Towards automated measurements of primary production

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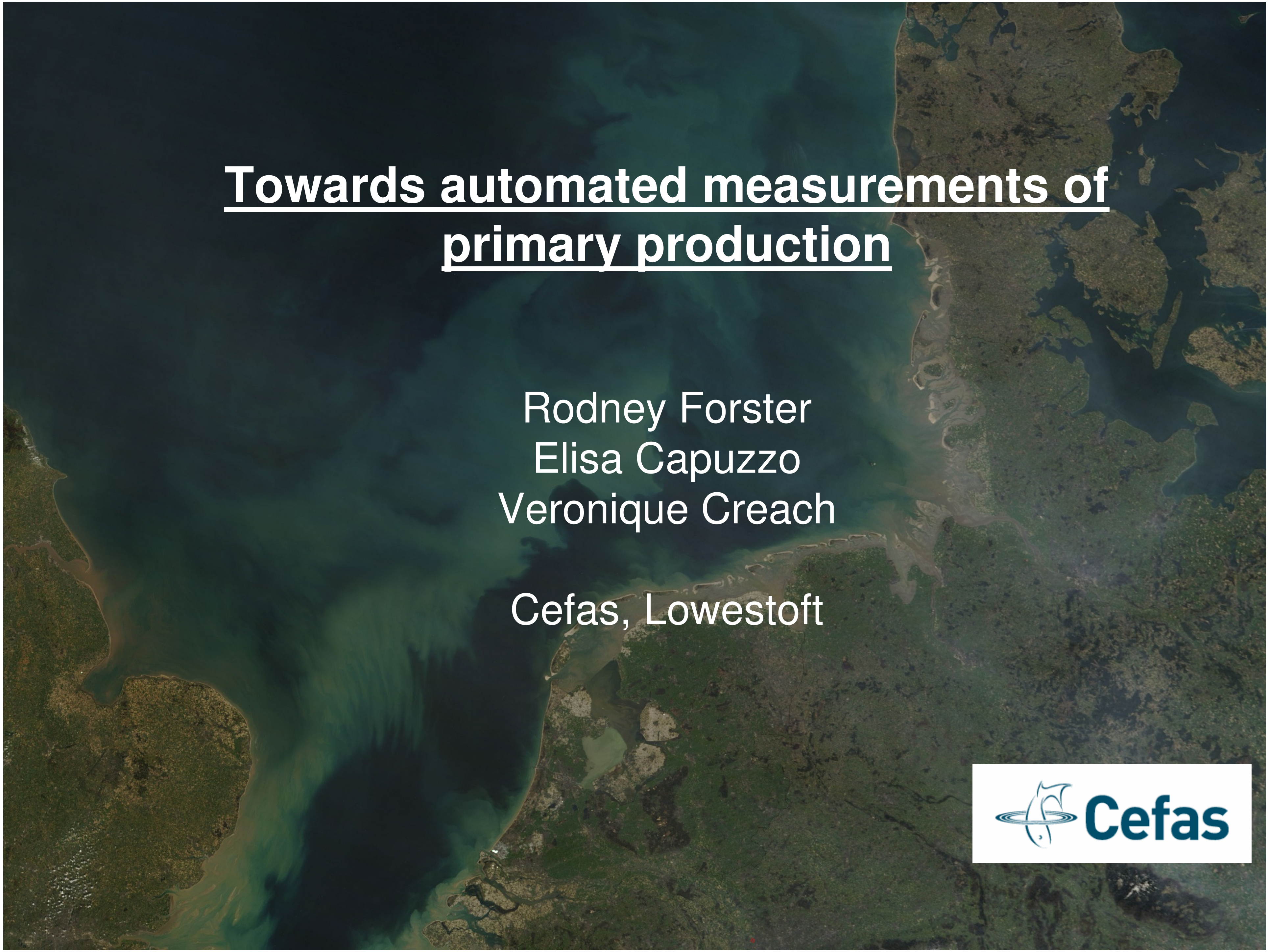

Why measure primary production?

Marine Strategy Framework Directive (2010)

This implements the whole ecosystem approach to monitoring and requires ‘Good Ecological Status’ of the marine environment to be achieved by 2020.

Descriptors include: biodiversity, fish stocks, food web structure and function, eutrophication, seabed integrity, contamination, litter, underwater noise, hydrography.

Contrasts with Water Framework Directive which only requires selected state variables (e.g. chlorophyll, benthos) and no knowledge of ecosystem function.

Renewed interest in links between primary production and fish production

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Global-scale predictions of community and ecosystem properties from simple ecological theory

Simon Jennings[1,*], Frédéric Mélin[2], Julia L. Blanchard[1], Rodney M. Forster[1], Nicholas K. Dulvy[1,†] and Rod W. Wilson[3]

ECOLOGY LETTERS

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LETTER

Global marine primary production constrains fisheries catches

Emmanuel Chassot,[1*] Sylvain Bonhommeau,[1] Nicholas K. Dulvy,[2] Frédéric Mélin,[3] Reg Watson,[4] Didier Gascuel[5] and Olivier Le Pape[5]

Abstract
Primary production must constrain the amount of fish and invertebrates available to expanding fisheries; however the degree of limitation has only been demonstrated at regional scales to date. Here we show that phytoplanktonic primary production, estimated from an ocean-colour satellite (SeaWiFS), is related to global fisheries catches at the scale of Large Marine Ecosystems, while accounting for temperature and

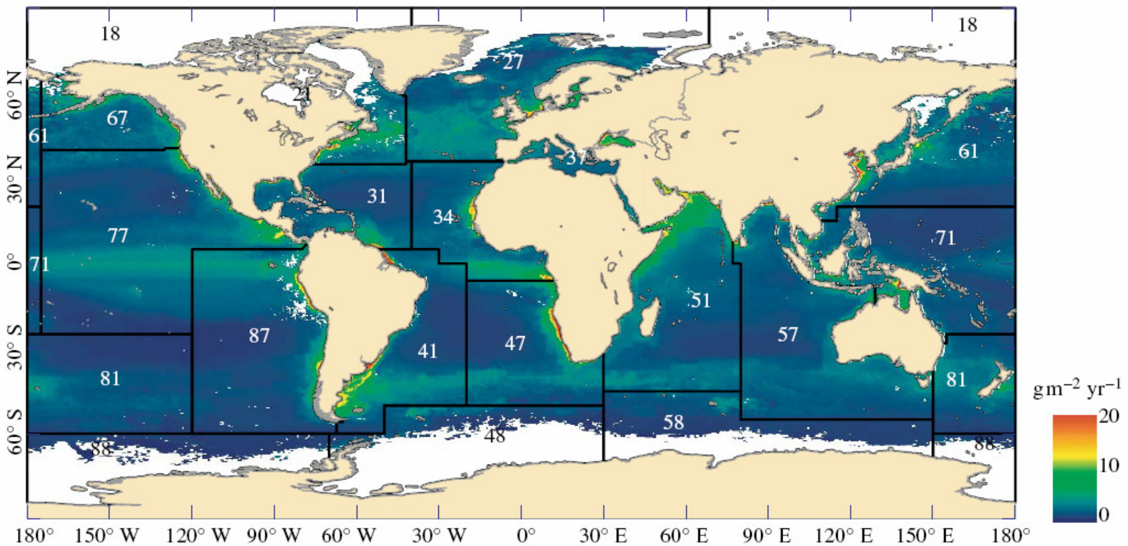

Figure 4. The distribution of teleost production. The overlays show the FAO fishing areas and their corresponding codes (see

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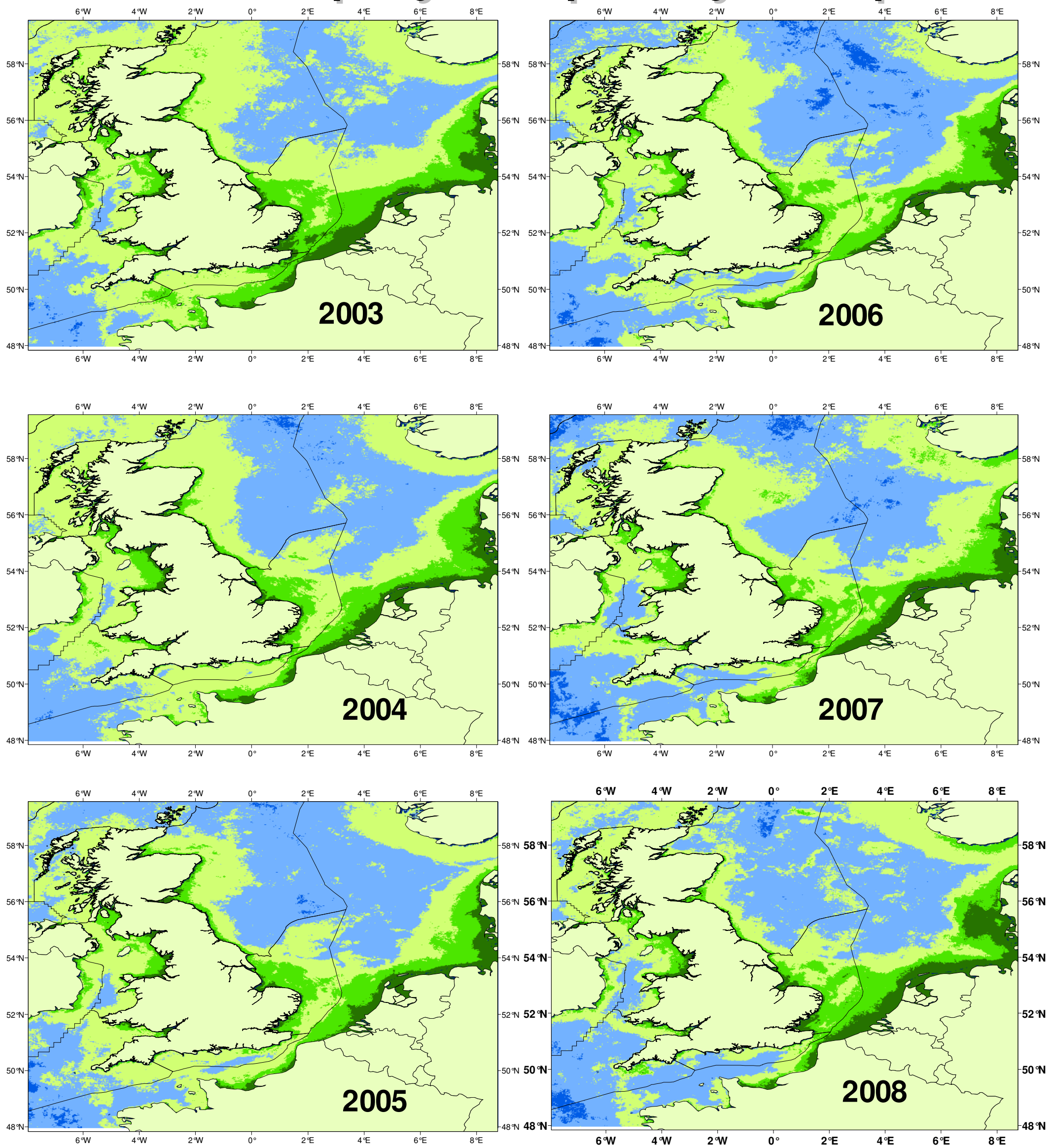
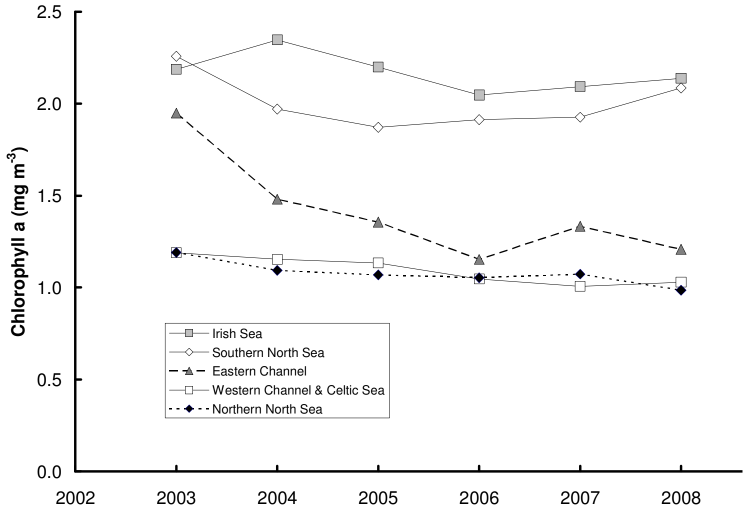
Is chlorophyll a proxy for primary production?





Legend

0.25 - 0.5

0.5 - 1

1 - 2

2 - 4

4 - 8

Chlorophyll a (mg m^{-3})

MERIS chl-II (K. Ruddick, MUMM)

The ProTool approach:

- Photosynthetic activity is under-sampled in space and time, and restrictions on ^{14}C use on research vessels will limit this further

- Indirect measurements of primary production e.g. optical models, or bulk gas exchange methods are useful

- But, direct measurements are preferred. The only technique which is cheap, scaleable and robust is the active fluorescence method.

Cefas aims

– to validate active fluorescence as a proxy for rates of carbon fixation (with NIOO and University Essex)

- develop a pre-operational system for measuring F_v/F_m and ETR autonomously on a research vessel

- to improve estimates of PP in the North Sea

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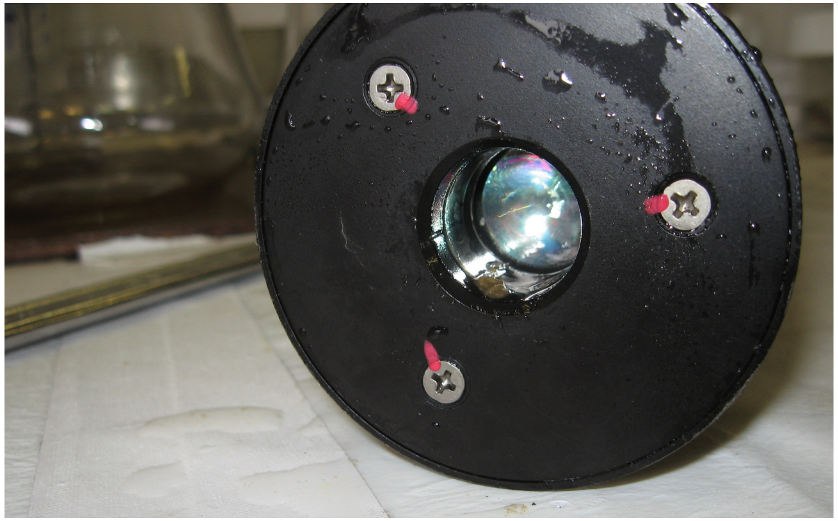
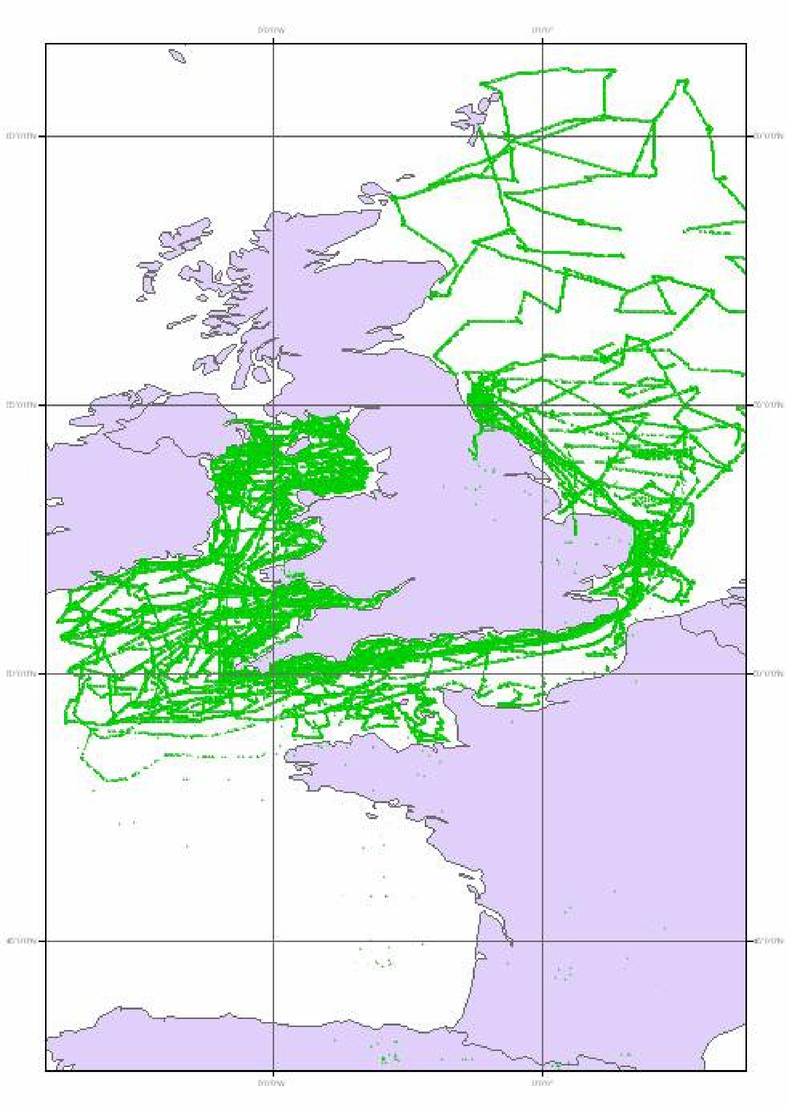
First steps: automated measurements of F_v/F_m



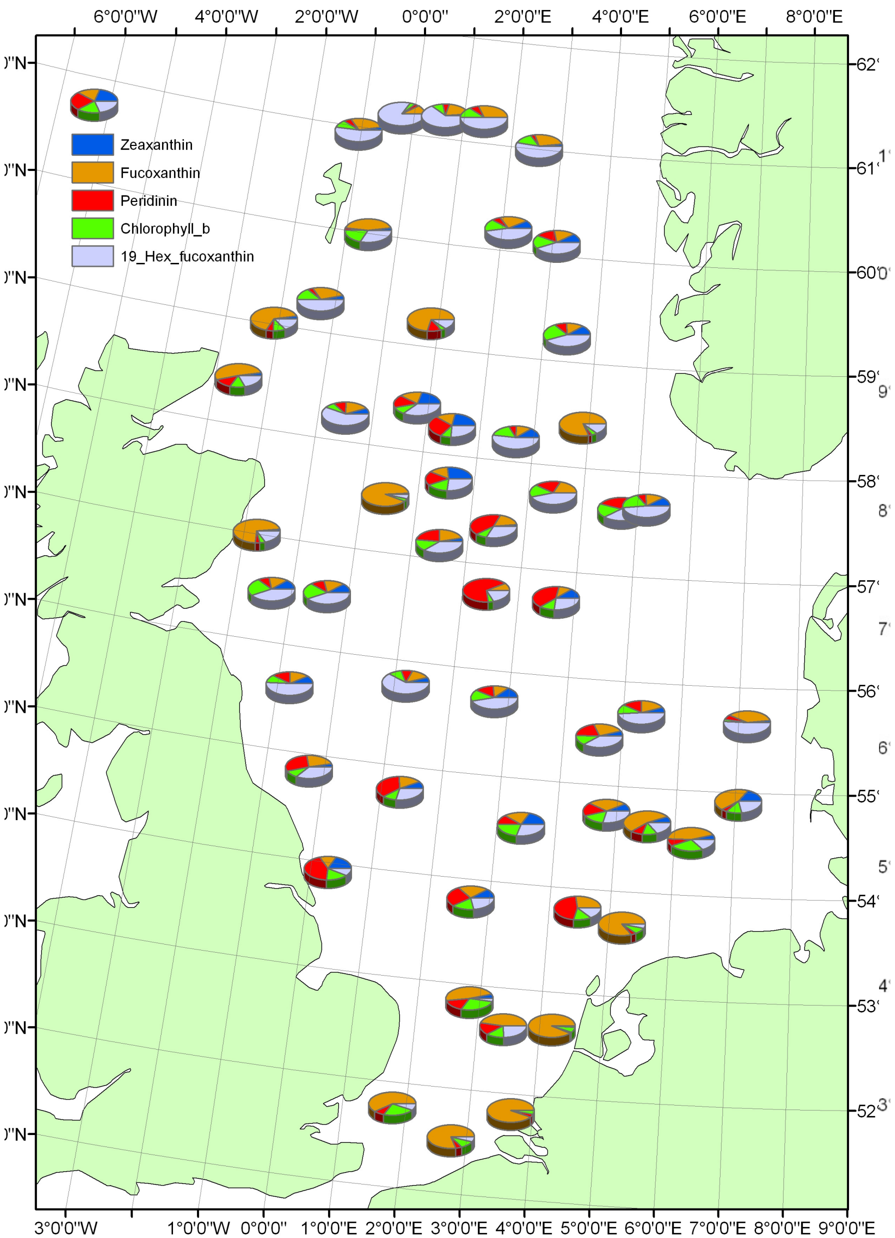
4h Jena system on
RV Cefas Endeavour

Survey tracks of Endeavour 2009-2010



‘random walk’ plus fixed grid

Fixed grid – International Bottom Trawl Survey



Fisheries cruise track with surface chlorophyll fluorescence logging

2007-2009 – addition of CTD + FerryBox

2010 – addition of microbial ecology

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Method: obtaining the correct *F* and F_m requires a blank correction

THE BLANK CAN MAKE A BIG DIFFERENCE IN OCEANOGRAPHIC MEASUREMENTS

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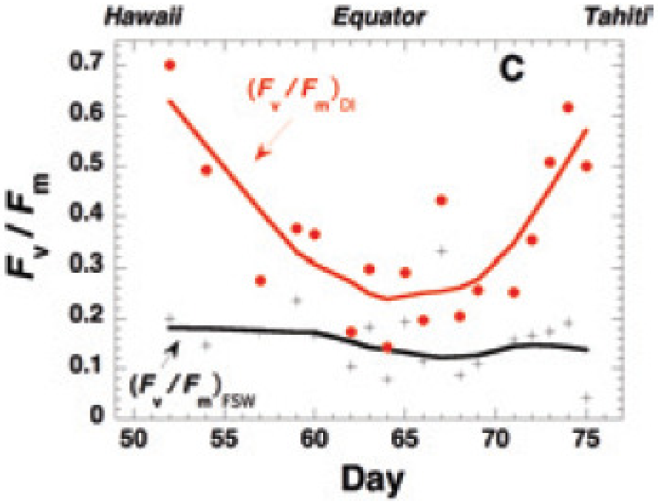
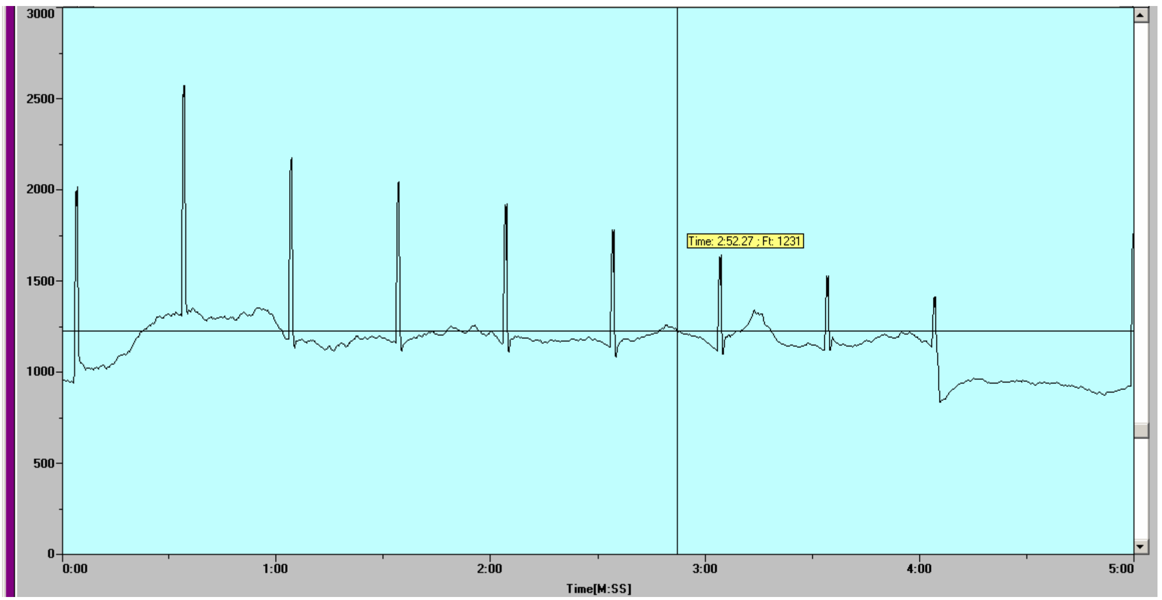
LIMNOLOGY AND OCEANOGRAPHY BULLETIN





Calibration of Phytoflash versus Water PAM and Fastracka

Measurements of GFF-filtrate are made at each CTD station and depth

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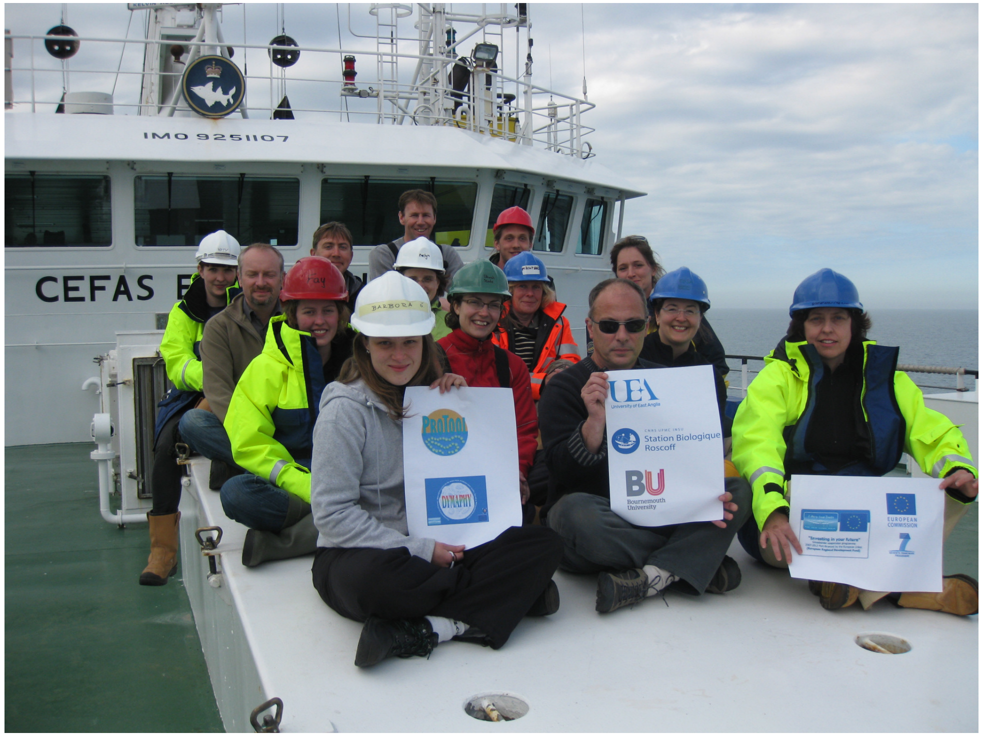
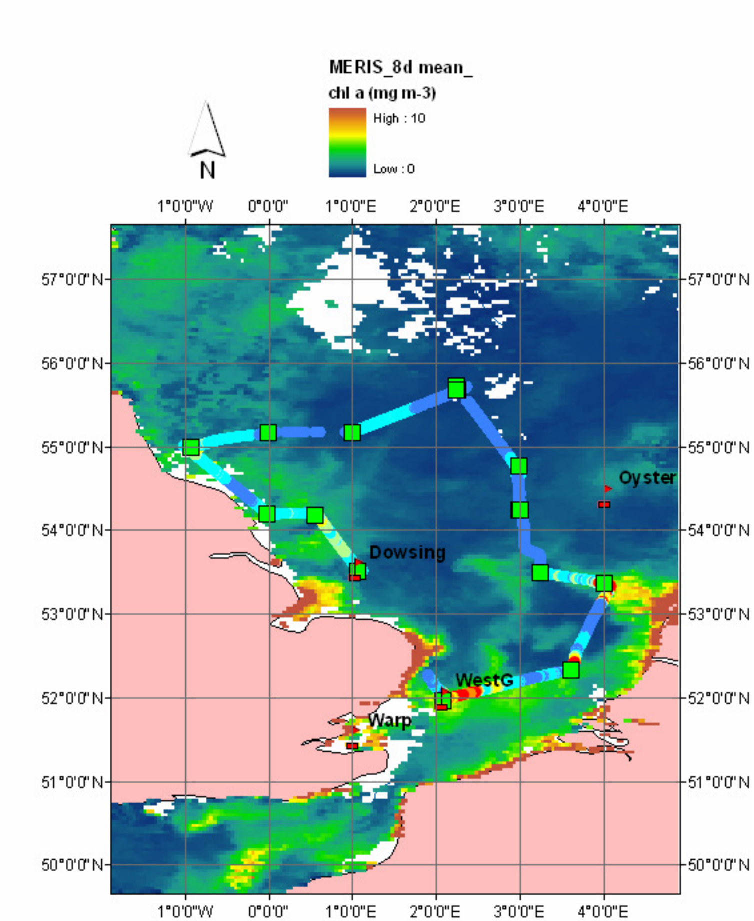
Testing: ProTool cruise in May 2011

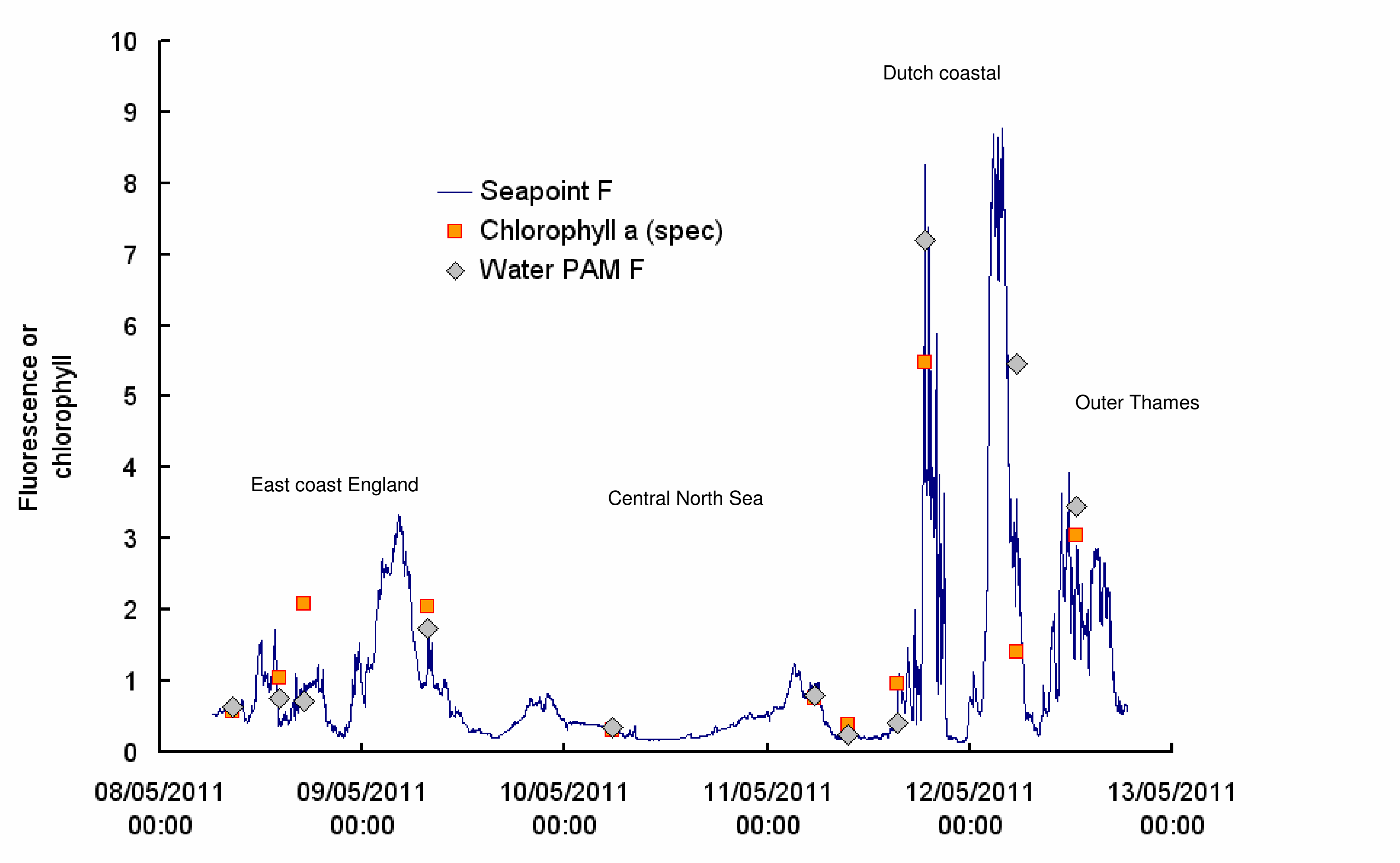




On-line measurements with Ferrybox (Cefas), portable Ferrybox (Ifremer), CytoSense (SB Wimereux)

Station measurements with PAM, Fastracka, PSI fluorometers; radiocarbon

Results: ProTool cruise in May 2011



In situ “chlorophyll” estimates show similar trends and agree with ocean colour

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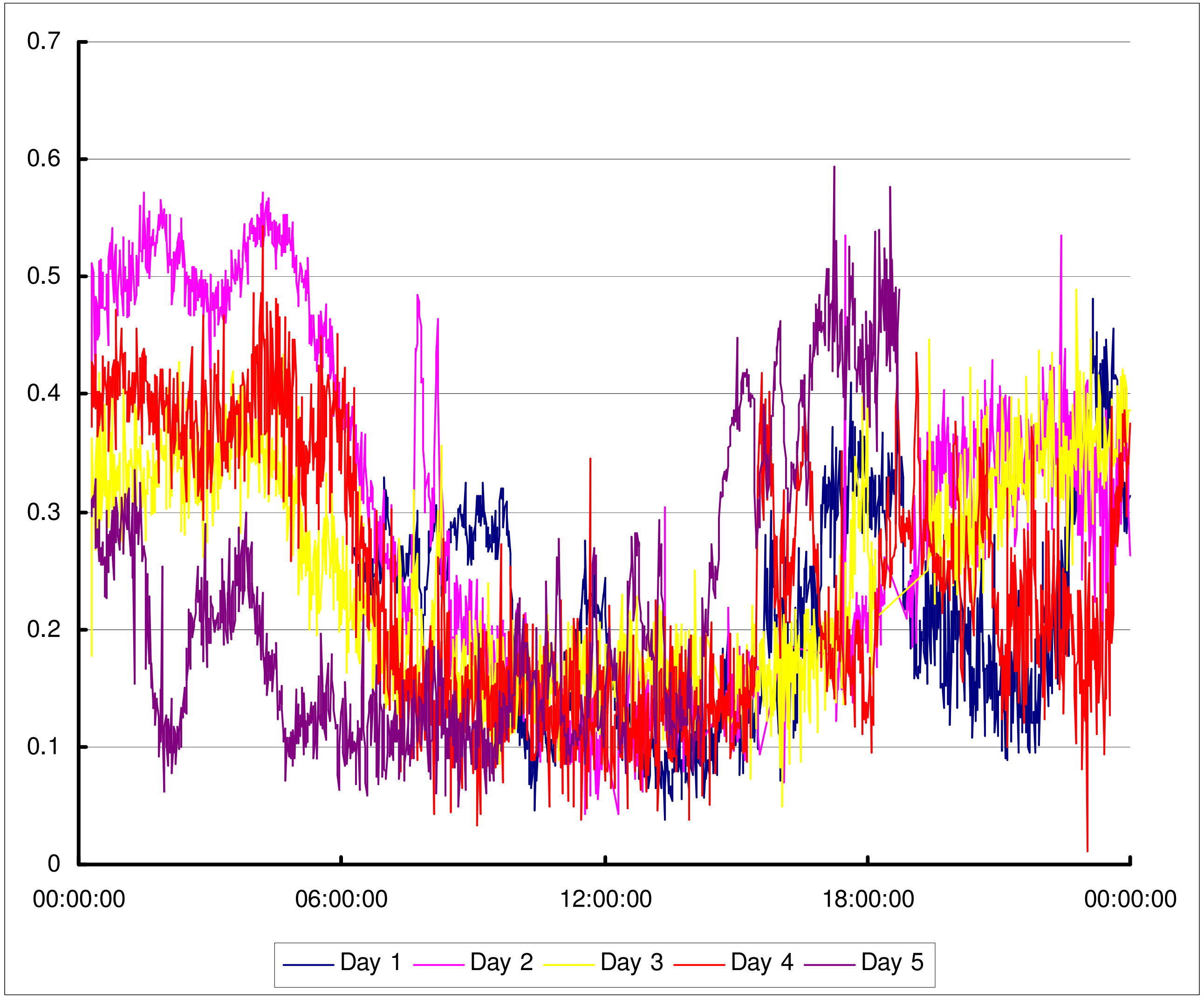
Results: diurnal variability in F_v/F_m



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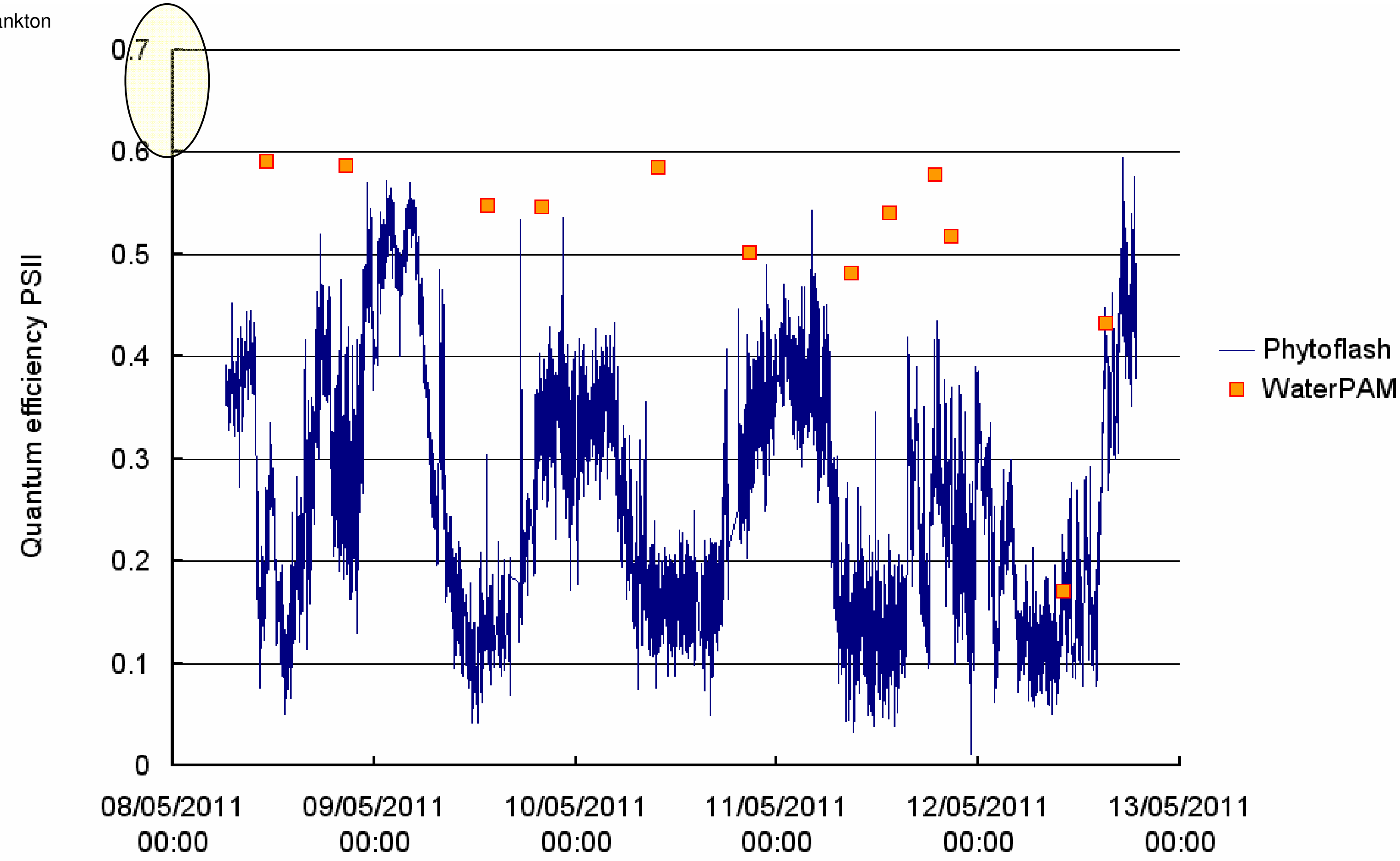
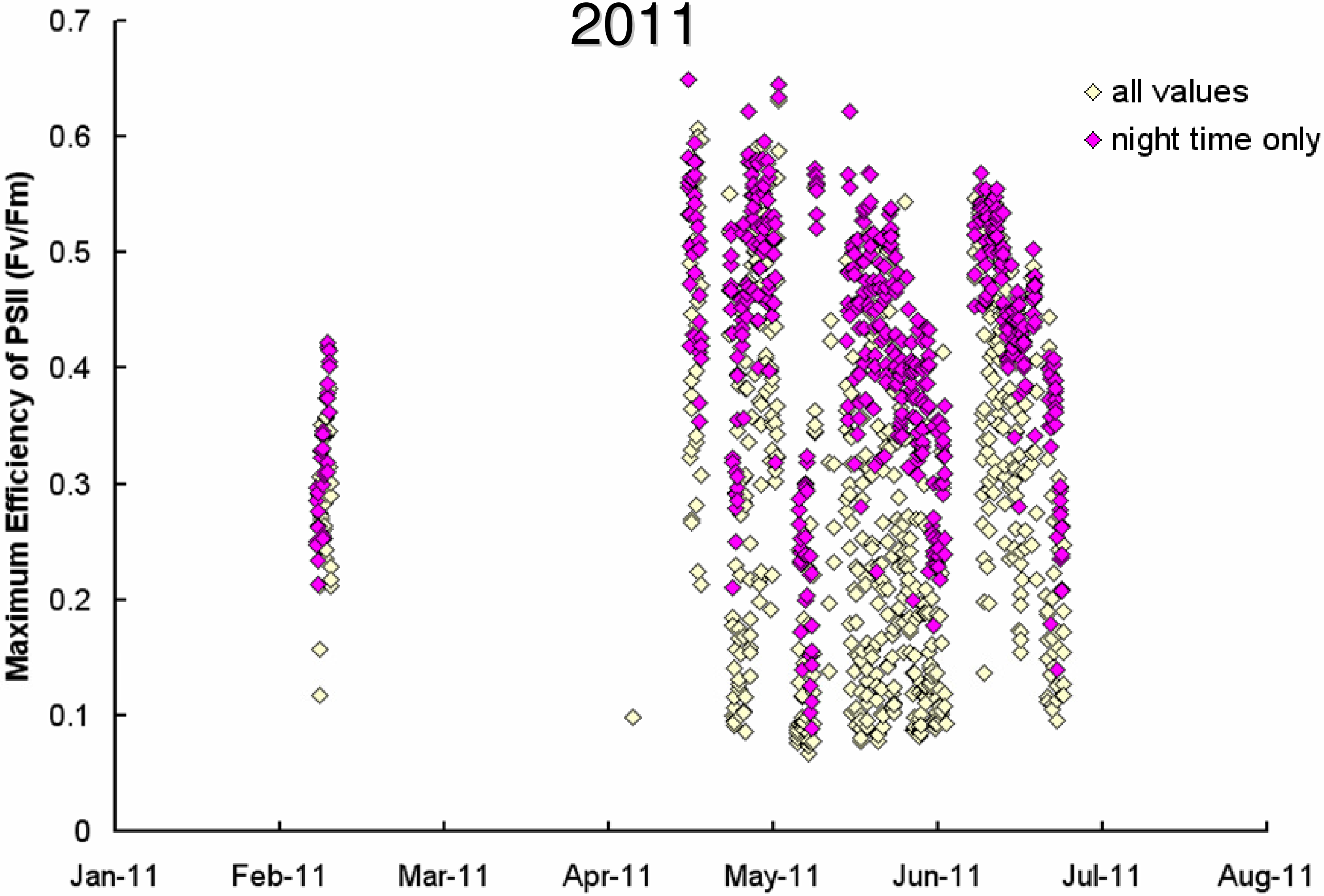
Results: comparison of Phytoflash with WaterPAM

optimal
value for phytoplankton



Results: all Ferrybox Fv/Fm measurements in 2011



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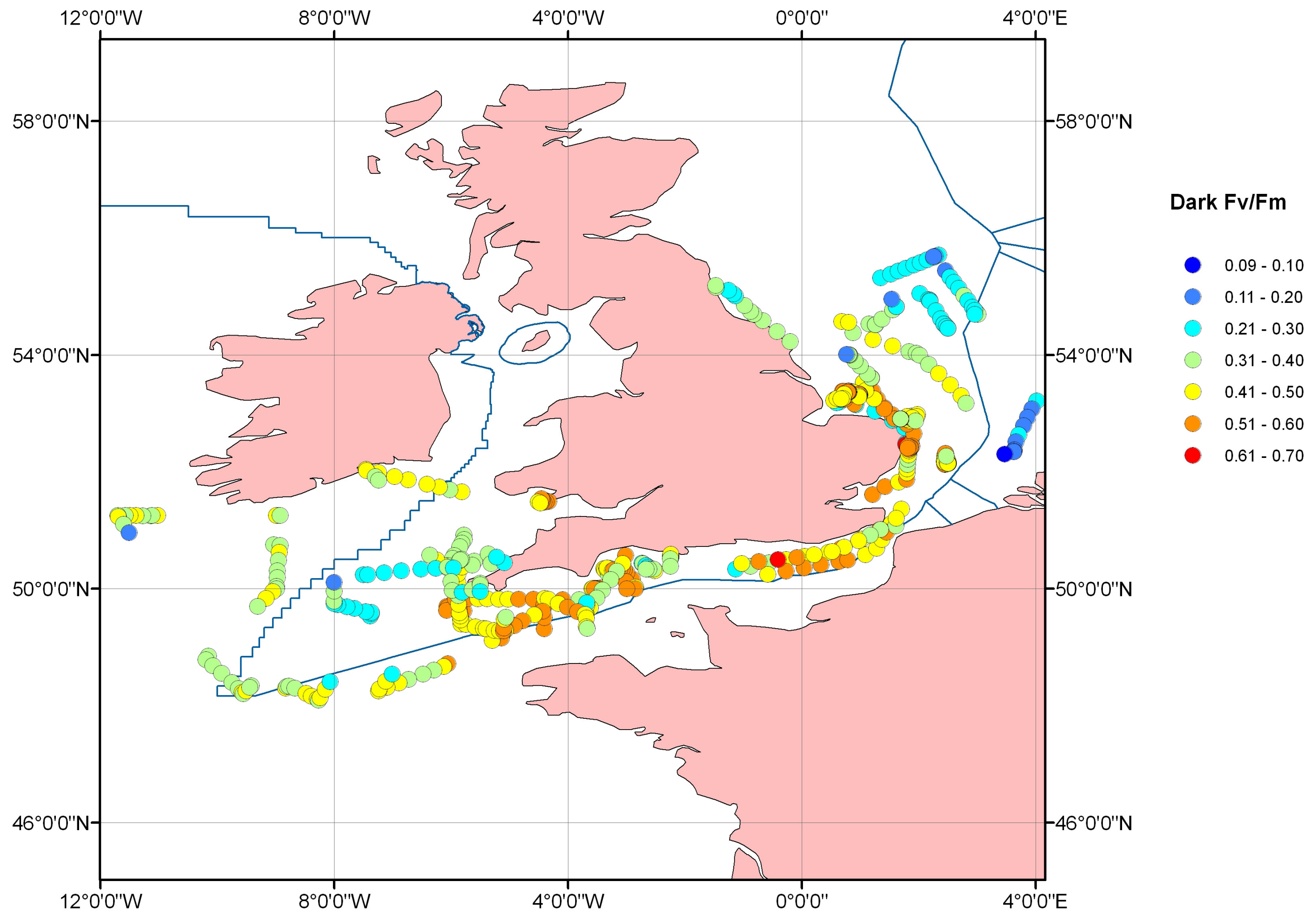
Results: spatial patterns in PSII efficiency



Summary:

- InitialProTool results in the Baltic and North Sea show that PS II electron transport can be converted into units of carbon uptake

- First measurements of dark-acclimated F_v/F_m the expected diurnal variability due to NPQ, and reveal an unexpectedly large range of night-time values

- This may be related to nutrient limitation or to differences in community composition (Suggett et al. 2009, in MEPS).

- Next step is to demonstrate an on-line system for measuring photosynthesis – irradiance curves

- Consider how to build an operational system, broadcasting the results to the community (GEOSS, GMES uptake).

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