Food limitation in the deep sea: a test of a paradigm using a long time-series photographic monitoring system with real-time data acquisition

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Food limitation in the deep sea is a major paradigm in marine ecology. However, the coupling between a pelagically-derived food supply and the dynamics of deep-sea, benthic communities has been difficult to establish without appropriate time-series measurements. Long-term monitoring in the deep sea has been limited by data storage, longevity of battery power, the inability to collect/analyze data and alter sampling frequencies in real time, and the inability to correct or compensate for malfunctions in real time. Given the large temporal variations recently discovered in particulate organic matter fluxes (as an indication of food supply) to several areas of the deep ocean, it is critical to expand time-series measurements in the deep sea. Long time-series measurements of both food supply and activity of deep-sea organisms are critical to any informed decisions regarding the health, longevity, and resilience of deep-sea communities.

The recent installation of the Hawaii-2 Observatory (H20) at 5000 m depth in the central North Pacific has made possible long-term monitoring in the deep sea. We will utilize the unique capabilities afforded by H2O, with power and communication provided over an underwater telephone cable, to conduct the first long-term, real-time monitoring of a deep-sea benthic community. We will study the short and long-term importance of a temporally-varying food supply on an abyssal benthic community, addressing the following questions - 1) What is the quality and quantity of sinking particulate matter reaching the sea floor at the H20 site as representative of the North Pacific central gyre? 2) What responses are elicited in the epibenthic megafauna, as a proxy for benthic community activity, by the quality and quantity of particulate matter arriving on the sea floor on time scales from hours to years? We will develop and install a monitoring system, including a sedimentation sensor, digital time-lapse cameras, and current meter, to monitor the flux of particulate matter as well as the activity of epibenthic megafauna in two 20m2 areas of the sea floor in real-time. Temporal changes in particle flux to the sea floor will be compared with the abundance and activity of the mobile epibenthic megafauna in the replicate photographic areas. We will conduct a one-year test, followed by an enrichment experiment in which we artificially enhance the food supply to the two areas photographed.

This long-term ecological observatory on the sea floor will serve as a nucleus from which to develop other remote-sensing systems to address questions concerning the ecology of deep-sea communities and their role in the functioning of open ocean ecosystems. Deep ocean observatories will become increasingly important as concerns for the health and longevity of the ocean and its communities become globally important environmental and political issues.