CRUISE REPORT: RV CEFAS ENDEAVOUR: 08/11

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DURATION: 8 May – 13 May 2011.

LOCATION: southern and central North Sea

All times are local time (GMT +1)

The cruise is staffed jointly by scientists from the ProTool[1] consortium and the DyMaphy[2] project, together with scientists from the University of East Anglia and University of Bournemouth and Station Biologique de Roscoff.

AIMS:

ProTool aims

a) To calibrate the variable fluorescence technique against ^{14}C or ^{13}C -based photosynthesis measurements for phytoplankton samples collected from a range of ecohydrodynamic regions (done)
b) To demonstrate the use of an on-line automated flow-through system using the variable fluorescence technique throughout the cruise (not done due to staff illness)
c) To investigate diurnal variability in the phytoplankton photophysiology (done)
d) To measure variability in spectral irradiance of the water column at different locations (not done due to equipment failure)
e) To measure low-temperature fluorescence excitation and emission spectra of phytoplankton throughout the cruise (done)
f) To measure size-fractionated primary production using the variable fluorescence method (done)
g) To map the distribution of “cDOM” type substances which contribute to the background fluorescence of the variable fluorescence fluorimeters (done)
h) To measure the effect of nutrient addition to phytoplankton exhibiting low fluorescence yields (done, at one station)

DyMaphy aims

a) To compare the analyses of functional groups of phytoplankton with different flow cytometers in different water bodies and in different conditions of nutrients and light (tank experiment) (done)
b) To compare results and performance of a portable Ferrybox with the on board Ferrybox (done)
c) To test the feasibility of analysing functional groups with on-line continuous flow with flow cytometry (done)

UEA aims:

a) (Queste) To deploy and retrieve a Seaglider for the first time in the North Sea (done)
b) (Owen)To estimate biovolume for different functional groups of phytoplankton by comparing carbon, chlorophyll and DNA content with flow cytometric analyses (done)

U Bourne aims:

a) Use an Accuri C6 flow cytometer to quantify the abundance of phytoplankton <15-20 microns in size (*Synechococcus*, picoeukaryotes and some nanoeukaryotes). (done)
b) Assess the 'viability' of these fractions of the phytoplankton by incubating samples with the cell stains CMFDA and SYTOX-green and to derive an index of physiological condition across different hydrographic conditions. (done)
c) Analyse water samples for the presence of chlorophyll, and the chlorophyll alteration products methoxychlorophyll a and hydroxychlorophyll a by HPLC as indicators of chlorophyll turnover and cell senescence.(done)

SECONDARY AIMS:

a) Continued calibration and utilisation of FerryBox on Cefas Endeavour. (done)

Cruise details

Saturday 7th May

Cefas Endeavour left Lowestoft at 22:00 in Saturday 7th May and steamed overnight to the first station alongside the Dowsing SmartBuoy mooring site. The wind was southerly force 4-5 and sea state slight. A comparison of ferryboxes was not possible during this first leg as the Cefas system had computer problems, and the Ifremer system had insufficient water supply from the ferrybox de-bubbler outflow. The Ifremer system was switched to pump from the clean seawater supply, and after rebooting the Cefas system both machines were operational on the following day (Cefas started logging at 06:30 and Ifremer at 11:00).

Sunday 8th May

The aim of the first day was to sample water masses of different temperature between the north Norfolk coast and Yorkshire coast, and the 'Flamborough Front' in particular. Maps of sea surface temperature obtained from the Met Office were used to position stations. An initial CTD rosette cast at the Dowsing mooring was made at 09:30. The water column profile was recorded

with all instruments measuring correctly, but the Surefire water sampling system did not operate (low voltage message during firing).
Problems with the water sampler persisted throughout the morning, with bottles firing successfully on deck but not in the water. The lower closing lid of one of the 30 l Niskin bottles broke as the bottle was being prepared for firing.
A continuous flow water sample was taken from the ferrybox supply (**Station Cend 0811_001**; Dowsing; N 053° 031.090' E 001° 4.322' ; Figure 1), this sample was processed by all scientists during the following hours. In the afternoon a northerly course was followed to station **Cend0811_002** at N 054° 12.07' E 000° 33.14' (outer Flamborough Front), this was reached at 15:00.
CTD bottle problems persisted so the continuous flow water sampling was again used for sampling. Two Niskins bottles were found to be damaged after retrieval of the cast (bottle numbers 116, 129). Plastic fatigue at the joint where the handle meets the body of the bottle was the problem.
All possible sources of electric leakage on the CTD cables were sequentially eliminated with great patience and skill by Katy Owen and Bastien Queste, with help from the deckhands and engineers of Endeavour, and bottle firing started again when the CTD unit (FSI 1351i) was replaced with another unit (FSI 1322i).
A third station was reached at 18:00 (**Station Cend 0811_003**; inner Flamborough N 054° 11.79' W° 000 0.48') with a water depth of 53m. This time, bottles were fired successfully at surface and bottom (6 m and 50 m).
The ship moved north overnight to a position off the Tyne, with both Ferrybox systems operating correctly, as well as the on-line flow cytometer.

Monday 9th May

The aim of the second day was to sample along a gradient of decreasing nutrient concentration along the latitude of 55°N. Station four was originally planned for a position of N 055° 0.00' W 001° 0.00' but inspection of the overnight ferrybox record showed that a large phytoplankton bloom was present further to the east (marked as "A" on the ferrybox trace, Figure 2). A new position was taken for station four (**Cend 0811_004**; Tyne; N 054° 59.93' W 000° 54.72') in order to sample the bloom. The CTD cast at 09:30 showed a large peak in chlorophyll fluorescence at 12 m during the downcast. Instrument recording from the CTD ceased at a depth of 47 m, thus the upcast was void and no bottles could be fired. A single 30 l bottle was deployed manually to sample the plankton layer at 12 m. Processing of the samples during the morning with the flow cytometers confirmed the presence of a large bloom. Fay Luxford and Bastien Queste worked on the CTD throughout the morning and traced the electrical problem to a leaking connector. The Cefas Ferrybox computer required re-booting at 10:52 and 12:16. A fifth station was taken at 14:05 (**Cend 0811_005**; outer Tyne; N 055° 10.285' E 000° 0.017') in clear, low chlorophyll water with a depth of 70 m. This was probably the most oligotrophic site of the cruise and featured a noticeable thin layer of chlorophyll fluorescence near the thermocline. The CTD instruments measured until a depth of 47 m when a fuse in the deck box blew. There was a burning smell from inside the cable connecting the wire to the CTD unit, and some signs of cracks in the rubber seal. A manual Niskin bottle sample was taken at 30 m and processed by all scientists. A nutrient

response experiment was started with seawater from this station. The CTD team continued to work on waterproofing the defect connector throughout the afternoon until connection was restored. En route, the Cefas Ferrybox was re-booted at 14:39, 15:55 and 17:15. It was thought that the new GPS feed between the Ferrybox PC and the CTD PC was the cause of the crashes, but problems continued after this was removed. Most likely that overheating in the Ferrybox PC was causing the problem.
The CTD was fully functioning again by the late afternoon when the next station was reached at 18:40 (**Cend 0811_006**; west Dogger; N 055° 10.251' E 001° 0.287'). The upper water column was profiled to 30 m with the CTD and bottles were fired at 5 and 30 m for water samples. Wind was light throughout the day, with full sun from dawn to dusk. The HPLC pigment data collected will be valuable for validation of ocean colour images (CoastColour project).
In the evening, the Endeavour encountered a group of white-beaked dolphins which stayed near the ship between 19:30 and 20:30. Bow riding was captured on video by Dan Franklin. After dark, the cruise track passed between many sandeel fishing vessels to the north west of the Dogger Bank.

Tuesday 10th May

The day started with a 06:30 station close to where Cefas had previously sampled in 2007 during the Ecosystem Connections series of cruises (**Cend 0811_007**; north Dogger; N 055° 40.767' E 002° 16.162'). Water samples were collected at 6 and 36 m with the CTD rosette. The sea state was slight with a light southerly wind and no cloud. The UEA glider was launched for the first time in the North Sea at 08:38 (**Cend 0811_008**; north Dogger; N 055° 40.767' E 002° 16.162'). The glider was lowered into the water nose-first from the stern gantry and released via a quick-release. Once communication had been established with the pilots at UEA then the glider was set to dive mode and started its first glide dive at 08:45, surfacing at 08:54 at a distance of 100 m from the ship's starboard side. The glider stayed on the surface for 10 minutes and was easily visible during this time.
Water sampling continued with an optics cast of the CTD rosette at 11:14 in full sun (1800 μmol m-2 s-1 measured by Licor on deck during the profile). This was **Cend 0811_009**; north Dogger; N 055° 41.857' E 002° 15.286', followed by a water sampling cast at 14:11 (**Cend 0811_010**; north Dogger; N 055° 44.549' E 002° 15.412'). The water sample from this cast was used for size-fractionated primary production experiments.
The last dive of the glider was programmed to surface at 18:00. Positions from the glider were sent by email every 20 min to the ship's master, enabling the ship to be positioned close to the estimated position of the glider. After receipt of the final position a search was started, lasting only 14 mins until the glider was spotted off the port bow. The ship's jet boat was launched to recover the glider at 18:40 with four crew including Bastien Queste. A short while later the glider was recovered into the jet boat and the boat was lifted back onboard Endeavour (**Cend 0811_011**; north Dogger; N 055° 44.549' E 002° 15.412'). A video of the launch and deployment procedures is available from the SIC.

During the glider recovery the water sampling team took another sample from the clean water system (**Cend 0811_012**; north Dogger; N 055° 41.176' E 002° 14.852').
There was only one Ferrybox crash on this day, at 14:53.

Wednesday 11th May

Overnight a course was set south-east across the Dogger Bank in order to sample an area of high backscatter identified from the previous days satellite image (**Cend 0811_013**; south Dogger; N 054° 46.306' E 002° 50.909'). A sample was taken at 7 m from this shallow station by CTD at 06:31. The flow cytomer scientists reported a cluster of highly scattering cells in this sample, most probably coccolithophores. The original cruise plan to sample at the Oyster Grounds was altered in order to gain time sampling the more productive inshore stations in Dutch territorial water. A mid-morning CTD cast was made at station **Cend 0811_014**; South Rough; N 054° 15.312' E 003° 00.115' with a depth of 45 m. This area is on the western edge of the Oyster Grounds and was oligotrophic with similar properties to the main Oyster Grounds site sampled in 2007. A second CTD cast was made at 11:35 to collect the underwater light profile, as the previous cast was shaded by the ship (this was **Cend 0811_014b**; South Rough; N 054° 15.312' E 003° 0.115'). The following station at 16:23 targeted the start of an area of high chlorophyll identified from the previous day's ocean colour image (**Cend 0811_015**; Nam Field; N 053° 29.891' E 003° 15.079').
The following station was taken at a position further east, using the Ferryboxes to gauge how much chlorophyll was in the water. The ship was stopped at what was judged to be the highest density of the bloom, and on station it was clear to the eye that the water was dark in colour, with the CTD rosette quickly disappearing from view. This was station **Cend 0811_016**; Pen Field; N 053° 22.245' E 004° 1.62'). Flow cytometric analysis of the samples showed the presence of *Phaeocyctis* colonies as well as other large algae, and all instruments recorded their highest levels since the beginning of the cruise (marked as bloom "B" on Figure 2).

Thursday 12th May

The cruise track overnight was to the southwest to reach a sampling position west of Rotterdam by early morning which was again rich in phytoplankton (**Cend 0811_017**; N 052° 20.797' E 003° 37.727'), the bloom "C" again being dominated by *Phaeocystis*. The density of algae was so high at stations 16 and 17 that readings on the Seapoint fluorimeter on the CTD rosette reached saturation. A long daytime transect allowed some scientists to sample events marked on the ferrybox trace, whilst others completed their experiments. Time differences between the response of the Cefas Ferrybox and the Ifremer Ferrybox were calculated by observing when the Endeavour crossed the wake of large container ships and timing how long it then took for signals on the instruments to respond.
The final station was taken near to a Cefas SmartBuoy at the West Gabbard (**Cend 0811_018**; West Gabbard; N 051° 58.696' E 002° 5.275'). A water

sample was taken on arrival at 13:30, and further instrument-only CTD casts were made at 14:39 (18A), 15:43 (18b), 16:12 (18c) and 16:15 (18d). The optical conditions were good and data will be used to calibrate the light sensors on the buoy nearby.

The cruise ended by steaming slowly back to Lowestoft on Thursday evening, to meet the pilot boat at 05:00 on Friday 13th May 2011.

Figure 1

Map of Cend0811 cruise showing record of chlorophyll fluorescence from the Cefas Ferrybox.

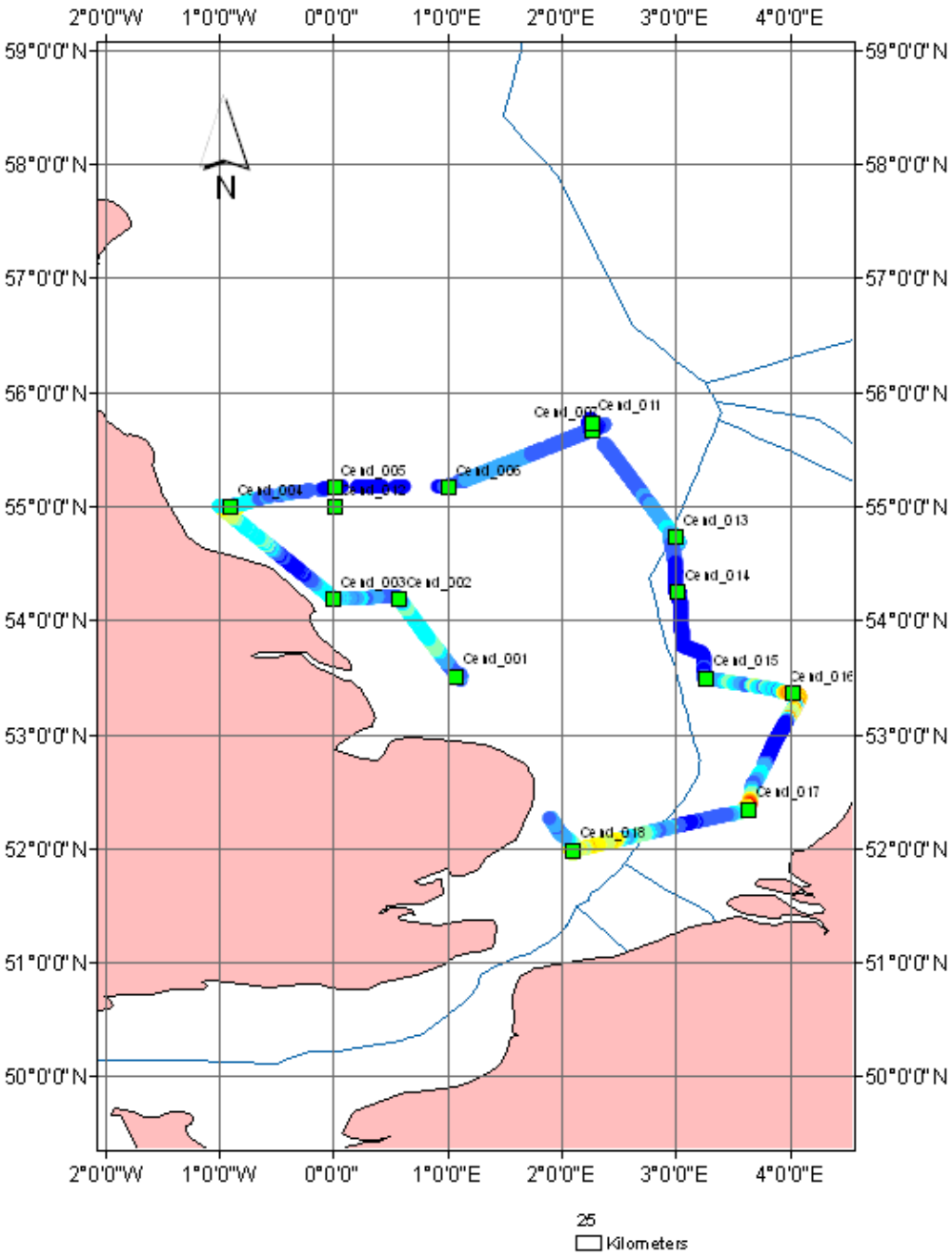

Figure 2

Records of chlorophyll fluorescence and oxygen from the Cefas Ferrybox, with the three main algal bloom events labelled.