A High-Resolution Insight into Microbial Biogeochemistry in the North Pacific Ocean

By Samuel T. Wilson and David M. Karl

In the summer of 2012, oceanographers at the Center for Microbial

Oceanography: Research and Education (C-MORE) embarked on a series of expeditions into the subtropical North Pacific Ocean to better understand the processes governing the seasonality of marine productivity and biogeochemical cycling. The project was called the Hawaii Ocean Experiment: Dynamics of Light and Nutrients (HOE-DYLAN).

Ocean processes occur over time scales that range from seconds to millennia, and across spatial scales that extend from a single drop of water to entire oceans (Figure 1). For example, many microscopic plankton have life spans of about one day and their immediate habitat ranges to a millimeter of seawater. However their populations respond to environmental fluctuations that occur on seasonal, annual, or even longer cycles and can be initiated from thousands of kilometers away. In order to understand the variability of physical and biogeochemical ocean processes, scientists need to account for the appropriate time and space scales in their research.

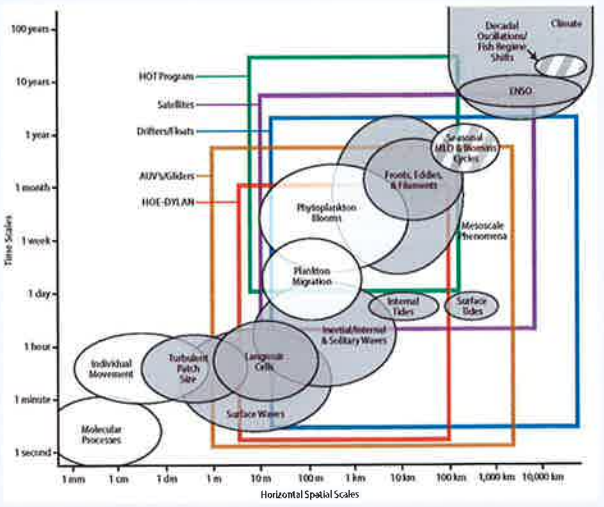


Figure 1. Schematic representation of the relevant time and space scales in the global oceans. The white circles indicate the biological processes and the gray circles represent the physical processes occurring in the surface ocean. The different boxes represent sampling/observations that occurred during the HOE-DYLAN field campaign.

Since 1988, the Hawaii Ocean Time-series (HOT) program has been sampling at a deep-water location in the North Pacific (called Station ALOHA) at near-monthly intervals (Figure 2). By measuring the same variables in the same way at the same place over an extended period of time, the HOT data provide vital insight into determining the critical time scales of variability in the open ocean environment. From this near-monthly sampling, seasonal, interannual, and decadal patterns have been identified.

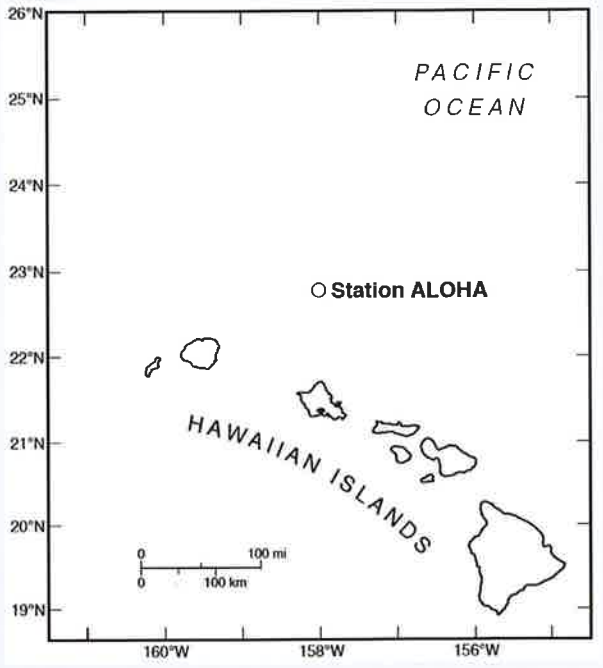


Figure 2. Station ALOHA situated at 22° 45'N, 158°W is located 100 km north of Oahu and is the long-term monitoring station of the HOT program.

However, the monthly datasets don't reveal everything and key processes concerning the production and consumption of oxygen and organic matter are being missed, leaving gaps in our understanding of the upper ocean ecology. A principal objective of the NSF-funded Center for Microbial Oceanography: Research and Education (C-MORE) is to resolve these knowledge gaps and better understand microbially driven biogeochemical cycles in the oligotrophic (low-nutrient) open ocean. Without microbes driving these oceanic processes, life as we know it would not be possible.

Between May and October 2012, C-MORE and HOT brought over 100 scientists, students, and teachers from 25 different institutions together on 11 oceanographic cruises for the at-sea phase of HOE-DYLAN. The research vessel used in all cruises was the *R/V Kilo Moana* and it maintained position 100 km north of Oahu, Hawaii (Figure 2). With near-continuous sampling over a three-month period, researchers collected thousands of water samples to help understand key ecosystem processes on temporal and spatial scales that matter to marine microbes. A snapshot of the resulting datasets is shown with the Deep Chlorophyll Maximum (DCM), which represents the depth in the water column of the maximum concentration of chlorophyll



R/V Kilo Moana

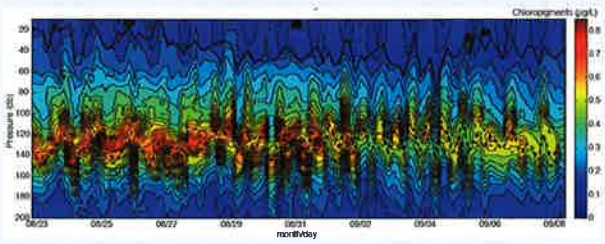


Figure 3. Vertical profile of chloropigments in the upper 200 m of the water column in the oligotrophic open ocean between 23 August and 8 September, 2012. The vertical oscillations in the fluorescent traces reflect the activity of internal tides (normal, internal gravity waves with tidal frequencies) passing through the study site.

(Figure 3). The DCM is typically situated between 100-160 m and its position in the water column depends on a variety of factors including light, nutrient availability, biological activity, and physical processes such as internal waves. Understanding how the marine microorganisms respond to these parameters will provide new insight into the roles that light and nutrients play in biogeochemical cycles and the relevance of marine microbes in climate cycles.

Although the HOT program continues their monthly expeditions to Station ALOHA, the intense sampling of HOE-DYLAN ended in October 2012. This project is now in the post-cruise operational phase, processing samples and analyzing the data to discover new insights about microbial oceanography. To learn more about this research expedition, please visit the project website at http://hahana.soest.hawaii.edu/hoedylan/hoedylan.html

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