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Designing and deploying a global ocean Mid-trophic Automatic Acoustic Sampler (MAAS)

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Despite their wide spatio-temporal distribution, huge abundance and crucial importance for both the biogeochemistry of the ocean and the distribution and abundance of top predators, mid-trophic level organisms (meso-zooplanktonic and micro-nektonic organisms preyed by top predators) are still one of the less known components of pelagic ecosystems.
To address this critical lack of information, the CLIOTOP Programme (see box below) promotes the development of the MAAS project which targets the large scale deployment of automatic acoustic recorders to provide the scientific community with near real time global scale monitoring of mid-trophic level organisms, their horizontal and vertical size-resolved distribution and abundance in the open ocean pelagic environment (see http://web.pml.ac.uk/globec/structure/regional/cliotop/MAAS.pdf for a detailed presentation of the MAAS project).

Such a monitoring of mid-trophic level organisms is indeed crucial for parameterizing, validating and ultimately constraining the numerical models of mid-trophic communities that provide, at the scale of oceanic basins, the missing link needed to couple ocean circulation and biogeochemical models from the one hand to models of higher trophic-levels exploited by fisheries from the other. Large scale synoptic observations are indeed available for the physical, biogeochemical and high trophic levels (top predator) components but no program has focused on the observation of mid-trophic organisms at the basin scale to date.
Biological observations in the oceanic realm are usually obtained using scientific vessels equipped with appropriate observation tools. This strategy is however expensive and surveys are generally conducted sporadically or on an annual basis in restricted regions. Their limited spatio-temporal coverage seriously limits their usefulness for large scale ecosystem models. Physical observations, on the other hand, are now gathered continuously on a global scale using automated oceanic moorings, drifters and gliders and data are transmitted to the users through satellite. Such technologically advanced observing systems have been evolving together with advanced oceanic models and they now provide together a major contribution to improved understanding and forecasting of the dynamics of the ocean from regional to global scales. This approach integrating observing systems and numerical modelling has been used with great success by oceanographers. Its extension to ecosystems is now timely and the CLIOTOP-MAAS project would be a major step in this direction.

The MAAS project targets two levels of technological sophistication: a high level adapted to large platforms such as fixed moorings, vessels or AUV and a low level adapted to a large number of autonomous drifters. As a first step, the priority has been given to the development of a drifter carrying a simple multi-frequency (at least two frequencies have to be used to discriminate taxonomic groups and sizes from 0.1 to 30 cm) acoustic equipment associated to

a data pre-processing software and a satellite transmission system. The use of simple and easy to deploy drifting floats is the easiest solution for covering large regions such as ocean basins. Releasing large numbers of drifters (one to two thousand buoys drifting permanently) is indeed the condition for achieving a good geographic coverage at a reasonable cost.
The MAAS drifters will be designed to enable detailed acoustic observations using several frequencies up to 100-150 m depth. Since most of the biomass is distributed in the first 1000 m of the oceans, the maximum depth of the MAAS observations will be at least 800 m, but with a lower resolution using a single frequency. The use of additional sensors such as LOPC (Laser Optical Plankton Counter) could also be envisioned. It would provide users with complementary data such as the size distribution of zooplankton at the surface.

The need for implementing global observing systems for marine biodiversity is urgent in the present global change era (e.g. Richardson and Poloczanska, 2008[1]) and it has become a priority for international organisations like GEO (Group on Earth Observation), GOOS (Global Ocean Observing System) or the proposed GEOBON (Group on Earth Observations Biodiversity Observation Network, e.g. Scholes et al., 2008[2]). Large scale international programmes on marine biodiversity such as CoML (Census of Marine Life) have been deploying such observing systems focussing on both low trophic levels (e.g. ICOMM for bacteria) and high trophic levels (e.g. TOPP and OTN for top predators) but no large scale project exist to date for the synoptic observation of mid-trophic levels in marine ecosystems, despite their pivotal role between biogeochemistry (/climate) and ecosystems (/fisheries).

We believe that the results obtained by the oceanographic community using mooring, drifters and gliders have clearly demonstrated the potential for global observational approaches. The technological developments that occurred during the last decade allow us to envision now the extension of those approaches to mid-trophic components of oceanic ecosystems.
The MAAS project is challenging but the rewards would be great. The 3D data that would be produced by a large scale MAAS network would indeed be of considerable interest for the whole marine science community and it can reasonably be expected that they would have the same kind of impact on marine ecology that satellite derived estimates of primary production had on biogeochemistry. The science involved in their analysis would undoubtedly be fascinating and the insights gained would add substantially to our understanding and predictive capabilities of the ecology and biogeochemistry of oceanic ecosystems.

CLIOTOP (CLimate Impacts on Oceanic TOp Predators) is a ten year program implemented under the international research programme GLOBEC (Global Ocean Ecosystem Dynamics, http://www.globec.org) from 2005 to 2009 and from 2010 to 2014 under the international research programme IMBER (Integrated Marine Biogeochemistry and Ecosystem research, http://www.imber.info/), two components of the International Geosphere-Biosphere Programme (IGBP, http://www.igbp.kva.se/).
CLIOTOP is devoted to the study of oceanic top predators within their ecosystems and is based on a worldwide comparative approach among regions, oceans and species. It requires a substantive international collaborative effort to identify, characterise, monitor and model the key processes involved in the dynamics of oceanic pelagic ecosystems in a context of both climate variability and change and intensive fishing of top predators. The goal is to improve knowledge and to develop a reliable predictive capacity combining observation and modelling for single species and ecosystem dynamics at short, medium and long term scales.

http://www.pml.ac.uk/globec/structure/regional/cliotop/cliotop.htm

[1] A. J. Richardson, E. S. Poloczanska, 2008. Ocean Science Under-Resourced, Under Threat. Science (320) 1294-1295.
[2] R. J. Scholes, G. M. Mace, W. Turner, G. N. Geller, N. Jürgens, A. Larigauderie, D. Muchoney, B. A. Walther, H. A. Mooney, 2008. Toward a Global Biodiversity Observing System Science (321) 1044-1045.