EFFECTS OF NUTRIENT ENRICHMENT AND MESOSCALE EDDIES ON METABOLIC BALANCE IN THE SUBTROPICAL NORTH PACIFIC OCEAN

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CHAPTER 4. CONCLUSIONS

In Chapter 2, it was shown that plankton community production and respiration can become decoupled following the addition of nutrients. This decoupling resulted in changes in net community metabolism and, for communities with near balanced or net heterotrophic metabolism, in a switch from net heterotrophic to net autotrophic metabolism. Natural phenomena or land anthropogenic activities, which introduce nutrients to oligotrophic surface waters, therefore, may have an important role in controlling variability in plankton net community metabolism.

While addition of nutrients to mixed layer water yielded increases in rates of primary production in the experiments presented in Chapter 2, the rates at which primary production measurements increased were not as easily discerned. GPP was measured at two time points: time-zero and final, which were 96 to 144 hours apart. In Chapter 3, changes in rates of GPP were measured daily for 96 hours, yielding better resolution of rate dynamics after nutrient addition. Although GPP was consistently greater in every experiment where nutrients were added, the magnitude and rate of the response varied among the experiments. This variation could have been caused by a number of factors including differences in the initial biomass and community composition. The results also imply that there may be a threshold nutrient concentration required to elicit a response by the plankton assemblage. Future work exploring the relationships between the initial community composition, population density and the magnitude of nutrient concentration would provide important information about the processes underlying plankton bloom dynamics and the decoupling of production and respiration.

The cyclonic mesoscale eddies discussed in Chapter 3 are, in essence, "natural" nutrient addition experiments, thereby providing insight on the temporal dynamics of bloom formation and decay. It is important to note that the mature eddy studied during EF-III had no sea surface chlorophyll signature. Models of plankton productivity and biomass based on satellite observations are inherently limited to the optical depth of the satellite radiometers that sense the upper ~20 meters of the water. Thus, such sensors cannot detect differences in chlorophyll concentration deeper in the water column. In the future, using gliders in conjunction with satellite imagery might overcome this problem because they (gliders) can monitor conditions deeper in the water column.

As we found during EF-III, plankton community dynamics can vary substantially between the upper and lower euphotic zone. The presence of a diatom bloom at the base of the euphotic zone is consistent with Goldman (1993), who proposed that diatoms at the base of the euphotic zone bloom as new nutrients are introduced from below. The data do not confirm that introduction of nutrients from below caused the bloom encountered during the E-Flux study; however, future work on these eddies should include studies of nutrient introduction to the euphotic zone from depth.

In Chapter 3, the concept of a threshold for net autotrophic community production was also explored. Results indicated a threshold GPP for net autotrophic production of ~1.5 mmol O_2 m^{-3} d^{-1} in these mesoscale eddies. These results were consistent with previous threshold estimates for the open ocean (1.1 mmol O_2 m^{-3} d^{-1}) but lower than the observed threshold for other marine environments (50 and 100 mmol O_2 m^{-3} d^{-1} for coastal and marsh areas, respectively) (Duarte and Agusti 1998). Future research efforts should focus on testing the relevance of these threshold determinations, similar to the approach described in Chapter 3. There is a rich database of radiocarbon (^{14}C)-based production measurements from various ocean ecosystems; if we can use a threshold value to infer community metabolism, it may be possible to utilize these measurements to increase our knowledge of metabolism in the global ocean.

Understanding the net metabolic state of the global ocean and the processes that control the balance between production and respiration continues to be an important area of research in earth systems science. The work presented in this thesis explored a mechanism for inducing changes in metabolic balance experimentally and then quantified rates of production associated with a mesoscale feature that may serve as a model ecosystem for the experimental results. The results emphasize the importance of considering time and space scales when interpreting and extrapolating data and provoke questions as to how and why changes in net community metabolism occur. A challenge is also presented to apply the threshold values of ecosystem metabolism, which would enable us to re-interpret existing data. As we work towards understanding the oceans' role in the global carbon cycle, understanding the role which marine organisms play in the marine carbon cycle will be of increasing importance.