The Variability Of Respiration Versus Photosynthesis And The Influence Of Mesoscale Dynamics*

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Abstract

Respiration is assumed to be much less variable than photosynthesis in aquatic ecosystems. An analysis of nine years of data from the NW subtropical Atlantic reveals that variability in heterotrophic processes associated with (sub)mesoscale features has a major impact on the balance between photosynthesis and respiration. Higher indirect estimates of net community production (NCPe) are associated with the center of Mode Water Eddies (MWE) and frontal regions between cyclonic and anticyclonic eddies (CA). The increase in NCPe observed at the center of MWE is driven mainly by an increase in autotrophic production, whereas in CA enhanced NCPe rates are the result of an important reduction in bacterial respiration. Both features also exhibit a decrease in nitrate concentration, consistent with nutrient consumption, and relative increases in oxygen anomaly and particulate and dissolved organic carbon in the upper 200 m. Plankton community composition in CA and MWE is characterized by the reduction in bacterial biomass, and the dominance of Prochlorococcus and Synechococcus in CA, and diatoms and dinoflagellates in MWE. Contrary to a common assumption, these results show for the first time that in ecosystems influenced by (sub)mesoscale dynamics, respiration can be as variable as photosynthesis.

Hypothesis

Respiration is as variable as photosynthesis and equally influenced by mesoscale dynamics

Objectives

1) To study the variability of respiration (R) versus photosynthesis (P)

2) To determine the contribution of different mesoscale features to the balance between P and R

Why does it matter...?

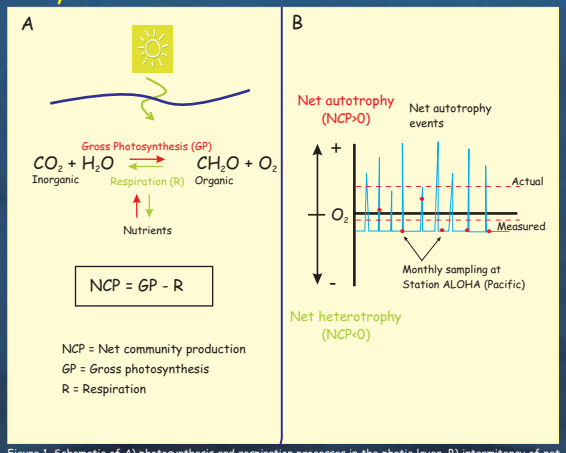

Figure 1. Schematic of A) photosynthesis and respiration processes in the photic layer, B) intermitency of net autotrophy events, decoupled from the most constant heterotrophic processes, in the monthly time-series sampling.

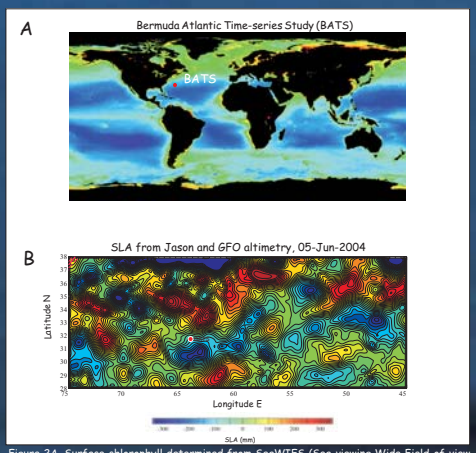

Figure 2A. Surface chlorophyll determined from SeaWIFS (Sea-viewing Wide Field-of-view Sensor) ocean color sensor. (B) Sea level anomaly for 5 June 2004. Location of BATS site is indicated.

The variability of R vs P

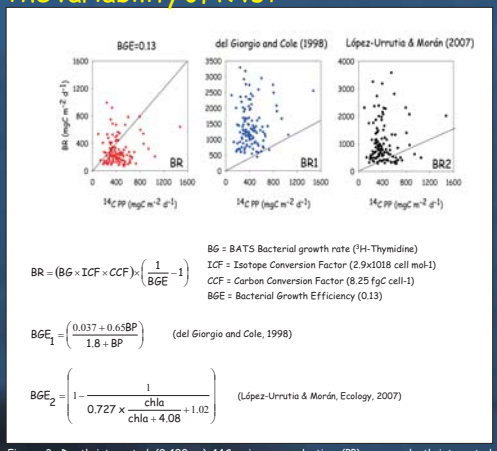

Figure 3. Depth-integrated (0-100 m) 14C primary production (PP) versus depth-integrated bacterial respiration (BR) estimated for the 1993-2002 period at the BATS site.

Contribution of different eddy features

Figure 4A. Sea level anomalies estimated for the 1993-2002 period at the BATS site. (B) Temperature in the upper 700 m for the 1993 2002 period at BATS site.

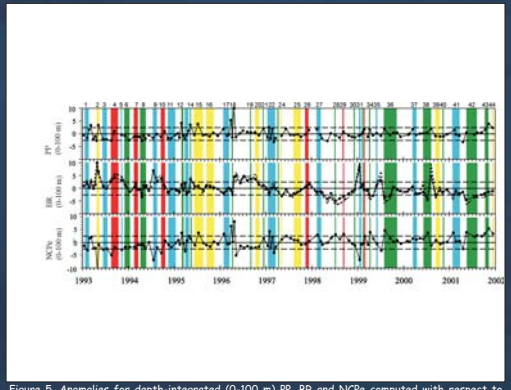

Figure 5. Anomalies for depth-integrated (0-100 m) PP, BR and NCPe computed with respect to monthly averages and rescaled to values between 1 and 10 for the 1993 2002 period at BATS site.

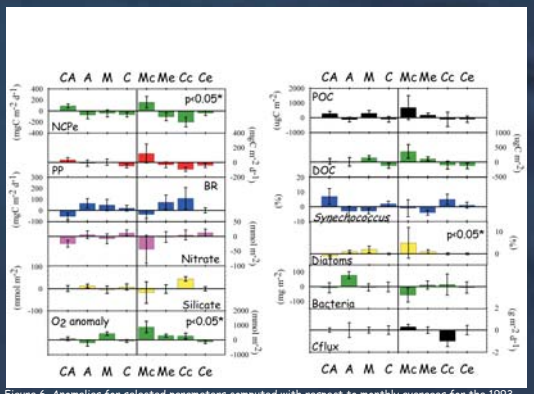

Figure 6. Anomalies for selected parameters computed with respect to monthly averages for the 1993 2002 period at BATS site.

Conclusions

1) Respiration (R) is as variable as photosynthesis (P) and equally influenced by (sub)mesoscale dynamics

2) Higher indirect estimates of net community production (NCPe) are associated with the center of Mode Water Eddies (MWEc) and frontal regions between cyclonic and anticyclonic eddies (CA)

3) Increase in NCPe rates observed at MWEc is driven mainly by an increase in P, whereas in CA is the result of an reduction in R

What is the relevance...?

Pulses in respiration need to be considered in order to quantify the metabolic balance of the photic layer and the potential for carbon export to the deep ocean.

Acknowledgements

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