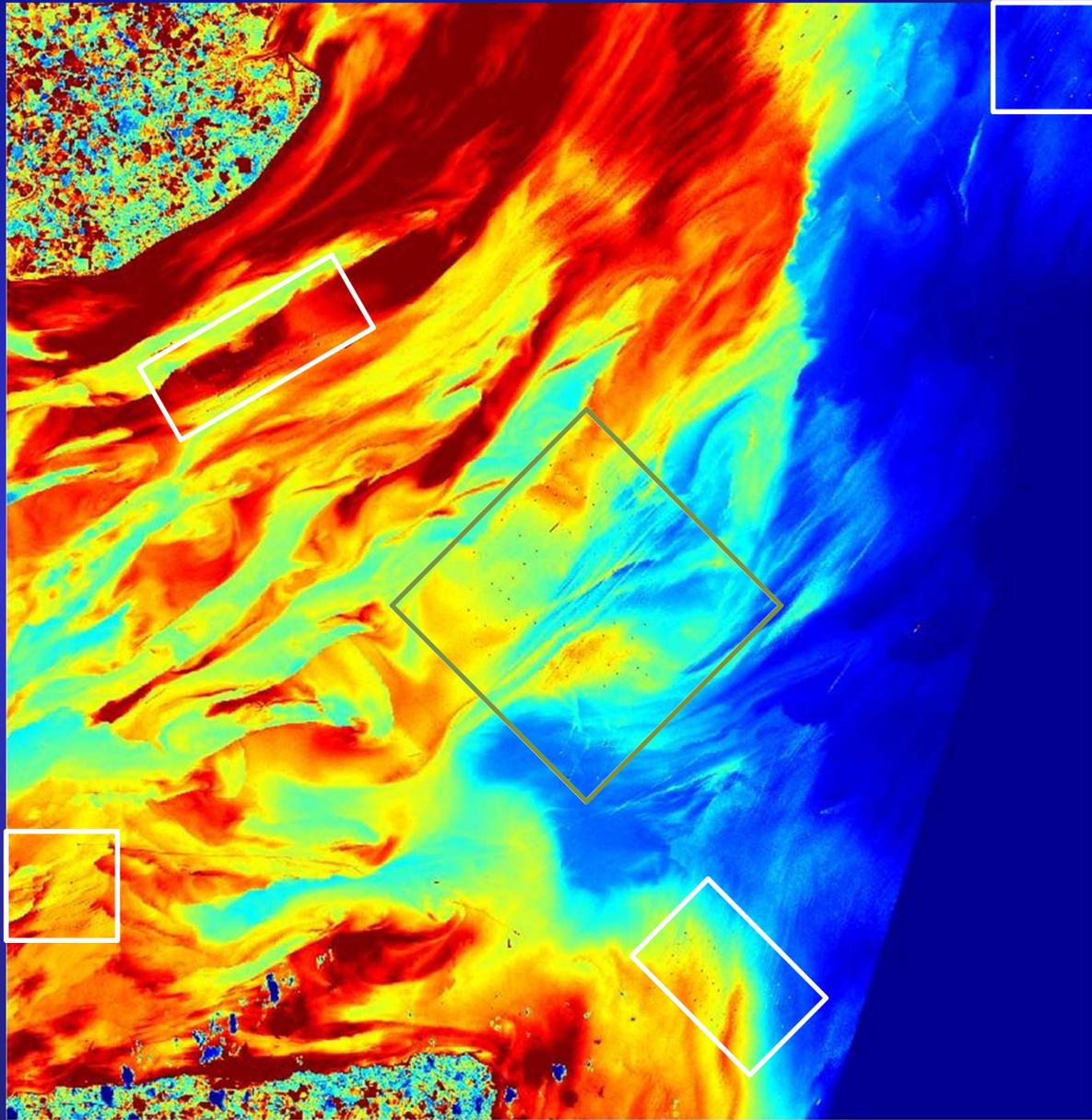
Want to observe interactions between energy installations and environment...

Landsat 8: High Resolution Imagery



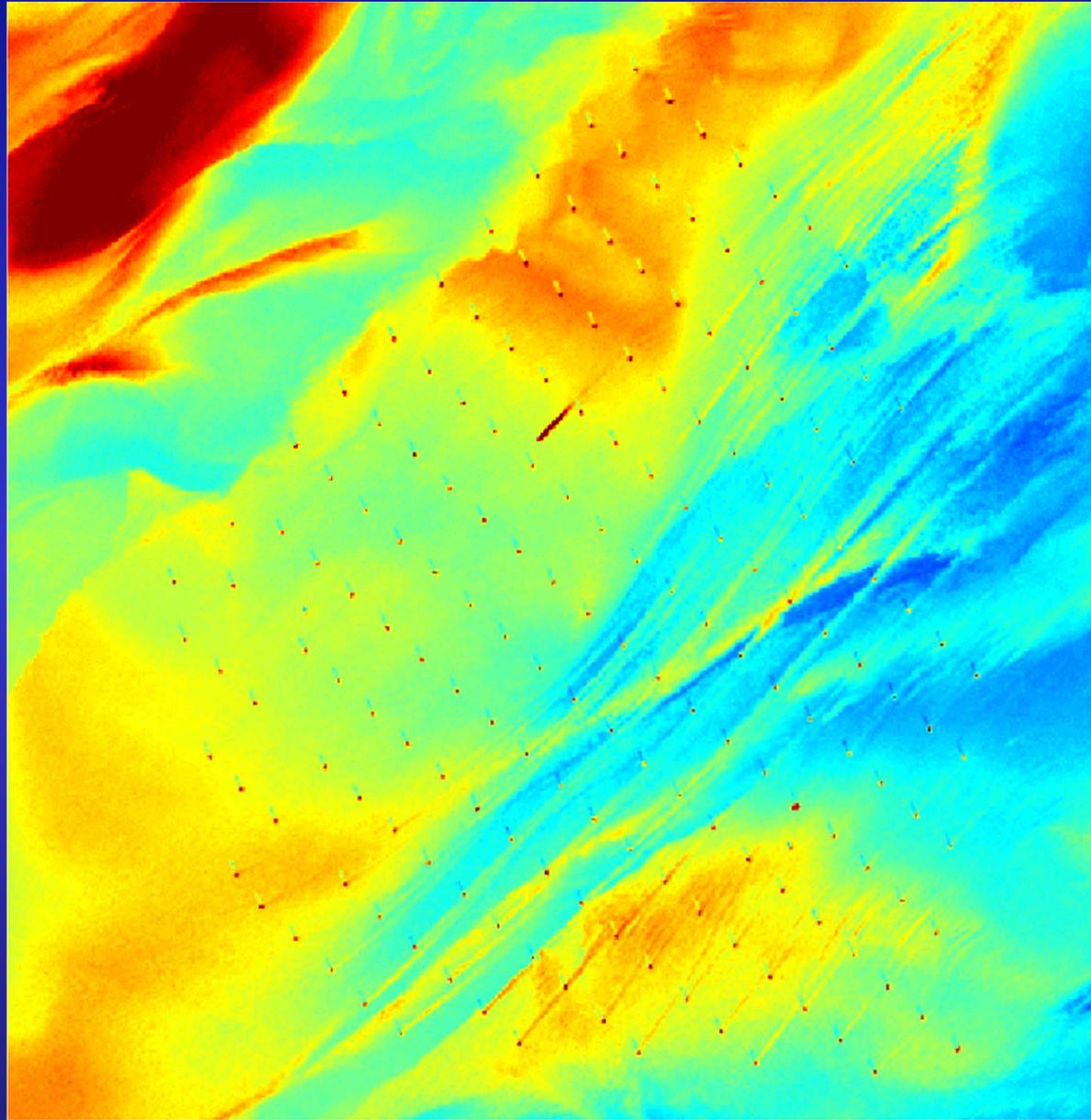
30m resolution, band 4 approx. for sediment algorithm

Landsat 8: High Resolution Imagery



Turbine arrays in the Thames Estuary

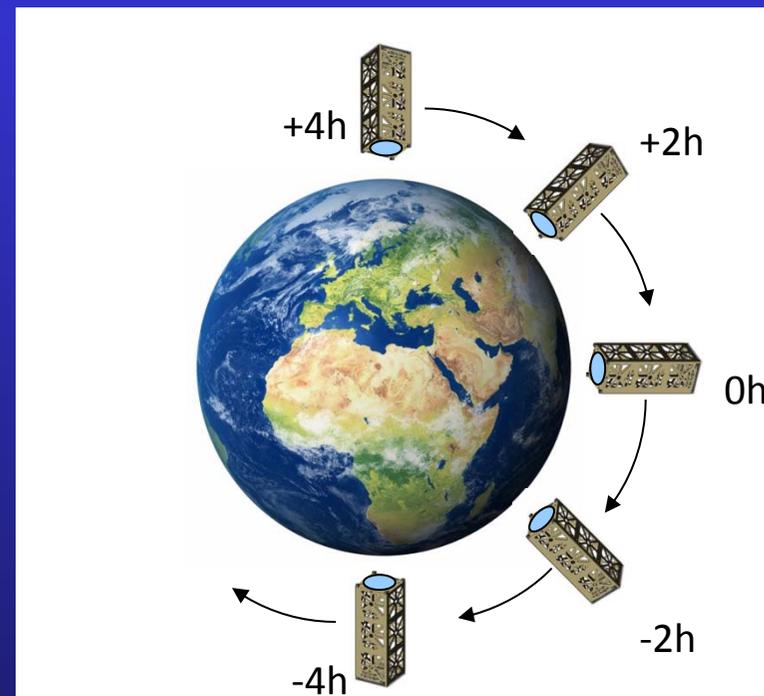
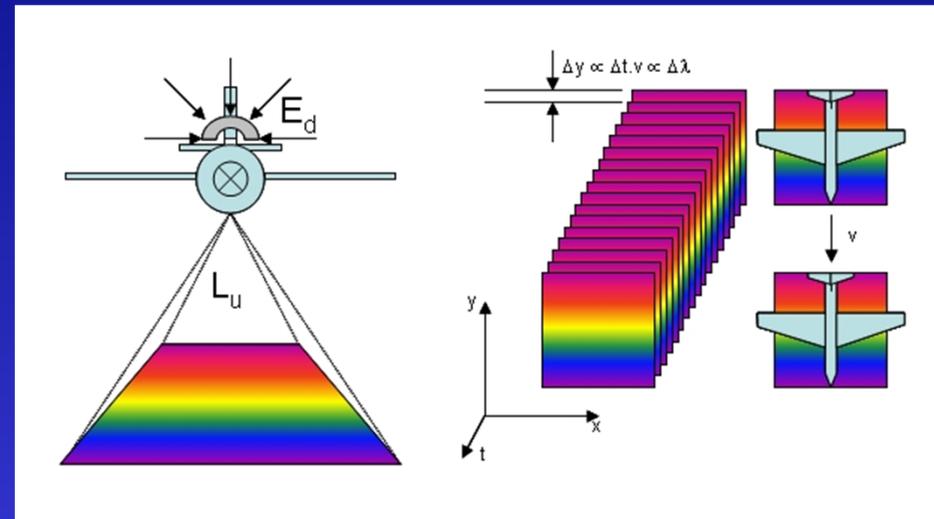
Landsat 8: High Resolution Imagery



London Array: sediment plumes streaming from turbine pilings

Future Directions: Remotely Piloted Aircraft and Cubesats

- Miniature hyper- / multi-spectral cameras for small RPAs (with SAMS, Oban).
- High spatial resolution for inshore and inland waters.
- HABs, pollution events, marine renewable sites, shallow benthic mapping, intertidal zone etc.
- Possible stepping stone to CubeSat ?
- Growing CubeSat development community.
- Opportunity to establish leading global position...



Conclusions

- Ocean colour remote sensing provides useful view of water quality.
- Potential applications in marine renewable energy engineering: sediment distribution, underwater light fields, turbulent wakes...
- Development of new sensing platforms e.g. remotely piloted aircraft, CubeSats will transform applications.
- Data quality essential – standard algorithms not appropriate for optically complex coastal waters – need for local validation.

Thanks!