

Interactive comment on “Ultraplankton distribution and upper ocean dynamics in the eastern Mediterranean during winter” by M. Denis et al.

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General comments:

The referee also emphasizes the fact that the study is the first one at the basin scale and we have modified the title to mention this point as detailed in the answer to referee 1.

Of course, the paper contains a large part of description which is necessary when combining physical, chemical and biological observations. What could be considered as innovative is the establishment of relationships between ultraplankton distribution and hydrodynamic structures. We are not claiming that hydrodynamism dictate

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the distribution of phytoplankton. We know that light, nutrients and temperature are the major factors in phytoplankton development. We simply show in a quantitative way to which extent hydrodynamism may affect phytoplankton distribution. When considering a thermohaline front which involves temperature, the impact of such a hydrodynamic structure might not be fully indirect. The focus of the present study being the eastern Mediterranean Sea, we did not refer indeed to flow cytometry studies conducted in the western basin. This probably gave the impression to the referee that we skipped comparisons which is not the case.

We agree with the referee that nutrient data should appear in this report (see joined figures) and we have added them and established regressions between them and environmental factors that support the role of hydrodynamism in this study.

Pigment data are not vaguely mentioned since we used chlorophyll a values to estimate the corresponding carbon biomass and determine the contribution of ultraplankton to it.

Specific comments:

Title:

The title was modified to take into account the remarks of referees 2 and 3 : “Ultraplankton basin-scale distribution and hydrodynamism in the eastern Mediterranean Sea in winter”.

The referee pointed out a misuse of the word Mediterranean. We corrected it throughout all the manuscript by using Mediterranean Sea.

Introduction:

We agree with the referee that hydrodynamism is not the major factor affecting phytoplankton distribution. The choice of the word “control” was not appropriate since the referee found it excessive. We just wanted to mean that hydrodynamism has an effect on phytoplankton distribution. For instance this has been largely investigated in the

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case of geostrophic fronts. To avoid this confusion, we replaced “control” by “affect”. See also our reply in general comments.

Methods:

Filtration: there was no other filtration than the initial 100 μm size mesh. What puzzles the referee probably stems from the concentration of ultraphytoplankton that is far larger than the one of cells above 20 μm . The analysed volume for acquisition is of the order of 300 μl . Consequently, cells with concentrations < 100 cells / cm^3 have a low probability to be detected during the analysis and those that could be detected might generate signals out of scale when the setting is adjusted for the smallest ones. This is why conventional flow cytometry only covers ultraphytoplankton.

Analysis date: samples were analysed shortly after the cruise and results were part of the thesis work of V. Martin (1997). This point is clarified in Materials and Methods. Cell biomass for *Synechococcus*: The point is not related to the more recent study. The value of 250 fg cell⁻¹ was established for cultures. Lower values were reported for different natural environments. We choose the one of 200 fg cell⁻¹ because we thought that it was more relevant to the eastern basin situation.

C:Chl a ratio: we are conscious that such a ratio is highly variable as outlined by the referee. Selecting a value from the literature remains a rough approximation that helps to give orders of magnitude, no more than that.

HPLC data: as answered with the general comments, since we are using Chl a values determined through HPLC analysis, it is justified to mention this analysis in the Method section.

Results:

Pg 6853 L 4: we agree with the referee and discarded the last part of the sentence.

Pg 6854 L 3: we agree with the referee and discarded the last part of the sentence.

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Nutrient data: we have added them and established regressions between them and environmental factors that support the role of hydrodynamism in this study.

Pg 6858 L 23: We agree with the referee that the phrasing is not appropriate and it does not reflect what we wanted to point out. This is now corrected. Indeed *Prochlorococcus* did not follow the vertical distribution of the other groups since it usually reached its maximum abundance below the layer occupied by *Synechococcus*. The presence of two *Prochlorococcus* ecotypes was derived from the mean cell fluorescence as reported by Martin (1997). This information is added in the text.

Cretan passage. :

The objective of this paper is to show the impact of hydrodynamism on ultraphytoplankton distribution. We therefore chose hydrodynamic structures (a front, a gyre) that could be easily identified and with a clear impact. We did not intend to provide an exhaustive study of hydrodynamism in the eastern Mediterranean Sea. We understand that the Cretan passage and the Levantine basin may deserve a dedicated study but this was not in the scope of the present study.

Discussion:

Pg. 6862 L 20: As mentioned in our answer to referee 2, the vertical distribution of cyanobacteria as observed at station 24 is quite similar to that reported by Tanaka et al (Fig. 5, Deep-Sea res. 20007) in the Levantine basin. The fact that *Prochlorococcus* is represented by at least two ecotypes is different from photoacclimation activated by other species to compensate the decrease of light with depth. Due to the dominance of *Synechococcus* over *Prochlorococcus*, we can mainly assign zeaxanthine as determined by HPLC to *Synechococcus* and zeaxanthine values did not change significantly with depth.

Pg. 6864 L 8: The transition from the western to the eastern Mediterranean basin is characterised by changes in temperature and salinity as shown on Figure 11. The re-

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relationship that we established between picoeukaryote abundance and salinity and that is illustrated on Figure 13 supports the fact that salinity had an effect on the distribution of picoeukaryotes in this transition area. We are not saying that it is the only factor contributing to the difference. Temperature is also known to affect phytoplankton development. To comply with the referee request, we took into account the nutrient data and found a relationship between nutrient concentration and salinity or density excess below 50 m depth. There was no significant correlation between nutrient concentration and pico- or nanoeukaryote abundances in the upper 50 m. These additional findings support the results of the present study about the effect of hydrodynamic structures on the distribution of phytoplankton.

To substantiate comparisons as asked by the referee, we made additional references to other studies in the eastern Mediterranean basin at other seasons. However we consider out of the scope of this study to discuss differences in the hydrodynamism of the eastern Mediterranean basin over seasons.

We report data for the Levantine basin but the density of sampling was not high enough to analyse the flow cytometry data with respect to the different eddies that occur in that region and that justified specific investigations at other seasons by other groups.

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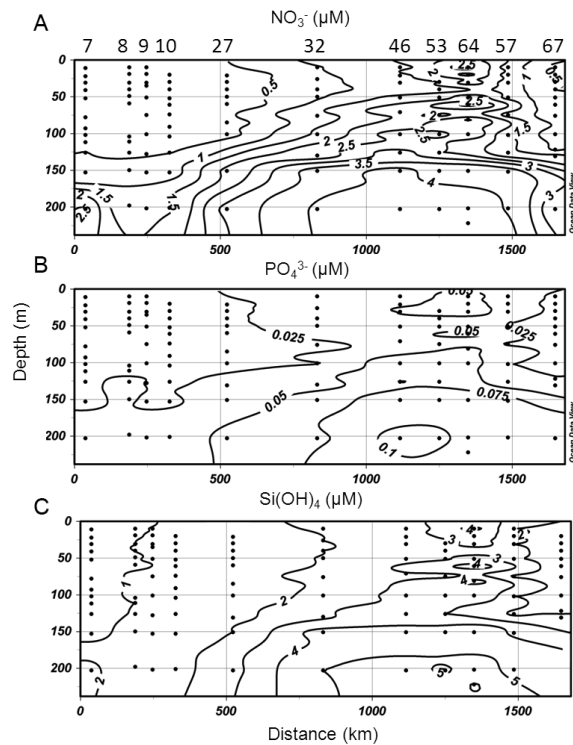


Fig. 1. Vertical distribution of (a) nitrate (NO_3^-), (b) phosphate (PO_4^{3-}) and (c) Silicate ($\text{Si}(\text{OH})_4$) down to 200 m along the cross section through the eastern Mediterranean Sea (similar to Fig. 4). Stations

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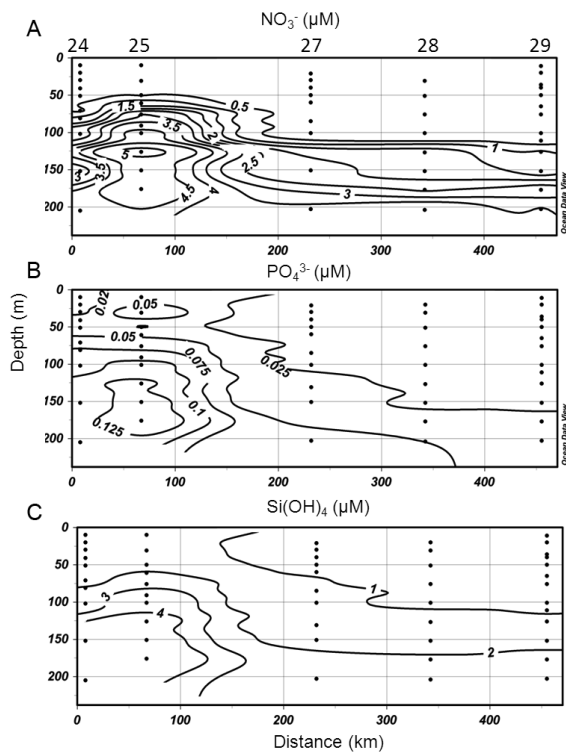


Fig. 2. Vertical distribution of (a) nitrate (NO_3^-), (b) phosphate (PO_4^{3-}) and (c) Silicate (Si(OH)_4) down to 200 m along the north-south transect defined by stations 24 to 29.

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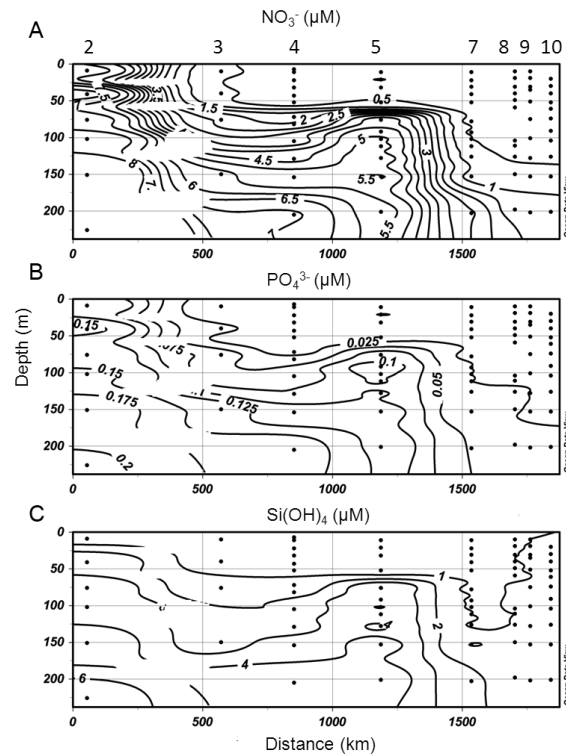


Fig. 3. Vertical distribution of (a) nitrate (NO_3^-), (b) phosphate (PO_4^{3-}) and (c) Silicate (Si(OH)_4) down to 200 m across the western Mediterranean Sea and the western part of the Ionian Sea.

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