Geophysical Research Abstracts
Vol. 13, EGU2011-12642, 2011
EGU General Assembly 2011

Observing deep-sea ecosystem shifts related to global change and human impact

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Here we propose future research objectives and strategies for the understanding of ecological changes in the deep Arctic and European Seas. Developing and improving methods in ocean ecosystem studies from the shoreline to the abyss have accelerated our insight into the function and composition of ocean realms. The past ten years of ocean observation by the recently concluded Census of Marine Life have improved our ability to study and explain the dynamics of diversity, distribution, and abundance of marine species in a multitude of ocean ecosystems. They have also provided clear evidence for many ocean environments to change faster than we can learn about them. Facing a dramatic overexploitation of fish stocks, the rapid retreat of sea ice in the Arctic both in extent and volume, increasing hypoxia and ocean acidification, the impact of giant oil spills, and other problems connected to human interaction with the ocean and climate, basic research on understanding ecosystem responses to ocean impacts and perturbations becomes an urgent societal issue. This, however, can only be achieved with multidisciplinary long-term observations. We discuss different examples of benthic observatories, which allow a linking of oceanographic and geological processes with ecosystem responses, some of which include important biogeochemical feed back mechanisms. The international scientific community has agreed on a continuous effort of improving atmospheric and oceanographical observations in order to achieve a better prediction capability on climate - ocean interactions in European Seas. Here we argue for the value of long-term deep-sea ecosystem observatories in the observation of global change and human impact. One example is the only high latitude deep-sea long-term observatory of export POC fluxes and connected changes in pelagic and benthic productivity and diversity, the station “HAUSGARTEN” (e.g. EU projects ESONET, EMSO, HERMIONE and HYPOX). At this site remarkable changes in sea ice cover, deep-water temperature, export fluxes and the structure of benthic communities were recorded during the past 10 years. New types of observatories have also been established to observe the consequence of hydrate dissociation on sediment dynamics (ESONET observatory LOOME), or to monitor temporal and spatial dynamics in oxygen availability in sensitive hypoxic areas (HYPOX). Such ecosystem observatories are urgently needed to obtain base-line information on habitats under increasing anthropogenic pressure. The “Deep Water Horizon” incident in the Gulf of Mexico has shown how such pressures can often not be anticipated, and how valuable even the most basic ecological knowledge can be, such as baseline biomass and community distribution, benthic oxygen consumption or methane turnover. Hence, one proposed strategy is to link industrial offshore installations and seafloor impacts with ecosystem observatories per default. According monitoring infrastructure concepts that allow for adequate temporal and spatial coverage of multidisciplinary parameters has been developed within ocean observatory initiatives such as ESONET/EMSO, OOI, NEPTUNE and DONET. The presentation summarizes the challenges of deducing the future of ocean ecosystems in light of global change processes, and in light of the steep learning curve in unraveling the diversity of ocean life. Ocean geo- and biosciences are challenged to speed up the exploration of the enormous diversity of ocean habitats and life, and its many functions and services. They will also face the need for a much higher level of input to programs of nature conservation and sustainable management, and of transdisciplinary insight into the value of ocean ecosystems for humankind.