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Hydrodynamic controls on cold-water coral growth in the Gulf of Mexico: Long term in situ seabed lander observations

Furu Mienis (1), Gerard Duineveld (1), Andrew J. Davies (2), Tjeerd C.E. Van Weering (1), Steve W. Ross (3), Murray Roberts (4), Harvey E. Seim (5), and John M. Bane (5)

(1) Royal Netherlands Institute for Sea Research (NIOZ), Den Burg, The Netherlands (furu.mienis@nioz.nl), (2) School of Ocean Sciences, Bangor University, Menai Bridge, UK, (3) University of North Carolina at Wilmington, Center for Marine Science, Wilmington, USA, (4) Centre for Marine Biodiversity & Biotechnology, School of Life Sciences, Heriot-Watt University, Edinburgh, UK., (5) Department of Marine Sciences, University of North Carolina, Chapel Hill, USA

Cold-water coral reefs and mounds are a common feature on the continental slopes of the North East Atlantic Ocean. On the European continental margin mound structures that are many kilometers long and wide have been discovered, often colonized by a thriving coral community. Similar structures have been found in the West Atlantic on the continental slope between 300-800 m water depth, along the slope from North Carolina to Florida. Presently detailed studies on the environmental constraints in cold-water coral areas are limited to cold-water coral areas in the North East Atlantic. This is the first study showing long term environmental variability in a cold-water coral habitat in the Gulf of Mexico, West Atlantic and the data highlight novel observations of short term environmental variability in a cold-water coral habitat. In the Gulf of Mexico Lophelia pertusa occurrences are scattered and form less dense communities than those situated on the Atlantic margins. The Viosca Knoll (VK826) area is the most extensive cold-water coral area presently known in the Gulf of Mexico, with Lophelia pertusa being the most common coral species. Broadly two characteristic coral habitats can be described on Viosca Knoll. Firstly, a dense coral cover that resembles a biogenic reef and secondly authigenic carbonate blocks with sparse coral coverage. Two benthic landers were deployed for over a year in the vicinity of the corals to measure the local environmental conditions. Both landers measured the current velocity and direction, temperature, salinity, fluorescence, optical backscatter and were equipped with a sediment trap. Furthermore CTD transects were made across the cold-water coral area. Transects showed no fluorescence signal below 150 m water depth and an oxygen minimum zone at the depth of the corals. A prominent intermediate nepheloid layer was present at 300-400 m water depth. Long term deployments of benthic landers of a period over 12 months revealed intra annual temperature (6.5-11.7 °C) and salinity (34.9-35.4) fluctuations. Temperature and salinity co-vary during the year, showing a large increase in July 2009. The average near-bed (1 m above bottom) current speed in the area varies at around 7 cms-1, whilst peak current speeds up to 38 cms-1 are occasionally recorded. The area is characterized by a dominant reversing east and westward flow of water. Short term variability is shown by changes in temperature and salinity, that can be related to internal waves over 5-11 hour periodicity. A further pattern which was observed over the coral habitat is a 24 hour diel vertical migration of zooplankton, that may form part of the food chain reaching the cold-water corals. Fluorescence data show that there is no fresh matter input from the water surface reaching the corals. However, sediment trap samples show high mass fluxes (4002-4192 mg m-2 d-1) in the area and video observations show the presence of large muddy aggregates in the water column. In June and July 2009 a considerable event was recorded, showing an increase in current speed, which was followed by an increase in temperature and salinity. During this period of three weeks a sustained westward water flow was observed. The environmental conditions recorded resemble those recorded in cold-water coral areas on the European margin. However, several main differences have been recorded, the high sediment load in the water column, the absence of fresh surface particles at the seafloor and low oxygen concentrations. Yet Lophelia pertusa still appears to thrive in this area.