The western English Channel long-time series validation site

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iseca INFORMATION SYSTEM ON THE EUTROPHICATION OF OUR COASTAL AREAS

Marine Matters

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INTRODUCTION TO ISECA

ISECA is an Interreg project running until 2014 that aims to advance and disseminate scientific knowledge related to eutrophication in the 2Seas area. The main objectives of ISECA are to develop a technologically advanced and flexible information system for the eutrophication of coastal waters. The system: will significantly enhance the current capability to monitor and manage coastal water quality; will be web-based and combine satellite Earth Observation (EO) data with simulation models to link eutrophication to the underlying causes and the potential mitigation strategies. The interaction with different coastal use functions (beach recreation, fisheries, aquaculture) and scientific knowledge from different domains will be incorporated.

PROJECT OBJECTIVES RELEVANT TO EO

1. Protocols for in situ bio-optical measurements in coastal waters
2. In situ dataset for validation of EO
3. Validation of Ocean Colour products in coastal waters

PROTOCOLS FOR IN SITU BIO-OPTICAL MEASUREMENTS

An update of the protocols produced for the EU - REVAMP project (Fig. 1) has been produced, incorporating the latest developments on in-situ bio-optical techniques. This document will be available on the ISECA Web Information System. This document will be used by the main scientific players in the 2Seas area to harmonize bio-optical data collection methodologies.

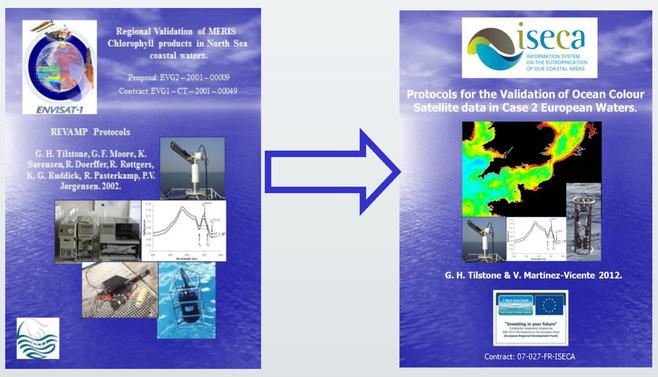


Figure 1. REVAMP protocols cover page (Tilstone et al., 2003) and ISECA protocols cover page (Tilstone and Martinez-Vicente, 2012)

IN SITU DATASET FOR VALIDATION OF EO LOCATION

ISECA bio-optical sampling is undertaken at the Western English Channel Observatory (WCO, Fig. 2) a long time-series of oceanographic and biological. In situ measurements are undertaken weekly at coastal station (L4) and fortnightly at the shelf station (E1) using the research vessels of the Plymouth Marine Laboratory and the Marine Biological Association. (http://www.westernchannelobservatory.org.uk)

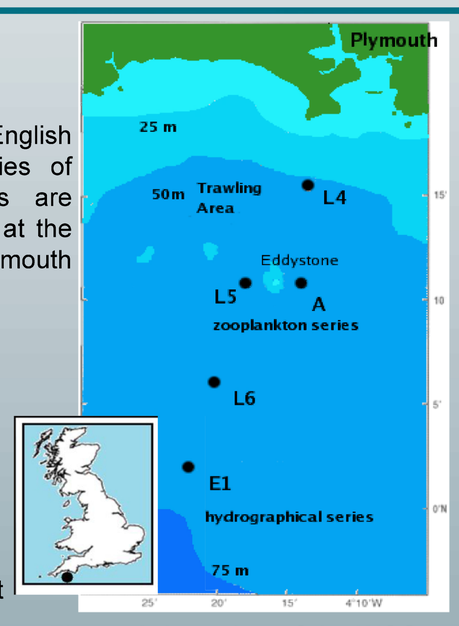


Figure 2. Location of the WCO

IN SITU DATASET FOR VALIDATION OF EO - DATA AVAILABLE

The bio-optical dataset for ISECA consists of 12 year time series of bulk biogeochemical and bio-optical variables measured weekly. The biogeochemical variables of relevance for MERIS and Sentinel-3 validation are pigment concentrations (including Chlorophyll-a) using HPLC and suspended particulate matter (SPM) (Fig. 3).

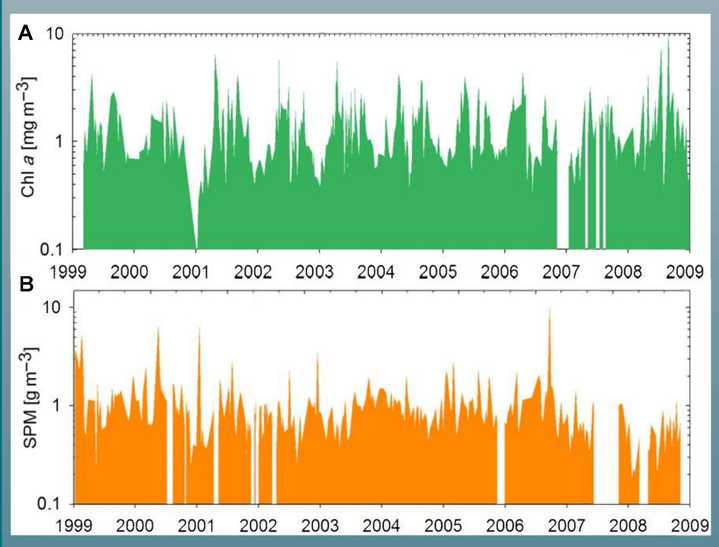


Figure 3. Weekly time series at L4 between January 1999 and January 2009: (A) suspended particulate matter concentration, SPM, (B) Chlorophyll a concentration, Chl a. (Martinez- Vicente et al. 2010)

Along with bulk biogeochemical variables, bio-optical variables relevant to EO validation measured include: coloured dissolved organic matter absorption (CDOM), particulate absorption (separated into phytoplankton and detritus fractions) and a suite of in-water optical measurements (Fig. 4). In-water optics include backscattering, absorption, scattering and attenuation.

The long time series allows for validation using a match up approach as well as exploring other statistical methods (See Summary and future work).

Finally, long time in-situ measurements allow for studies of change for continuity of ocean colour missions (i.e. verification of consistency between MERIS and Sentinel 3).

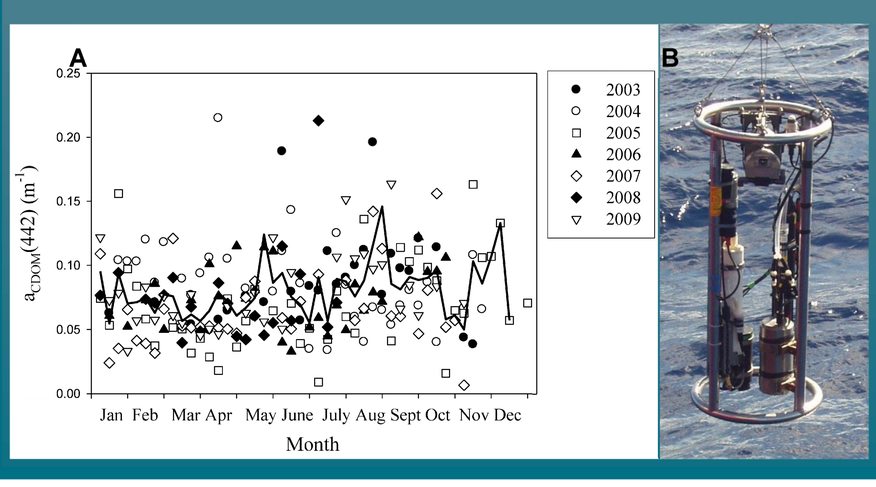


Figure 4. (A) Time Series of absorption coefficient of coloured dissolved organic material (B) In-water optical profiler: Typical deployment setup includes a Wetlabs ac9+, a Hobilabs Hydroscat-6 and a SeaBird CTD.

VALIDATION OF MERIS PRODUCTS

Data from the biogeochemical and bio-optical database are being used to validate MERIS data:

(A) Std. MERIS (B) HYDROPT MERIS sIOP (C & D) COASTCOLOUR

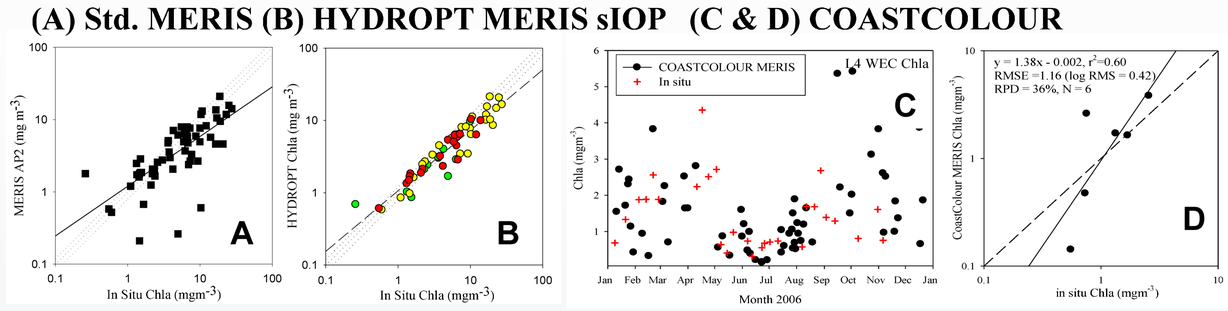
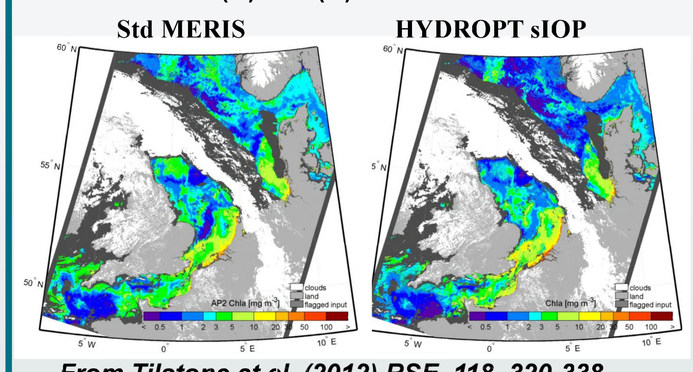


Figure 5. Comparison of *in situ* and satellite derived (A) MERIS AP2 Chla, (B) HYDROPT sIOP Chla and (C) and (D) MERIS COASTCOLOUR full resolution data over seasonal cycle.



A clustering method applied to a database of specific-absorption properties of the North Sea and WEC gives more accurate water quality products from MERIS (Fig. 5B) compared to the standard algorithm (Fig. 5A). This algorithm is being tested alongside the new MERIS COAST COLOUR algorithm (Fig. 5C, D).

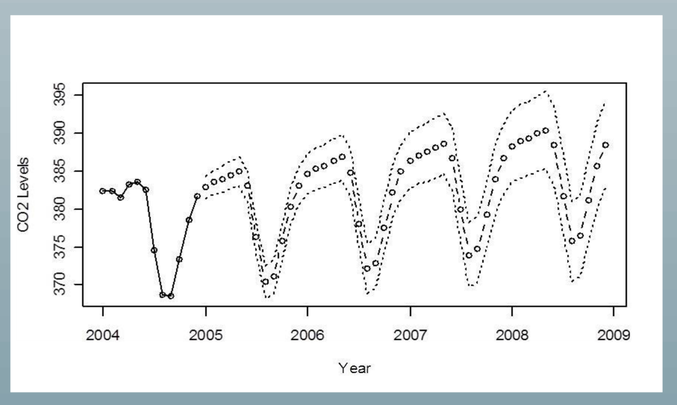
From Tilstone at el. (2012) RSE, 118, 320-338.

SUMMARY AND FUTURE WORK

We have presented the validation activities within the Interreg ISECA project (2011-2014). These include the construction of a database of in situ biogeochemical and bio-optical measurements of relevance for historic (MERIS) and future (Sentinel-3) ocean colour sensors in the coastal zone.

The long time series of data collected with consistent methodologies (REVAMP protocols evolution to ISECA protocols) allow for a robust dataset for the in situ verification of precision and accuracy of the EO sensors. Although affected by cloud cover, the weekly sampling at WCO in the last 12 years has produced a large dataset that can be used to perform match-up studies.

New approaches will be explored within the life of the ISECA project to validate satellite products taking advantage of the statistical properties of the time series. With our future analyses, to help refine and identify the system characteristics we will be fitting appropriate Box-Jenkins ARIMA times series models (see for example Young , 2011 and Bruun et al, *in prep*), and using intervention analysis to help account for missing data components. Here is an example of applying such a model to a C02 times series which is characterised by both seasonal components and a slowly increasing trend. Our future validations will include a cross-comparison of ARIMA models applied to in-situ and satellite observations and furthermore an application of the Data Based Mechanistic Approach (DBM) of Young (2011) to help explain the reasons for trends and observed structures observed in these series by linking these with explainable physical and biological drivers.



The model is an example of stochastic underlying trend:

$y_t = M_t + S_t + e_t$

M_t: non seasonal slowly changing trend; S_t: Seasonal; e_t: white noise

Figure 6. Example of a statistical technique applicable to in situ bio-optical data from ISECA for validation of MERIS/Sentinel-3 sensors. Test data are monthly CO2 levels: Alert, NW Territories, Canada
The ARIMA(0,1,1)x(0,1,1)12 can be used to forecast ahead based on the identified model structure

Finally, the long time series may allow studies of the detection of trends in sensors and the verification of the consistency between MERIS and Sentinel-3 in coastal waters.

References and Acknowledgements

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