Cruise Report Dana0606

Conducted from 11-7-06 to 20-7-06

Summer Production over the Dogger, Great and Little Fisher Banks.

Scientific Party

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Cruise Objective

The productivity of the central North Sea during the summer is fuelled by subsurface primary production. This is at a time of year when there is very little other production to sustain juvenile fish at a critical stage of their development. Over the years DFU has built up a time series of observations with a view to understanding the dynamics, both physical and biological, ecological consequences and the inter-annual variability of this system. There were three specific objectives to the cruise:

- To observe the subsurface chlorophyll maximum adjacent to the Dogger Bank, sample its phytoplankton composition, and measure its geographic extent, fluorescence characteristics, 1^o production and its related subsurface oxygen surplus.
- To link this production to hydrographic and topographic features.
- To observe the impact of this production on secondary producers.

Previous years surveys have concentrated on the Dogger Bank. This cruise extended the area of interest to specifically include the Great and Little Fisher Banks.

In addition, some topics to be addressed include (i) the fine structure of the subsurface chlorophyll maximum, (ii) estimate bacterial activity in the water column, (iii) estimate community growth through dilution incubations, (iv) observe the distribution of larval fish and their buoyancy characteristics in connection with hydrographic features, (v) test a method for determining the percentage of dead copepods found naturally in the water column.

This cruise presented an opportunity to utilize DFU's newly established Optical Plankton Facility under field conditions. This Optical Plankton Facility is composed of a series of instruments designed to investigate the composition of the plankton community by means of multi-channel

fluorometry, laser and optical particle sizing, and automated direct imaging of individual organisms. This facility allows for the rapid identification and enumeration of the plankton community in the field. These instruments were, on this occasion, used in conjunction with a gradient sampler that allowed the collection of water samples at high spatial resolution in the vertical.

These instruments will be used on the Galathea III expedition, and this cruise presented an ideal opportunity to deploy them in earnest for the first time.

Narrative of the Cruise

The cruise left Hirtshals at 15:00 on Tuesday 11th July and sailed for a station in the relatively deep waters along the Norwegian trench north of the Little Fisher Bank where the gradient sampler was deployed.

From this position, TRIAXUS was deployed. It was to sail continuously for 48 hours in a course covering the Little and Great Fisher Bank, and the north-eastern approaches to the Dogger Bank. However, after about 26 hours sailing, TRIAXUS was lost on the eastern flanks of the Great Fisher Bank (56.763° N, 4.501°E). A search of some 4 hour duration both visual and acoustically from a zodiac located TRIAXUS, but established that it was lying on the bottom in about 50 m of water.

While inquiring as to possibilities of retrieving TRIAXUS, it was decided to continue along our standard transect (cf Table 1) using the CTD and water sampler.

After about 10 stations along the transect, the CTD suffered a serious break down. It appeared that communication between the CTD and deck unit was malfunctioning.

Weighing together the various concerns: the possibility of getting an ROV and side-scan sonar, an option to trawl TRIAXUS up, the possibility of TRIAXUS drifting and the use of a spare CTD, it was decided to steam back to Hirtshals. On the way, the location of TRIAXUS was checked again by zodiac, and we arrived back in port at 07:00 on Saturday 15th July.

Station Number	Distance (nm)	Latitude	Longitude
1	0	56° 39.0'	03° 27.0'
2	10	56° 30.0'	03° 35.5'
3	20	56° 21.0'	03° 44.0'
4	30	56° 12.0'	03° 52.5'
5	40	56° 03.0'	04° 01.0'
6	45	55° 58.5'	04° 05.3'
7	50	55° 54.0'	04° 09.5'
8	55	55° 49.5'	04° 13.8'
9	60	55° 45.0'	04° 18.0'
10	65	55° 40.5'	04° 22.3'
11	70	55° 36.0'	04° 26.5'
12	75	55° 31.5'	04° 30.8'
13	80	55° 27.0'	04° 35.0'
14	85	55° 22.5'	04° 39.3'
15	90	55° 18.0'	04° 43.5'

Table 1. Station positions along Dogger Bank transects

The ROV and side-scan option turned out to be a non-starter, as the equipment could not be assembled rapidly. The trawl and CTD were loaded, and course was set towards TRIAXUS resting place. Trawling commenced and continued for the next 2 days with an 8 hour pause while the crew took a mandatory rest break. During this break, the scientific party took the opportunity to visit

station 1 at the head of the transect to conduct CTD, gradient sampler (termed the DOOR because of its size and shape), and zooplankton net deployments.

The DOOR is about 3 m long and ½ m wide. It is equipped with 2x20 150 ml syringes spaced at 20 cm intervals. The syringes are cocked by means of rubber bands and notched plugs, and are fired by means of a messenger. Deployment took place from the rear deck by means of the crane. On this cruise, a Fluoroprobe was attached to the DOOR so as to place it accurately in the water column with reference to the chlorophyll maximum.

Fig 1. TRIAXUS finally caught in the trawl

TRIAXUS was finally trawled up on the afternoon of Monday 17th July. There was surprising little damage to it. The apparent cause of its loss was the failure of the cable just where it joined the electronic coupling. The wire here looked corroded. The fact that the wire failed here, rather than at the weak link, meant that the electronic coupling, weighing some 5 kg, was attached to TRIAXUS when lost, causing it to sink rather than float as it is designed to do. It is strongly recommended that some failsafe device be attached to TRIAXUS before any future deployment. Such a failsafe device might include a pressurized gas tank that can inflate a floatation balloon either automatically in the event of communication loss, or by means of an acoustic signal.

Fig 2. TRIAXUS on deck again after 4 days on the bottom of the North Sea.

Transect work, including CTD, DOOR and plankton nets, recommenced on Monday evening and continued through to Wednesday afternoon. Primary sampling at stations included CTD, water samples for salt, nutrients, oxygen and chlorophyll analysis. 4 transects were completed in the time remaining. On Wednesday afternoon, course was set for Hirtshals and we arrived in port at 10:00 on Thursday 20th July.

Specific activities and findings

Deployments and Calibrations

Despite the lost time, we were able to complete 8 transects: 3 with TRIAXUS and 5 with the CTD. The main CTD failed before sufficient samples could be taken for reliably calibration. However there were more than enough samples taken to calibrate its replacement. A total of 63 CTD casts were made from which 180 nutrient samples (nitrate, nitrite & phosphate). An additional 64 nutrient samples were take with the DOOR. To calibrate the CTD data, 52 salt samples, 86 chlorophyll and 72 oxygen samples were also taken. All of the chlorophyll and oxygen samples were analysed

during the cruise, and preliminary calibrations showed reasonably linear regression fits. The exception was the oxygen calibration. Two things contributed to this. The oxygen probe on the replacement CTD was an older model, with a lower resolution and response time to that which we used previously. In addition, there was nearly always a strong oxygen gradient in the vicinity of the chlorophyll maximum where water samples were taken for calibration (a factor that has not occurred before). This meant that these samples were less than reliable. This was remedied towards the end of the cruise when samples were specifically targeted to be taken in the oxygen maximum.

Salt and nutrient samples will be worked up on land.

The DOOR was deployed 10 times resulting in some 160 plankton samples and 64 nutrient samples (for nitrate, nitrite, phosphate and silicate). 6 plankton nets were taken for Neutral Red staining.

Hydrography and the Deep Chlorophyll Maximum

The waters over the Great and Little Fisher Banks (surveyed using TRIAXUS: *appendix 1*), and the northern approaches to the Dogger bank (surveyed using CTD: *appendix 2*) were strongly stratified with well mixed warm water (>15^{o}C) over lying a well mixed cold (<7^{o}C) bottom layer. The thermocline was located at about 35 m (somewhat deeper than previous years) and varied in thickness from 10 to 20 m. At the base of the thermocline there was a pronounced chlorophyll maximum with concentrations typically 10 times higher than in the surface. It appeared that this maximum was also lying somewhat deeper than in previous years. In association with the chlorophyll maximum, there was also an oxygen maximum. The oxygen maximum lay about 5 m higher than the chlorophyll maximum. Approaching the crest of the Dogger Bank, there was a bottom front at water column depth of about 40 to 50 m marking the transition from stratified to well-mixed waters. Over that bank at shallower depth, the water column became isothermal with low chlorophyll concentrations.

Fine Structure of the Deep Chlorophyll Maximum

The combined sampling and analysis using the DOOR and optical instruments revealed that the chlorophyll maximum is richly structured, with large variations in biomass and species composition occurring on scales of 10s of cm. The procedure was as follows: the DOOR, equipped with the FluoroProbe was lowered into the chlorophyll maximum: the FluoroProbe giving us both depth and the fluorescence at different wave lengths. A connecting cable (approx 50 m) was specially sought for this purpose. When brought on board, water samples from syringes were run through the FlowCam to measure size and fluorescence

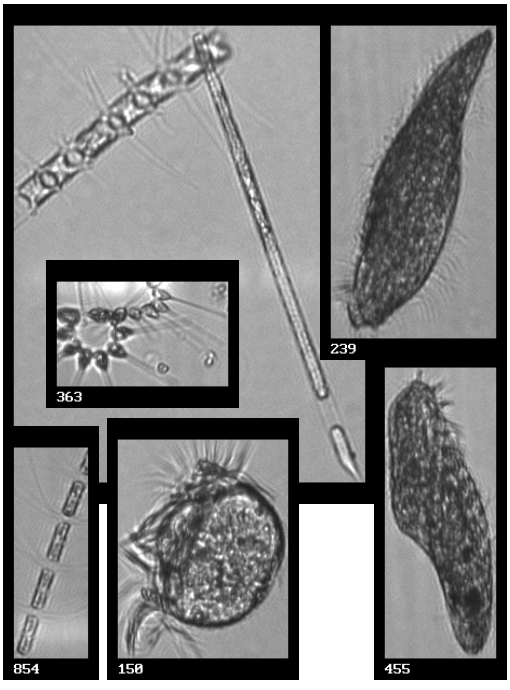


Fig 3. Some examples of ciliates and diatoms, images taken by FlowCam.

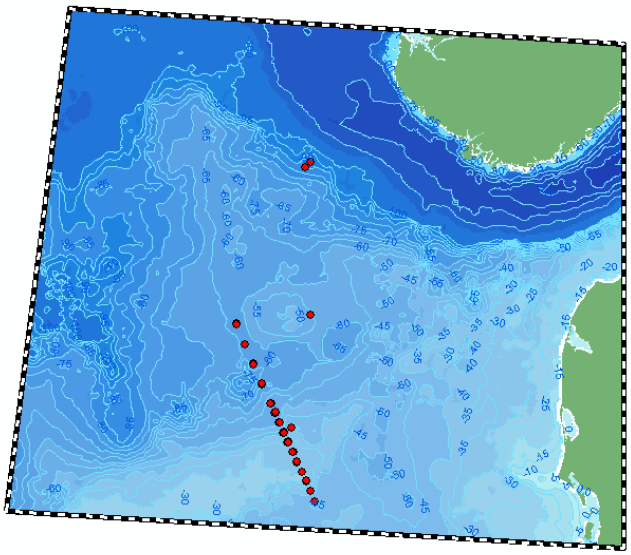


Fig 4. Stations visited during cruise

of individual plankton cells, and take their image. A general structure emerged where close to the Dogger Bank, the chlorophyll maximum assumed a two layer structure, with large diatoms dominating near the bottom, and small flagellates higher up. Further away from the Bank, diatoms disappear from the plankton community, and flagellates and ciliates dominate.

Prevalence of Copepod Carcases in the Water Column

In taking zooplankton samples, it is usually assumed that all organisms captured in nets were alive at the time of capture. However, recent measurements seem to show that some 20% of organisms are in fact dead. This has a significant influence on the potential resources available to bacteria, as well as estimates of active grazing by zooplankton on algae. In connection with this finding, we conducted observations to (i) determine if we had a feasible field method to distinguish live and dead copepods, and to see what percentage are dead in the central North Sea. The method was quite simple. Zooplankton were collected using a WP2 net with a large 90µ mesh cod end. A measure sub sample (670 ml) was placed in a staining jar, and 1 ml of Neutral Red added and gently mixed. The staining jar was then placed in the refrigerator for 15 min, after which it was filtered and washed several times to remove excess stain. The final sample, filtered onto nylon gauze, was then frozen for further analysis on land. Animals that take up the stain and become pink were alive at the time of staining, while those that do not, were dead. Preliminary examination indicates that in the central North Sea, only a small fraction (<10%) of animals were dead, less than that found in other areas (e.g. Cheasapeak Bay, USA). This indicates either a healthy, rapidly growing population relatively free of disease and parasites, or a rapid degradation of carcasses by bacteria and other agents.

Some comments

FlowCam and Fluoroprobe

It is foreseen that the FlowCam (or similar) will become a standard piece of equipment on board research cruises. It allows for a rapid evaluation of the plankton community, both qualitatively and quantitatively. This cruise has demonstrated its utility, particularly in conjunction with a high

resolution water sampler. With respect to the water sampler, that used on this cruise was on loan from DMU. We should look into the possibility of making such a sampler ourselves to be available for future DANA cruises. The Fluroprobe, attached and deployed with the water sampler proved an excellent means of positioning the sampler at very specific locations. The Optical Plankton Facility established a HØK is unique in the world as it couples together so many new sensors and techniques. This cruise on Dana has been extremely successful in being the first rigorous field test of the facility.

Problems and failures.

Concerning the CTD
The major problem faced during this cruise was of course the loss and retrieval of the TRIAXUS. This took in all some 4 days off the planned cruise activities. It masked however, a more serious failure, that of the CTD. The CTD is the work horse of nearly all oceanographic research, and has to be counted on to be reliable on any modern research cruise. The fact that a replacement could be taken on board during the activities surrounding the retrieval of TRIAXUS is but cold comfort. Had this happened at any other time, an unacceptable delay to research activities would have arisen.

As with last year, we had a problem with oil leaking onto the CTD and in particular, into the water samplers on the rosette. This has to be seen into.

Concerning TRIAXUS
It is strongly recommended that some failsafe device be attached to TRIAXUS before any future deployment. Such a failsafe device might include a pressurized gas tank that can inflate a floatation balloon either automatically in the event of communication loss, or manually by means of an acoustic signal.

Other
The doors under the cabinets in the kemi and fælles labs are not well fixed and tend to fall out when opened.

Concluding Remarks

In all, we can count Dana cruise 06 2006 a success. Despite set backs, the crew and scientific party proved resilient, and a good proportion of the planned works was able to be carried out. There was of course some activities that had to be dropped. Because of time and manpower constraints, the larval fish surveys with MIK nets over the Great and Little Fisher Bank had to be abandoned. It is hoped that this work can be completed next summer.

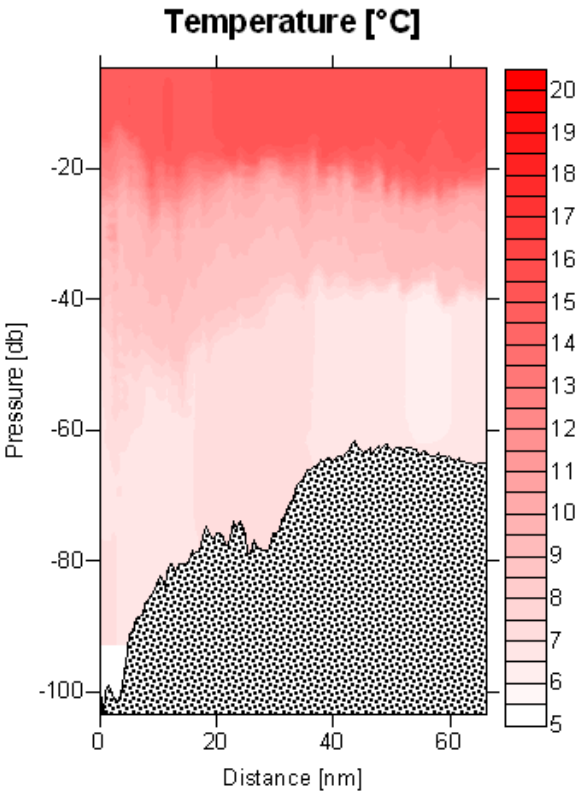
Finally we would like to thank the crew of the RV Dana for their cooperation, their enthusiasm and interest, and not least, their most excellent hospitality throughout the cruise.

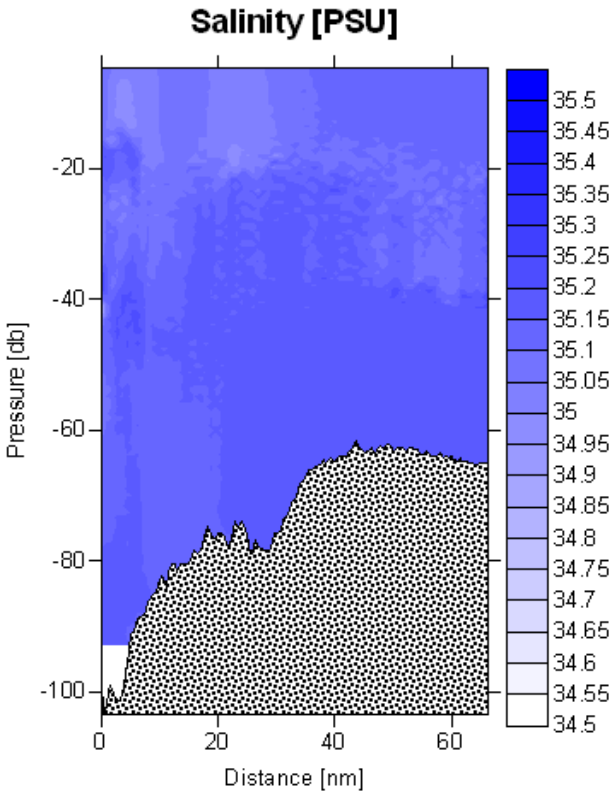
Appendix

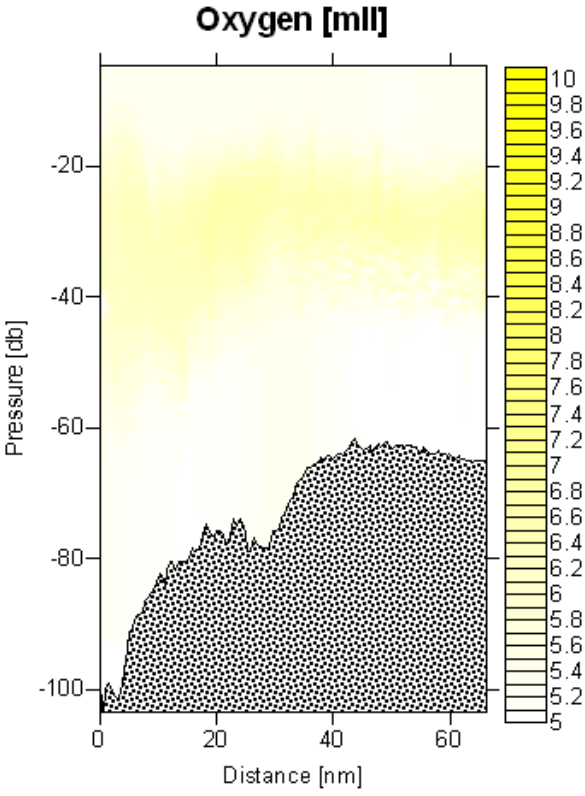
Observations of temperature, salinity, oxygen and fluorescence along transects. Transects 1-3 were conducted by TRIAXUS while transects 4-8 were mapped using the CTD.

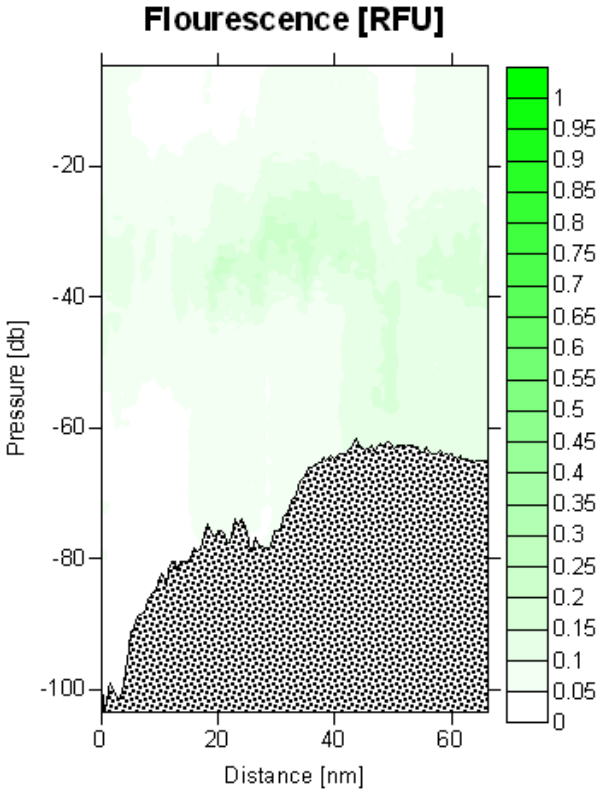
26DA.2006.6.Dogger Bank Transect 1

26DA.2006.6.8.2









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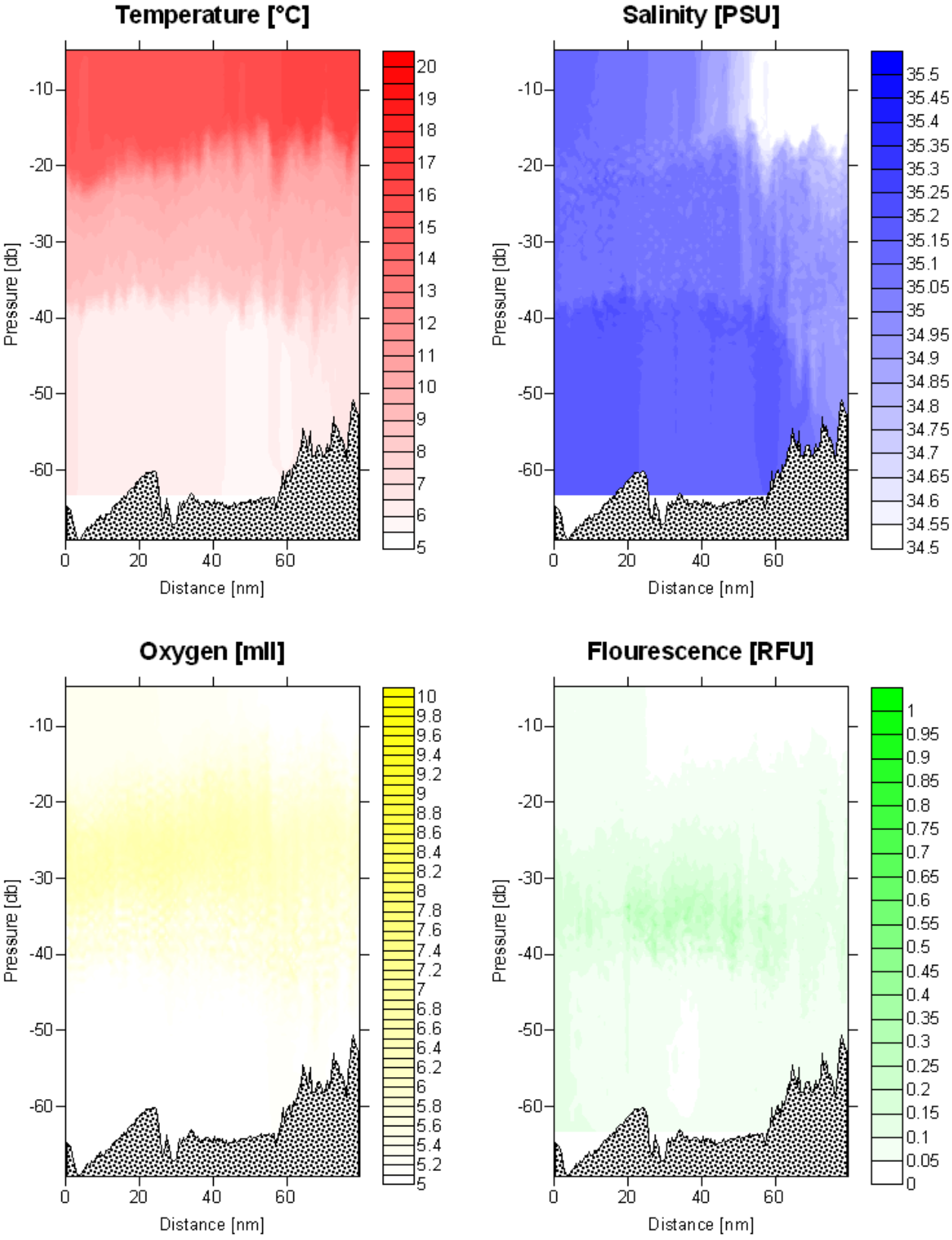
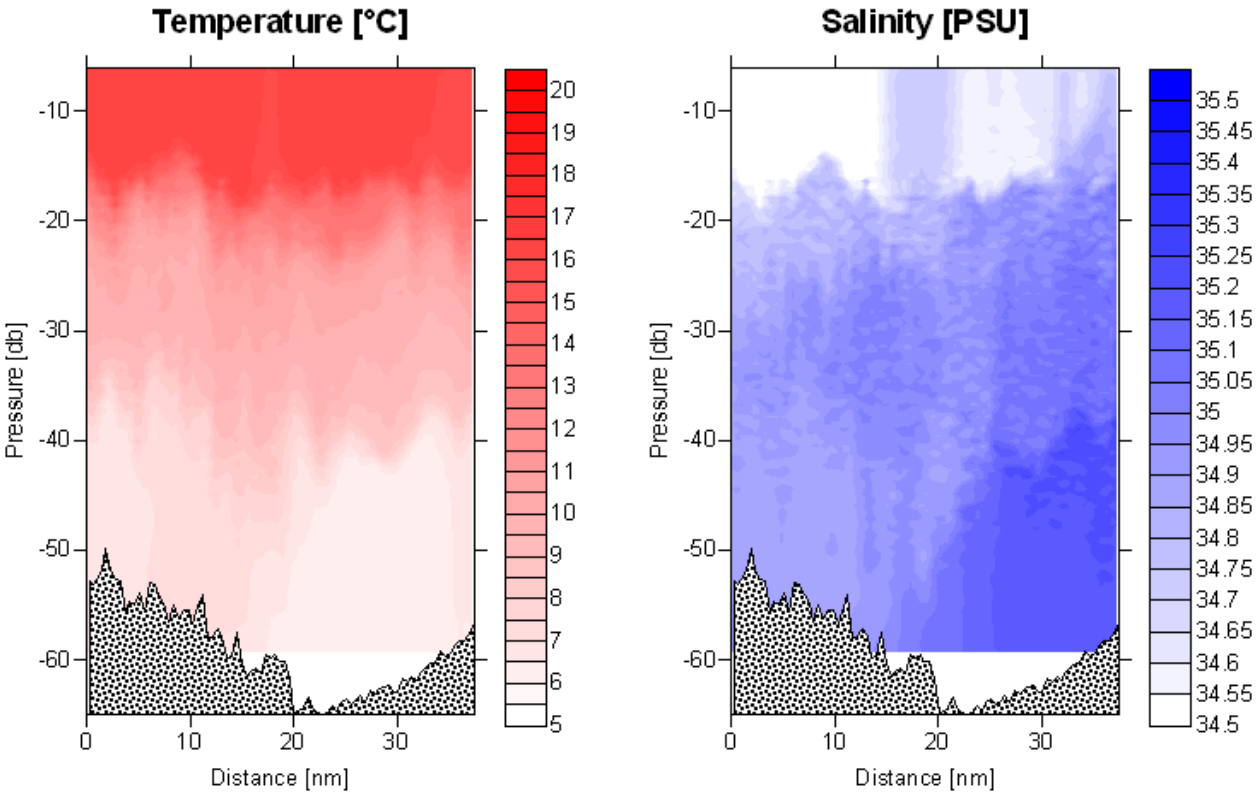
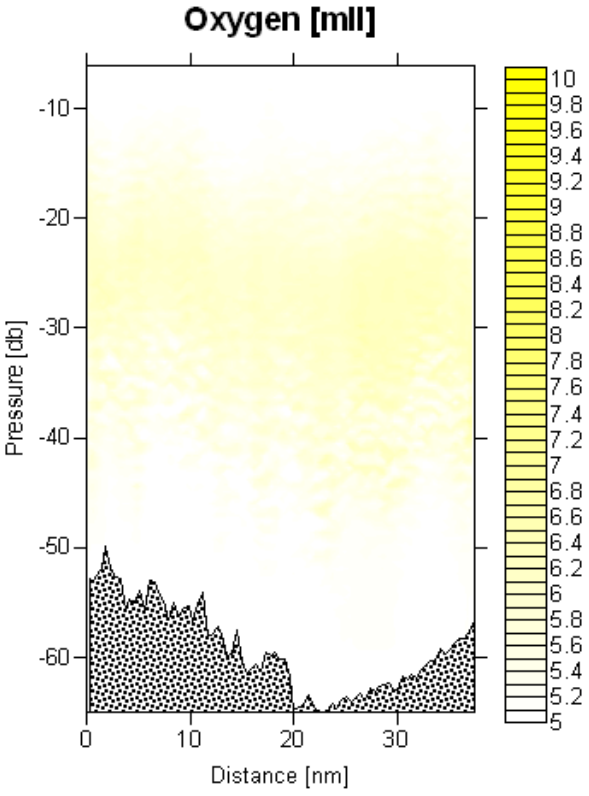
26DA.2006.6.9

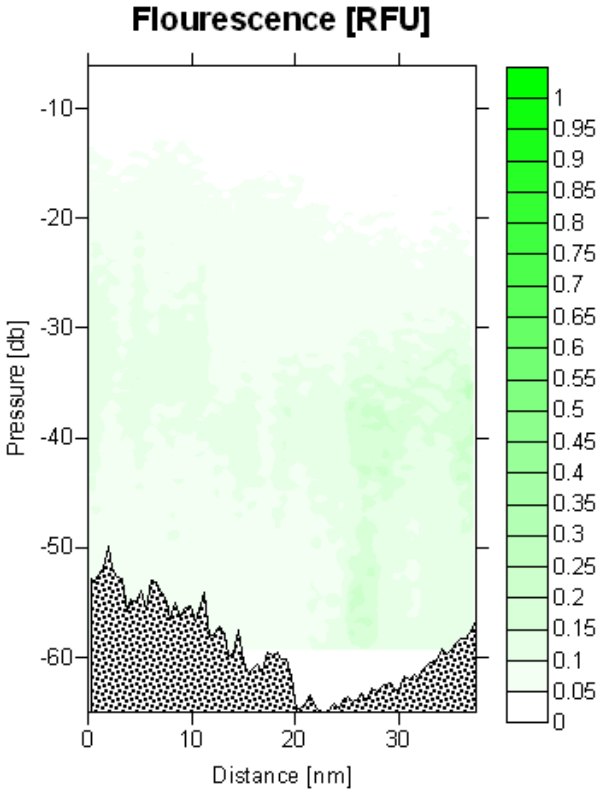


26DA.2006.6.Dogger Bank Transect 3

26DA.2006.6.10







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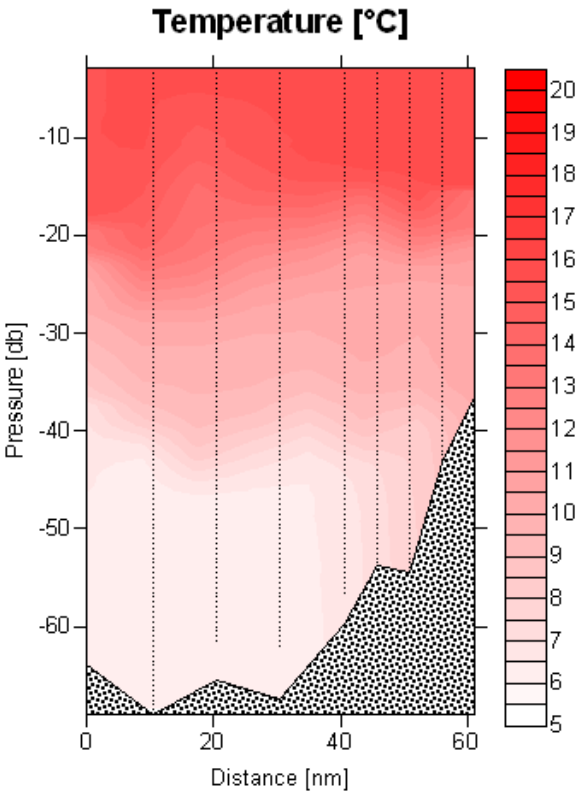

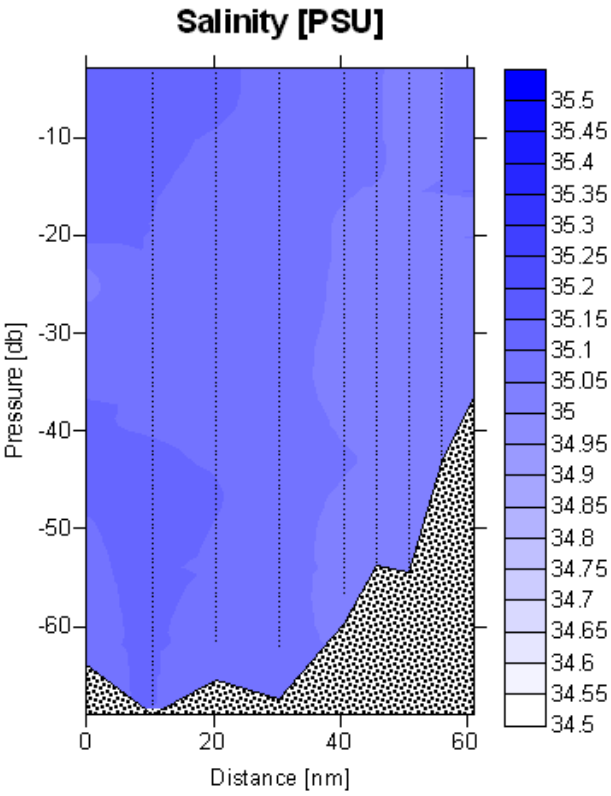

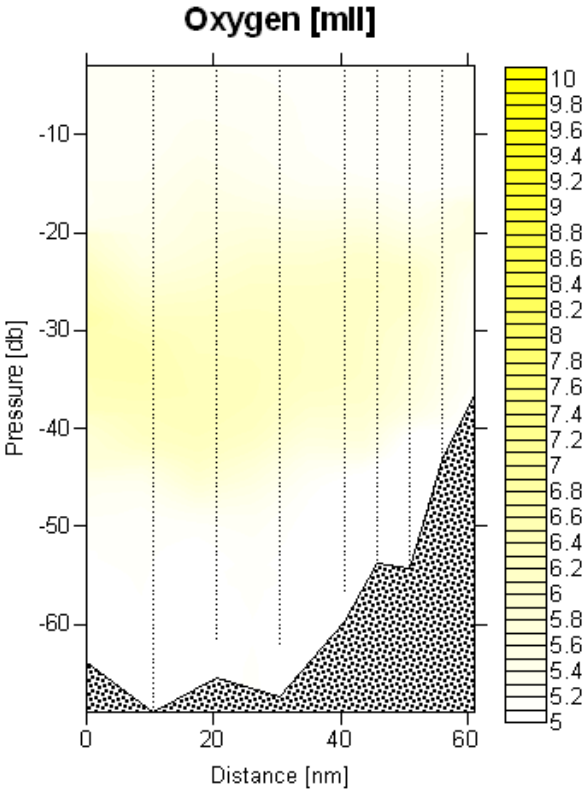

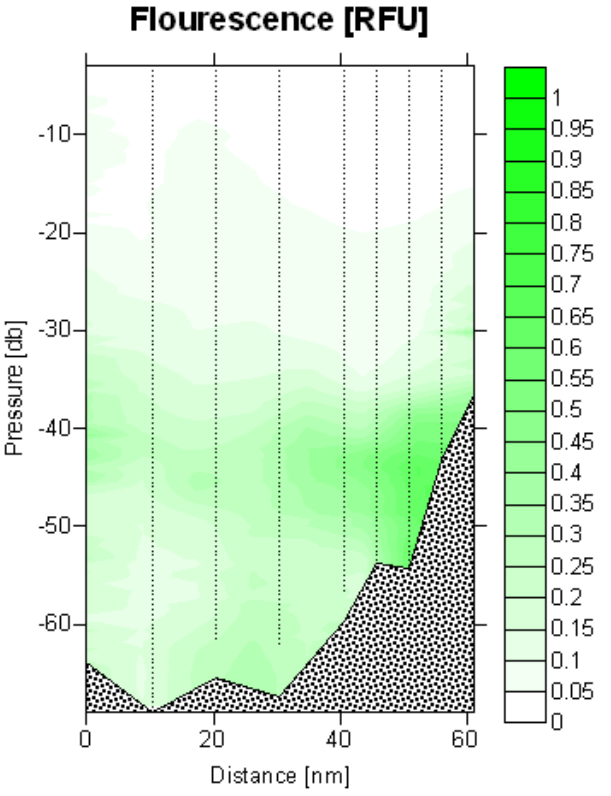

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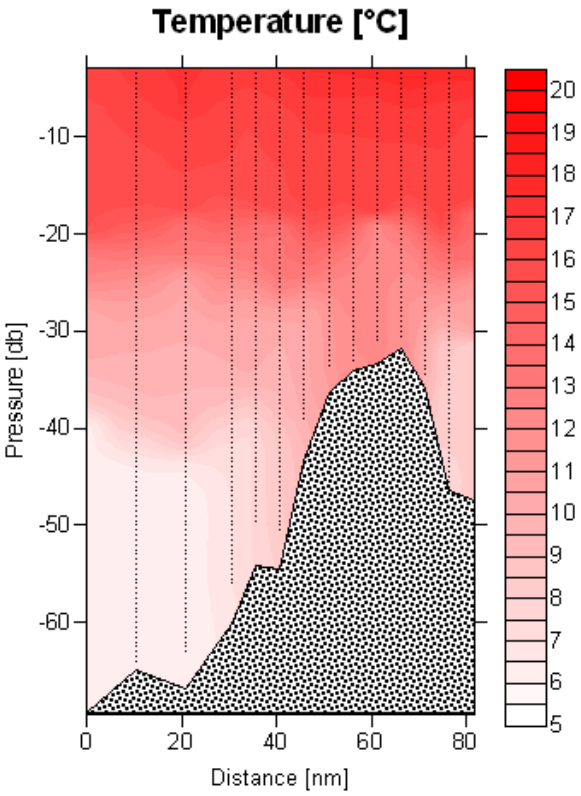

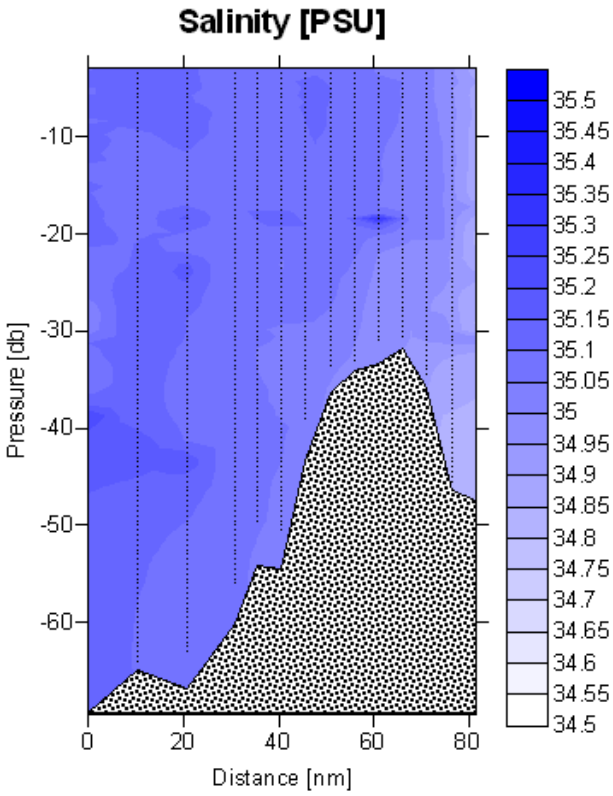

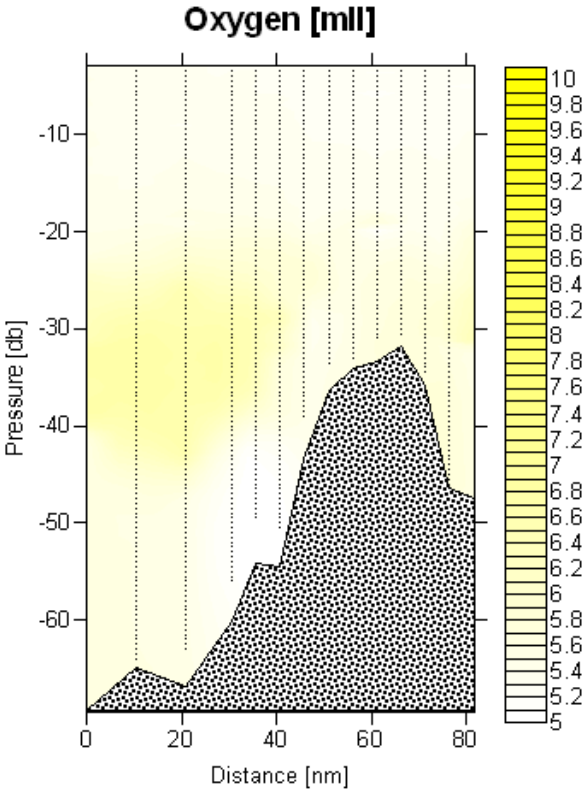

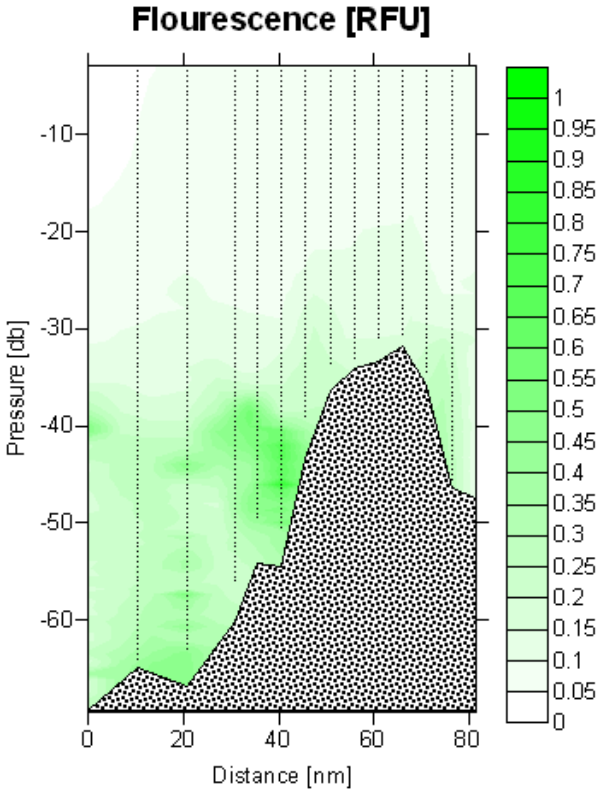

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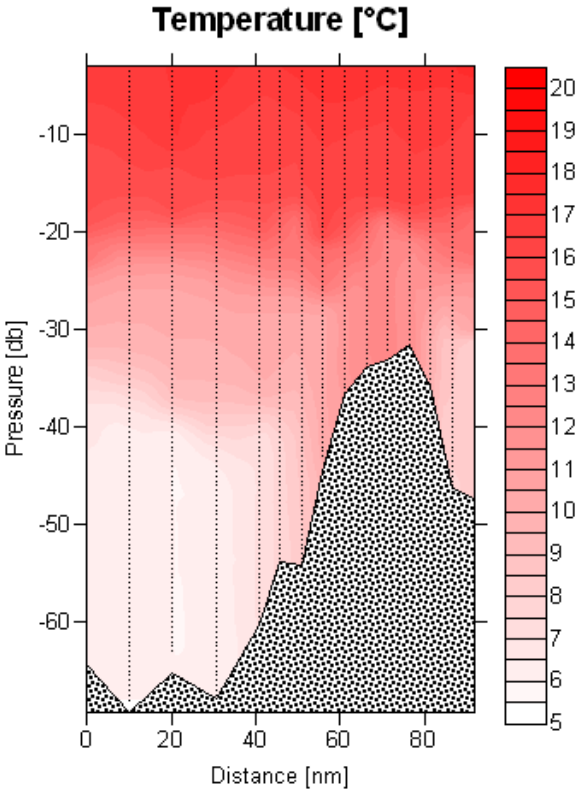

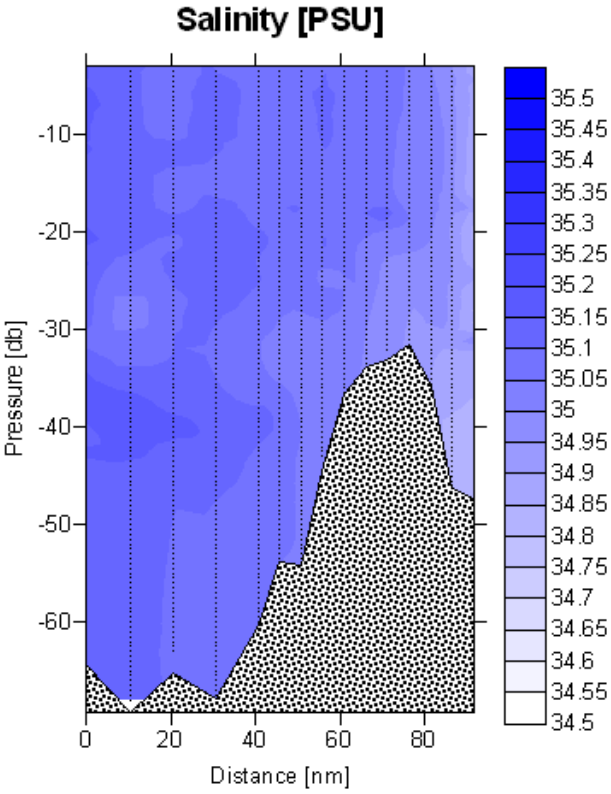

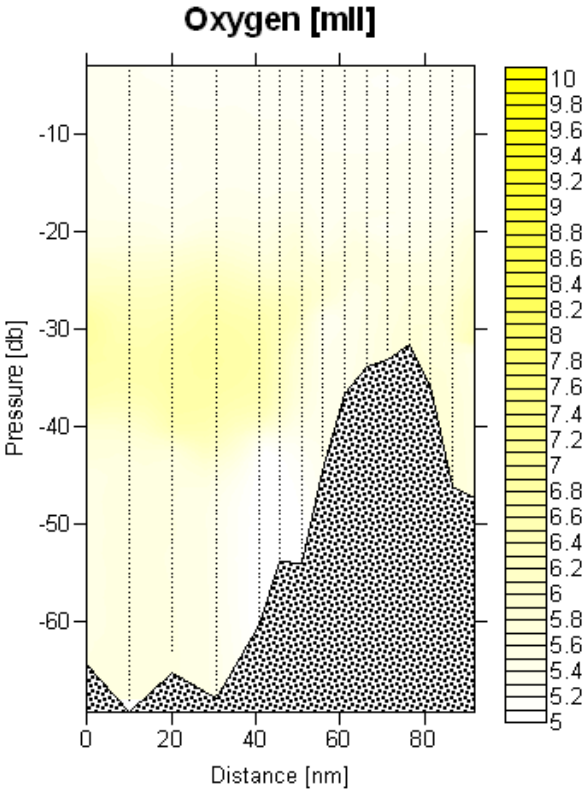

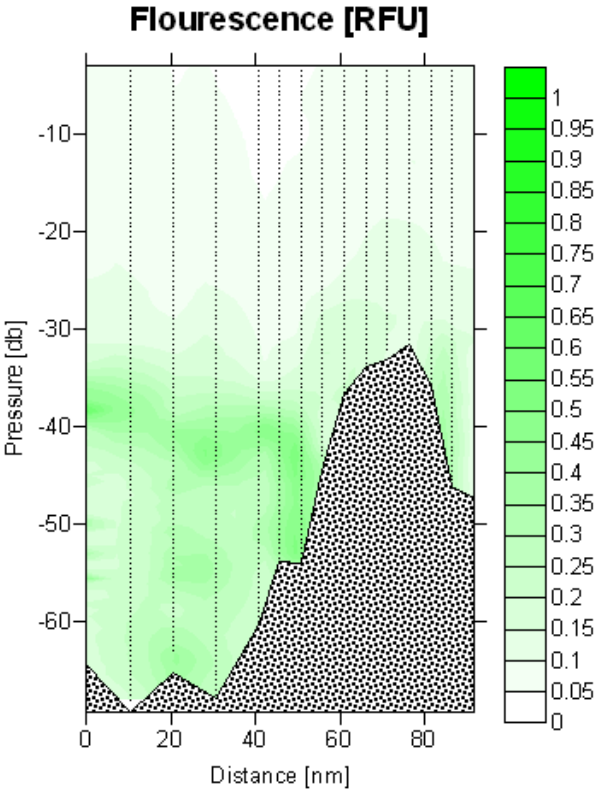

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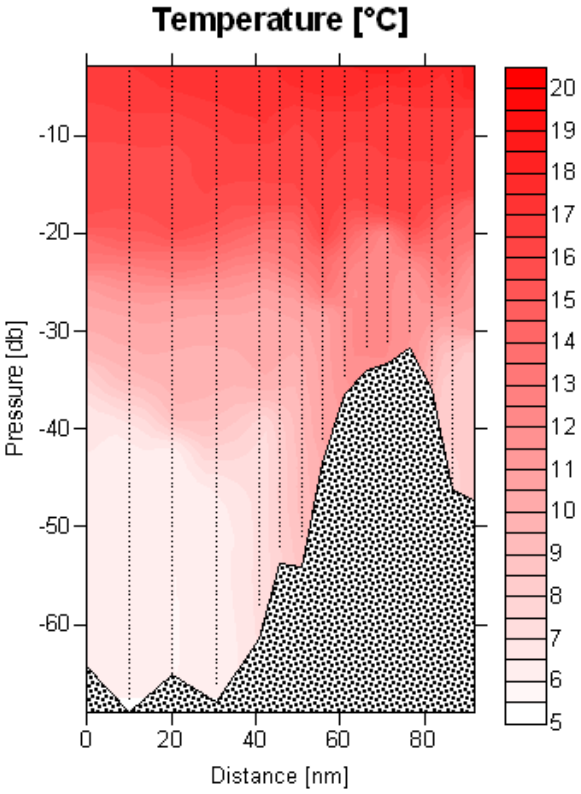

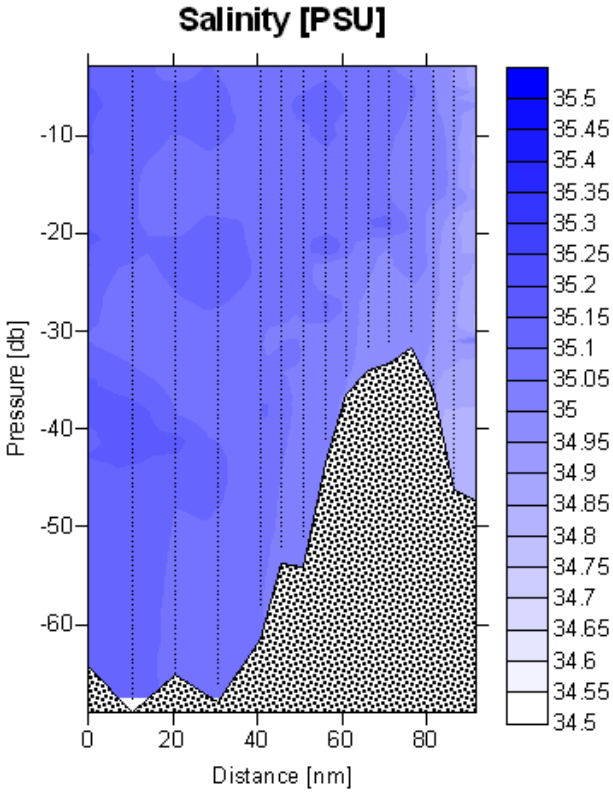

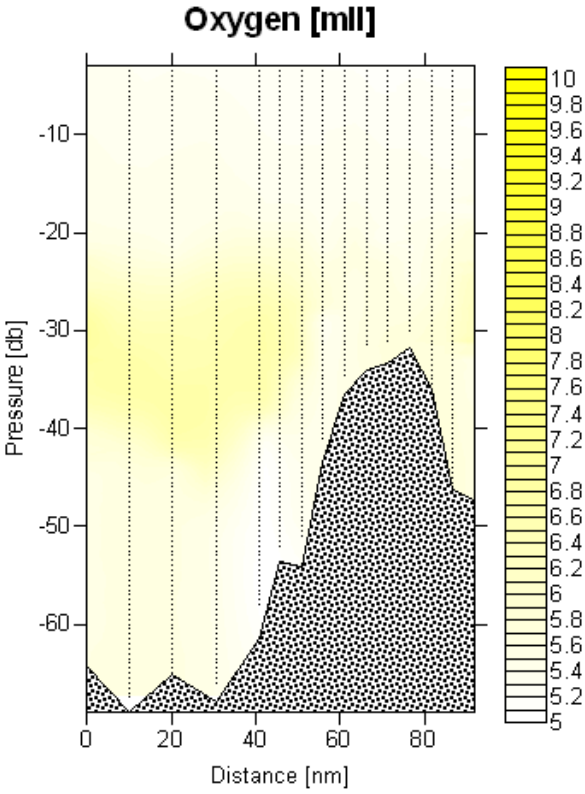

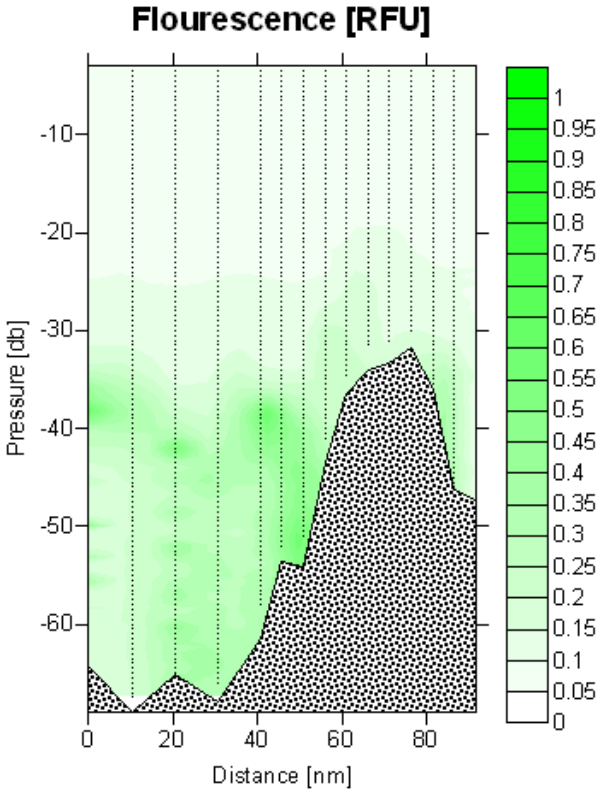

26DA.2006.6.Dogger Bank Transect 8

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