

Interactive comment on “Adding nitrate and phosphate separately or together in the Central Indian Ocean: a nutrient enrichment experiment” by S. Tang et al.

Anonymous Referee #2

Received and published: 4 January 2010

This paper describes a small study carried out in the Indian Ocean for investigation of phytoplankton nutrient limitations. The authors reach the conclusion that addition of nitrogen or combination of nitrogen and phosphorus leads to the greatest phytoplankton growth while temperature and N:P ratio were not controlling phytoplankton growth.

General comments

Nutrient limitation in the open ocean varies from one basin to the next, thus regional studies such as those presented in this manuscript are important. Information on phytoplankton nutrient limitations in the Indian Ocean is more limited than many other ocean basins, thus such studies are of interest. Although the major conclusion about

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nitrogen being the proximate nutrient limiting phytoplankton biomass is evident from the data, I feel quite a few clarifications and revisions are necessary on the manuscript data analysis and presentation. Below I've listed my comments point by point.

Specific comments

1. The experiments were carried out in non-trace element clean conditions. The influence of this approach on the results should be addressed in the discussion.
2. The authors have used regressions of chlorophyll or growth rate values measured in one barrel against values in temperature, N, P, or N:P in the same tank over time. This is incorrect, because measured values over the time series are not independent. Discussion and conclusions based on this analysis should be revised.
3. The work would be more interesting if information were presented on what phytoplankton taxonomic groups responded to nutrient additions. The experiment was continued for a time period that appears too long for investigations of simple phytoplankton nutrient limitations and it is likely community composition changed over this time period. It is unclear why such long time period was chosen when community dynamics, trophic transfer etc. are not discussed. Calculating growth rate at day 17 by difference of chlorophyll a measured at days 17 and 0 is a reflection of net accumulation of growth after 17 days of growth, death and sedimentation, grazing, and new growth (of probably different phytoplankton groups) after recycling of nutrients. Discussing such values as “growth rates” is misleading. For the goals of the study as presented, the time period until the end of the exponential growth phase is relevant.
4. Abstract should state what the results and conclusions mean in the broader context of phytoplankton nutrient limitation in oceans/Indian Ocean. It would be relevant and interesting to hear how the results relate to previous information on phytoplankton and nutrient limitations in Indian Ocean. Are there reasons why we might expect the area to be N vs. P limited? What might the results tell us about the biogeochemistry of the basin?

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5. Introduction should mention Fe limitation of phytoplankton growth occurs in many ocean areas (citing appropriate references) and state whether this work does or does not address potential Fe limitations.

Materials and methods (pages and rows refer to the authors' revised paper)

P2 R11-12 Please clarify: "After nitrate was consumed, substantial amount of phytoplankton survived with the supplied phosphorus" and corresponding section in the main text. Live phytoplankton requires both nitrogen and phosphorus.

P4 R15 Here it is stated FeSO₄ was added to the barrels. Is this an error in the text? Iron additions/limitations are not discussed in the introduction, results and discussion.

P4 R17 More detail should be provided on nutrients and chlorophyll a methods. How were samples collected and stored? Where analyses done onboard or later? Were replicates run? What instruments were used? What were the detection limits? NH₄⁺ concentration seems high. How was potential background contamination in NH₄⁺ measurements addressed? In addition to stating these points in the text, please include a citation for all nutrient and chlorophyll methods.

P4 Were the barrels covered? Were they mixed during the 17 d they were incubated? Sedimentation may have caused a major bias if mixing was not done.

P4 Information should be provided on any statistical methods used, including tests of data assumptions.

P7 R12 Here phytoplankton continued to increase although NO₃ was low. It would be appropriate to discuss nitrogen recycling and potential influence of NH₄ and DON supporting chlorophyll a.

Table 2. It is shown that 5 mM concentration of nitrogen was added. However, nutrient measurements show concentrations were <14 uM in the barrels with nitrogen addition, starting from day1. Similarly, P addition is shown as 0.7 mM, but concentrations in P addition barrels were <3 uM. Perhaps the numbers are nutrients added per barrel?

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Please clarify the nutrient additions as calculated final concentrations in barrels at the beginning of the experiment.

Table 3: Average rate of phytoplankton growth is shown. Each growth rate is calculated from the difference in chlorophyll a at the initial time point and at time t. Average growth rate is, however, not informative for treatments in which phytoplankton experiences an exponential growth phase, then crashes, followed by low chlorophyll levels. These trends show instantaneous growth rates must vary widely. Why not use maximum growth rate for the exponential part of the growth curve only and compare maximum growth rates among treatments? At what time point is N:P from in Table 3?

Table 4. This test does not appear valid because data in each test are from the same barrel, thus autocorrelation is an issue.

Technical comments Proofreading English would improve readability.

Interactive comment on Ocean Sci. Discuss., 6, 2649, 2009.

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