# International Group for Marine Ecological Time Series

## Assessing global oceanic changes one time series at a time

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United Nations Educational, Scientific and Cultural Organization

Intergovernmental Oceanographic Commission

## BACKGROUND

Sustained time series observations provide a wealth of data about ocean physics, biogeochemistry, and ecology that can be used to examine, test, and refine paradigms and hypotheses about the functioning of the ocean. Such time series generate information not only about ocean warming, circulation patterns, ocean eutrophication, and ocean deoxygenation, but also about global key ecological processes and how the changing climate affects the marine environment at the local, regional and global scale.

They help to disentangle natural and anthropogenically-induced change in marine ecosystems.

The IGMETS builds up on activities which were part of GLOBEC (supported by the International Geosphere-Biosphere Programme - IGBP, the Scientific Committee on Oceanic Research - SCOR and the IOC), and later continued through working groups funded by ICES and SCOR, which stressed the need to broaden the utilization of existing time-series data sets and to link current and past studies (Fig. 1).

The analysis of present data is critical to improve the information delivered to decision makers so that they understand marine ecosystem responses to a changing climate and plan accordingly.



**Figure 1.** Previous and ongoing activities within the scientific community which led up to the IGMETS effort.

## METHODOLOGY

Theoretical framework:

- Compilation of concepts and ideas used-in, discussed-by, or envisioned during 15+ years of time series work with an assortment of ICES and SCOR time series analysis working groups. (125 & 137)

- The analysis, at the very minimum, will be a global coverage, expanded-variable-set of the general analyses done in the North Atlantic by the ICES WGZE and WGPME.

- Temporal resolution: minimum annual changes; if possible, monthly analysis provides an additional layer of detail.

- The overall analysis focuses on individual variables (e.g., total zooplankton biomass) as well as multi-variable analysis (e.g., nutrient ratios and diatom ratios), discussed in comparison with satellite observations and existing literature.

Implementation:

- Compilation of data of > 300 ship-based marine ecological time series sites (plus about 100 estuarine sites) (Fig. 2 & 3)

- Comprehensive report will be published in November 2015

- Online depository for additional analysis and further information describing single time series
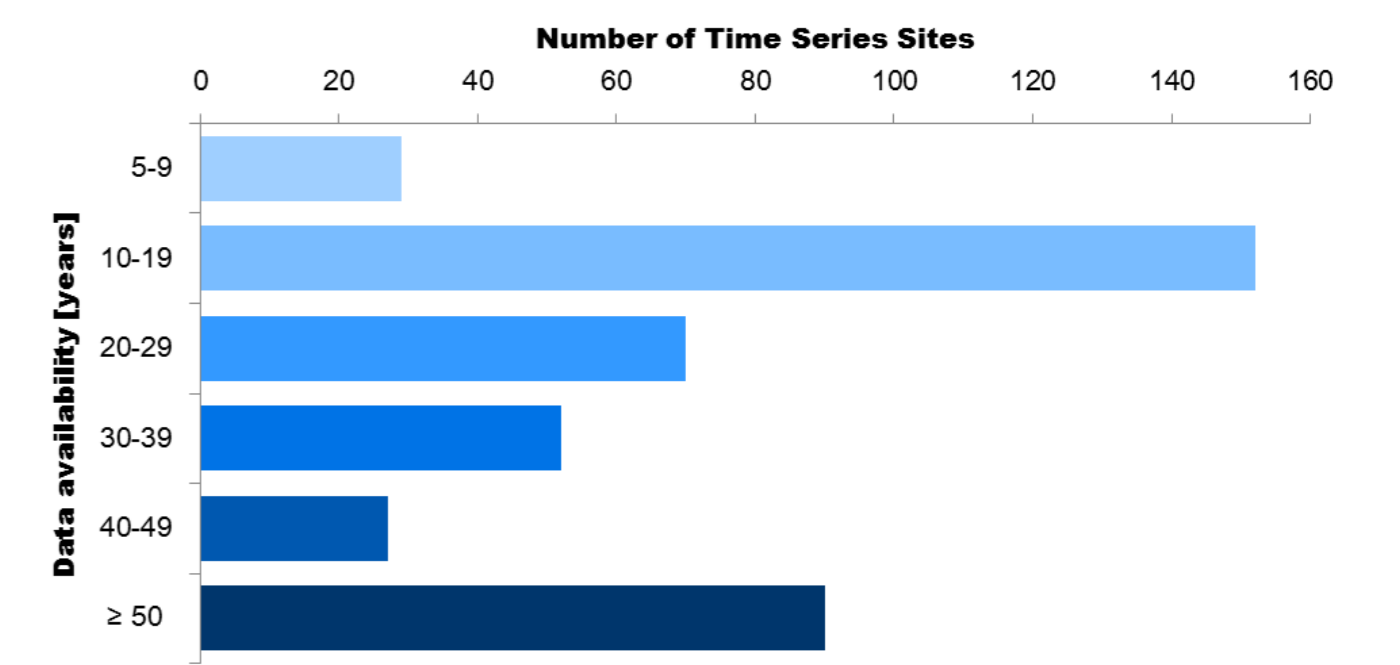


**Figure 2.** Number of time series sites included in IGMETS (February 2015) broken down by the number of years data are available for.

## VISION

IGMETS intends to:

- Encourage the use of already-established common metadata standards and formats to further facilitate cost-efficiency of new and existing sampling programmes and projects by designing them based on known spatial, temporal and process-related data coverage;

- Analyze time series data at the global and regional level to create a platform for modelling studies based on maximized input quality and quantity;

- Increase the visibility of less internationally connected groups;

- Allow the possibility for web-based quick-look analysis of time series variables;

- Provide a strong base for future predictions which in turn can strengthen policy advise/suggestions.
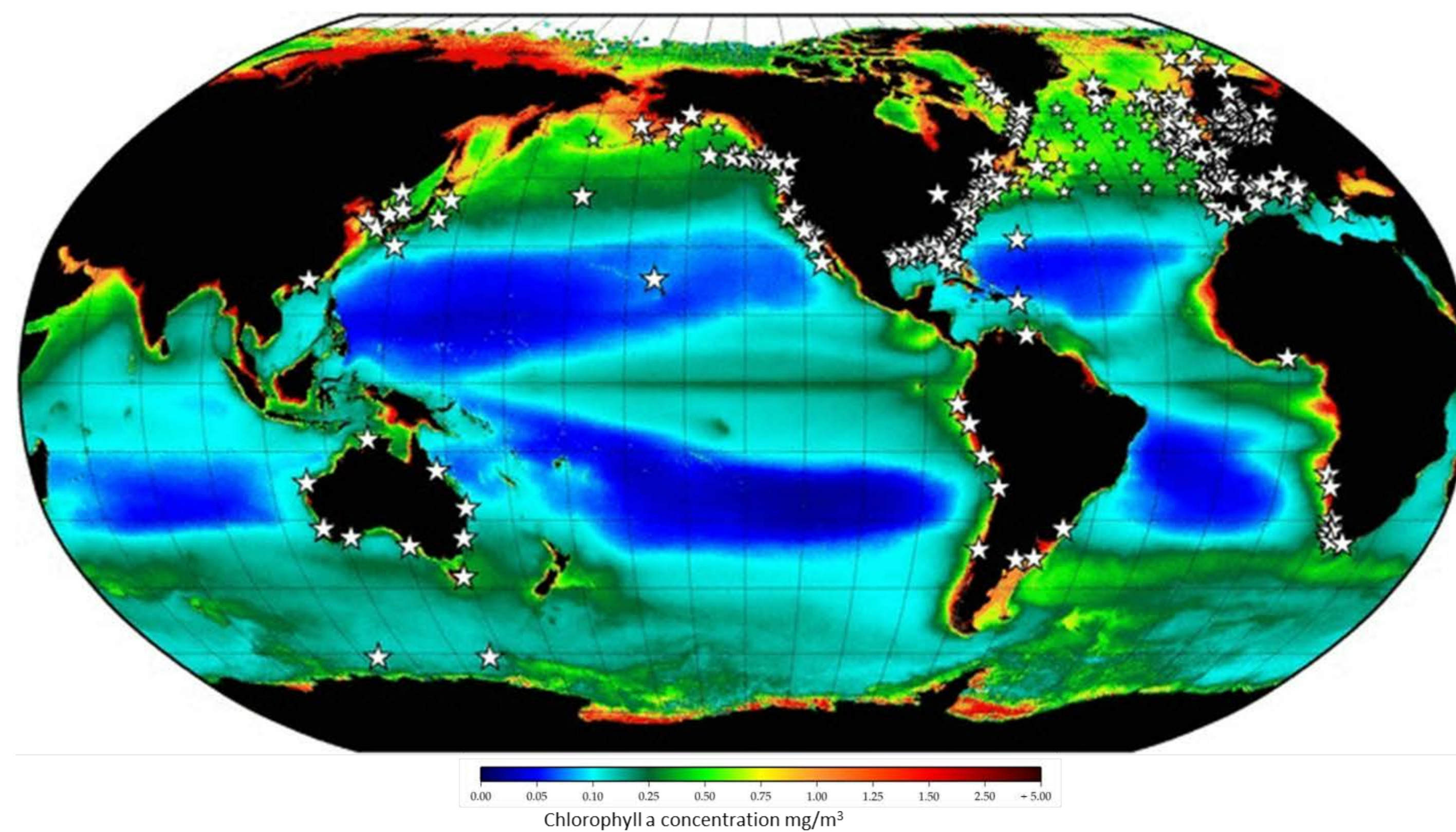


**Figure 3.** Map showing Time Series sites involved in the IGMETS assessment.

### SINGLE TIME SERIES ANALYSIS

I. Identification of temporal patterns.

II. Understanding of local processes.

Refer to Fig. 6

### JOINT TIME SERIES ANALYSIS

I. Identification of temporal and spatial patterns.

II. Establishment of regional baselines.

III. Understanding of regional and global processes – insights on linkages between climate variability and ocean biogeochemistry at regional, basin and world ocean scales can be gained from several time series geographically distributed. (e.g. ,Fig. 4 & 5)

IV. Separation of stressors.

V. Projection and forecasting.
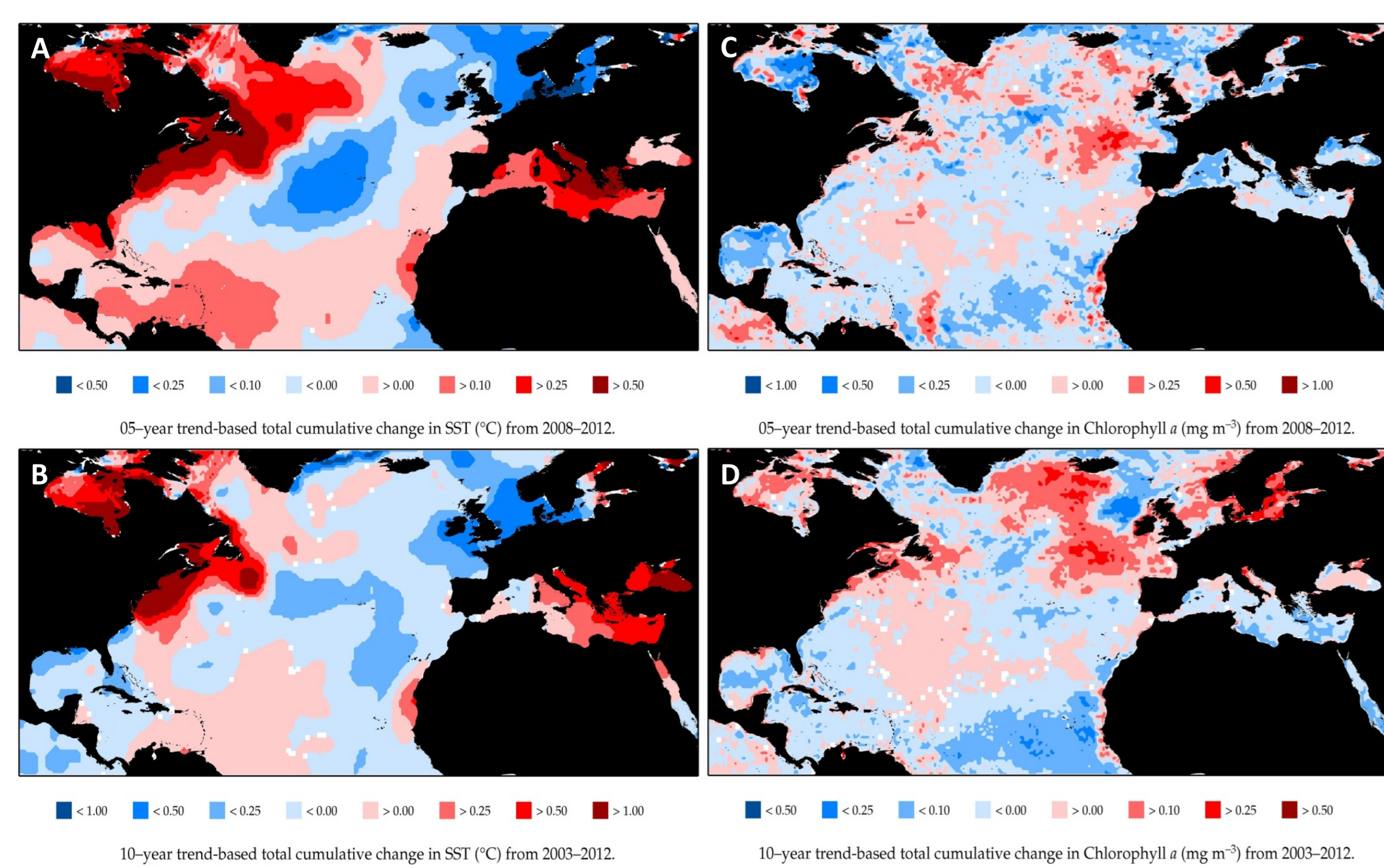
Refer to Fig. 6



**Figure 4.** Maps illustrating trend-based cumulative change in the area of the North Atlantic using satellite data A. Cumulative change in SST from 2008-2012. B. Cumulative change in SST from 2003-2012. C. Cumulative change in Chlorophyll a from 2008-2012. D. Cumulative change in Chlorophyll a from 2003-2012.
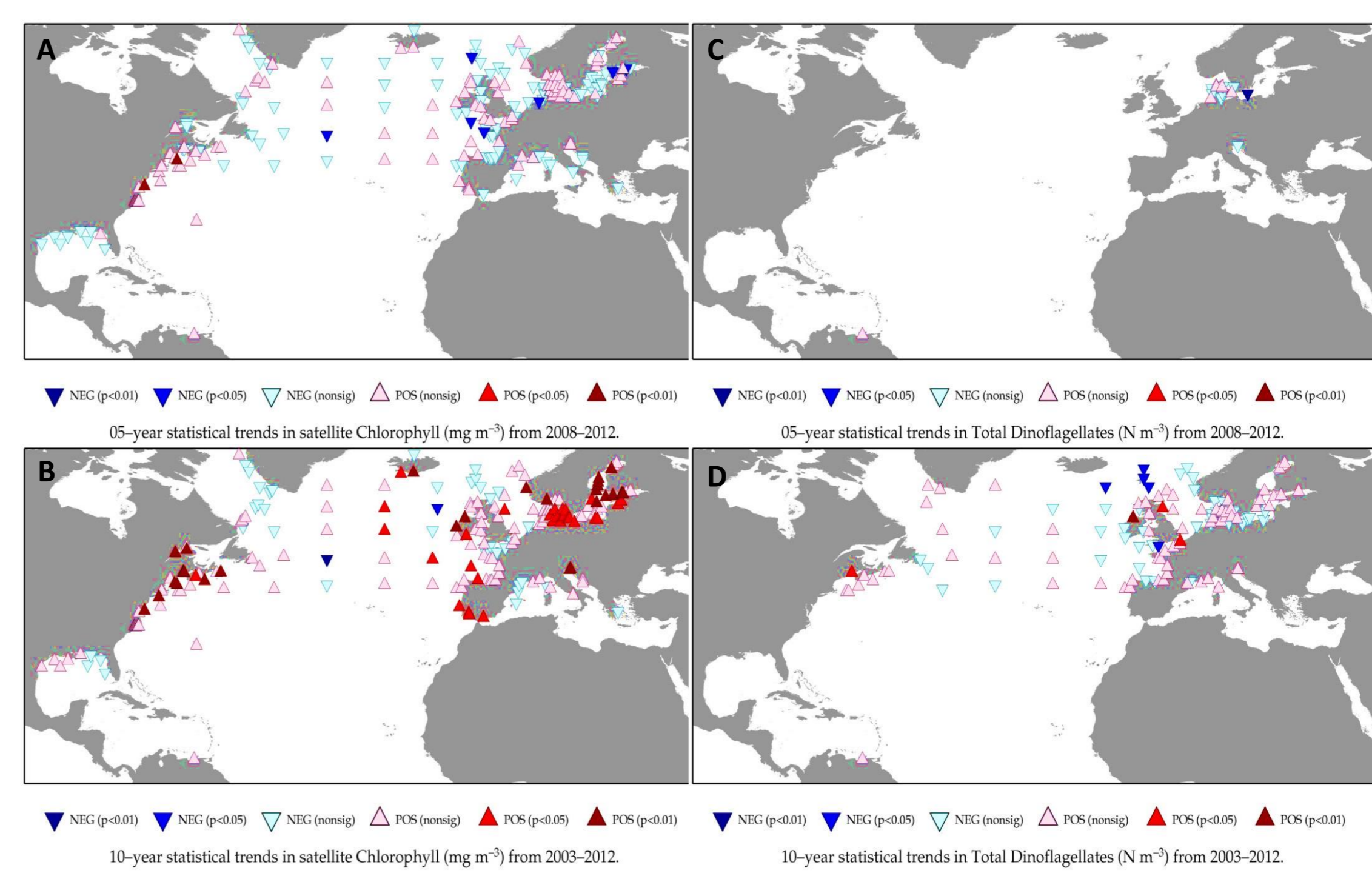


**Figure 5.** Maps illustrating statistical trends (NEG – negative trend, decreasing values; POS – positive trend, increasing values) in the area of the North Atlantic. A. Trends in satellite Chlorophyll from 2008-2012. B. Trends in satellite Chlorophyll from 2003-2012. C. Trends in total number of dinoflagellates from 2008-2012 (not including CPR data). D. Trends in total number of dinoflagellates from 2008-2012 (including CPR data).

## VALUE OF OCEAN TIME SERIES – OCEAN'S HERITAGE

I. **No substitute exists for adequate observations.**
Sensors for biological measurements are limited, automated sensors and remote sensing analysis need in-situ data calibration and validation.

II. **Observations which are not made today are lost forever!**
In the past, especially during the 1980's, financial drawdowns caused the termination of continuous measurements, e.g., in the UK. Nowadays several multi-decadal time series sites face similar threats.

III. **Existing observations are limited in use if are not made accessible.**
Observations, which were conducted in previous times are often not digitalized and therefore are not available for currently ongoing analysis/ and comparisons.

IV. **Collective value of data sets is greater than its dispersed one.**
Joint analysis, assuring needed conversion of units, methods etc., allow to detect global stressors for the marine environment. Due to ocean's nature of being 'one big waterbody' the two parts of cause and effect can occur in different places, and global analysis assist explaining observed phenomena.

V. **Models will evolve and improve, but, without data, will be untestable.**

VI. **Today's climate models will likely prove of little interest in 100 years. But adequately sampled, carefully quality controlled and archived data for key elements of the climate system will be useful indefinitely.**
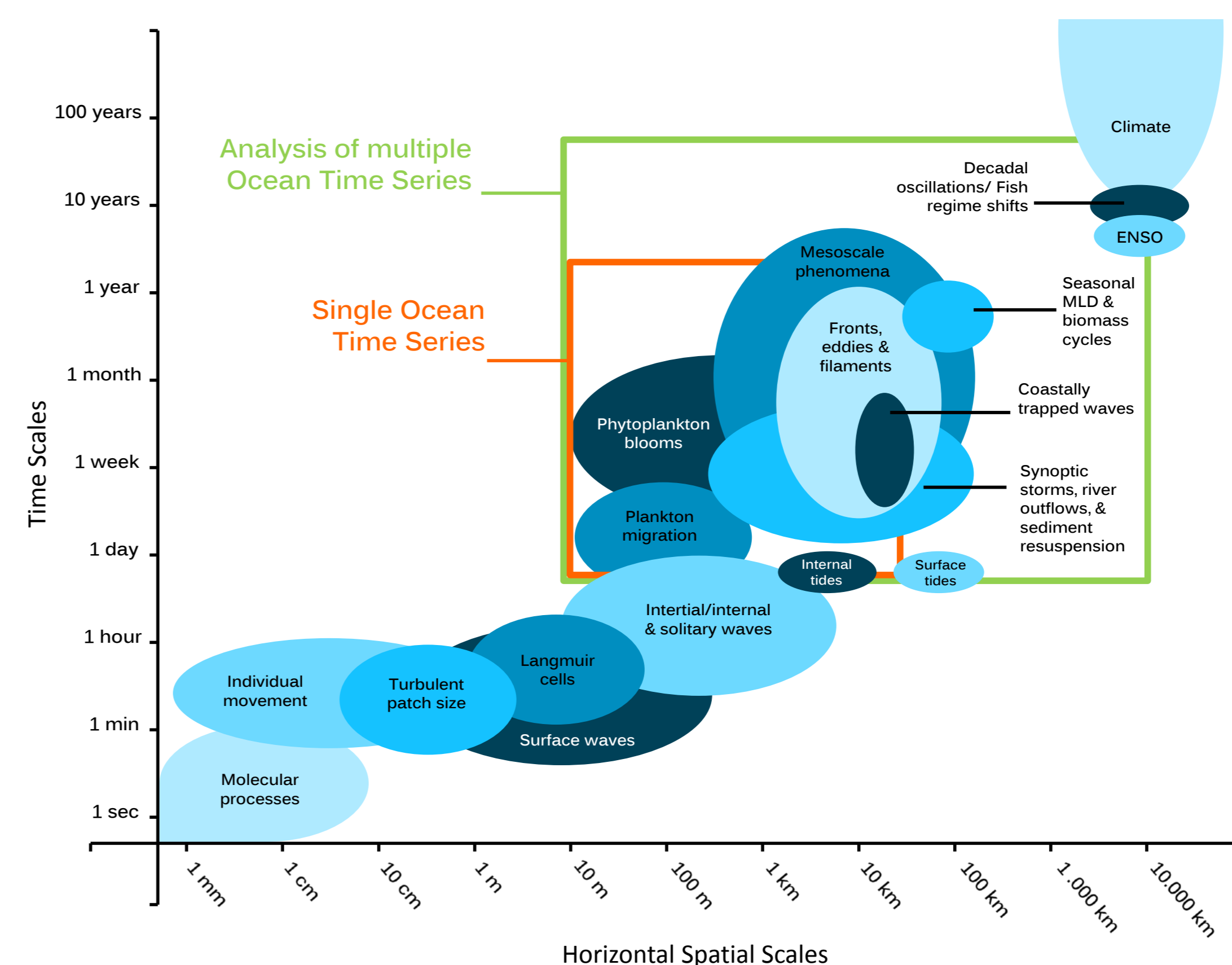


**Figure 6.** Schematic representation of relevant temporal and spatial scales for key physical and ecological process in the sea. The orange box indicates, what kind of processes can be explained with single Ocean Time Series measurements, and the green box, what kind of processes can be followed with the analysis of multiple Ocean Time Series. (Adapted from Dickey 2002)