Biogeosciences Discuss., 5, S1816–S1821, 2008
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Biogeosciences Discussions

Interactive comment on "Sub meso scale phytoplankton distribution in the north east Atlantic surface waters determined with an automated flow cytometer" *by* M. Thyssen et al.

M. Thyssen et al.

Received and published: 27 September 2008

Anonymous Referee #1

Received and published: 31 July 2008

The authors present a complete dataset of autotrophic pico-, nano- and small microplankton sampled at a high frequency, across different provinces of the NE Atlantic Ocean. Their analysis aimed at explaining both meso and sub-mesoscale spatial and temporal variability of cytometrically-defined phytoplankton clusters, by using a novel cytometer (CytoSub) that considers from small to large cells. Their results give insights into cell cycle dynamics and spatial heterogeneity. My general comments are that the MS is well written and the approach is novel. The impressive amount of information is

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Interactive Discussion
Discussion Paper

treated and analysed by employing appropriate statistical tools that allow the authors to separate from general trends to small scale and short-term variability (on an hourly basis). Their conclusions underline the need of carrying out high frequency sampling for understanding spatial heterogeneity and short-term variability, in order to feed phytoplankton distribution models.

Some specific comments concern mainly two issues.

First of all, the authors should be more precise when underlining both temporal and spatial sub-mesoscale features, as sometimes their analysis seem rather confusing. If mesoscale spatial features are revealed by the 24h average values and by the description of a smoothed general trend of variation through the different water masses encountered (Fig. 8), in most of the MS the authors explain changes in cell abundance, FLR and FSW by the short-term variability mainly due to cell cycle. However, even though the MS is focused on the sub-mesoscale spatial distribution of autotrophic cells, only a few spatial heterogeneity at sub-mesoscale is pointed out or discussed so far.

Reply: The difficulty in this manuscript, as pointed out by Reviewer #1 is that no typical data about physical features were available. Some sub meso scale features may have an action on cells, on their abundance by mixing and diluting patches, and on the fluorescence, by advection of water to different light intensities. The obtained red fluorescence, forward scatter and abundances express such a strong pattern of cycles that it seems difficult to say that it may come from external physical processes rather than from physiological reactions. In order to give any information between hydrological processes and cluster variables, correlations were done at a large scale and at the water mass scale. The results at a large scale (water masses M1+M2+M3) were presented in Table 4, while significant correlations at the water mass scale (correlations were calculated within each defined water mass) were only described in the text since they were poor.

BGD

5, S1816–S1821, 2008

Interactive Comment

I think the authors should make a clearer distinction between what they consider to be temporal from spatial at sub-meso scale, in spite of the assumption that both spatial and temporal variability are connected, as it is stated in the discussion and conclusion sections. Moreover, figures describing the variability of hydrological, chemical and cytometric data should be shown either on a spatial or on a temporal axis (i.e. figs. 3 to 7 and fig. 8). The description of one or another feature should be clearly separated as well (i.e. p. 2477, line 17). If the sub meso scale spatial variability should be considered to be less important than the temporal variability, then spatial aggregation or dispersion processes might have been underestimated to some extent and should be better addressed in the discussion section.

Reply: The description of the potential feature that would have been illustrated by a peak in surface salinity values is purely speculative. Many small scale cyclonic eddies bring deep waters to surface, which are most of the time saltier than the surrounding waters. It is not possible to make a specific paragraph for the potential features observed, since they are not defined. Thus, only a short comment about modifications of the general pattern, discussed further more in the discussion section, is, to my concern, the best thing to do when no accurate physical information is available. The temporal axis was chosen on Figure 8, because this figure represents a temporal process (evidence of cellular cycle). Since the homogeneity of the x axis was asked from another reviewer, the longitude values were used. Some high increases of abundances are visible for all defined groups that are superimposed on cellular cycles. However, it is not possible to say if cells in a patch have variable division rates or if an aggregation phenomenon occurred or both. Furthermore and as the one example I may found in our data, if aggregation may explain C2 high abundance inside of M0 and M2, then I do not understand why it is not visible on the other cluster abundances. It can be true may be for larger cells that divide slowly. A sentence was added to discuss about it.

My second concern would be the definition of cytometric clusters: to what extent may changes in the cytometric signals as FLR and FSW be responsible for the definition

BGD

5, S1816–S1821, 2008

of new clusters instead of reflecting physiological changes within a same phytoplankton community? A discussion on this issue would be useful for the interpretation of the authors’ results. As some changes are inferred by the authors to reflect "phenotypic changes"...are the authors also considering "composition changes"?

Reply: indeed, composition may have changed also. The sentence was modified accordingly.

I would also like to point out the fact that nor hydrological neither chemical data seemed to be included in the sub-mesoscale variability analysis. These analysis would probably allowed to give insights into the causes of clusters spatial and temporal variability, at sub-mesoscale.

Reply: In order to make evidence of the link between hydrological and abundance variations at a meso scale, correlations between nutrients, salinity, temperature and the abundance, FLR and FWS are reported in Table 4 and discussed in the text. In order to make evidence of the impact of the hydrological variations at the sub meso scale, only significant correlations between the same parameters and inside of each water mass were mentioned in the text and discussed.

Some detailed issues are reported below: -at least 10 citations are not reported in the "References" section

Reply: The reference list was updated.

-p. 2474, line 23: could you precise the nature of the pump employed and the "non toxic seawater supply"?

Reply: The precision were added.

-p. 2475, line 4: Wasn't the Cytosub designed to analyze cells within the range from sub-micrometric particles ($<1\mu$m) to microplankton (up to 1000 μm)?

Reply: The used version of the Cytosub is the first commercially available and was

BGD

5, S1816–S1821, 2008

Interactive Comment

build to analyse the size range 1 - 1000 μm. The actual version of the instrument has a wider range of detection and is able to analyse $<$ 1 μm cells accurately.

-p. 2478, lines 10, 12, 16: "μm"; should be replaced by "μM";

Reply: The modification was done.

-p. 2479, lines 13-15: reference should be made to figures 6 & 7 when describing FWS & FLR variability. The decrease in FLR for cluster C2 is not as obvious when looking at fig. 6.

Reply: The figures were interchanged accidently. Figure 6 being FWS and figure 7 FLR. So that the decrease on the corrected Figure 6B is obvious.

-p. 2480, lines 26-27: the stability of FLR average values is not clear when compared to the variability of FWS (that is supposed to increase along the transect, Figs. 6 & 7).

Reply: As for the previous question, the figures were interchanged accidently. Figure 6 being FWS and Figure 7 FLR. So that the decrease on the corrected Figure 6B is obvious.

-p. 2482, line 7: "μm"; should be replaced by "μM";

Reply: The modification was done.

-p. 2485, lines 3-6: is there any correlation between nutrients and C1 abundance supporting this hypothesis?

Reply: The Table 4 shows the existing correlations.

-p. 2485, line 29 & p. 2486, line 30: when talking about water masses, the authors compare spatial and temporal features: shouldn't it be all referred to spatial or temporal features instead?

Reply: The water masses are used here as a specific area where temporal features are distinct. It is important as well to talk about temporal features affecting cluster

BGD

5, S1816–S1821, 2008

Interactive Comment

cycles inside specific spatial areas, since both may have a role in the behaviour of the observed clusters. This emphasises the strong link that exists between spatial and temporal features.

-p. 2487, line 29 & p. 2488, line 1: the assumption on the identity of C6 is made only on their abundance? Or on their cytometric signature as well?

Reply: This assumption was omitted since it was only linked on their abundances and their geographical observation (inside of the bay of Biscay).

Interactive comment on Biogeosciences Discuss., 5, 2471, 2008.