Generation and Fate of a Trichodesmium Bloom around Station ALOHA

A proposal submitted to C-MORE EDventures

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Address:
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Budget estimate:

Travel $1,400
Total $5,095
Background

The North Pacific Subtropical Gyre is characterized by low nutrient concentration and biomass standing stocks. However, large cells and high surface phytoplankton concentration are usually associated with late summer chlorophyll blooms in the region. These blooms are characterized by a wide range of scales—from sub-mesoscale (2 km) streaks to mesoscale (100 km) patches—and their triggering mechanism is still unknown. The OPEREX cruise was designed to investigate the formation and evolution of a *Trichodesmium* bloom around Station ALOHA and its impact on particle export. The study area was occupied by a mesoscale dipole, with a cyclonic eddy to the north and the anticyclone to the south. We performed 2 transects at different resolutions during the 2 weeks of the cruise. The high resolution (7-10 nautical miles) transect revealed patchiness at the sub-mesoscale (Data from the Underwater Video Profiler).

Optical measurements revealed that large particles converged to the region between the eddies and were exported down to 300 m. Identifying the biological and physical processes responsible for the particle distribution and export is key to understand both regional and basin-scale carbon export as well as improve parameterization of global climate models.

Synopsis of proposed research

The main thrust of this proposal is to combine the analysis of the CMORE-OPEREX cruise data with remotely-sensed data to investigate how submesoscale processes modulate the evolution of a *Trichodesmium* bloom observed during the cruise.

The analysis of the surface chlorophyll images (MODIS) indicates that the spatial variability of the bloom was related to the existence of two mesoscale eddies—a cyclone to the north and an anticyclone to the south—that were present in the region, with the accumulation of particles in the convergence region between the two eddies.

Based on this evidence, a decision was made to realize two transects across the most contrasting regions, namely the centers of the two eddies. Among the wealth of data collected, the Underwater Video Profiler (UVP) has so far been the most revealing about the spatial structure of vertical particle export. It was found that the largest concentration of particles occurred in the convergence zone between the two eddies and at the southern edge of the anticyclone. In addition, the increase in average particle size in the transition zone highlights potential coagulation processes or zooplankton particle repackaging that are likely to generate particle export.

Combining analysis of the particle size distribution across the 2 eddies with the surrounding circulation will allow to clarify the mechanisms that could generate the observed particle distribution and lead to a better understanding of the export of carbon from the euphotic zone.

An effort is underway to relate the evolution of the bloom with the surrounding environment (e.g. Chlorophyll, SST, SSH and wind stress) and to identify key processes, both physical and biological, in the generation, dispersion, and destruction of a bloom as well as its importance in particle export.

Specific questions being addressed are:
• What are the mechanisms that induce submesoscale motions around the mesoscale vortices?
• What is the response of the biology and biogeochemistry to such motions?
• What physical/biological processes can lead to the observed spatial variability of the particles size distribution?
• Are there submesoscale ‘triggering’ mechanisms of carbon export in the oligotrophic North Pacific?
• Can these results be generalized to other regions?

In order to answer these questions a thorough analysis of in situ UVP and CTD data as well as remotely-sensed altimetry, sea surface temperature and chlorophyll-a data is being performed. Moreover, Lagrangian diagnostics (e.g. Lyapunov exponents) are being used to evaluate the importance of the horizontal stretching of the eddying flow in modulating the dispersion of tracers. Also, hindcast model runs are being compared with in situ and remotely sensed data. This will help us analyze the evolution of the 3-D density field on a synoptic scale and speculate about physical mechanisms that could directly supply limiting nutrients as well as favorable environmental conditions for biological processes (e.g. N2-fixation) to occur.

**Reason for travel**

Given that the authors are working on many different projects at the moment, it would be beneficial if a specific time could be dedicated to the compilation of the final results as well as the writing of the manuscript. For this reason we would need to meet twice. Dr. Paulo Calil will come at the beginning of November to UH for 5 days to analyze the satellite data and combine them to the in situ observation with the help of Dr. Lionel Guidi. Then the physical processes that could be at the origin of the observed particle distribution will be analyzed with the help of model simulations. At the end of the week a poster will be ready to be presented by Dr. Calil at the AGU meeting in Portland.

After this first meeting we will work separately on the manuscript and we will meet for another week at WHOI (Dr. Lionel Guidi will go in January) in order to finalize the manuscript.

**Inter-Institution Collaboration and Educational Component**

Dr Lionel Guidi will give a seminar at WHOI (invited by Ben Van Moy). In addition Dr. Paulo Calil will submit an abstract to the Ocean Science meeting (AGU-Portland 2010) and both investigators will use the funding to co-prepare the presentation/poster. This project adds to the multi-disciplinary character of CMORE by bridging its modeling and biogeochemistry components.

Regarding ‘proof-of-concept’, this preliminary work led to the submission of two NSF proposals (one by Dr. Lionel Guidi in collaboration with Amanda Whitmire and one by Dr Susan Brown (UH) with the collaboration of Dr. Paulo Calil). These submissions are only a start and both investigators are working on combining the 2 proposals in order to closely link the Physics and Biogeochemistry within the context of CMORE objectives.
**Edventure proposal**

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29 September 2009

Dr. Lionel Guidi – Postdoctoral Scholar
Department of Oceanography
University of Hawai‘i
1000 Pope Road, MSB205
Honolulu, HI 96822

Dear Lionel,

It was great meeting with you at the recent AGU Chapman Conference on the Biological Carbon Pump of the Ocean. The talk you presented there on particle export using the underwater video profiler was absolutely one of the most fascinating that I have seen in some time. I am certain that members of the WHOI community could learn much from your exciting findings; as the current coordinator of the Marine Chemistry and Geochemistry Seminar here at WHOI, I would like to formally invite you to present on this topic. Unfortunately, due to the impact of the current economic downturn on WHOI discretionary funds, we cannot offer support for your trip from Hawai‘i. However, if you were to ever find yourself in New England, we would be happy to support your local travel to WHOI.

Please let us know if you will be able to visit WHOI and give a talk in the near future; we have many dates available. This would be a good opportunity for our Scientific Staff to become more familiar with your work, and for you to learn more about related research being conducted at WHOI.

Best regards,

Dr. Benjamin Van Mooy
Associate Scientist
Department of Marine Chemistry and Geochemistry

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