BGD Reply to Referee comment #3

Some of the issues might already have been discussed in our response to Referee comment #1 and #2, so we apologize for possible redundancy.

Light supply

Examining our calculations for light supply revealed a mistake in the manuscript. The number given for maximum irradiance intensity (690 W m-2) is the number calculated for depth = 0. The actual target intensity was 32%, corresponding to a daily maximum irradiance (at noon) of ~270 W m-2. However, the maximum realized intensity with our light supply is ~80 W m-2 (corresponding to approximately 400 µmol photons m-2 s-1). Therefore a plateau of maximum light intensity was established, holding the realizaed maximum values long enough to compensate for the lack of desired maximum intensity, in order to achieve the desired integrated light supply of ~1100 Wh m-2. Thus, light conditions in our experiment were high and saturating, but not improbably high. We apologize for the confusion resulting from the presentation of the wrong numbers and will correct this error for the revised manuscript.

Mass balance / missing nitrogen and implications for C:N

The temporal development of total nitrogen (PON+DON+DIN) indeed suggests a loss of organic matter in our experiment.
Mechanisms that may potentially lead to a loss of nitrogen (and carbon as well) include sinking of organic matter to the bottom of the mesocosms, wall growth or mesozooplankton dynamics. It is difficult to quantify the proportional effect of the above mechanisms for the observed loss in our experiment. However, both wall growth and grazing effects cannot explain the observed large loss of organic matter. Therefore we reckon that sinking of particles is the most likely reason for the observed loss of organic matter during the bloom phase Previous studies have shown, that sinking of organic matter can lead to a considerable loss of biomass from the surface layer in mesocosm experiments [Keller et al., 1999; Wohlers et al., 2009]. Since high concentrations of POC and PON were reached very rapidly in our experiment, it is possible that some of this newly produced biomass has sunken to the bottom of the mesocosms. Although mixing of the water column by the propeller should minimize particle settling, this can obviously not excluded entirely. While we did not measure TEP in our experiment, POC data suggests that TEP might have contributed substantially to the observed POC dynamics. Since TEP also plays an important role in particle aggregation, this mechanism could have potentially facilitated sinking of organic matter to the bottom of the mesocosms.
Degasing of regenerated ammonium might have contributed further to the observed loss of nitrogen.

It is true, that some of the observed temporal dynamics in POC:PON might be partly attributable to differences in PON / missing nitrogen. This might be the case during the bloom phase (~t2 to t9) where lower maximum levels of PON were observed at higher temperatures. However, maximum POC:PON ratios are merely affected, since they were reached between t12 and t14, i.e. after maximum PON concentrations, when the differences in PON among the temperature treatments had become very small again and differences in POC are the main driver for differences in POC:PON.

Furthermore, sedimentation of particles seems to be the most likely explanation for the observed loss of organic matter. While it was not possible to measure the C:N of the lost organic matter, it is likely that it corresponded to the C:N of measured POM and C and N drawdown.

We will discuss these issues in the revised manuscript.

Air-water gas exchange

The estimate for wind speed for our calculations of gas exchange is based on observed changes in the carbon budget:
Of course, there was no actual wind in our culture rooms. Wind speed in our calculations for gas exchange was adjusted, in order to account for mechanical mixing of the water column in the mesocosms. Without gas exchange, the amount of total carbon (DIC+POC+DOC) should not increase, as biological processes only lead to shifts between the different pools. Therefore any change in this mass balance is attributable to gas exchange, assuming no loss of carbon e.g. through sinking. The temporal development of total carbon (DIC+POC+DOC) in the mesocosms suggests a net carbon uptake of ~200, 310 and 420 µmol C L^{-1} at low, intermediate and high temperatures, respectively, over the course of the experiment (Fig. 4B). To account for this increase, wind speed was adjusted and a value of 6 m s^{-1} was assumed, yielding the best fit to the observed net carbon uptake in the mesocosms at different temperatures.
Of course, this number for wind speed seems quite high for an indoor experiment. However, high rates of gas exchange are facilitated through continuous mixing of the water column by propellers attached to the mesocosms. Thereby, the boundary layer, which is exchanging gas with the atmosphere, is constantly renewed and rapid air-water gas exchange is facilitated even at virtually zero wind speed. Furthermore, the positive effect of temperature on gas transfer velocity resulted in higher rates of gas exchange at higher temperatures.
In fact, the magnitude of gas exchange in our mesocosms setup has been tested in a follow-up experiment (data not published yet) and supports rates of gas exchange in the same magnitude as observed in the presented experiment.

To make these considerations clear, the issue of gas exchange will be discussed in more detail in our revised manuscript.

Further comments:

- We will look into the issues of inappropriate statistical analysis of the experimental data for the revised manuscript
- The rate of temperature change in the initial phase was not monitored, but usually it takes 24-48h to reach target temperatures. In this experiment, filling of the mesocosms started two days before nutrient addition and the beginning of the actual experiment.
- POM filters were rinsed immediately after filtering of samples in order to avoid accumulation of DOM on the filters. However, since DOM concentrations were very high, and TEP (which is in the continuum between

DOM and POM) accumulation might have been high, it cannot be completely excluded that some material smaller than the actual poresize of the filters remained on the filter.

- Biomass estimates for community composition of phytoplankton (line 208-213) are based on cell counts and cell volumina conversion to carbon following Menden-Deuer & Lessard (2000).