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Water-mass dynamics of an Arctic cold-water coral reef: First results from a new ocean observatory system

Sascha Flögel, Johannes Karstensen, Peter Linke, Olaf Pfannkuche, Kseniia Ashastina, and Christian Dullo
GEOMAR Helmholtz-Zentrum für Ozeanforschung Kiel, Marien Geosystems/Paleoceanography, Kiel, Germany (sfloegel@geomar.de)

Cold-water coral reefs occur at various sites along the European continental margin, like in the Mediterranean Sea, on carbonate mounds West off Ireland, or at shallower depths between 100 and 350 m on the Norwegian shelf. Their occurrence is related to different physical parameters like temperature, salinity, seawater density, dissolved oxygen, and to other environmental parameters such as internal wave activity, nutrient supply, strong currents, which keep sediment input low, etc.
Here, we present first results from a long-term observation in one of the nortnermost cold-water coral reefs at 70.5°N – the Stjernsund in northern Norway. The Stjernsund is a 30 km long and up to 3.5 km wide sound connecting the open North Atlantic with a fjord system. A deep-seated SW–NE oriented morainic sill with varying depths (203–236 m) splits the more than 400 m deep sound into two troughs. Living Lophelia pertusa dominated reef complexes occur on the NW slope between 235 and 305 m water depths and on the SE slope between 245 and 280 m.
To investigate the dominating physical and biogeochemical boundary conditions a new modular seafloor observatory, MoLab, consisting of five sea-floor observatories and two moorings was deployed for 100 days during the summer of 2012. The various lander systems and moorimgs were equipped with sensors to measure current velocities and directions, temperature, salinity, pressure, pH, turbidity, fluorescence, oxygen concentration and saturation.
Results showed that near-bottom salinities, temperature and current velocities are dominated by a semi-diurnal tidal forcing (pronounced M2 constituent), which cause vertical water mass movements of up to 100 m. These influence large parts of the living reef. Closer examination revealed overturning cells on the south-eastern slope of the sill during high tide, when Atlantic Water flows over the sill. The appearance of living cold-water corals is limited to a density envelope of sigma-theta=27.25-27.50 kg/m-3, which marks the boundary between Norwegian Coastal Water and Atlantic Water.
Globally, Lophelia pertusa lives in waters covering a wide range of physical and biogeochemical parameters. This new data sets indicates parameter ranges, of e.g. current velocities (15-30 cm/s), temperature (6.0-6.8°C) and salinity (34.1-34.8), pH (8.22-7.39), turbidity (0.1-0.9 NTU), and oxygen concentration (300-339 μM) that are in agreement with other cold-water coral reefs in the NE Atlantic.
The overall circulation depicts a complex dynamic system with pronounced differences not only vertically, but also important horizontal changes on top of the sill.