

Initial results with automated ship-borne reflectance measurements and data processing in near-coastal waters in the Western Channel

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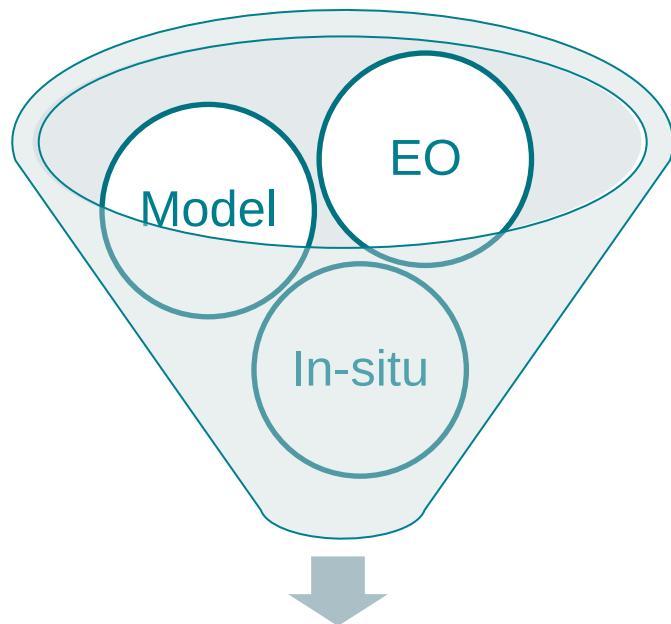
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<http://www.iseca.eu>



Web information system

Interreg project (2010-2014)
AIMS to “develop and promote a web-based tool to improve the evaluation of the coastal water quality and analyse eutrophication in the 2Seas coastal areas”

Can chlorophyll from EO be used to do Eutrophication assessments?

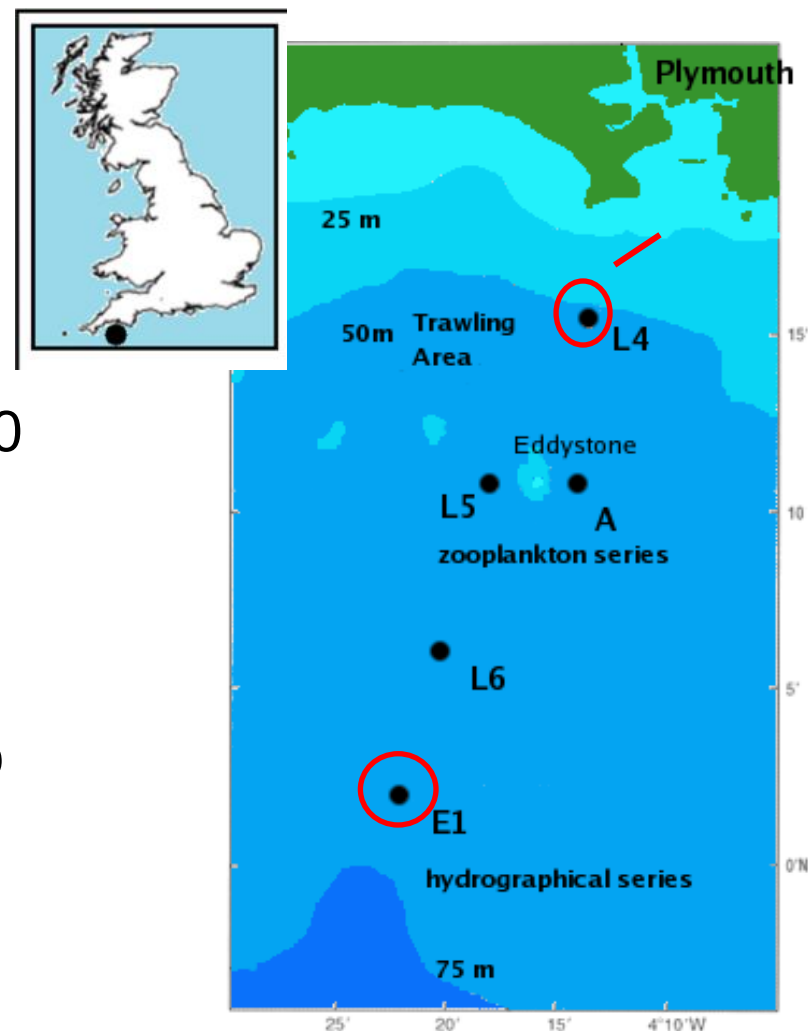
USERS

Question 1: What are the uncertainties of EO coastal products?

Question 2: How close to the coast can EO products be “trust”?

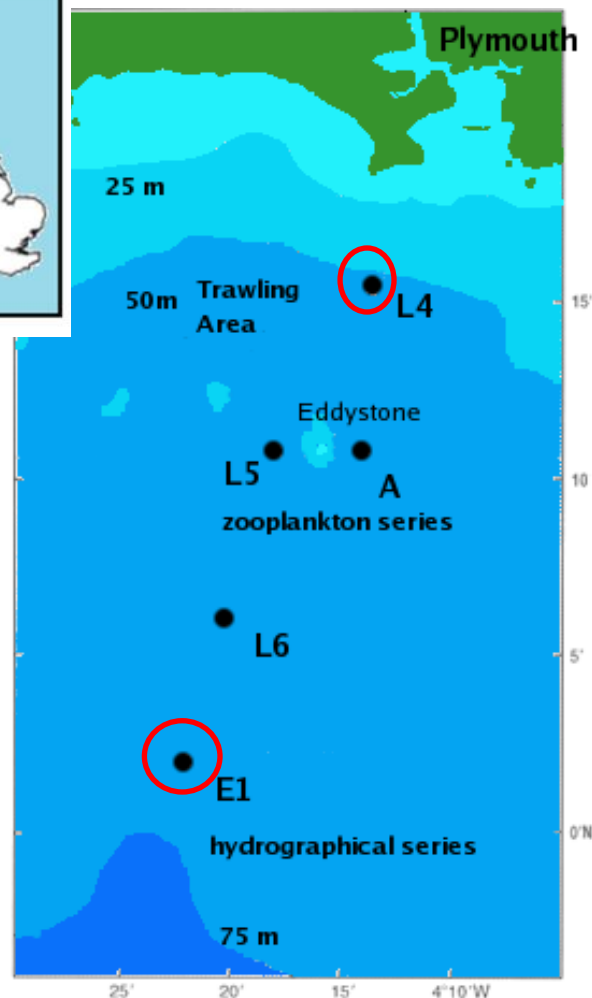
ISECA *in-situ* database

- **Question 1:**
 - **Biological data and In-water bio-optical data:** long term (+10 years) measurements at fixed stations
- **Question 2:**
 - **Above water optics:** dataset to test atmospheric correction and adjacency effects



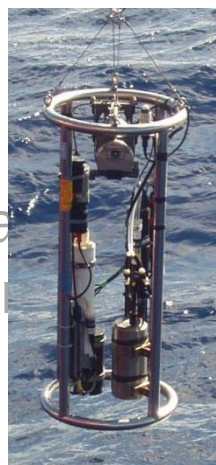
ISECA in-situ database

- **Question 1:**
 - **Biological data and In-water bio-optical data:** long term (+10 years) measurements at fixed stations



- **Question 2:**

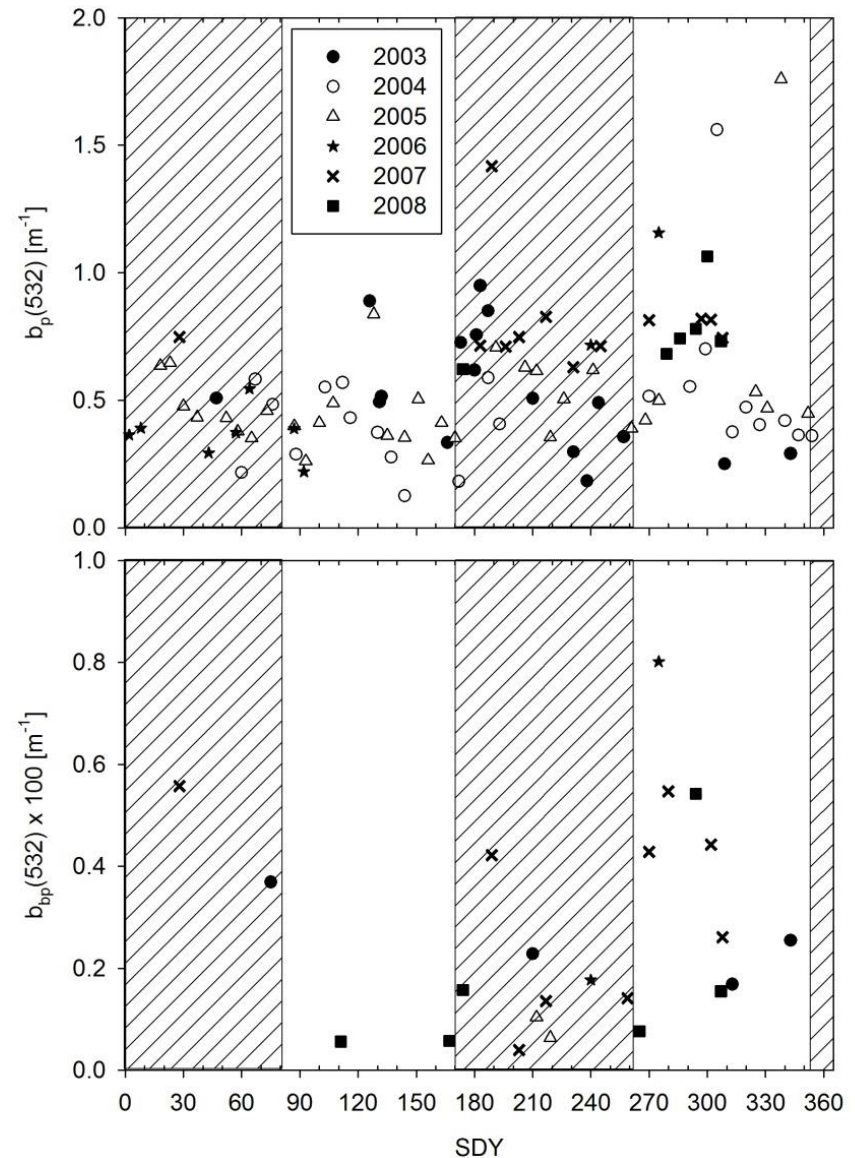
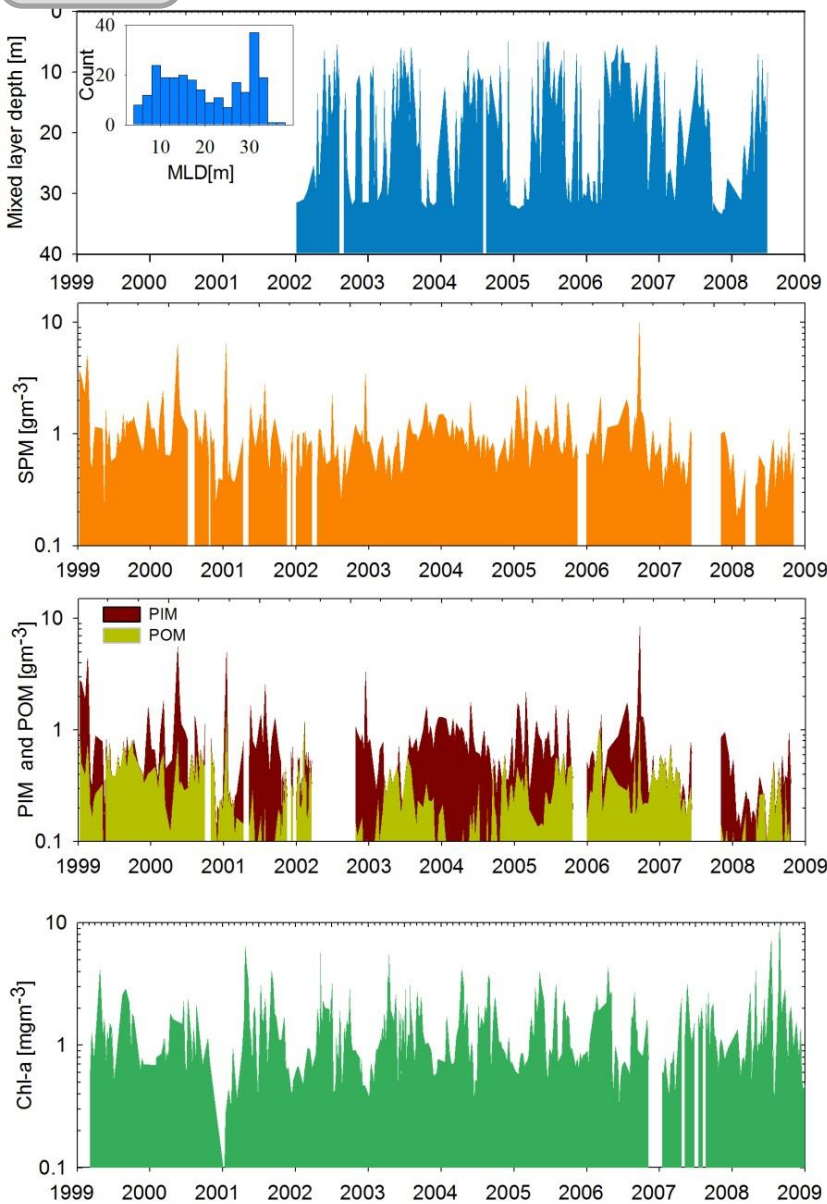
- **Acoustic data:** data correction



WetLabs ac-9; a & c
Seabird 19 CTD; T & S
WetLabs ECO-VSF3 : b_{bp}
Satlantic HyperOCR; E_d

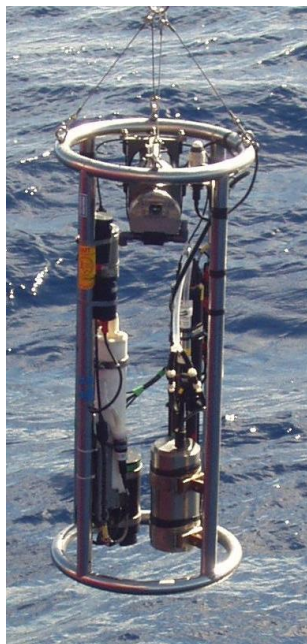
- Historically L4 originated as a biological monitoring station.
- Developed into bio-optical time series during the 2000's.
- Weekly sampling of biological and optical parameters

Measurement	< 1999	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
HPLC																	
PABS																	
CDOM																	
SPM																	
POC - CHN																	
Chla(fluoro)																	
Primary production																	
FRRF																	
Ed, Lu																	
ac9																	
bb6																	
VSF,bb3																	
Above water RSR																	
PAR																	
Transmissometer																	
Flow cytometry																	
Coulter Counter																	
Phytoplankton counts																	
CTD																	



Martinez-Vicente et al. (2010)

L4

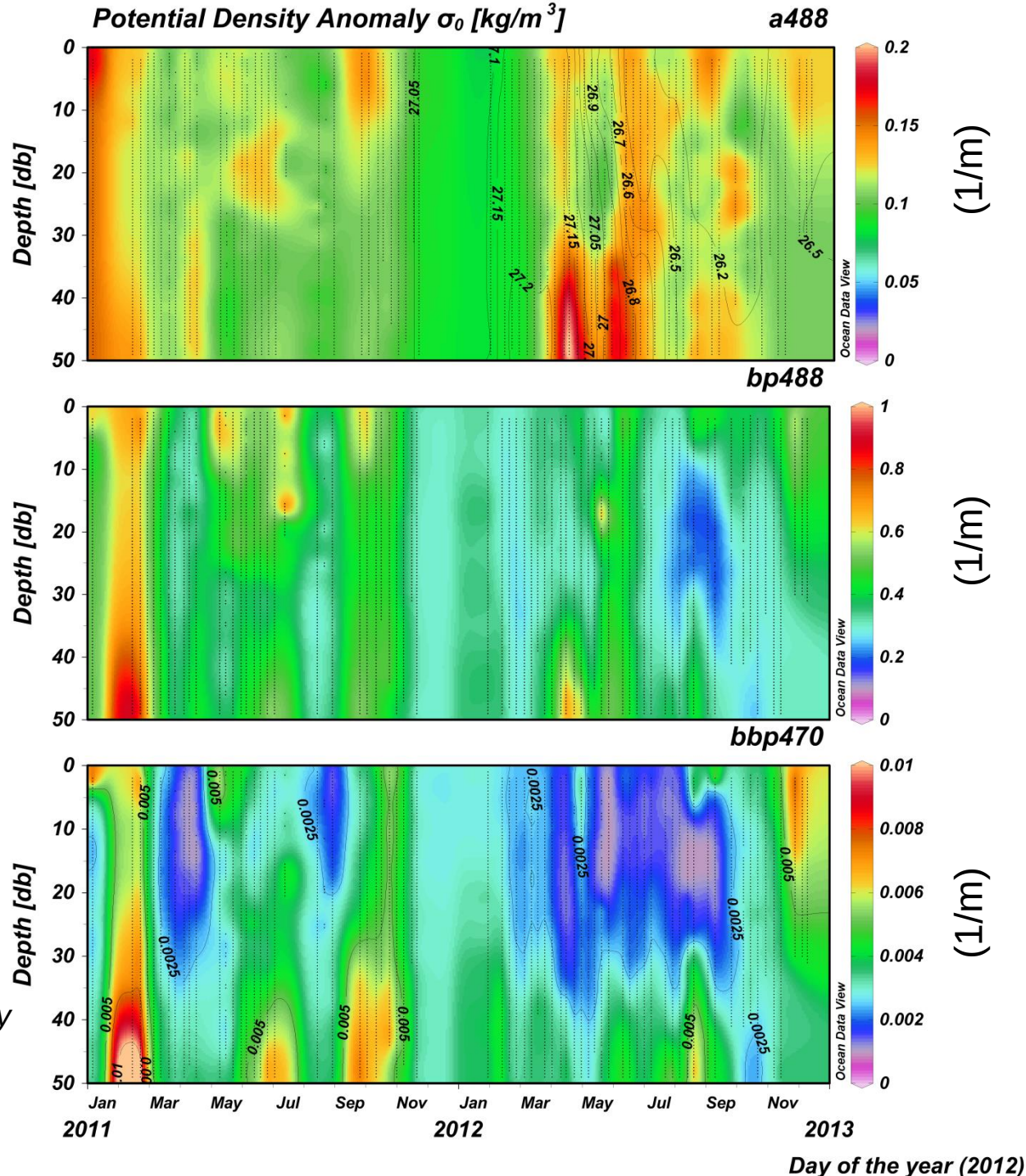


WetLabs ac-9; Absorption & attenuation

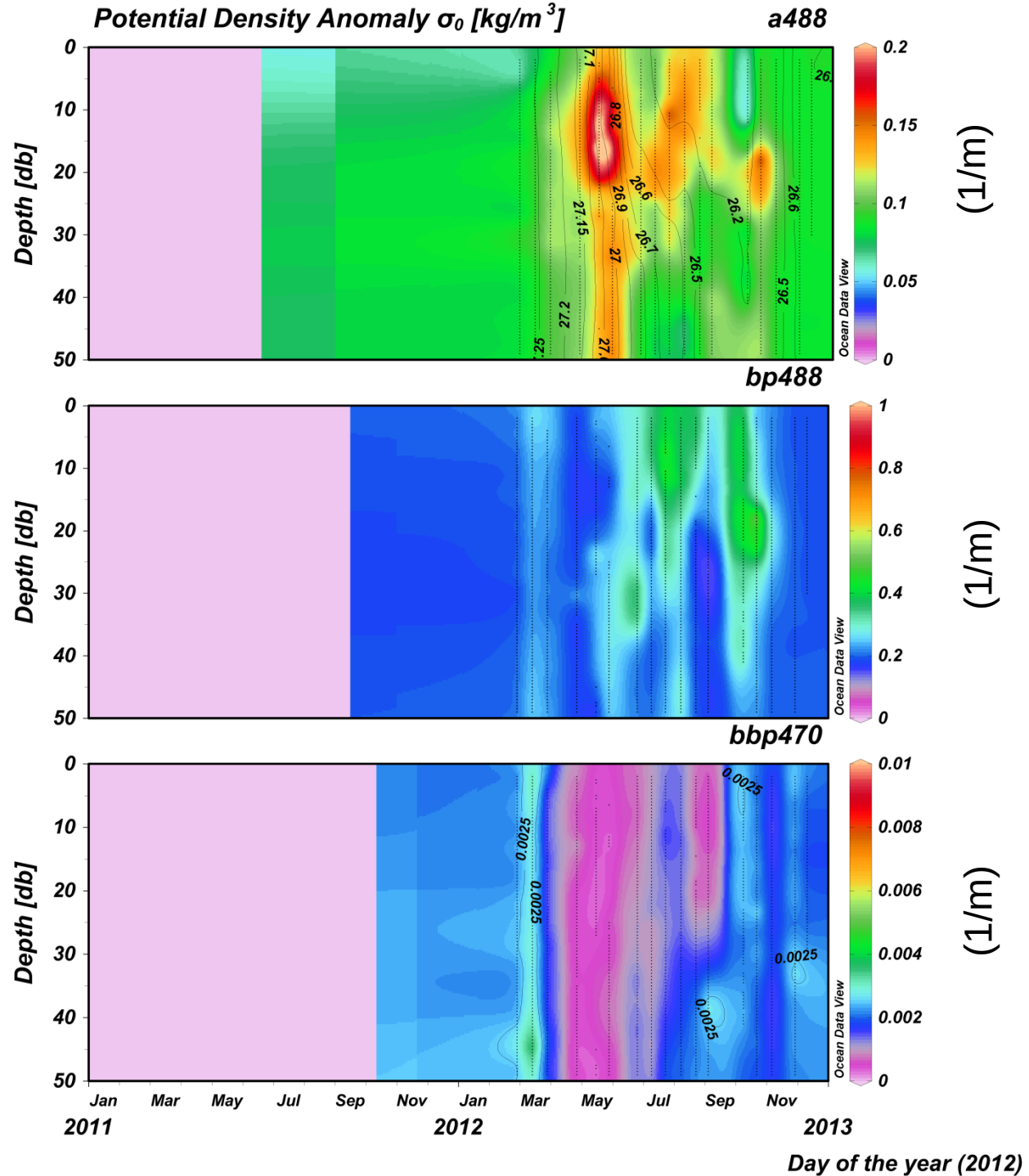
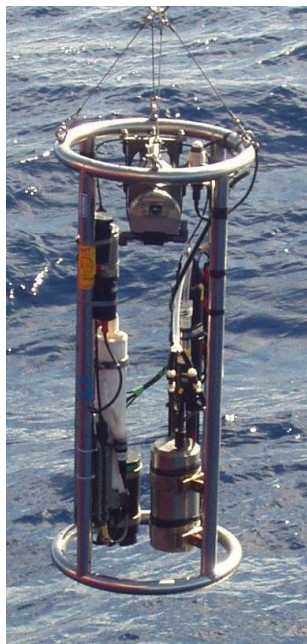
Seabird 19 CTD; Temperature & salinity

WetLabs ECO-VSF3 ; backscatter

Satlantic HyperSAS; Downwelling irradiance



E1



ISECA in-situ database

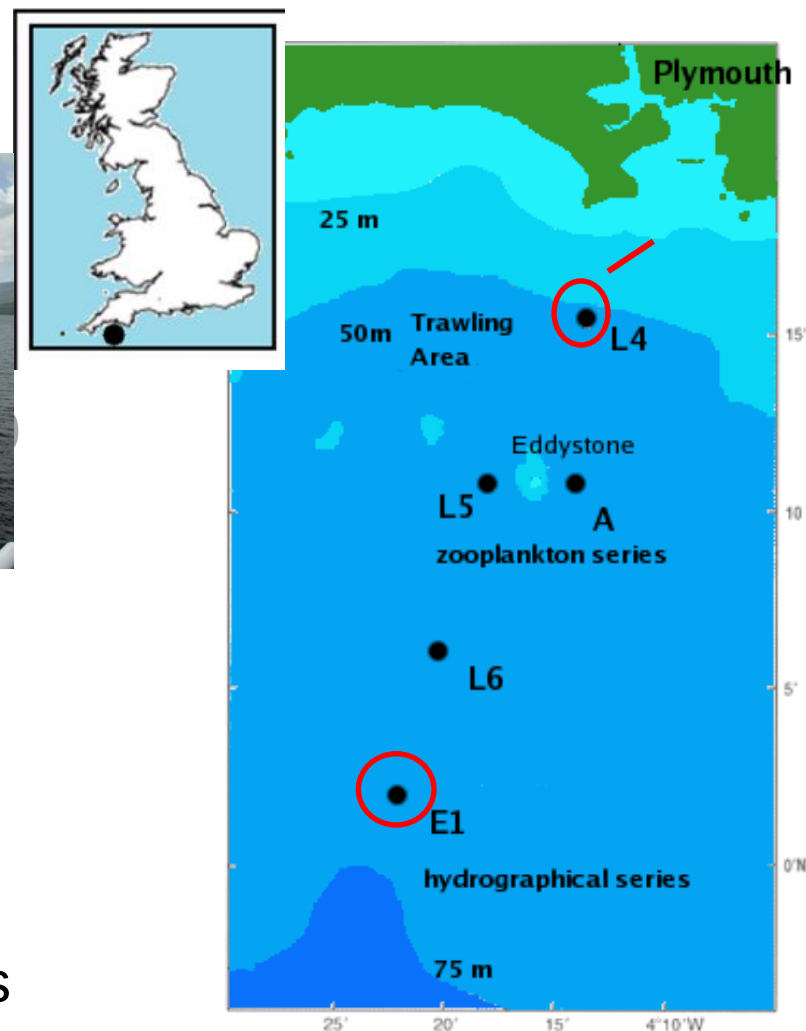
A common tool to test and develop EO products for eutrophication



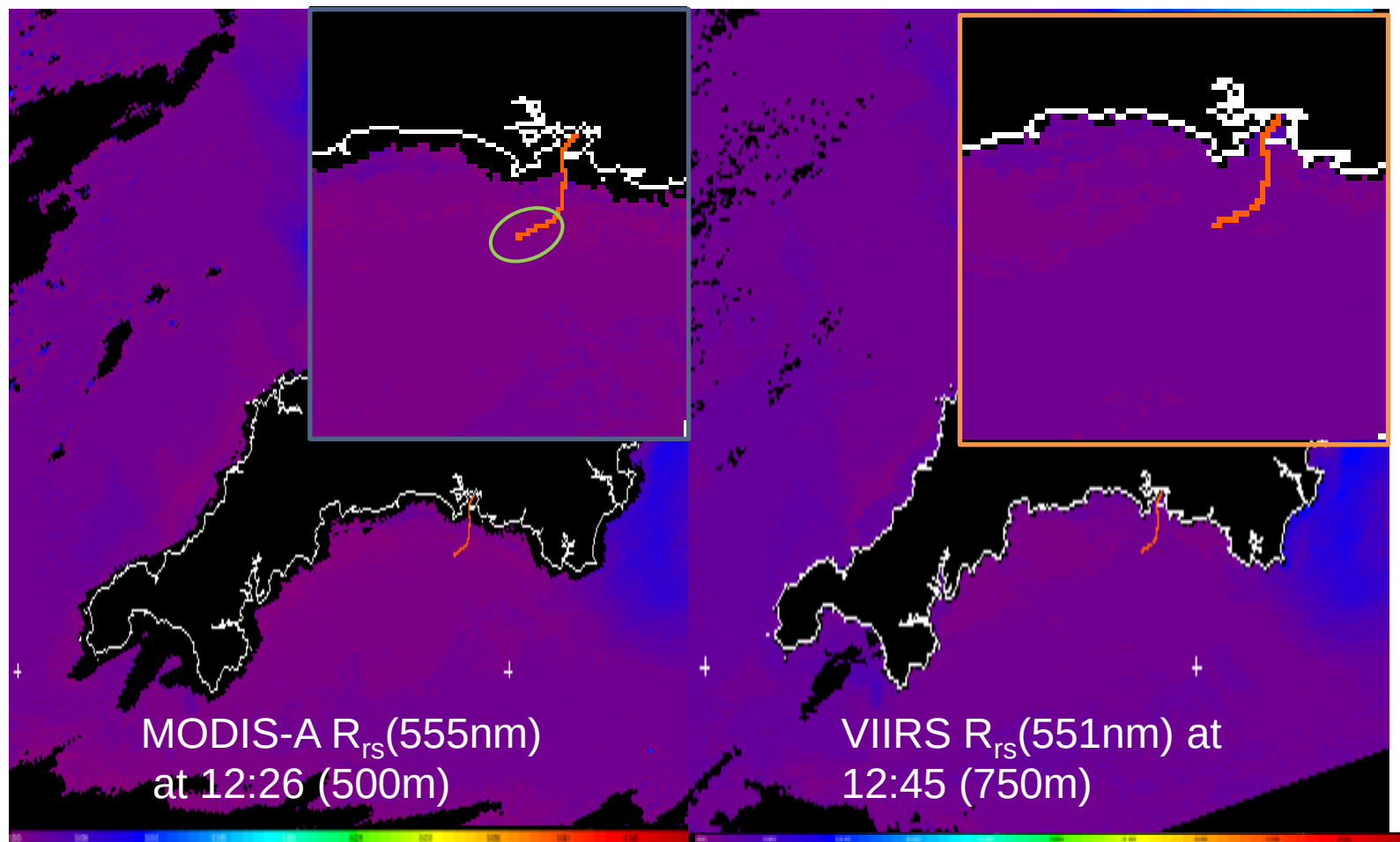
stations

• Question 2:

- **Above water optics:** dataset to test atmospheric correction and adjacency effects (~2h of data)
- Quantify the uncertainty sources from the in-situ data



Transect : 5th Sept. 2012 (9:30 – 11:20)

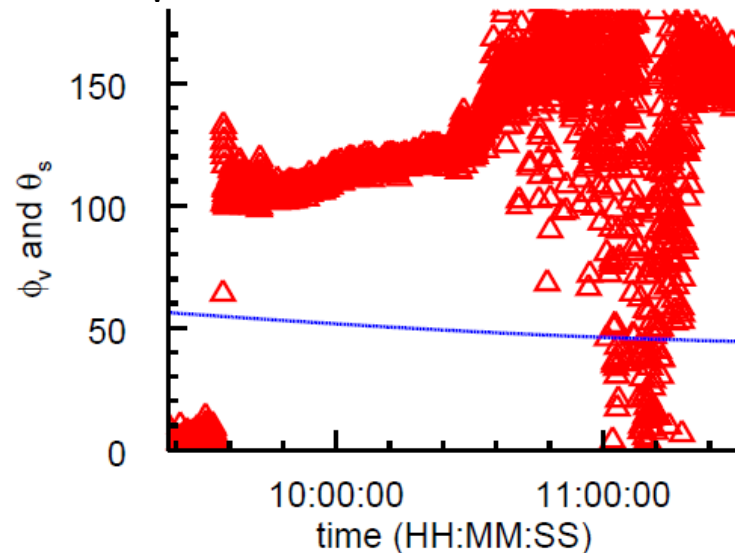




Sampling conditions

- $\sim 40^\circ$ from nadir (θ_v)
- Solar zenith angle (θ_s) $\sim 50^\circ$
- Crew “instructed” to maintain 135° away from sun (azimuth viewing direction ϕ_v)
- 7 m above the water surface
- Clear sky

Effective $\phi_v \sim 100 - 170^\circ$

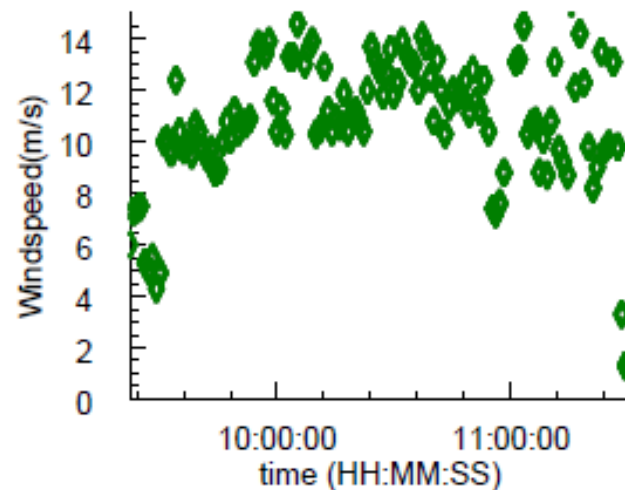


Satlantic HyperSAS above water system

Hyperspectral sensors (350-800 nm):

- Downwelling Irradiance (E_d)
- Upwelling radiance (L_u)
- Sky radiance (L_s)
- Tilt and Heading sensor (THR)
- Sampling frequency $\sim 0.5\text{Hz}$
- FOV $\sim 3^\circ$

Median Wind speed = 11ms^{-1}



Mobley (1999)

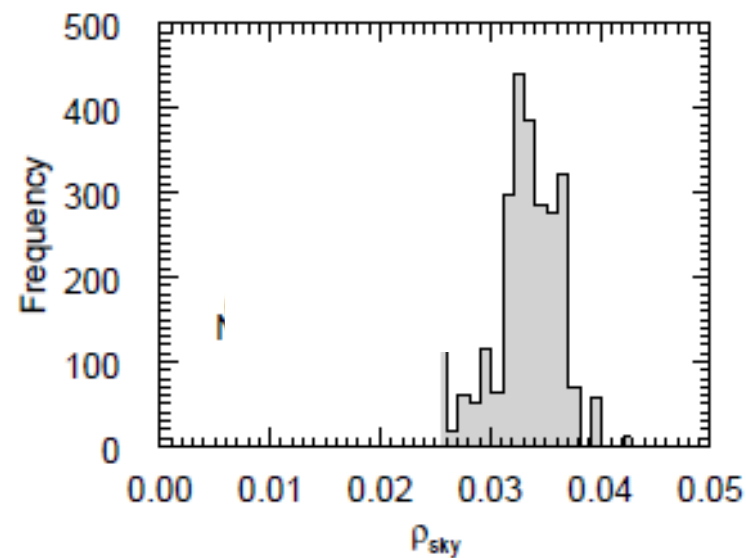
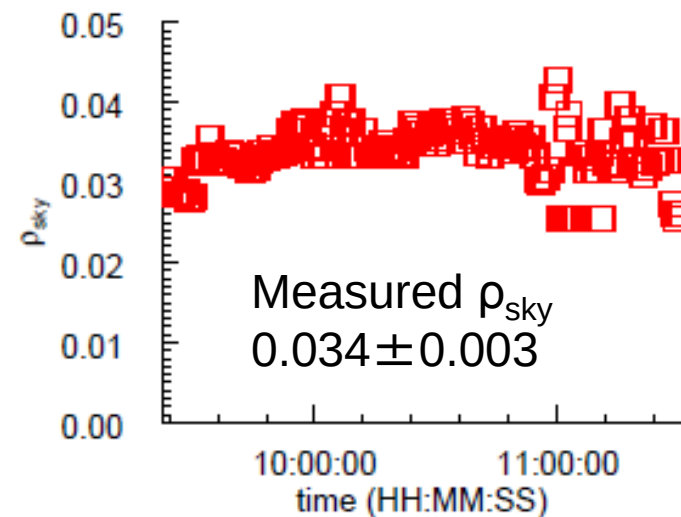
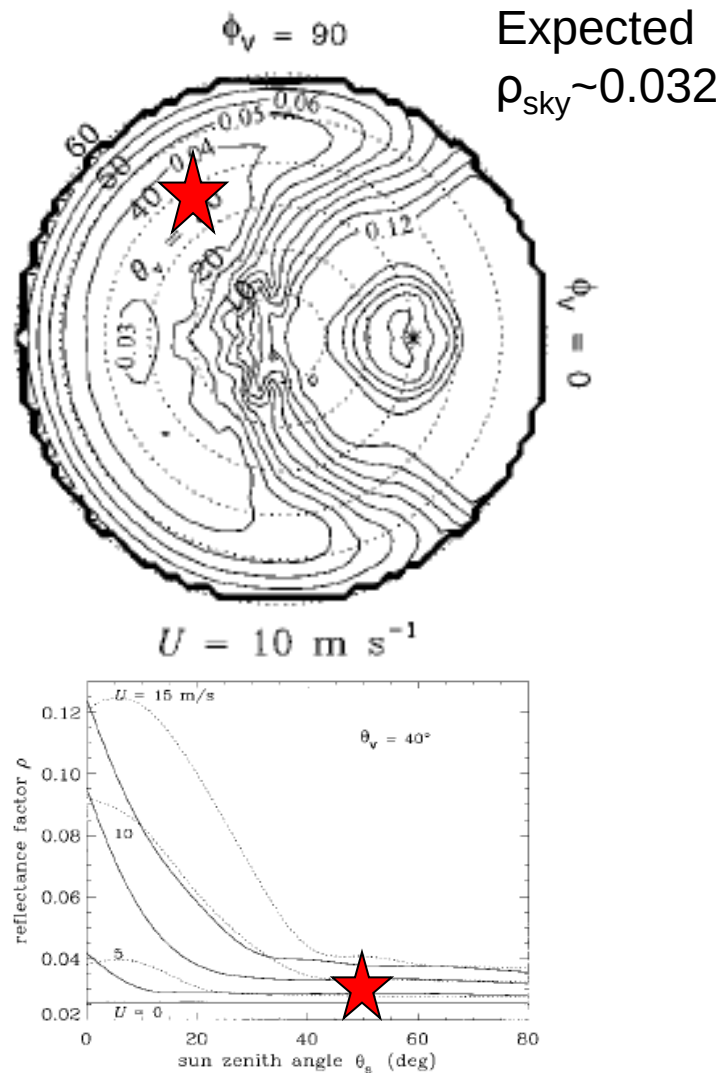


Fig. 9. Effect of wind speed and Sun zenith angle on ρ for a viewing direction of $\theta_v = 40$ deg and a clear-sky radiance distribution. The solid curves are for an azimuthal viewing direction of $\phi_v = 135$ deg and the dotted curves are for $\phi_v = 90$ deg.

Processing

- Standard processing (S95, with reflectance factor of Mobley, 1999)
- Similarity spectra (Ruddick et al.2006)
- Automated QC (Simis & Olsson, 2012)

Method overview

1. Find atmospheric gas absorption features in L_s and L_u

use derivative spectra, locate 10-15

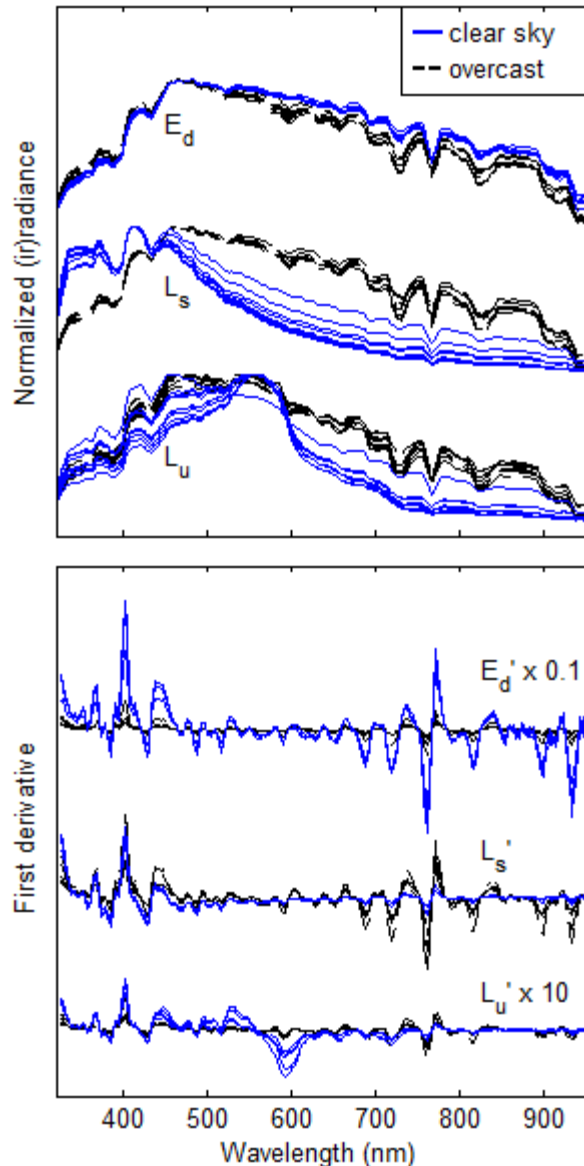
2. define limits for ρ_{sky}

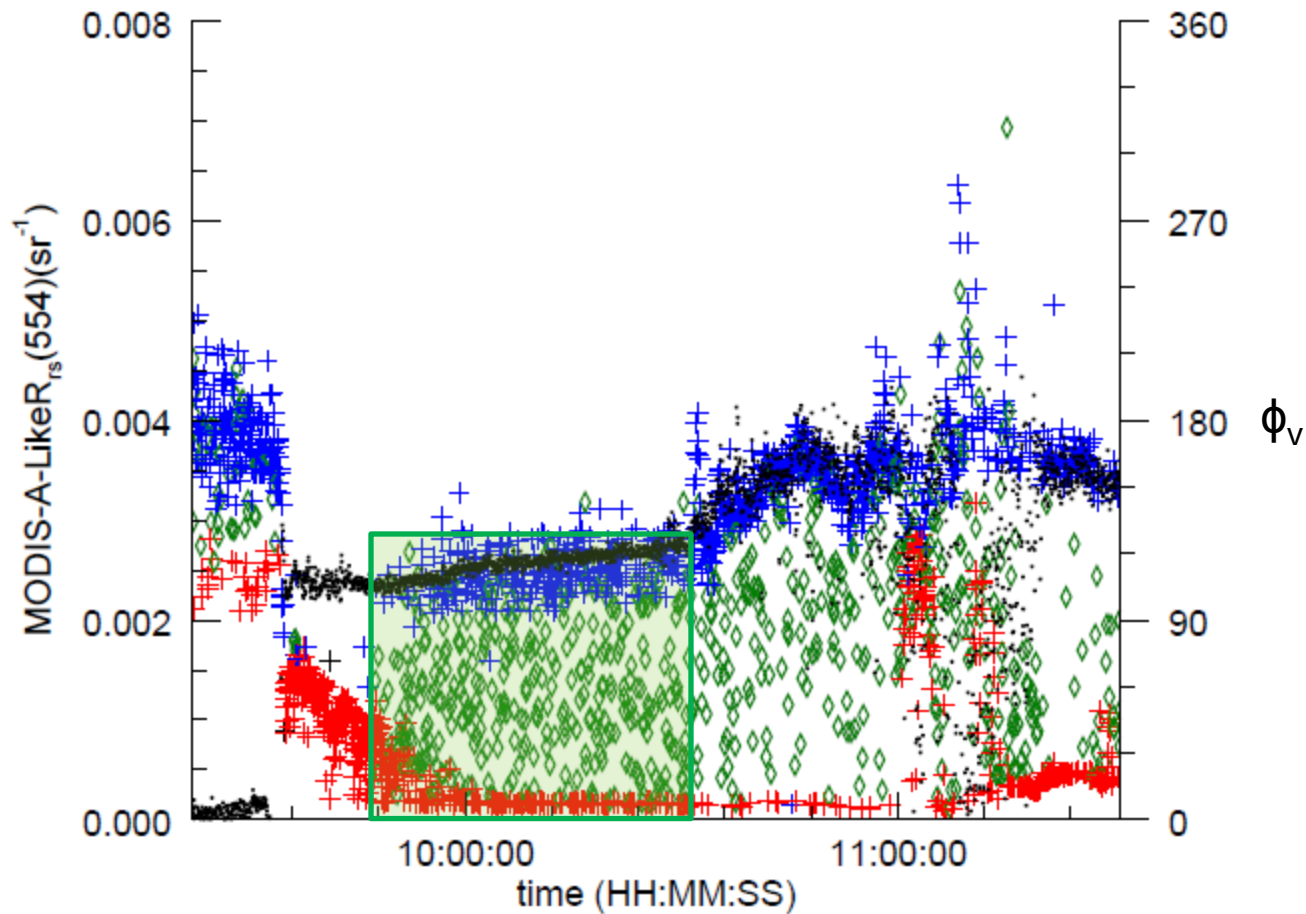
min: 0.0247 – max: R_{rs} not negative

3. Optimize ρ_{sky} in

$$R_{rs} = [L_u - (\rho_{\text{sky}} L_{\text{sky}})]/E_d$$

so that R_{rs} is curved but smooth:
gas absorption features are narrow but water absorption features are broad.

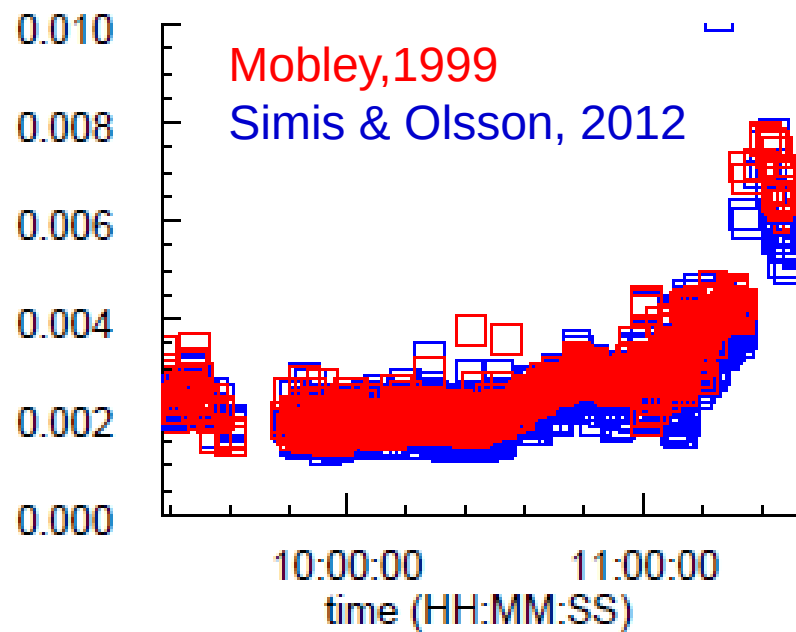
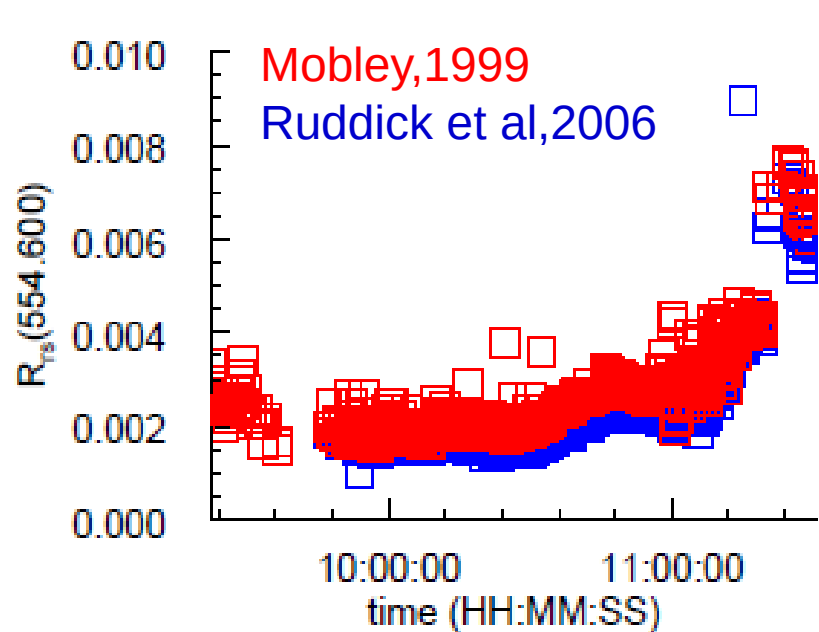




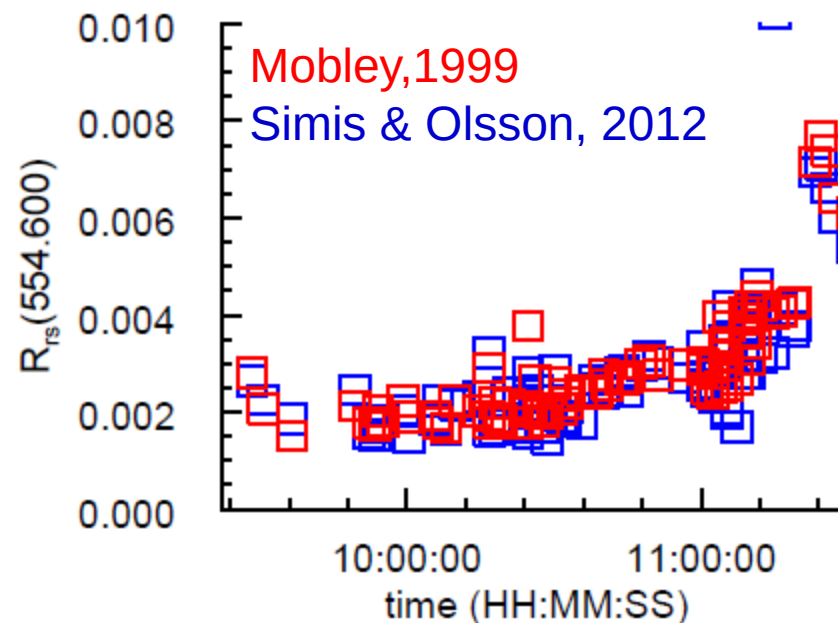
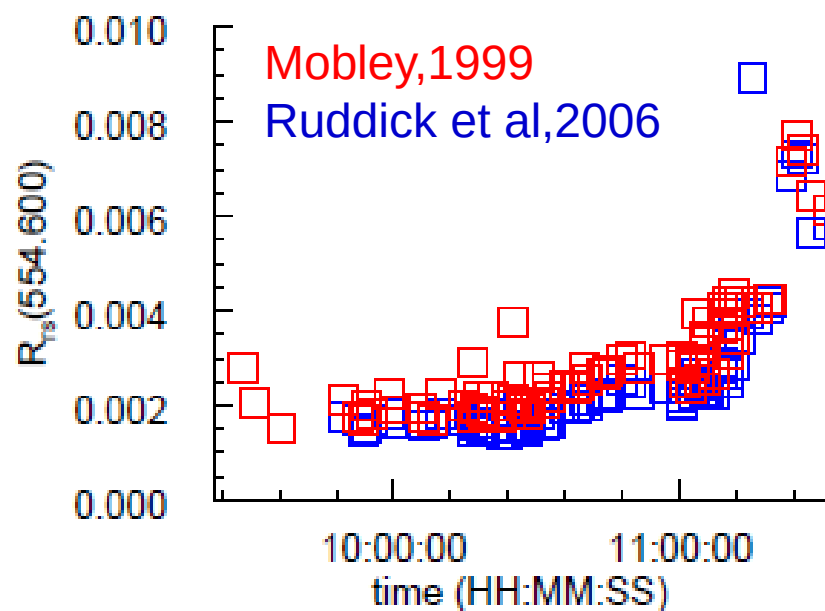
Black – viewing azimuth, ϕ_v

Green - Valid estimates of ρ_{sky}

Blue and red – Invalid estimates of ρ_{sky}

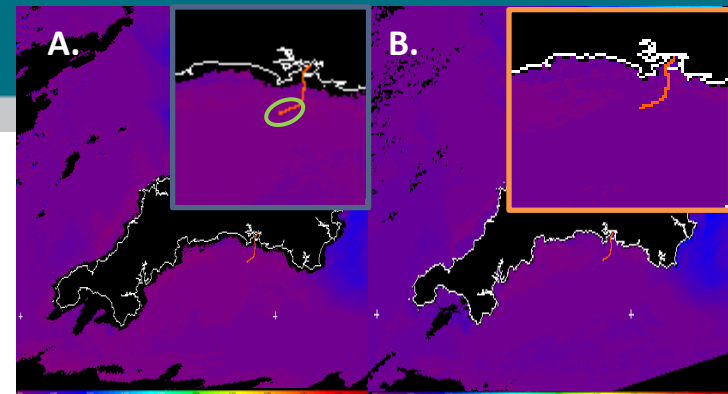
Valid ρ_{sky} , N=1876

Median UPD (%)	412	442	466	488	530	547	554	Average
Ruddick et al.(2006)	22	20	19	16	18	19	20	19
Simis & Olsson (2012)	19	15	12	9	8	8	8	11

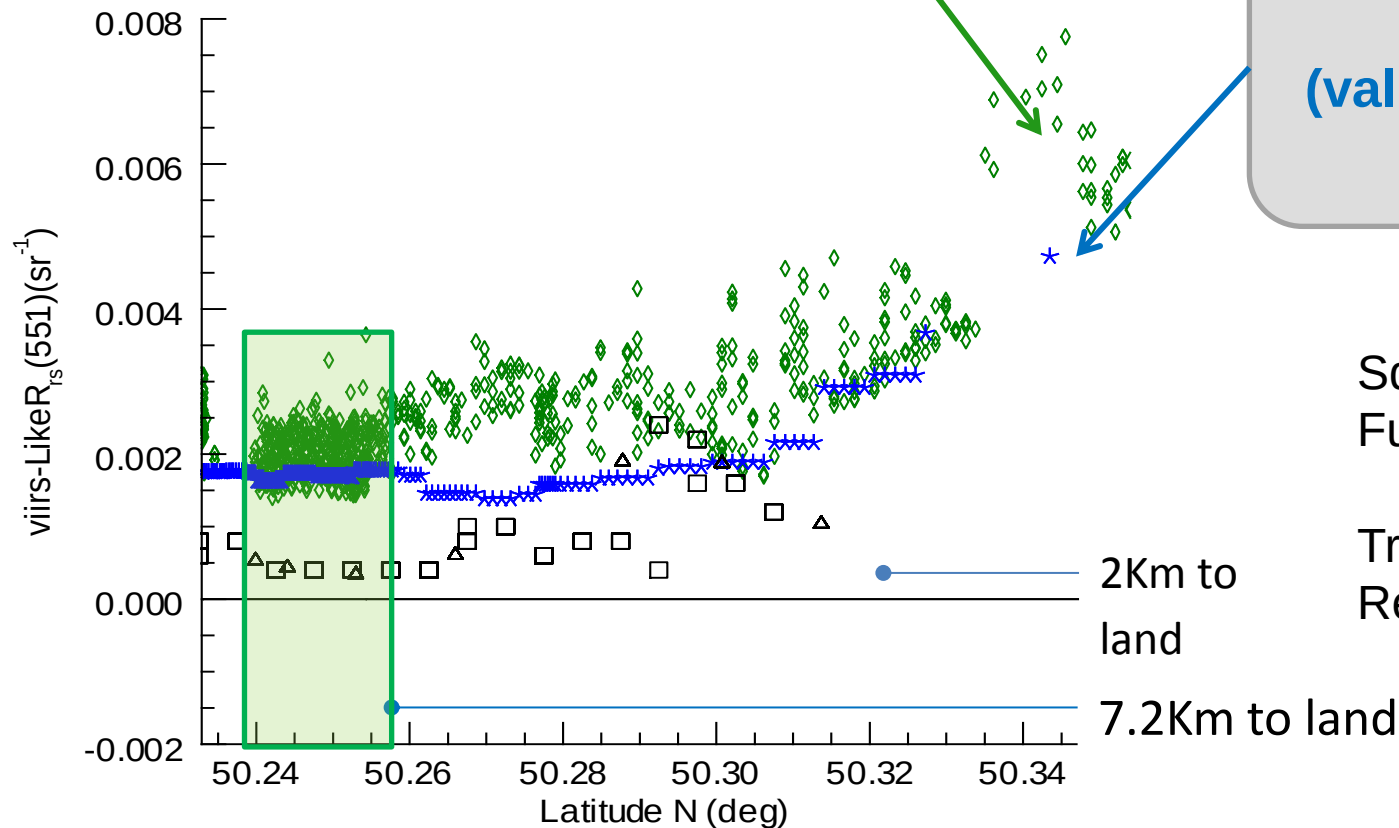


Median UPD (%)	412	442	466	488	530	547	554	Average
Ruddick et al.(2006)	34	30	28	26	28	30	30	29
Simis & Olsson (2012)	24	19	15	13	11	11	11	15

In-situ HyperSAS



VIIRS
(values repeated for same pixel)



Squares – MODIS- A
Full resolution

Triangles – MODIS-A
Reduced resolution

Conclusions and future work

- In-situ bio-optical coastal work on-going
- Double approach:
 - Long term bio-optical monitoring
 - Occasional testing with other data
- Preliminary results show large differences just by processing methods.
 - First adaptation of this method on Satlantic. Not >800nm
 - SEAPOL correction (Santer & Zagolski, 2012)
 - Do comparisons with other above water/in-water systems.
- Routine measurements for 2013
- Coupling to azimuth adjusting system (S. Simis, OOXXI-2012)

Funding

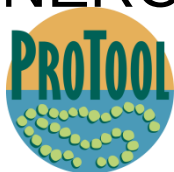


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NERC National Capability: Western Channel Observatory



WaterS



<http://sourceforge.net/projects/rflex>

People

Master and crew of RV *Plymouth Quest*, James R. Fishwick for wind and underway data.

Partners in ISECA:

