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New light for time series: international collaboration in ship-based ecosystem monitoring

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Summary
Ship-based biogeochemical and ecological time series are one of the most valuable tools to characterize and quantify ocean ecosystems. These programs continuously provided major breakthroughs in understanding ecosystem variability, allow quantification of the ocean carbon cycle, and help understand the processes that link biodiversity, food webs, and changes in services that benefit human societies. A quantum jump in regional and global ocean ecosystem science can be gained by aggregating observations from individual time series that are distributed across different oceans and which are managed by different countries. The collective value of these data is greater than that provided by each time series individually. However, maintaining time series requires a commitment by the science community and sponsor agencies.. Based on the success of existing initiatives, e.g. ICES and SCOR working groups, IOC-UNESCO launched the International Group for Marine Ecological Time Series (IGMETS, http://igmets.net) to promote collaborations across different individual projects, and jointly look at holistic changes within different ocean regions. The effort explores the reasons and connections for changes in phytoplankton and zooplankton at a global level and identifies locations where particularly large changes may be ocurring. This compilation will facilitate better coordination, communication, and data intercomparability among time series.

Introduction
Much of the progress in understanding ocean ecosystem functions has come from the analysis of in situ and remotely-sensed observations sustained during long periods of time (Henson, 2014). Biogeochemical modelling has benefited from observations used to parameterize model functions and test their predictions. Remote observations of biogeochemical and biological variables from satellites or automated buoys, still need to be based on calibrations from water samples collected from ships (Cloern et al., 2014). The importance of continued sampling by existing marine time series is now highlighted by the Intergovernmental Oceanographic Commission of UNESCO (IOC-UNESCO). The International Group for Marine Ecological Time Series (IGMETS) seeks to aggregate time series dispersed around the world in an effort to augment the observing power to look at changes within different ocean regions, to explore plausible reasons and connections at a global level, and to highlight any locations of especially large changes that may be of special importance.

Material and methods

The IGMETS analysis methodology is based on concepts and ideas evolved during 15+ years of time series work with an assortment of ICES (e.g. O'Brien et al., 2013) and SCOR (Mackas et al., 2011) time series analysis working groups. The IGMETS analysis will be a global coverage, extended variable-set expansion of the general analyses done in the North Atlantic to >250 in situ time series distributed over the main ocean basins. The initial IGMETS analysis is web based and designed as a discovery tool rather than a statistical tool. For this purpose several maps and summary tables allow to summarize the main trends and their correlation for discrete periods spanning from 5 to 30 years before present. Because of the uneven geographical distribution of the compiled time series the emphasis is first on the basin or subbasin scale.

Results and discussion

An example of the maps produced by IGMETS illustrates the trends found in ship-based observations indicates phytoplankton biomass over the last 10 years compared with model-based sea surface temperature in the North Atlantic (Fig. 1). Warming (mostly in the SW) and cooling (mostly in the NE) accounted for almost equivalent fractions of the surface ocean in this region. However there are different kinds of relationships between biomass trends and those of temperature. For instance, increases in biomass were observed in almost all coastal and shelf areas coincident with either warming (e.g. NW shelf of USA) or cooling (e.g. NE coast of Europe). Biomass decreases were measured also in both situations but they were clustered at subregional scales (e.g. stations in the Canadian shelf). Further analysis of these trends and their association at different time and space scales will provide new hypotheses to be tested in future field and modelling studies required to understand the responses of marine ecosystems to multiple, cumulative pressures, as those represented by climate and anthropogenic forcing (Duarte, 2014).

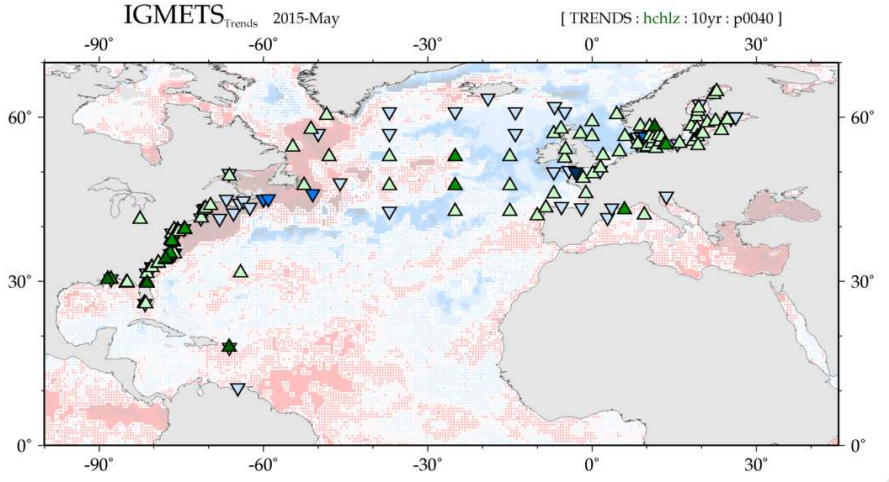

Figure 1. Trends in phytoplankton biomass (chlorophyll) at ship-based time series (triangles) compared with model-based trends in sea surface temperature in the North Atlantic (background colours) duirng the last 10 yr. Positive (negative) trends are indicated by upward- (downward-) pointing triangles and red (blue) background colours, respectively. The background (red/blue) darkness represents the rate of the warming (cooling). Darkest tones indicate a rate of 0.1 C yr^{-1}

References

Cloern, J.E., Foster, S.Q., Kleckner, A.E., 2014. Phytoplankton primary production in the world's estuarine-coastal ecosystems. Biogeosciences 11, 2477-2501.

Duarte, C.M., 2014. Global change and the future ocean: a grand challenge for marine sciences. Frontiers in Marine Science doi: 10.3389/fmars.2014.00063.

Henson, S.A., 2014. Slow science: the value of long ocean biogeochemistry records. Phil. Trans. R. Soc. A 372(20130334), http://dx.doi.org/10.1098/rsta.2013.0334.

Mackas, D.L., Pepin, P., Verheye, H., 2011. Interannual variability of marine zooplankton and their environments: Within- and between-region comparisons. Prog. Oceanogr. doi:10.1016/j.pocean.2011.11.002.

O'Brien, T.D., Wiebe, P.H., Falkenhaug, T., 2013. ICES Zooplankton status report 2010/2011. ICES Cooperative Research Report, 208 pp.