United Nations Educational, Scientific and Cultural Organization

Intergovernmental Oceanographic Commission

Organisation des Nations Unies pour l'éducation la science et la culture

Commission océanographique intergouvernementale

Organización de las Naciones Unidas para la Educación la Ciencia y la Cultura

Comisión Oceanográfica Intergubernamental

Организация Объединенных Наций по вопросам образования науки и культуры

Межправительственная океанографическая комиссия

Sampling once….

Using data multiple times

Luis Valdés[1], Antonio Bode[2], Todd O'Brien[3] and Kirsten Isensee[1]

[1] Ocean Science Section/ IOC of UNESCO
[2] Instituto Español de Oceanografia / A Coruña, Spain
[3]National Marine Fisheries Service, NOAA, USA

AAAS 2015 ANNUAL MEETING
INNOVATIONS, INFORMATION, AND IMAGING

Sunday, 15 February 2015

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(or more often)

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Value – Potential
of biogeochemical Time Series

VALUE today

I. Evaluation of the statistical significance of the variability of measured parameters, e.g. environmental data, species distribution, community composition.

II. Quantification and evaluation of the dimension of interactions between key physical/chemical oceanographic processes and biological rates in plankton communities.

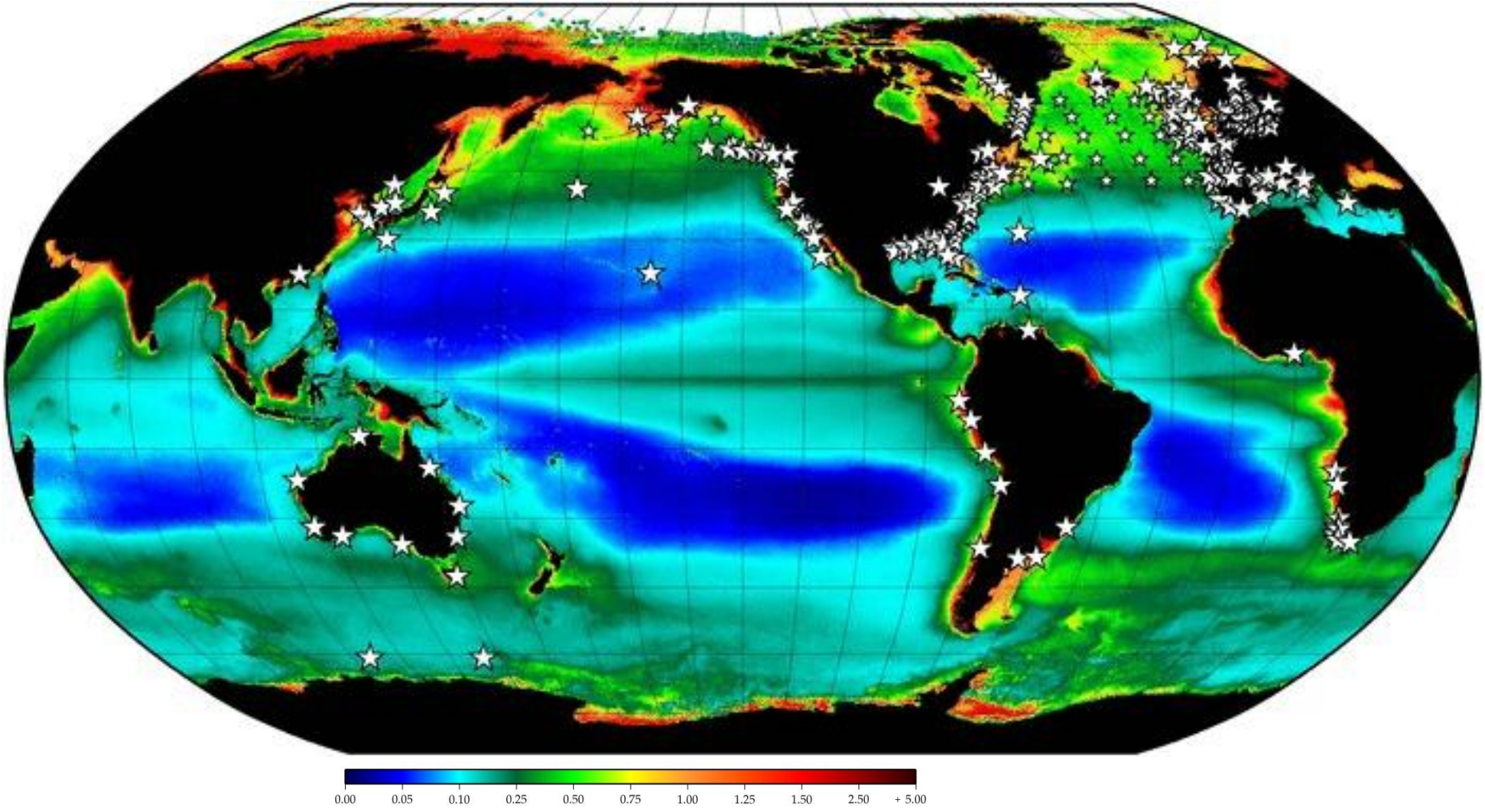
POTENTIAL

I. Detection of climate change and its impacts.

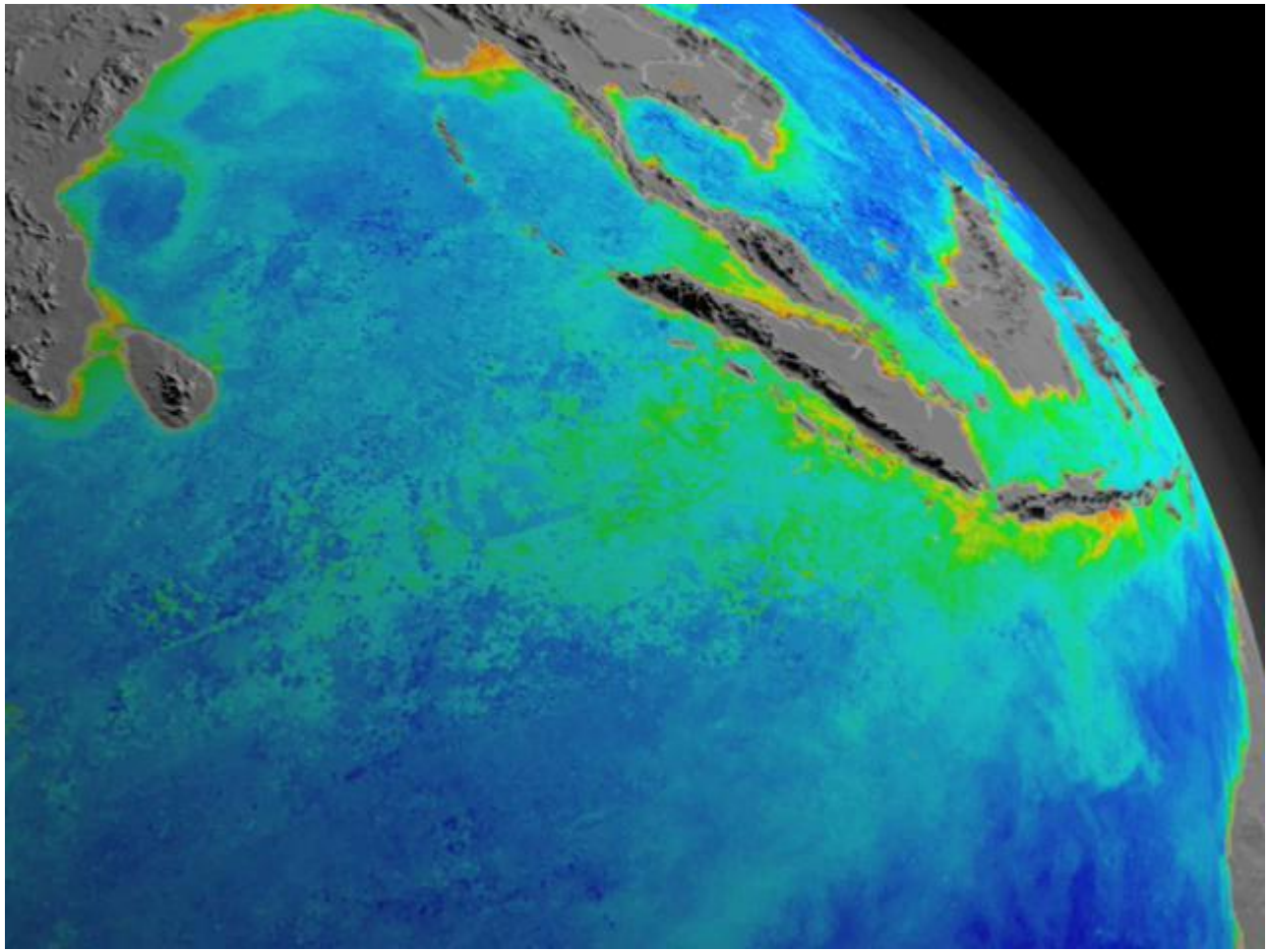
II. Process understanding and new technology development.

III. Using existing data – Creating new science!

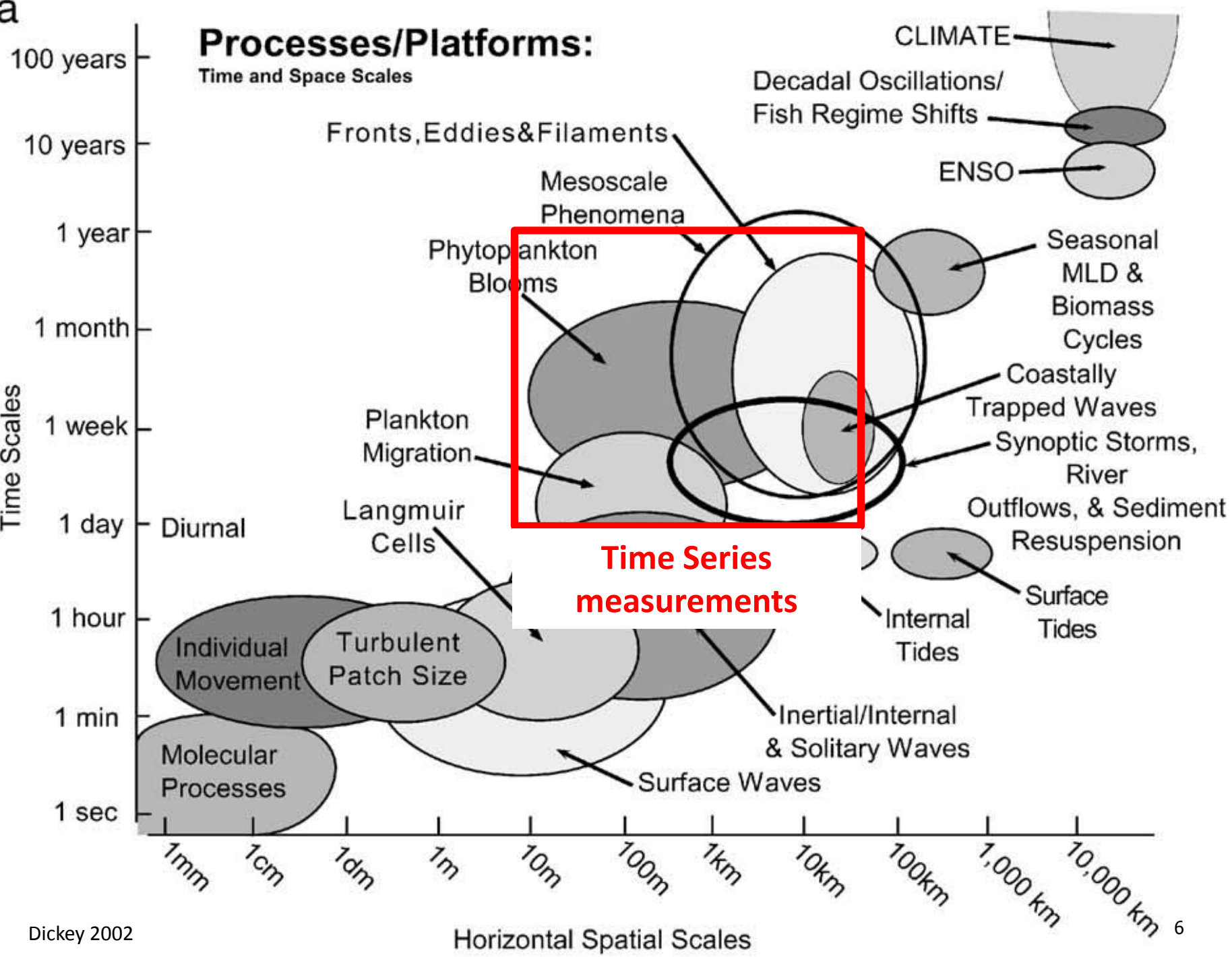
Marine biogeochemical Time Series



IGMETS site locations (symbols) on a background of SeaWiFS satellite chlorophyll a concentrations.

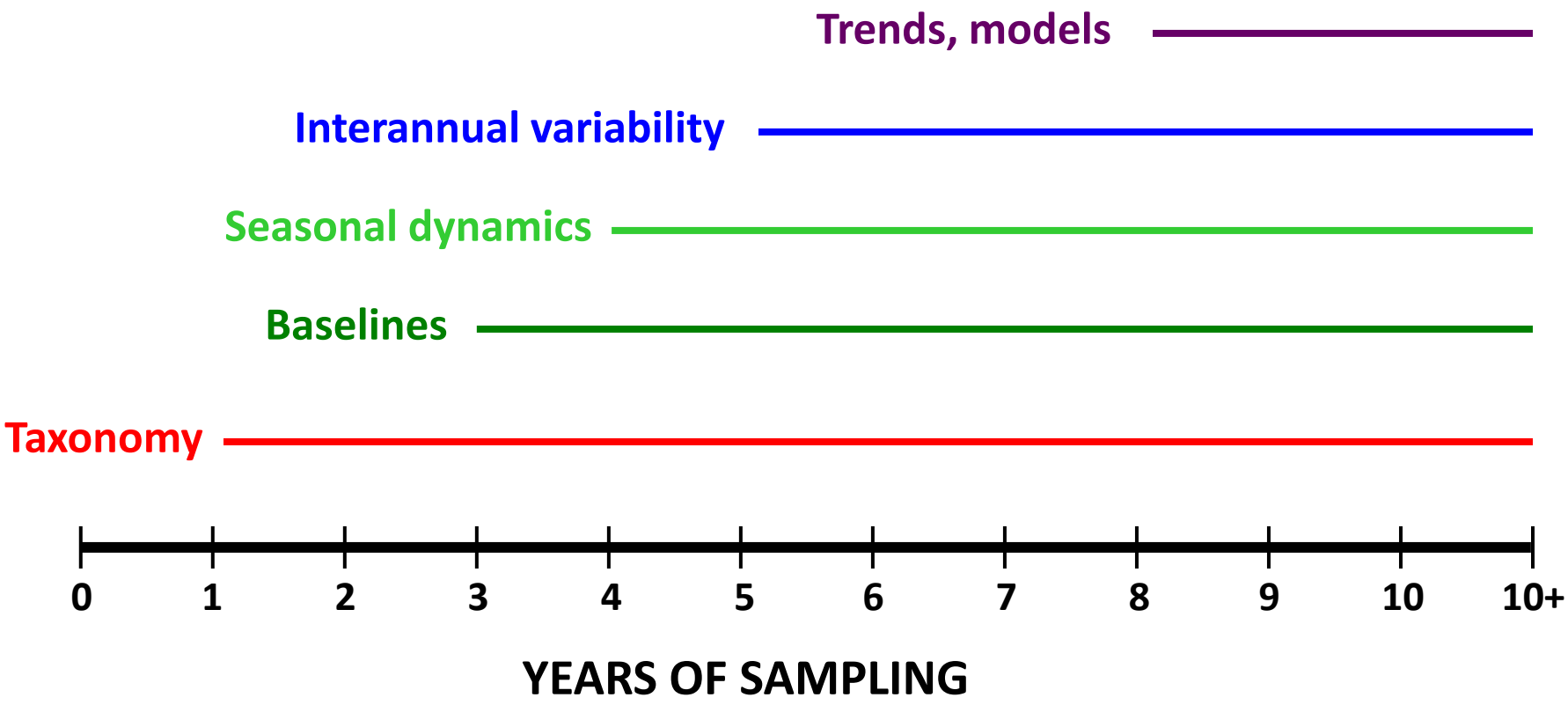


Dark blue represents warmer areas where there is little life due to lack of nutrients, and greens and reds represent cooler nutrient-rich areas. (SeaWIFS)

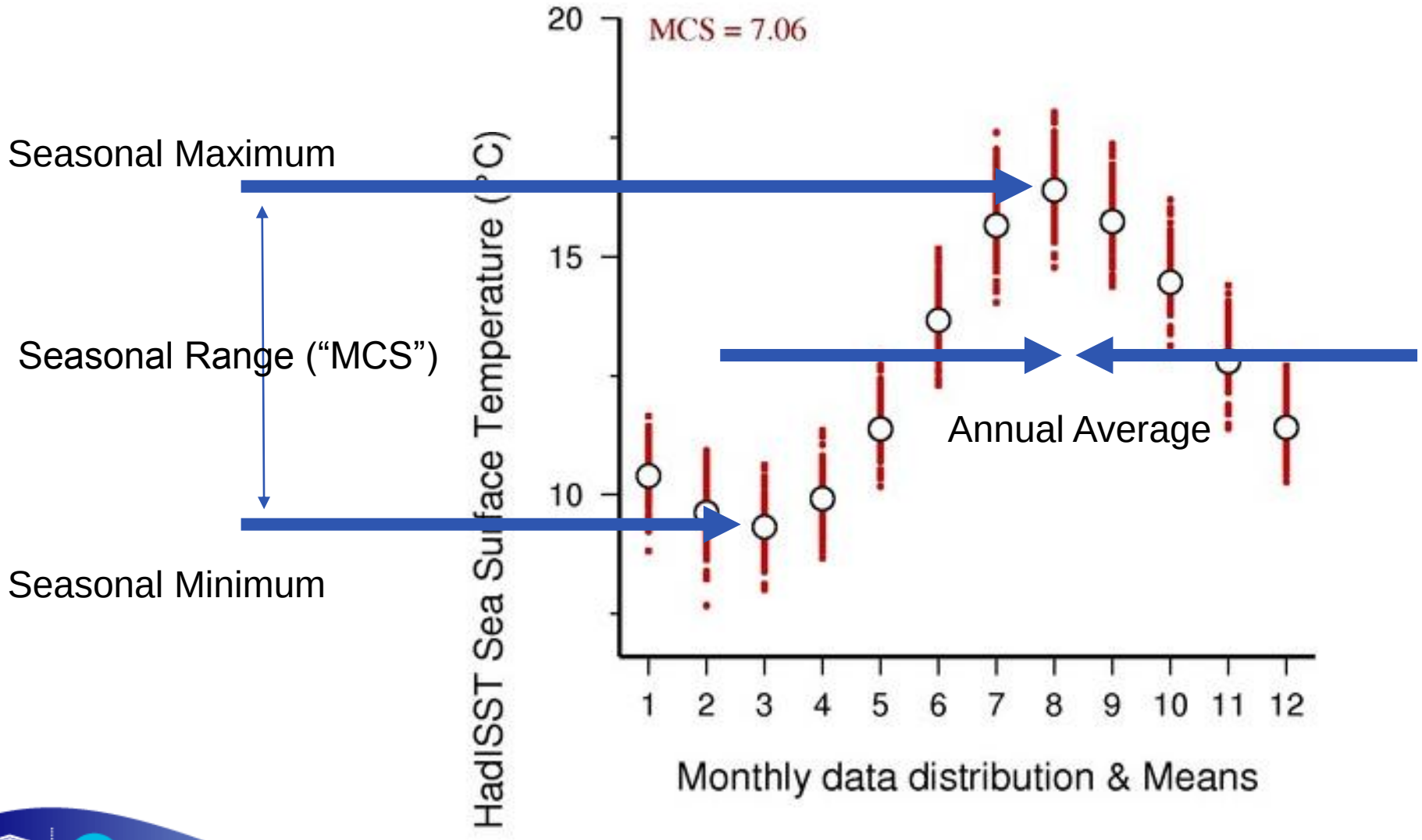

Processes/Platforms:
Time and Space Scales
CLIMATE
Decadal Oscillations/
Fish Regime Shifts
ENSO
Fronts,Eddies&Filaments
Mesoscale
Phenomena
Phytoplankton
Blooms
Seasonal
MLD &
Biomass
Cycles
Coastally
Trapped Waves
Synoptic Storms,
River
Outflows, & Sediment
Resuspension
Plankton
Migration
Langmuir
Cells
Diurnal
Surface
Tides
Internal
Tides
Individual
Movement
Turbulent
Patch Size
Inertial/Internal
& Solitary Waves
Molecular
Processes
Surface Waves
Time Series
measurements
100 years
10 years
1 year
1 month
1 week
1 day
1 hour
1 min
1 sec
Time Scales
1mm
1cm
1dm
1m
10m
100m
1km
10km
100km
1,000 km
10,000 km
Horizontal Spatial Scales

Dickey 2002

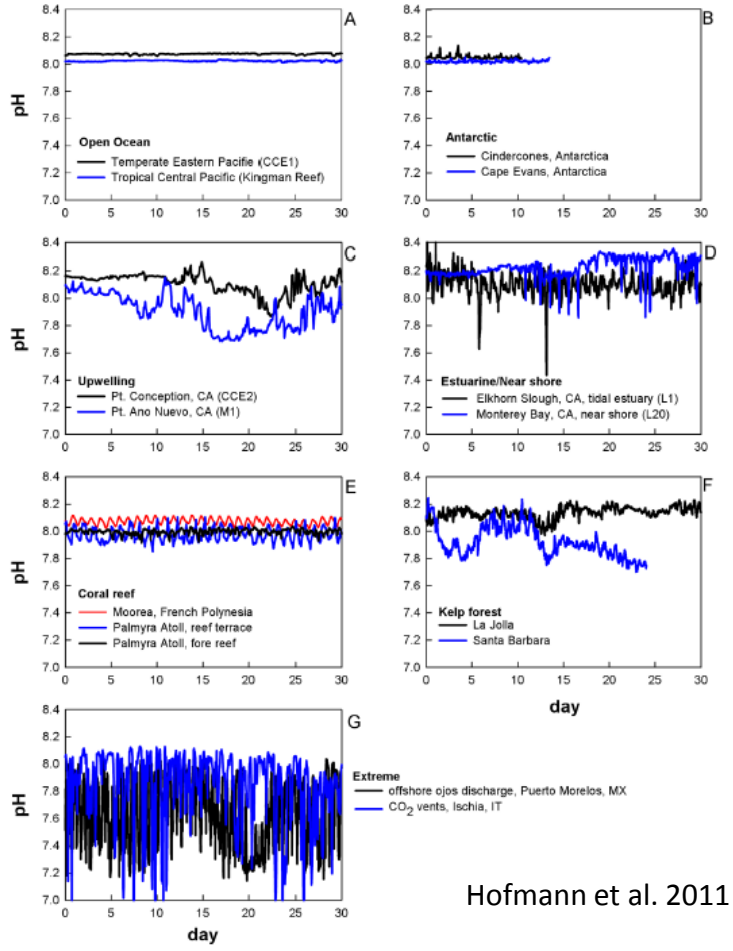
Levels of understanding – Need for continued sampling



Marine ecosystems – Temporal variation

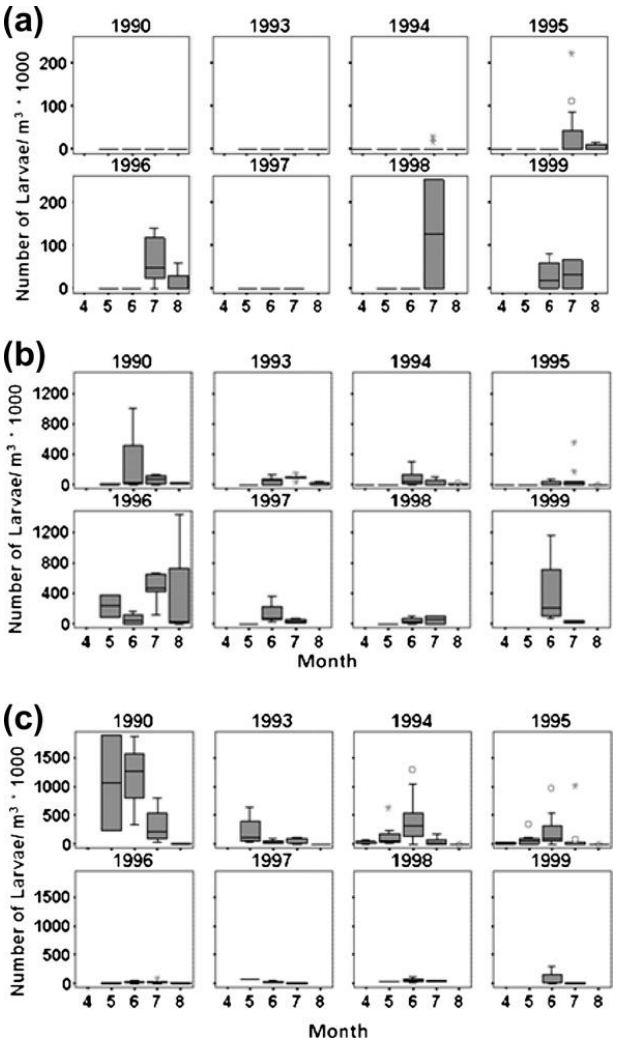


Marine ecosystems – Temporal variation



Hofmann et al. 2011

Figure 2. pH dynamics at 15 locations worldwide in 0–15 m water depth. All panels are plotted on the same vertical range of pH (total hydrogen ion scale). The ordinate axis was arbitrarily selected to encompass a 30-day period during each sensor deployment representative of each site during the deployment season. See Table 1 for details regarding sensor deployment.
doi:10.1371/journal.pone.0028983.g002



Abundances of (a) anchovy larvae, (b) sardine larvae and (c) sprat larvae (1000/m^3) collected at Helgoland with CalCOFI net.

Alheit et al. 2012

Marine ecosystems – Spatial variation

Figure 11.5
Spatio-temporal map of 10-year trends in total diatom abundance present within the CPR standard areas (star symbols) and other monitoring sites (circle symbols). Symbol colors indicate slope (blue/cyan = negative, red/pink = positive) and statistical significance (dark red/blue = p< 0.01, pink/cyan = p< 0.05). Symbols with a white, unfilled, centre indicate slope with a non-significant (p >0.05) trend.

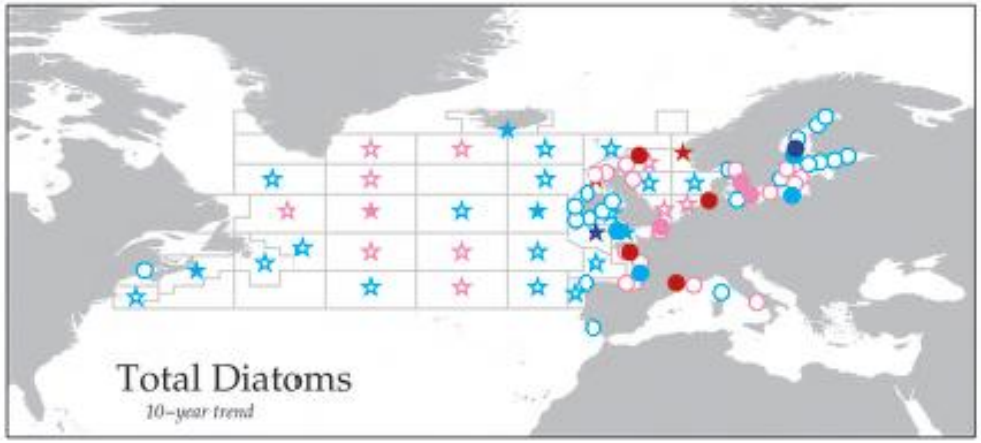
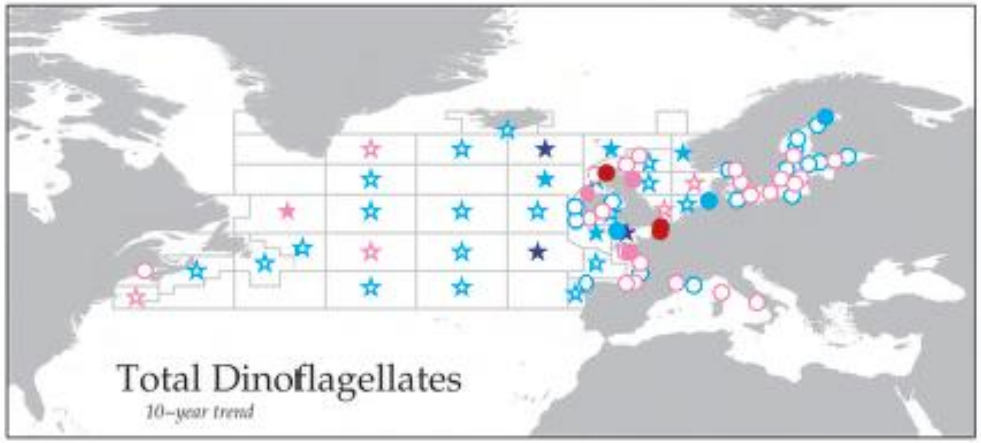
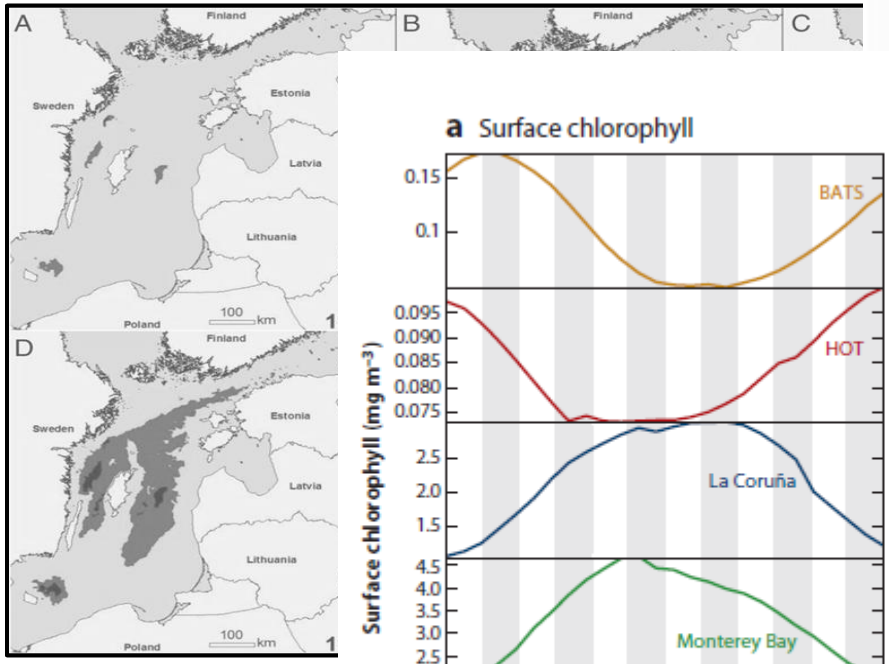


Figure 11.6
Spatio-temporal map of 10-year trends in total dinoflagellate abundance present within the CPR standard areas (star symbols) and other monitoring sites (circle symbols). Symbol colors indicate slope (blue/cyan = negative, red/pink = positive) and statistical significance (dark red/blue = p< 0.01, pink/cyan = p< 0.05). Symbols with a white, unfilled, centre indicate slope with a non-significant (p >0.05) trend.



ICES Phytoplankton and Microbial Plankton Status Report 2009/2010. ICES Cooperative Research Report No. 313. 196 pp.

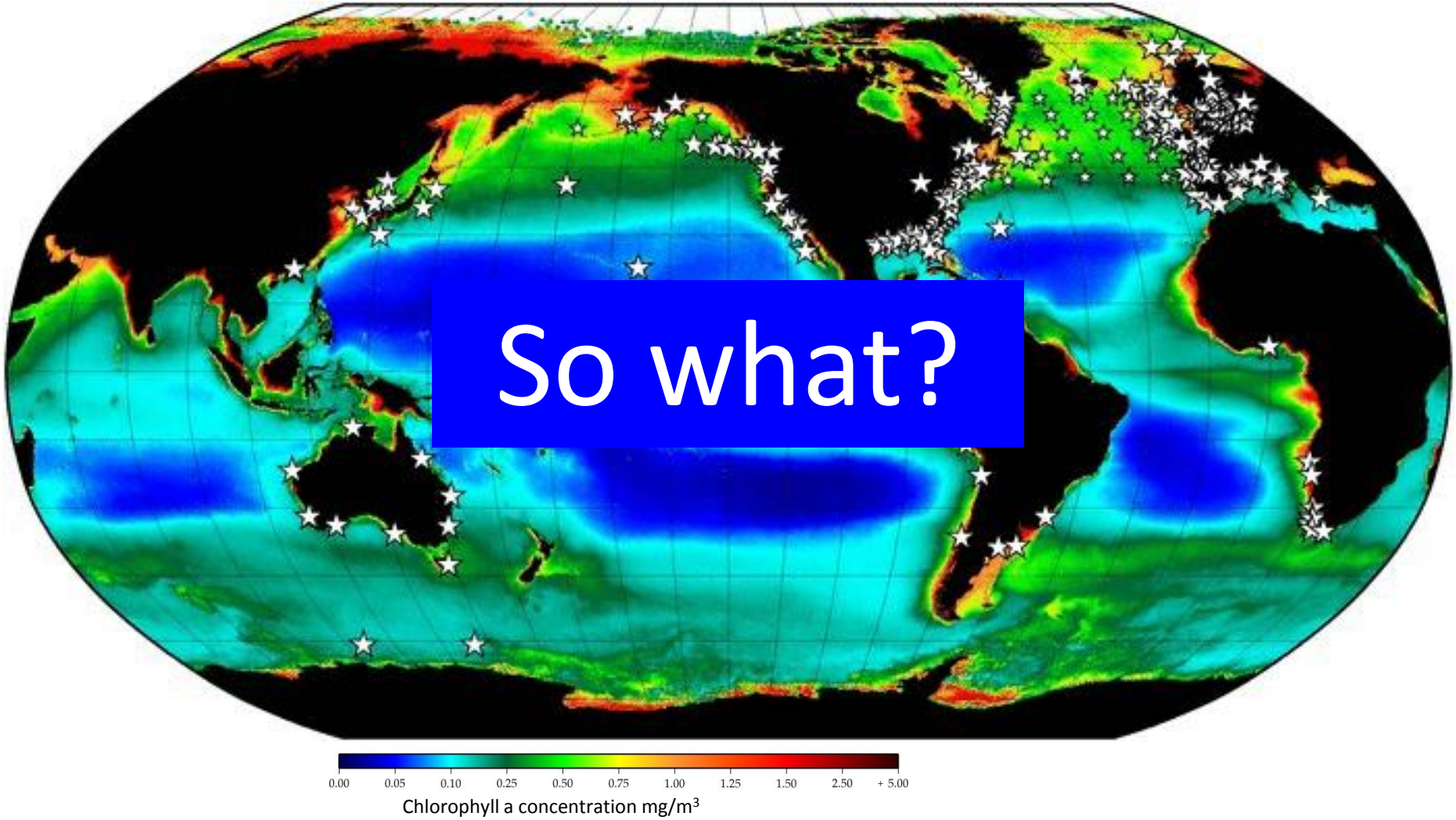


Spatial distributions
J et al. PNAS 2014;11

Average Surface Chl*a* and primary production
Chavez et al. (2011)

Time-series surface seawater carbonate system at Station ALOHA . Atmospheric CO_2 data is from the Mauna Loa Observatory, Hawaii. Source: Adapted from Dore et al. (2009).

Marine biogeochemical Time Series



IGMETS site locations (symbols) on a background of SeaWiFS satellite chlorophyll a concentrations.

Roadmap to IGMETS

International Group for Marine Ecological Time Series

Analysis and synthesis of global marine ecological changes as seen through biogeochemical and plankton time series.

http://igmets.net

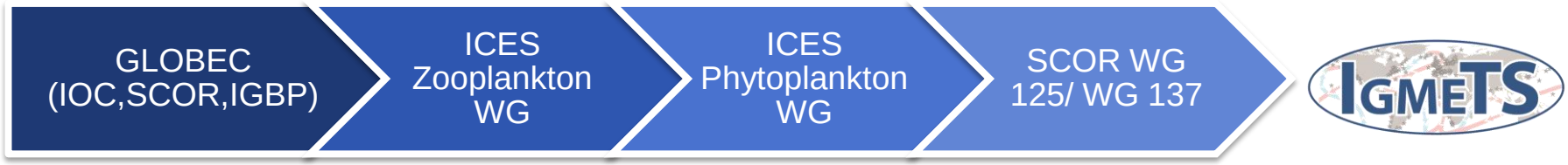
Objectives

I. Look at holistic changes within different ocean regions.

II. Explore plausible reasons and connections at a global and regional level.

III. Highlight locations of especially large changes that may be of special importance.

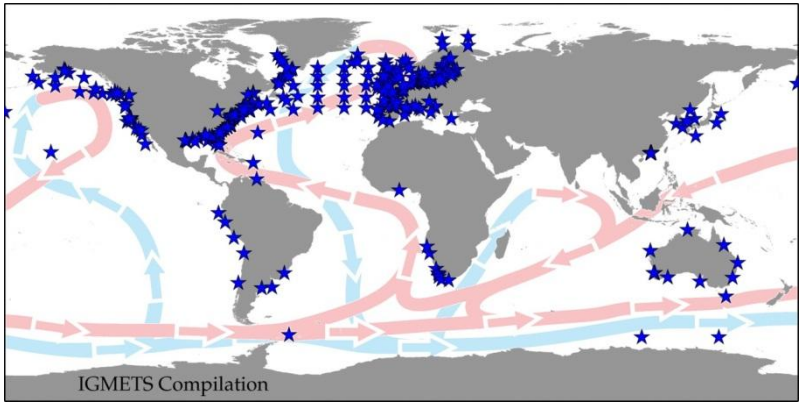
Background



Individual TS analysis

I. Identification of temporal patterns.

II. Understanding of local processes.



Joint TS analysis

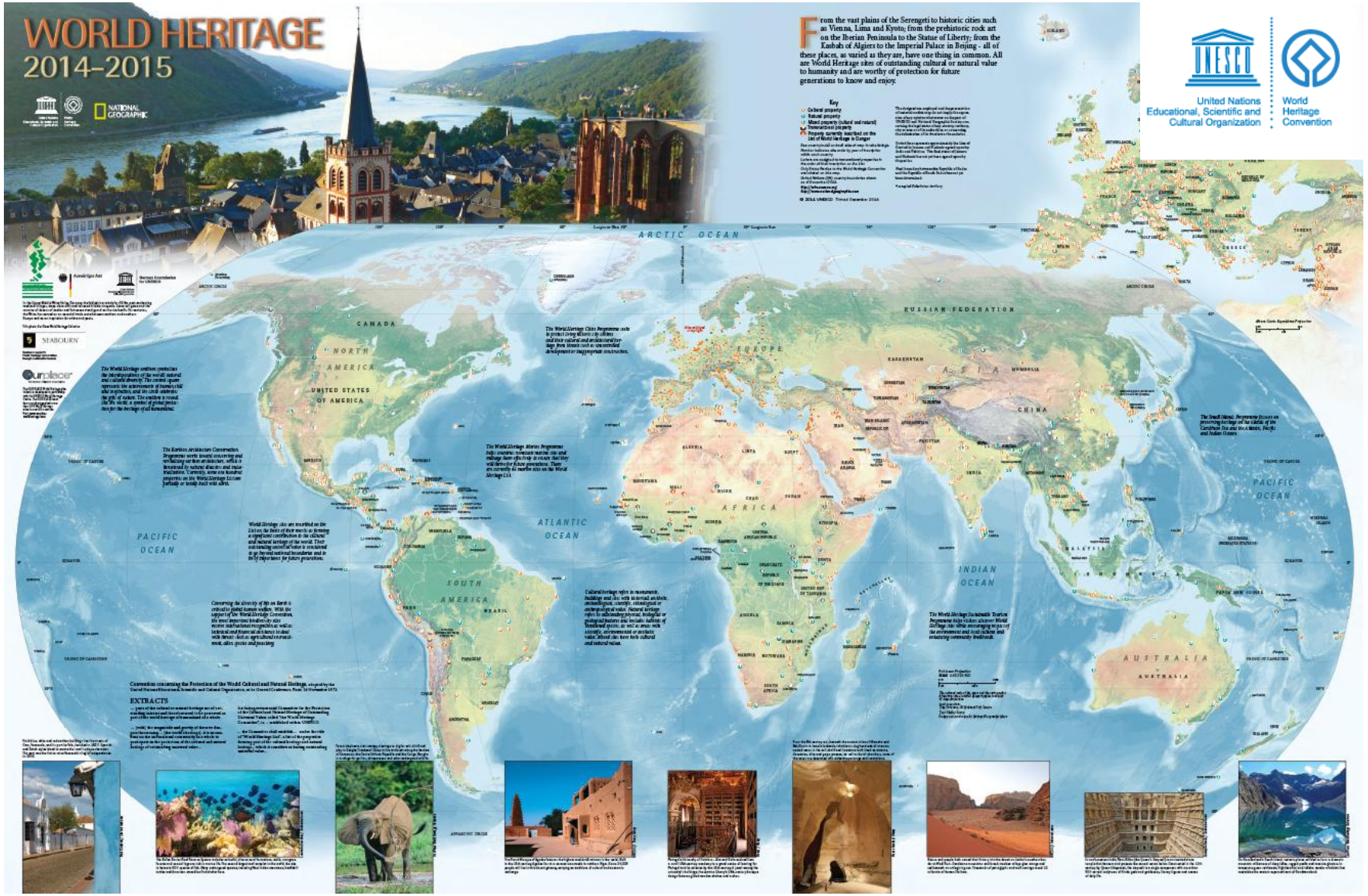
I. Identification of temporal and spatial patterns.

II. Establishment of 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.

IV. Separation of stressors.

V. Projection and Forecasting.

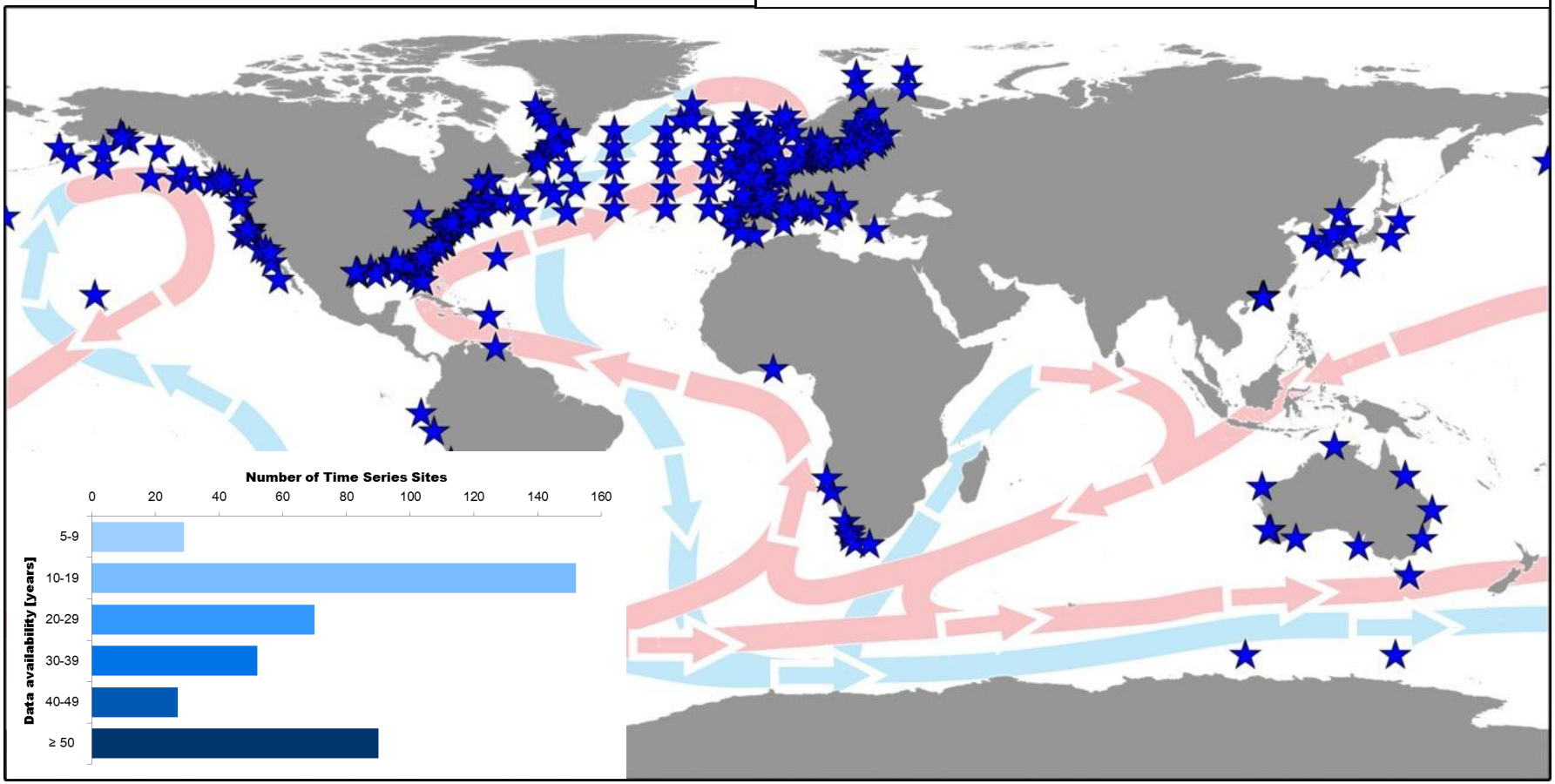

WORLD HERITAGE
2014–2015
NATIONAL GEOGRAPHIC
From the vast plains of the Serengeti to historic cities such as Vienna, Lima and Kyoto; from the prehistoric rock art on the Iberian Peninsula to the Statue of Liberty; from the Kasbah of Algiers to the Imperial Palace in Beijing - all of these places, as varied as they are, have one thing in common. All are World Heritage sites of outstanding cultural or natural value to humanity and are worthy of protection for future generations to know and enjoy.
Key
Cultural property
Natural property
Mixed property (cultural and natural)
Transnational property
Property currently inscribed on the List of World Heritage in Danger
United Nations Educational, Scientific and Cultural Organization
World Heritage Convention
ARCTIC OCEAN
CANADA
NORTH AMERICA
UNITED STATES OF AMERICA
RUSSIAN FEDERATION
EUROPE
KAZAKHSTAN
ASIA
MONGOLIA
CHINA
INDIA
PACIFIC OCEAN
ATLANTIC OCEAN
AFRICA
SOUTH AMERICA
BRAZIL
INDIAN OCEAN
AUSTRALIA
SEABOURN
Qurioplace
EXTRACTS

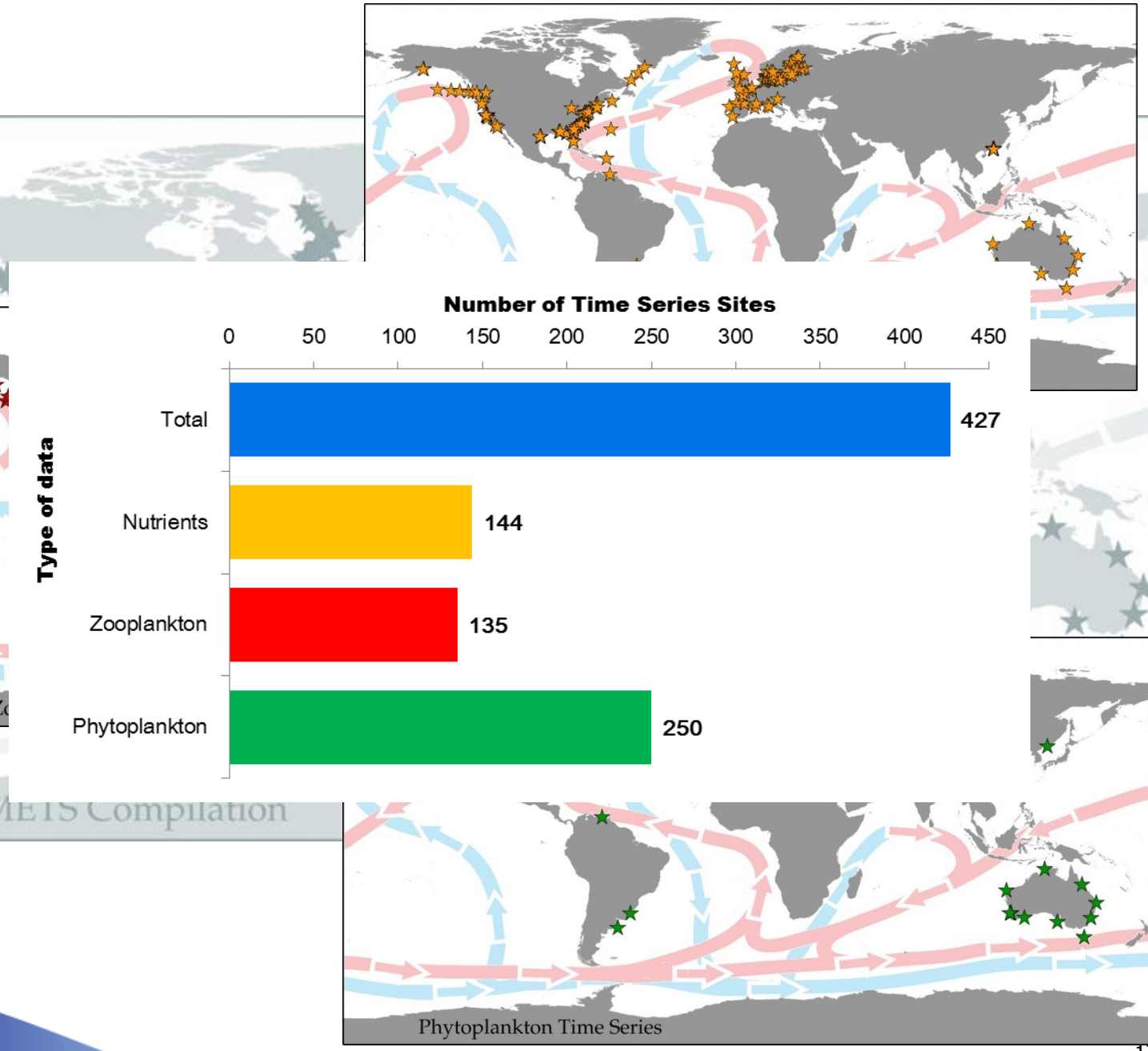
‘Ocean TS Heritage’

IGMETS

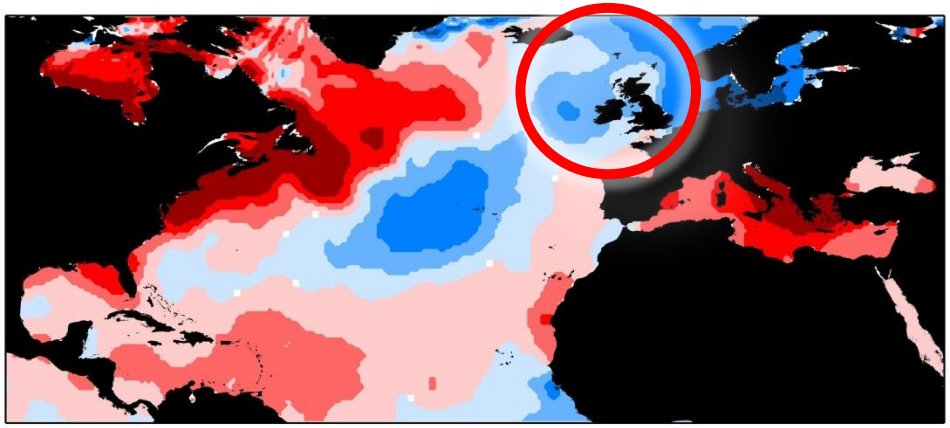
International Group for Marine Ecological Time Series

Analysis and synthesis of global marine ecological changes as seen through biogeochemical and plankton time series.



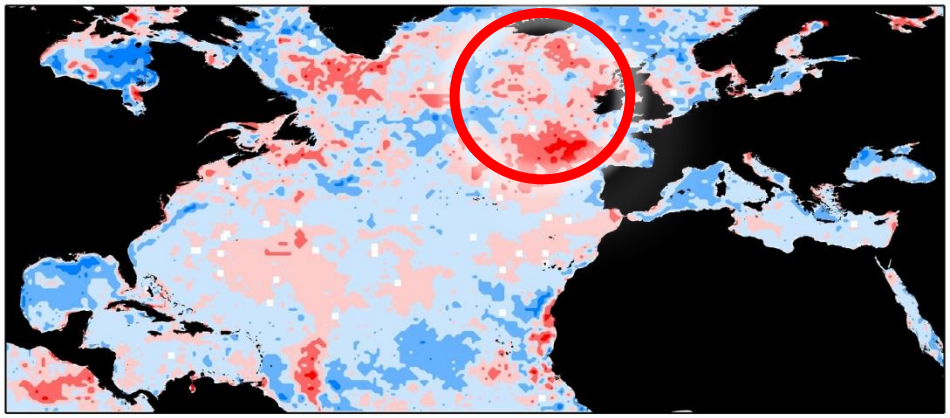

Number of Time Series Sites
0
50
100
150
200
250
300
350
400
450
Type of data
Total
427
Nutrients
144
Zooplankton
135
Phytoplankton
250
IGMETS Compilation
Phytoplankton Time Series

Sea Surface Temperature *Chlorophyll*



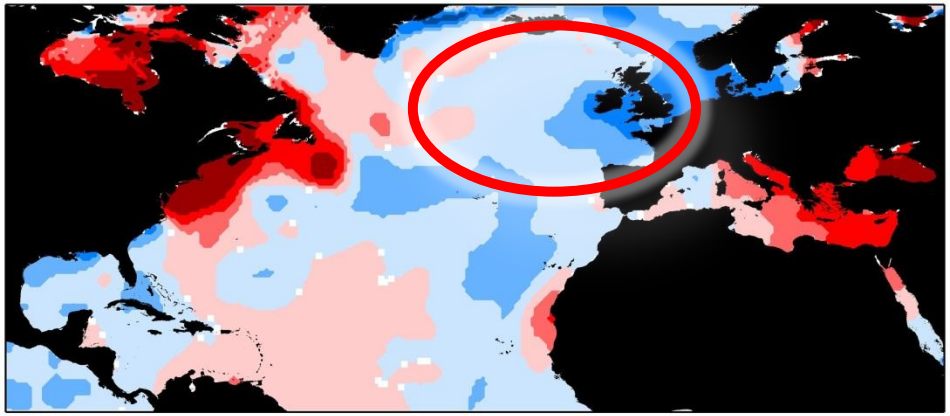
< 0.50 < 0.25 < 0.10 < 0.00 > 0.00 > 0.10 > 0.25 > 0.50

05–year trend-based total cumulative change in SST (°C) from 2008–2012.



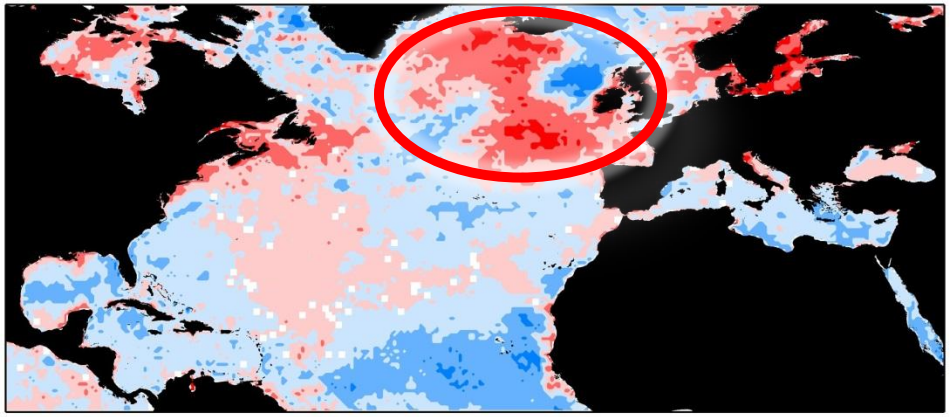
< 1.00 < 0.50 < 0.25 < 0.00 > 0.00 > 0.25 > 0.50 > 1.00

05–year trend-based total cumulative change in Chlorophyll *a* (mg m^{-3}) from 2008–2012.



< 1.00 < 0.50 < 0.25 < 0.00 > 0.00 > 0.25 > 0.50 > 1.00

10–year trend-based total cumulative change in SST (°C) from 2003–2012.

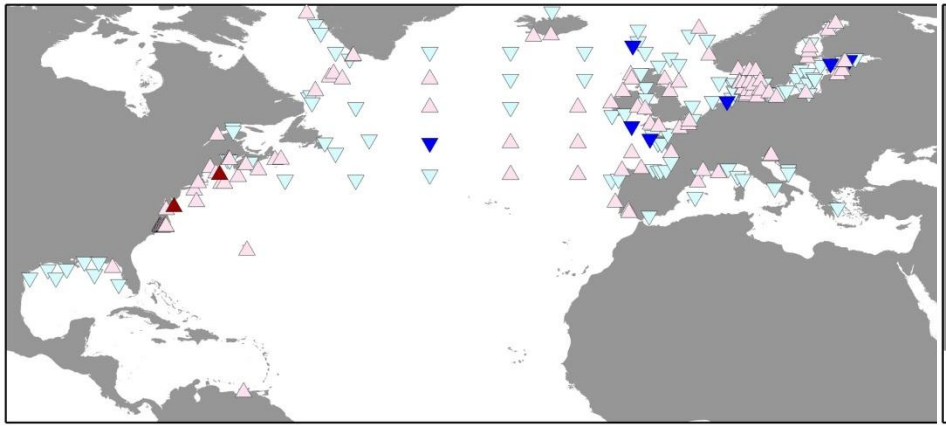


< 0.50 < 0.25 < 0.10 < 0.00 > 0.00 > 0.10 > 0.25 > 0.50

10–year trend-based total cumulative change in Chlorophyll *a* (mg m^{-3}) from 2003–2012.

Chlorophyll

Dinoflagellates

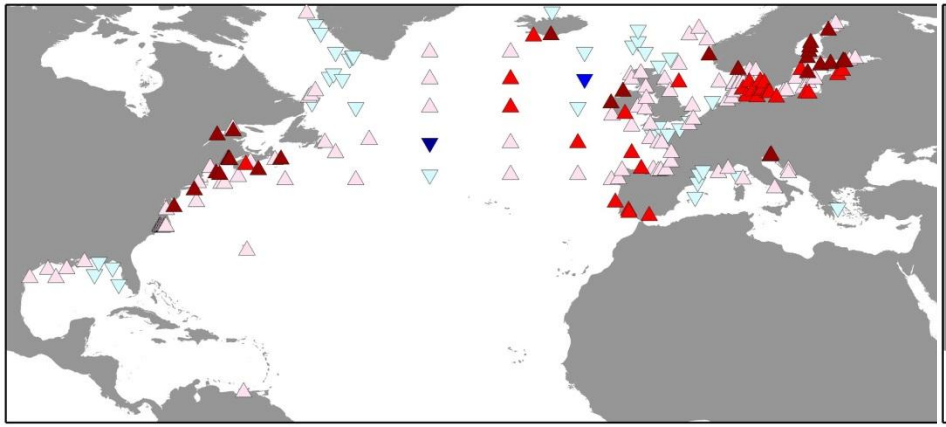


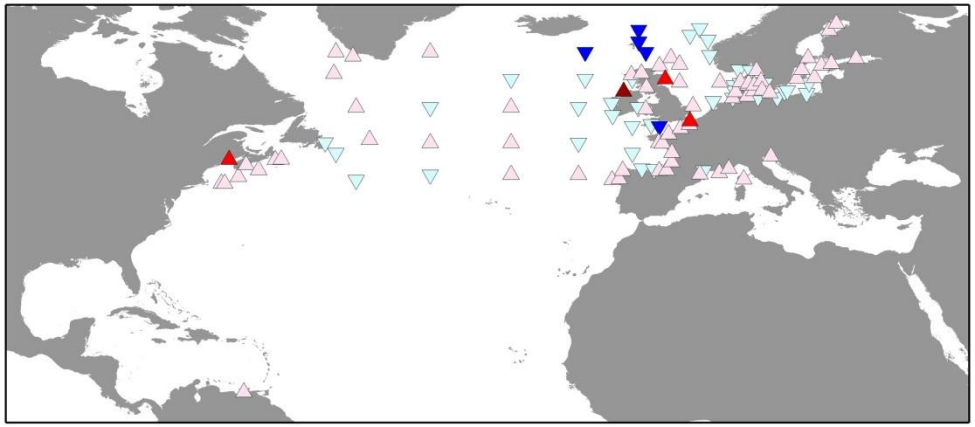
NEG (p<0.01) NEG (p<0.05) NEG (nonsig) POS (nonsig) POS (p<0.05) POS (p<0.01)

05–year statistical trends in satellite Chlorophyll (mg m^{-3}) from 2008–2012.

NEG (p<0.01) NEG (p<0.05) NEG (nonsig) POS (nonsig) POS (p<0.05) POS (p<0.01)

05–year statistical trends in Total Dinoflagellates (N m^{-3}) from 2008–2012.





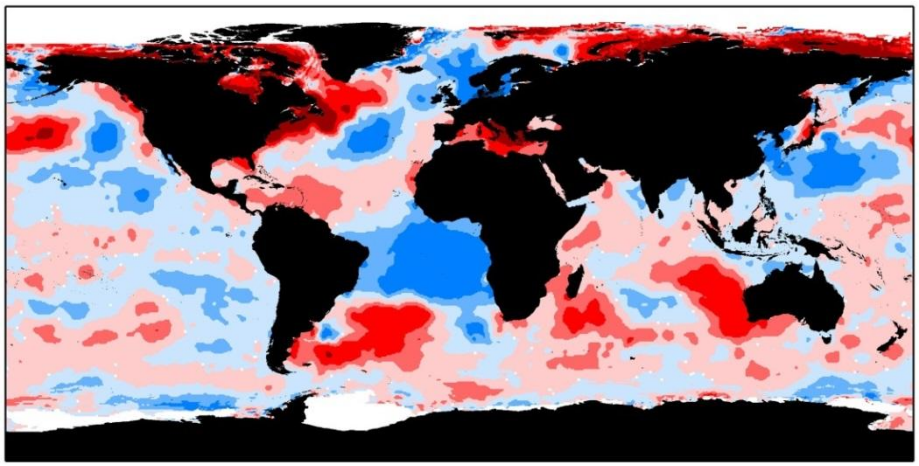
NEG (p<0.01) NEG (p<0.05) NEG (nonsig) POS (nonsig) POS (p<0.05) POS (p<0.01)

10–year statistical trends in satellite Chlorophyll (mg m^{-3}) from 2003–2012.

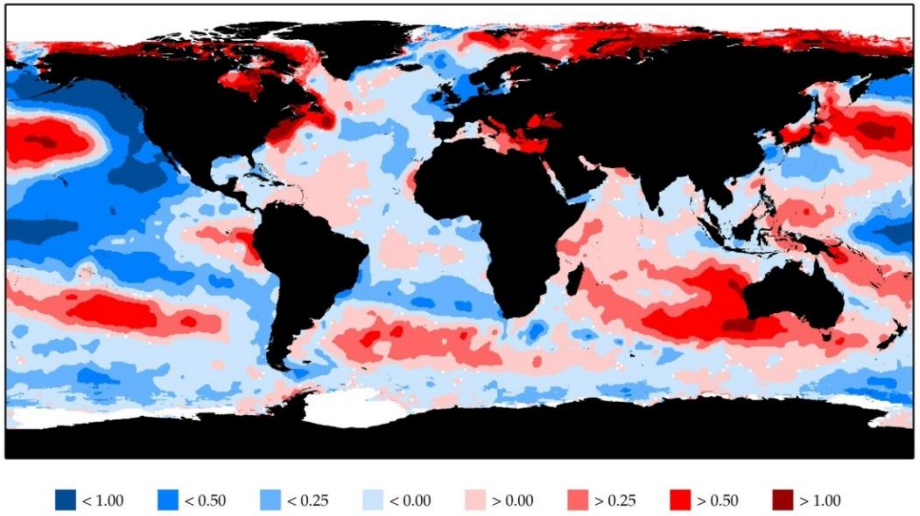
NEG (p<0.01) NEG (p<0.05) NEG (nonsig) POS (nonsig) POS (p<0.05) POS (p<0.01)

10–year statistical trends in Total Dinoflagellates (N m^{-3}) from 2003–2012.

Sea Surface Temperture



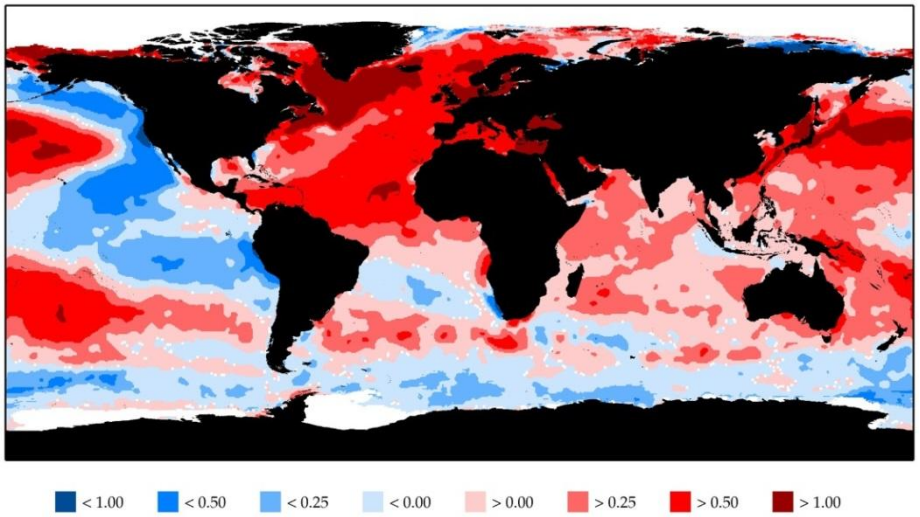
05–year trend-based total cumulative change in SST (°C) from 2008–2012.



10–year trend-based total cumulative change in SST (°C) from 2003–2012.

Satellite data can be used to fill in-situ data gaps.

Temporal variations are high, but ocean warming is visible.



30–year trend-based total cumulative change in SST (°C) from 1983–2012.

'Ocean TS Heritage'

I. Observations which are not made today, are lost forever!

II. Existing observations are lost if are not made accessible.

III. Collective value of data sets is greater than its dispersed value.

IV. No substitute exists for adequate observations.

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.

Prediction is very difficult, especially about the future.

Niels Bohr

The farther backward you can look,
the farther forward you are likely to see.

Winston Churchill