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Marine Matters

Integration of ecological indicators with the network of ocean observations

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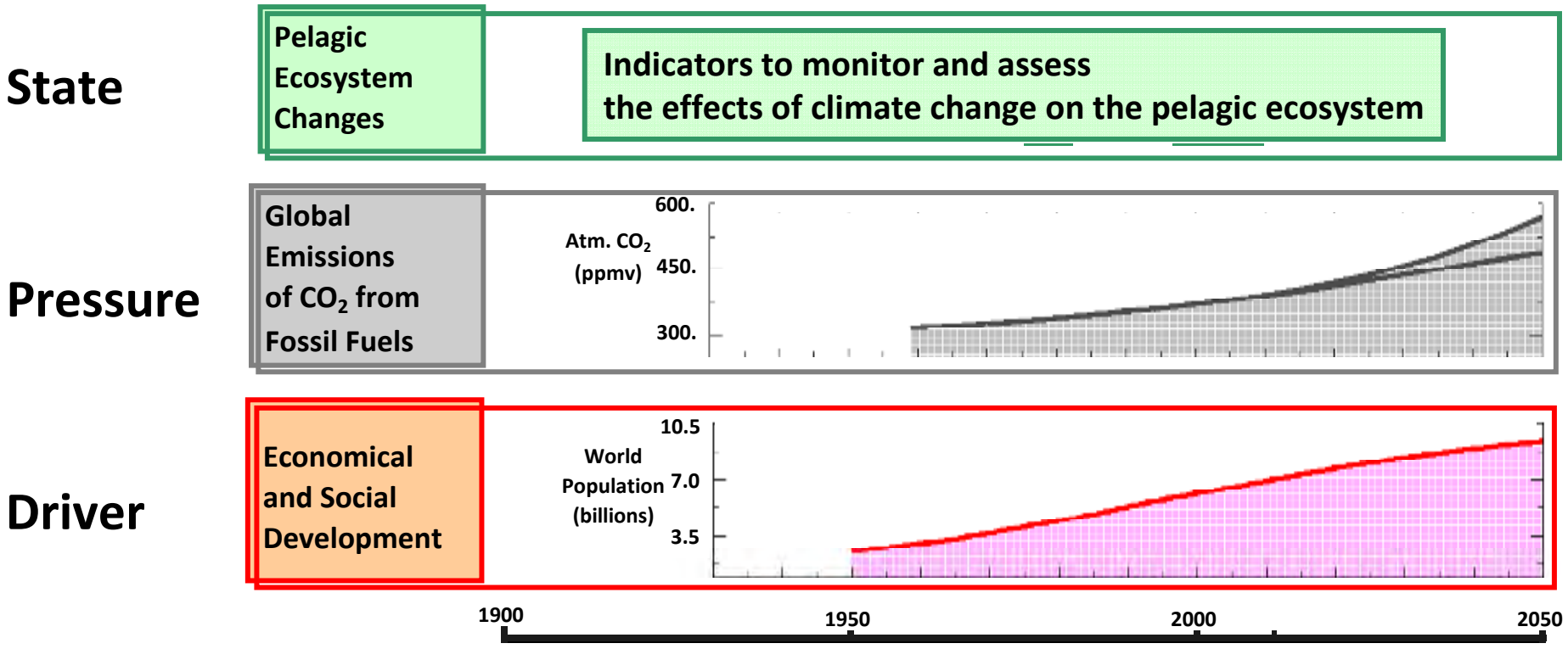
Effects of Climate Change on the World's Ocean
Yeosu, May 2012

Context

Climate Change: chronic environmental hazard

- spatial and temporal scales involved



Ecological Indicators:

Definition *(Walz 2000, Heink and Kowarick 2010)*

An indicator in ecology is a component or a measure of relevant phenomena used to depict or evaluate the state of a system

Selection

"Selection will always be a **compromise** among many factors and must be **optimized for the intended purpose**" (Niemi and McDonald, 2004)

Conceptual frameworks for indicators selection (Lin et al., 2009):

. Causal Network – DPSIR

. Ecological Hierarchy Network

Ecological Indicators: theory… and practice

Implementation challenges

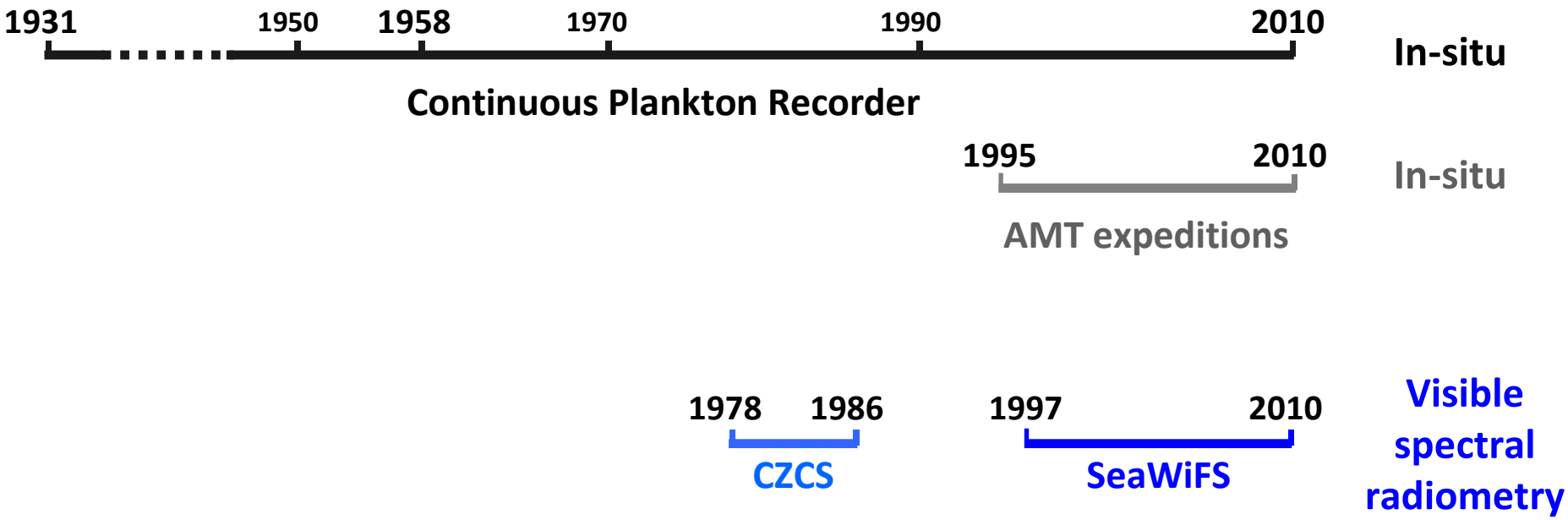
. Practical – coverage, availability

. Analytical – representativeness, consistency

. Numerical – variability, trends

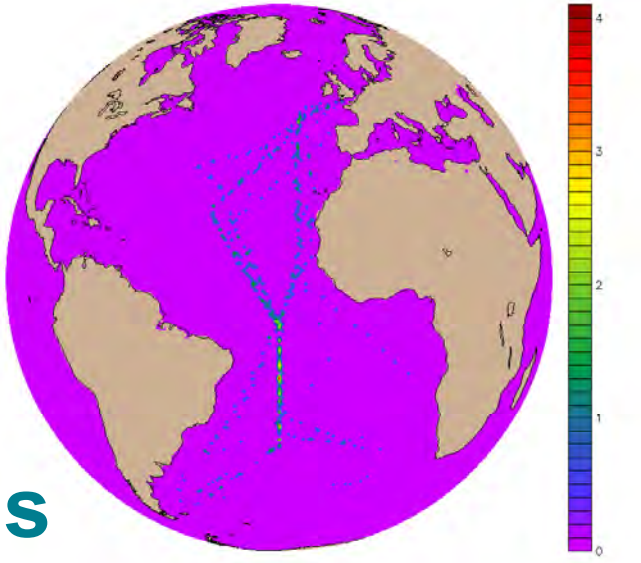
Network of observations

Availability of Observations

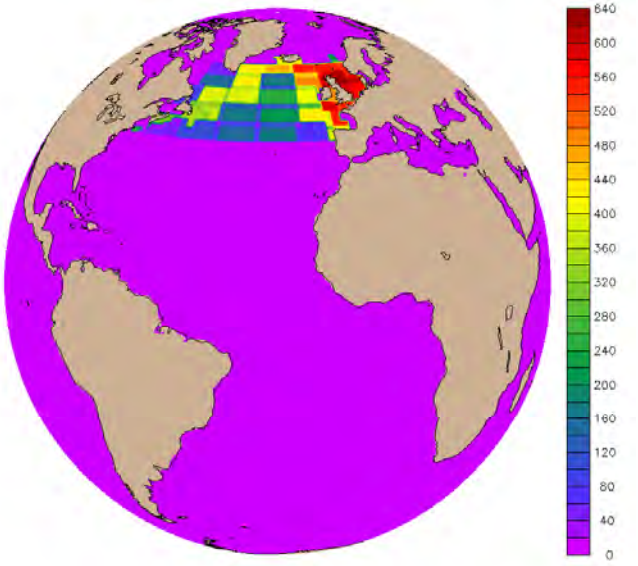


Density of Observations

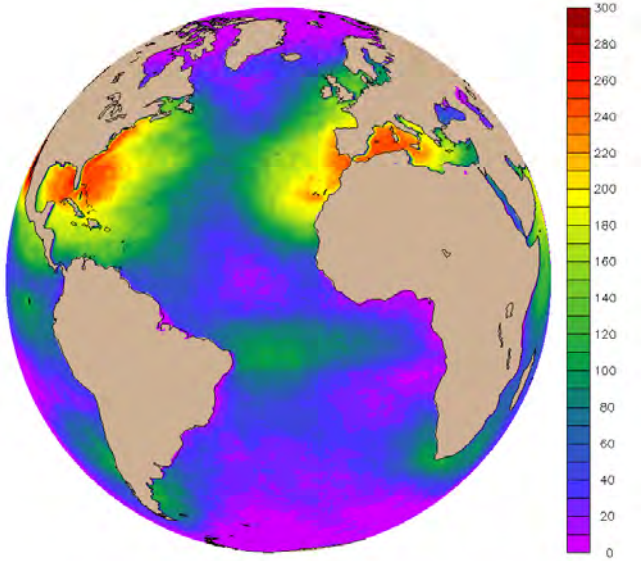
Atlantic Meridional Transect
1995-2010



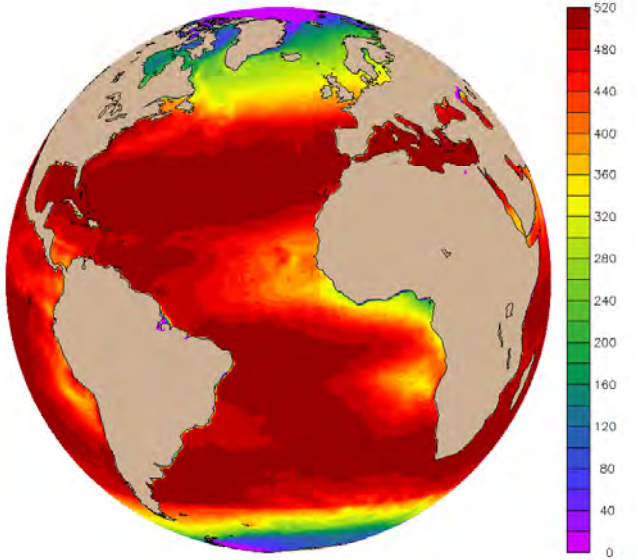
Continuous Plankton Recorder
1958-2010



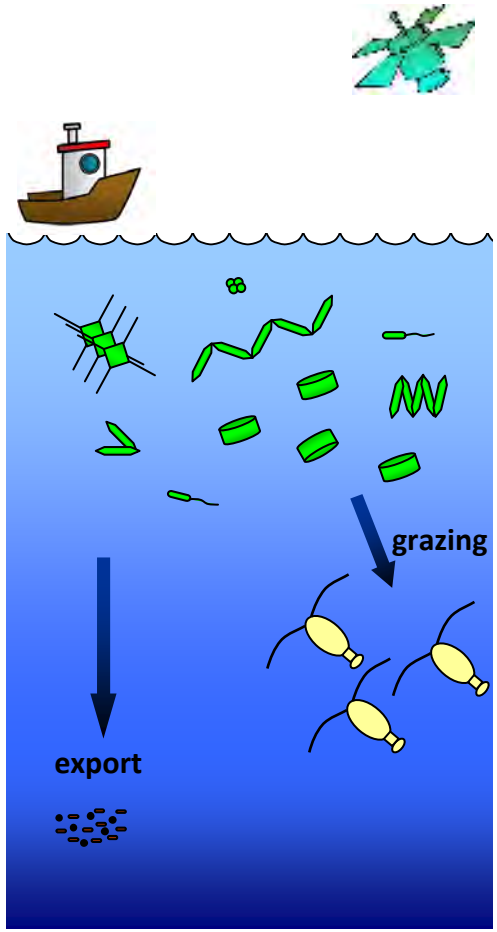
CZCS Sensor
1978-1986



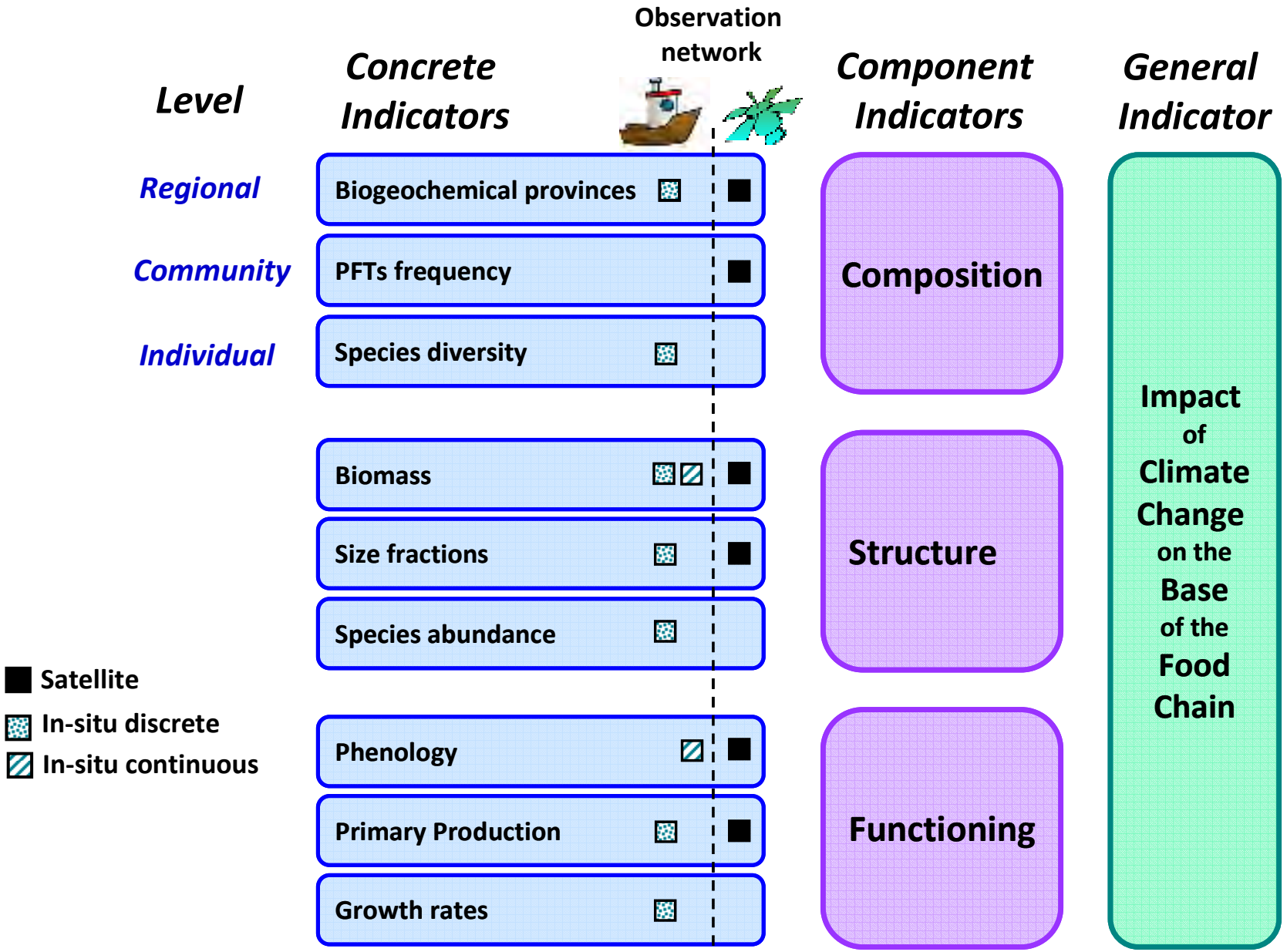
SeaWiFS Sensor
1997-2010



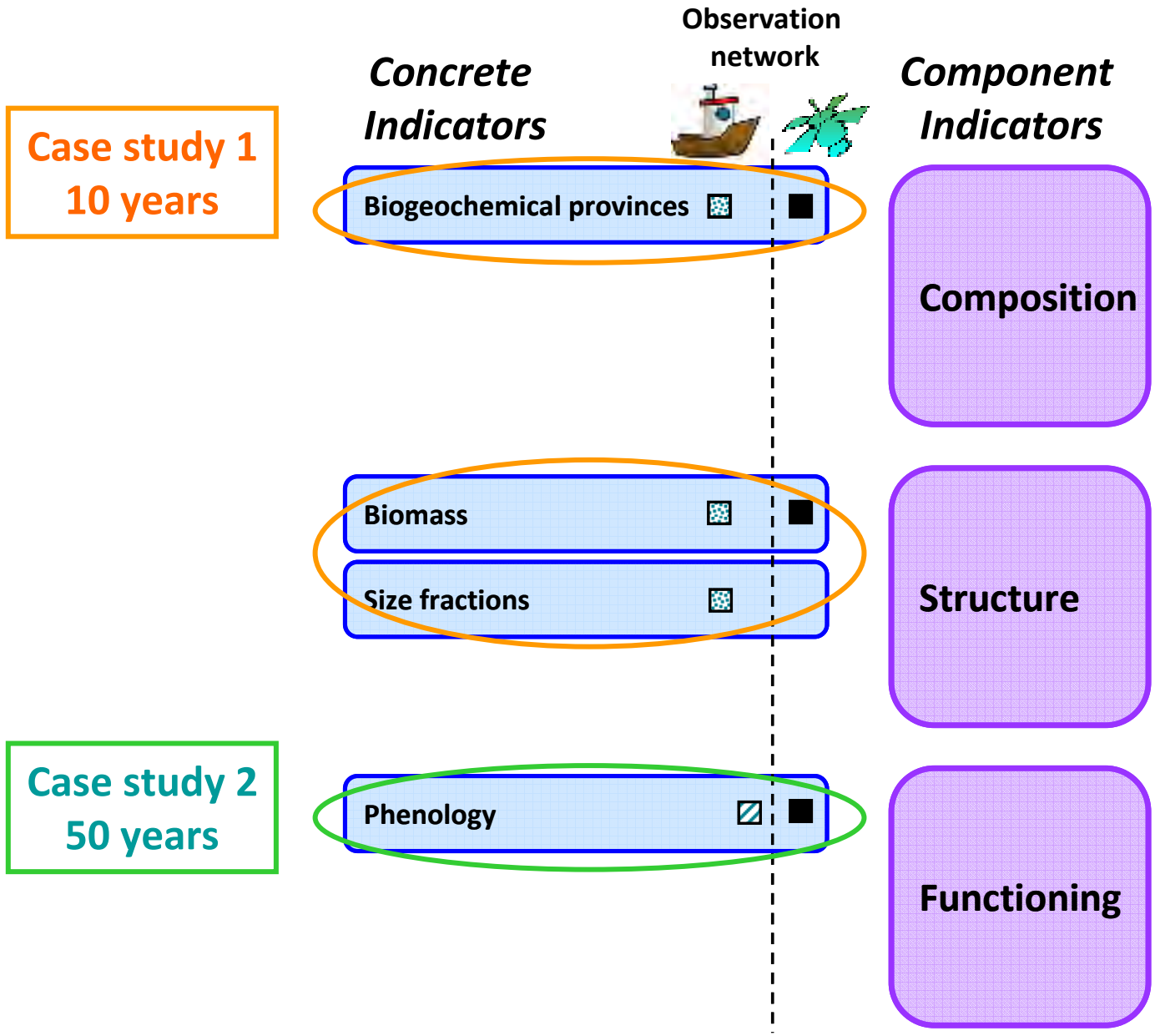
Indicators of the pelagic ecosystem



PML Plymouth Marine Laboratory — Ecological indicators of the pelagic ecosystem



Case-study analysis



Case study 1

Trends in phytoplankton biomass and size fractions

Agirbas et al. *in prep.*

1 - Has phytoplankton biomass changed on a decadal scale in the Atlantic?

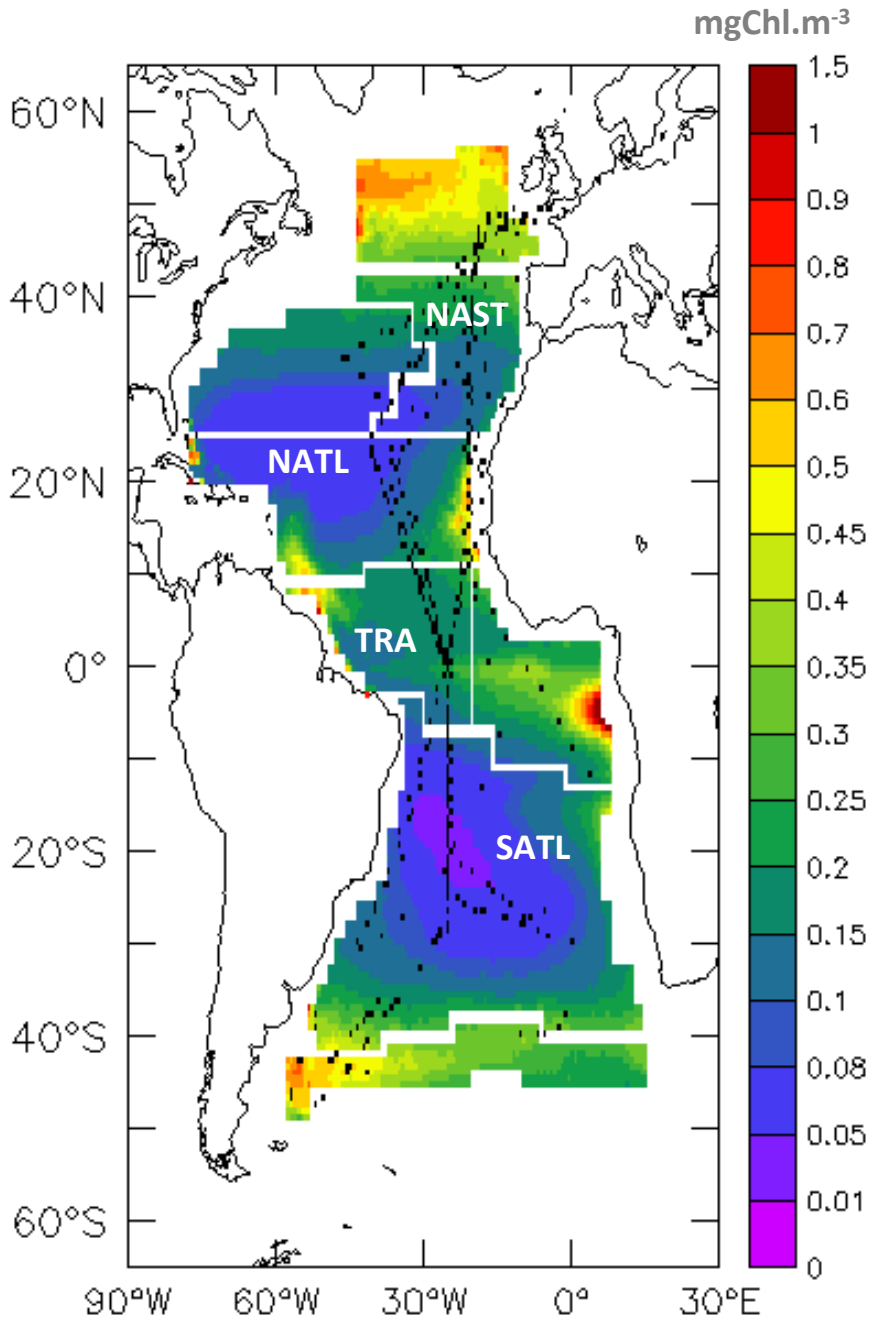
Atlantic Meridional Transect (AMT)

Data selection:

Vertical selection : First optical depth
Temporal selection : October-November
Quality evaluation: Aiken et al., 2009 and Bricaud et al., 2004

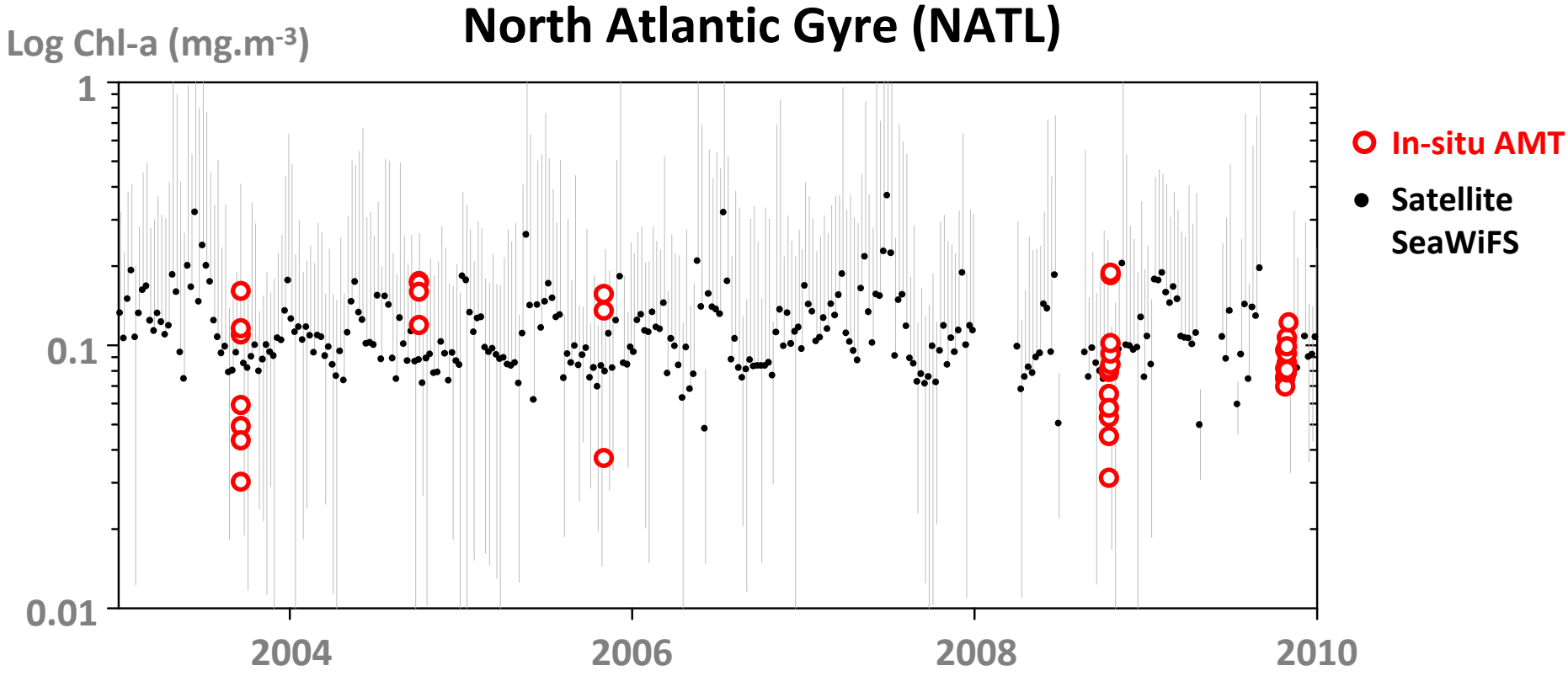
Provinces sampled

NAST: North Atlantic Subtropical Gyre
NATL: North Atlantic Gyre
TRA: Tropical Atlantic
SATL: South Atlantic Gyre



Representativeness of AMT expeditions

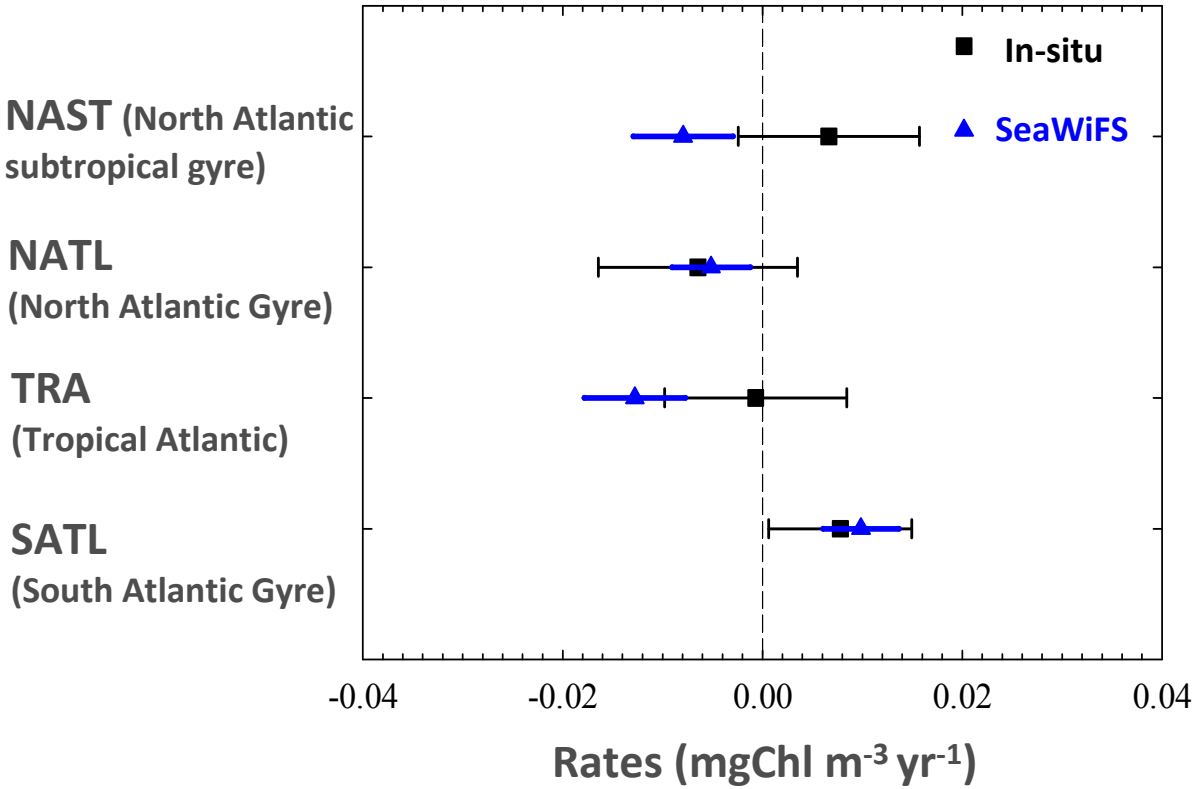
Satellite data selection: weekly composites SeaWiFS L3 Chl-a 9 km resolution for the period of the cruises in coincident years averaged over each province.

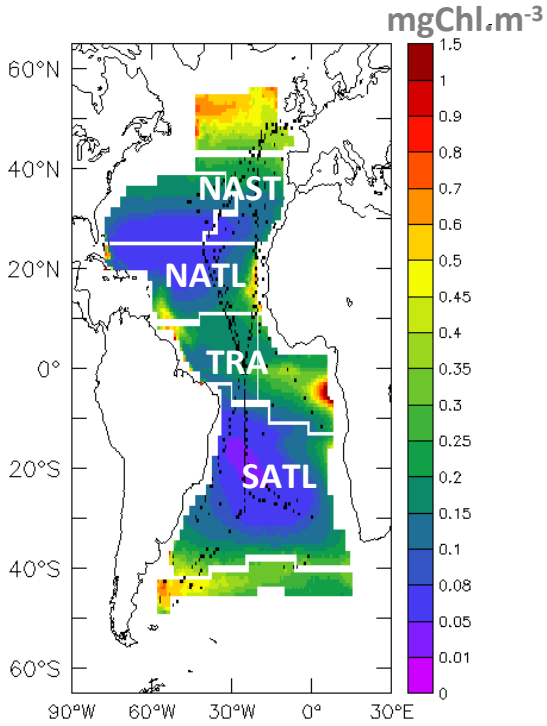


Trends estimated using **linear regression analysis** on the log-transformed data

General Linear Model (GLM) applied to data for comparisons

Trends in phyto. biomass over the period 2003-2010 in the Atlantic



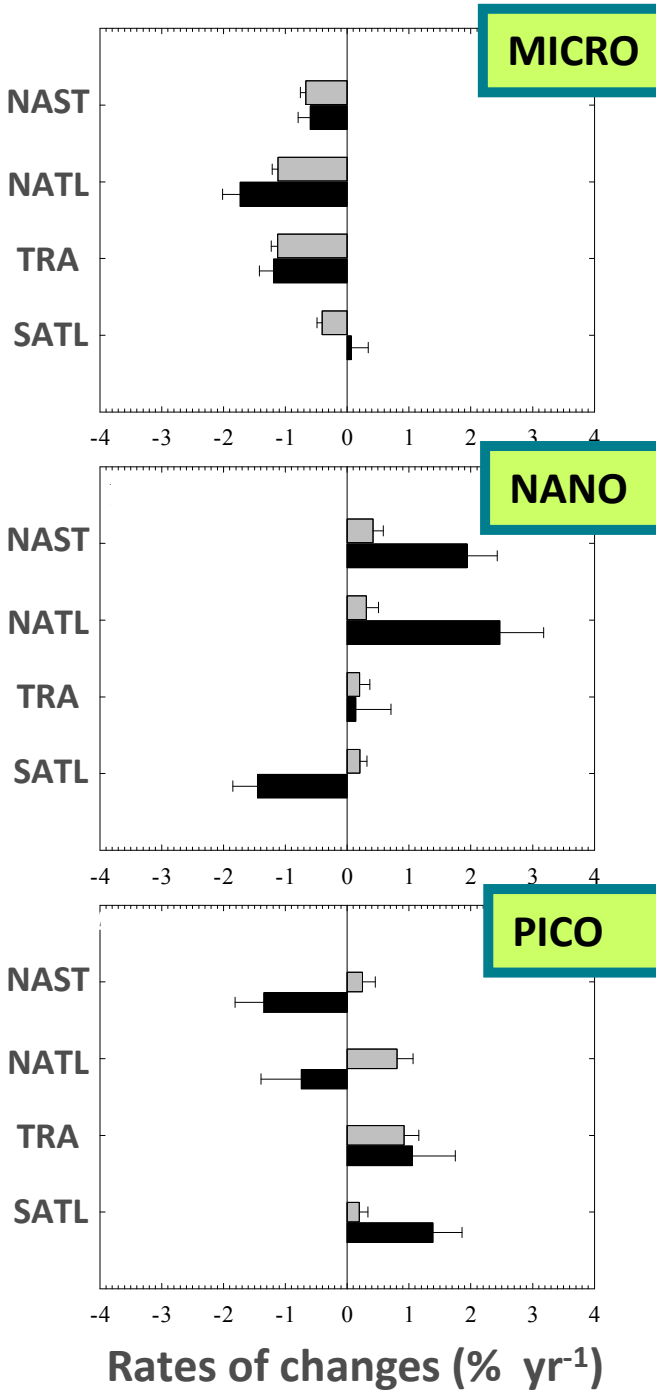


No significant	**differences in gyres between in-situ and SeaWiFS** **changes in total phyto biomass in the central Atlantic** **differences ($p<0.05$) in trends among provinces**

2 – Are we observing similar trends in the different phytoplankton size fractions?

Uitz *et al 2006* model
(using pigments as input)

Brewin *et al 2010* model
(using Chl-a as input)



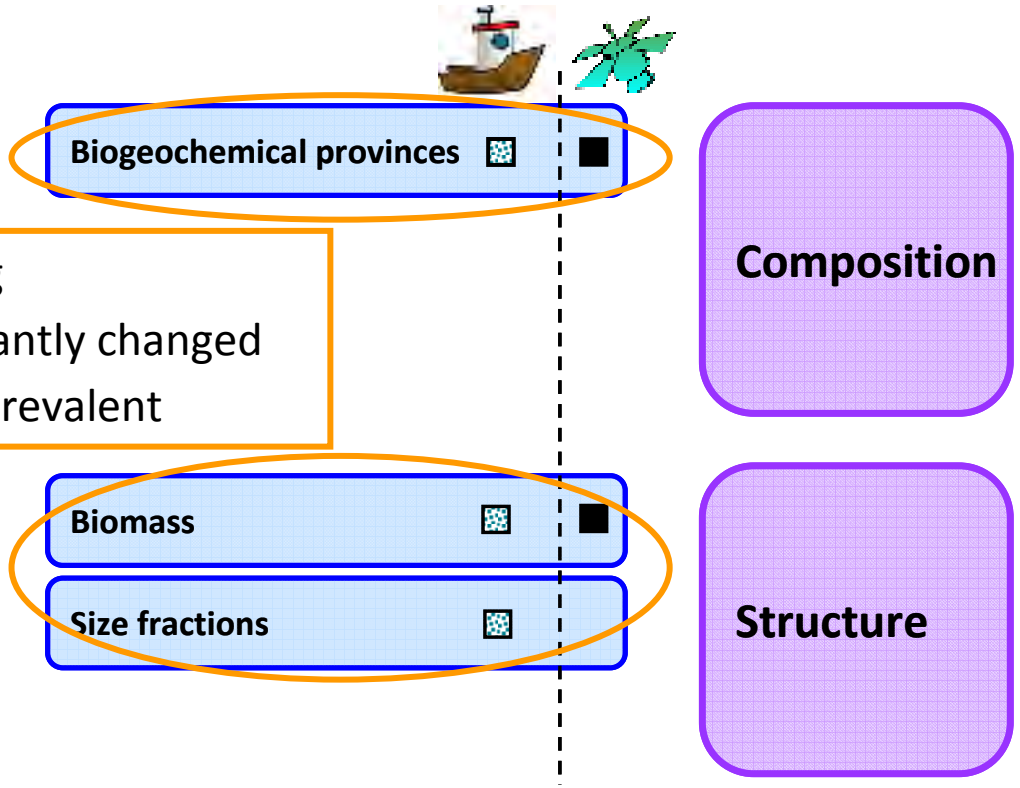
Statistically significant changes in phytoplankton size fractions:

- **Decline in MICRO (phytoplankton) size fraction**
- **Both increases and decreases in NANO and PICO size fractions**

Case-study analysis

Case study 1
10 years

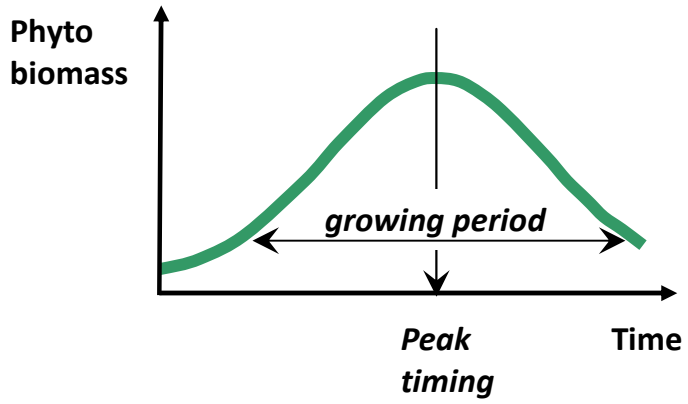
- Representativeness of ship sampling
- Total phyto biomass has not significantly changed
- Smaller phyto. have become more prevalent



Case study 2

Decadal variability in phytoplankton phenology

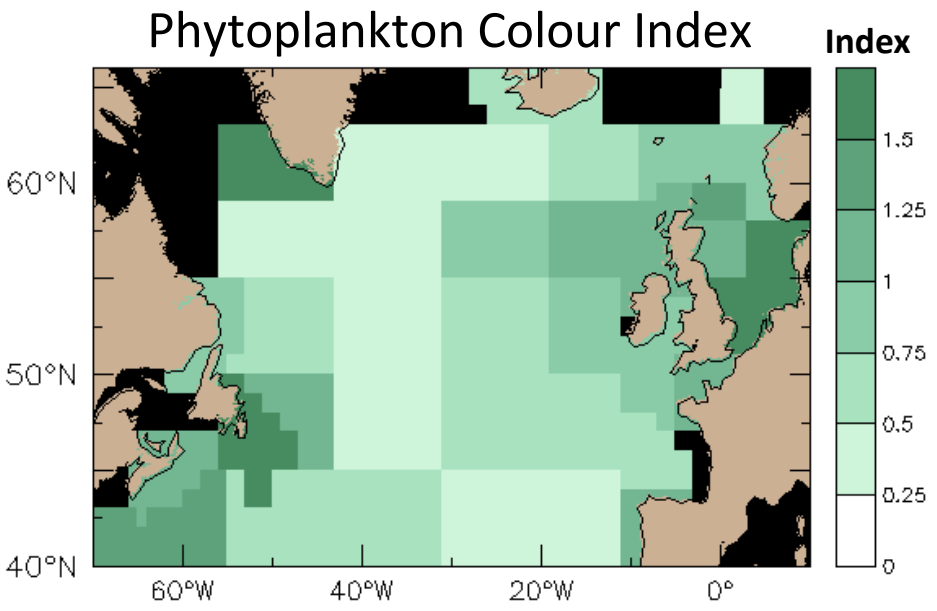
Phenology: *study of timing of events*

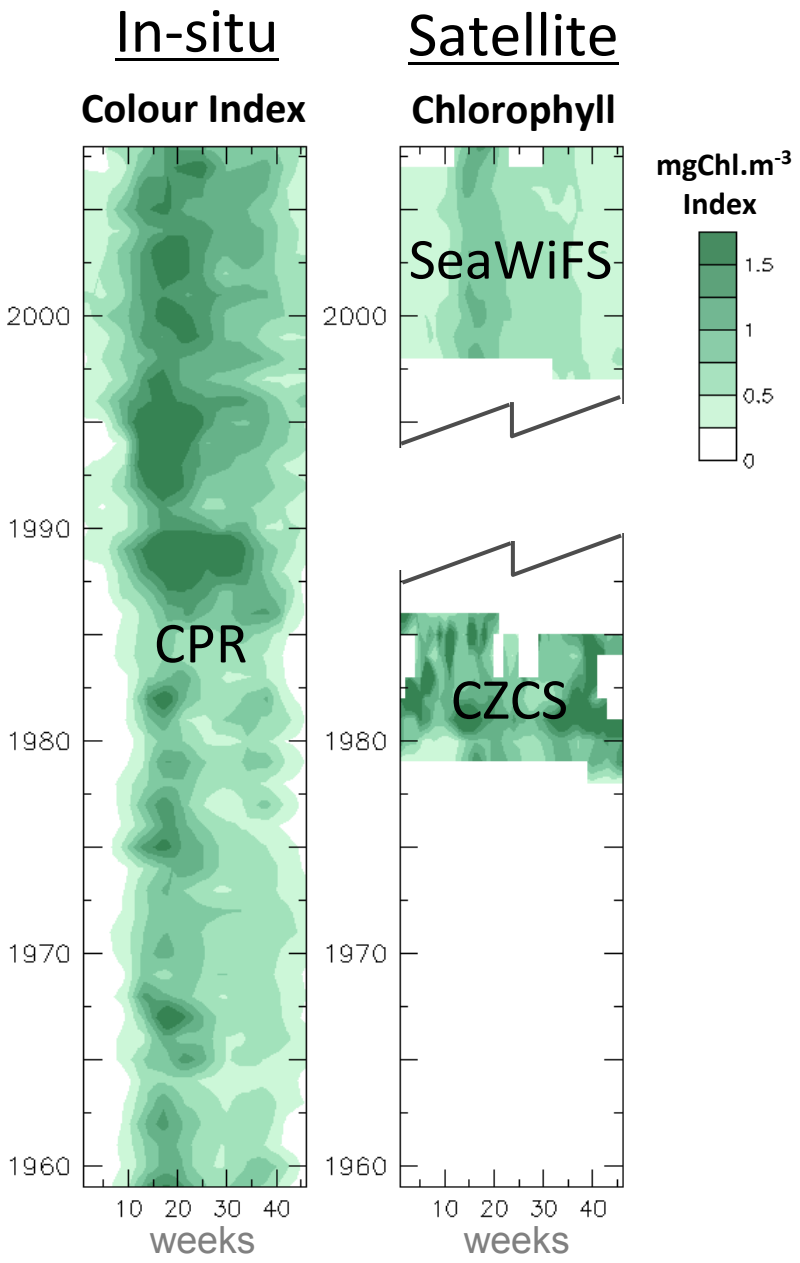


Method from Racault *et al.* (2012)

How phytoplankton phenology varies on decadal scale in the North Atlantic?

Continuous Plankton Recorder (CPR) 1958 - 2008





Time-series consistency

Integration of phenology indicator with the network of observations

Advantages of **relative indicator** over absolute one:

→ bring together data from various satellite sensors

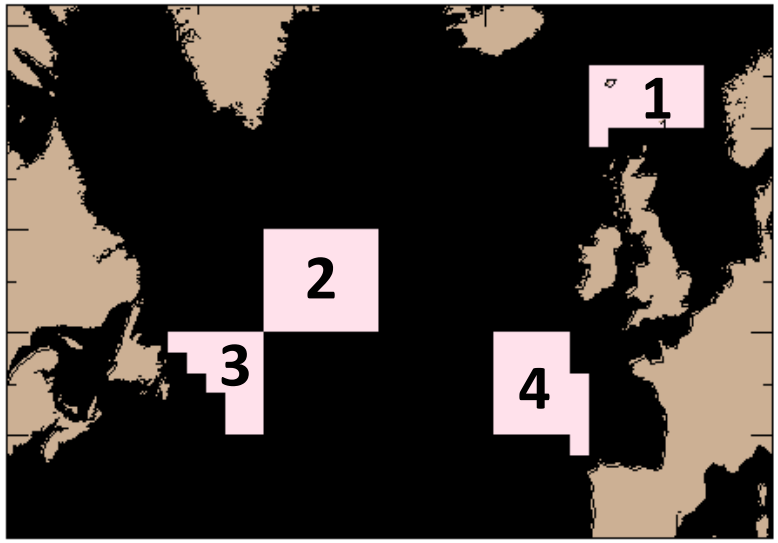
→ synthesis of in-situ and remote sensing phyto biomass estimates

Areas selection based on:

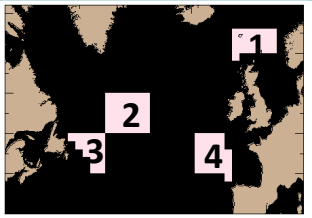
In-situ data availability 1958-2008

In-situ and Sat. data availability 1998-2008

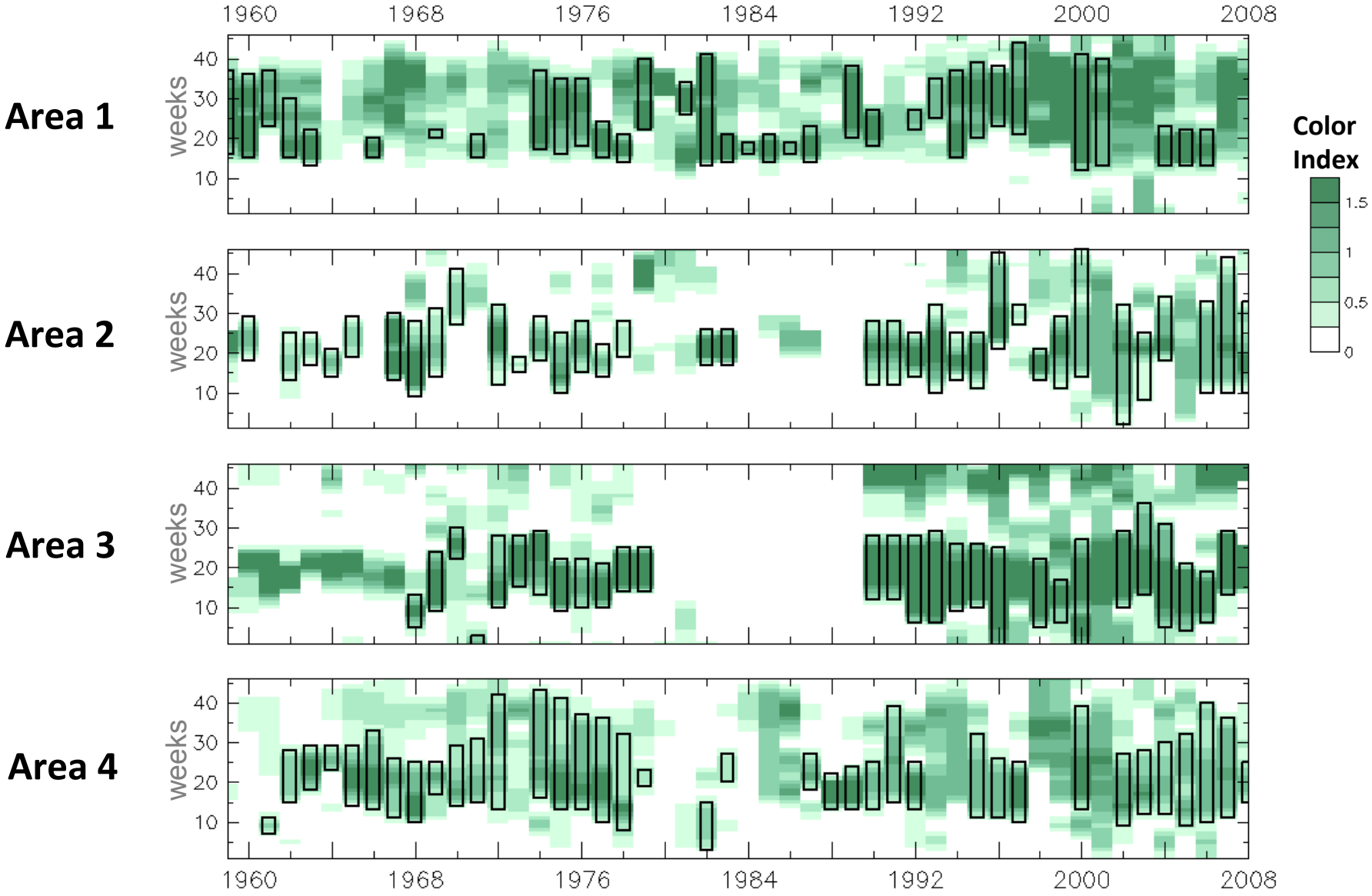
t-test on peak timing between In-situ and Sat.



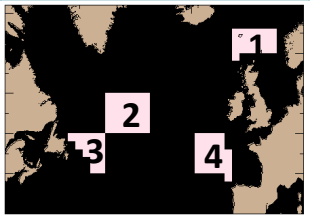
Phytoplankton phenology 1958 - 2008



In-situ: Continuous Plankton Recorder



Phytoplankton phenology 1958 - 2008



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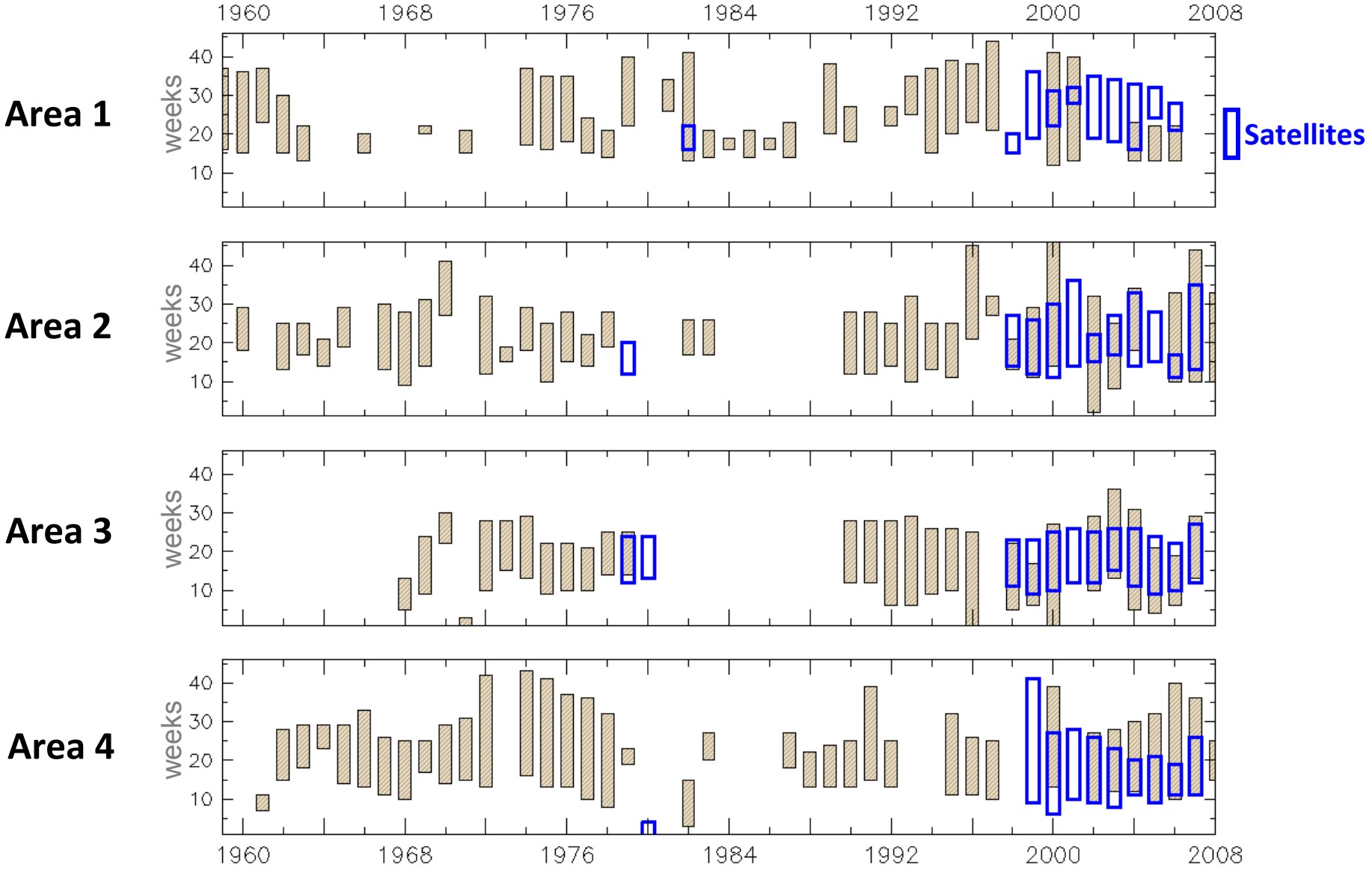
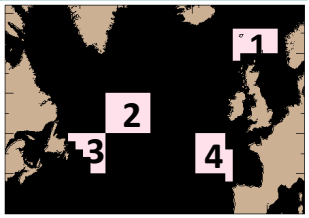
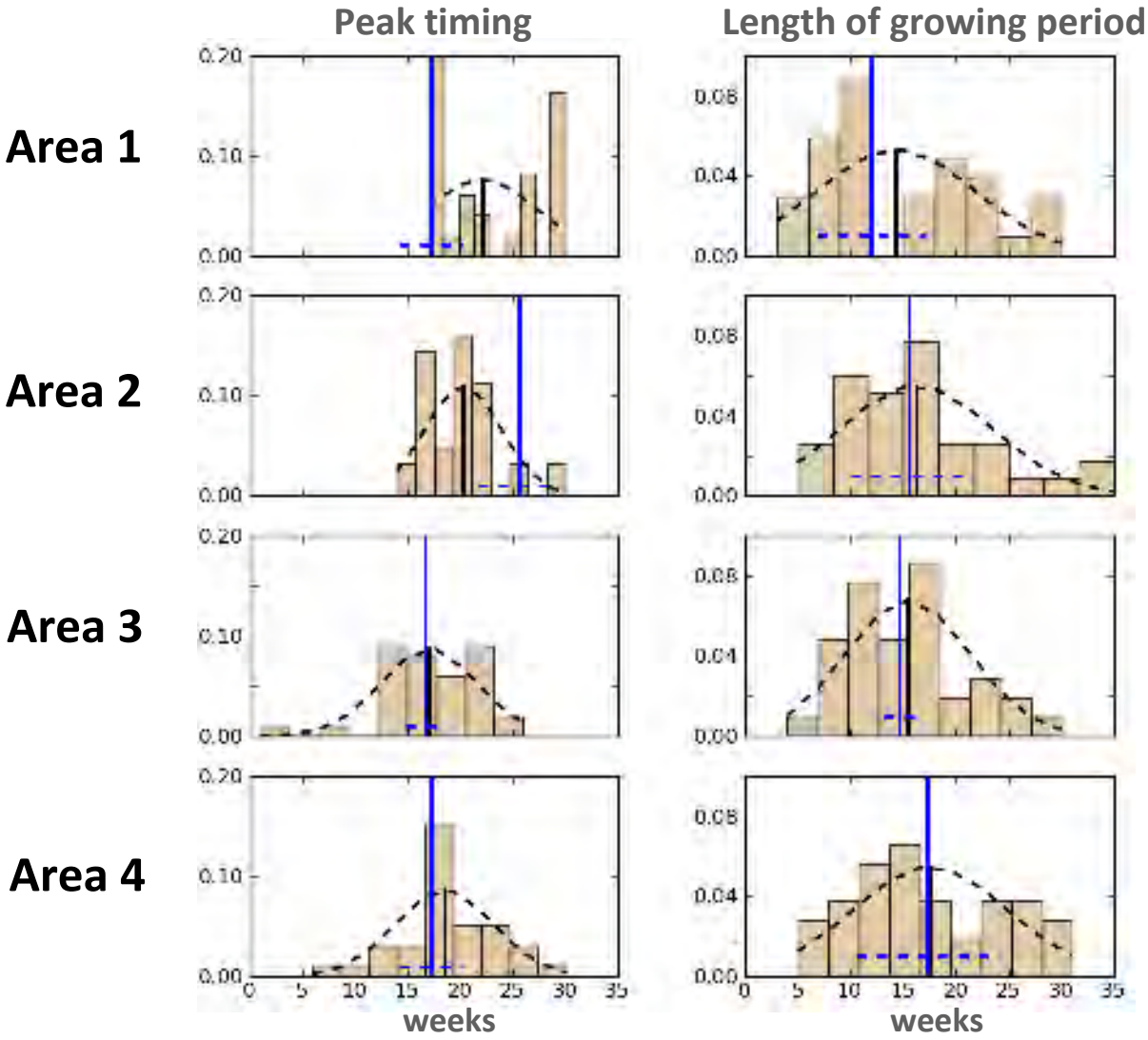


Decadal variability in phytoplankton phenology



Frequency distributions



In-situ

SeaWiFS

Peak timing:
week 19±3

Growing period:
15±6weeks

Case-studies summary

Case study 1
10 years

- Representativeness of ship sampling
- Total phyto biomass has not significantly changed
- Smaller phyto. have become more prevalent

Biogeochemical provinces

Biomass

Size fractions

Phenology

Case study 2
50 years

- Growing period: 15±6weeks

Composition

Structure

Functioning

Concluding remarks and future of observations

- When we are required to combine quite different set of data, it may be rather difficult to make strong conclusions about trends

- Apparent consistency inferred from stable structural properties (such as autotrophic biomass) may conceal significant changes at the community level (such as seen in the size fractions)

- Develop and support:
  - . Collaboration
  - . Evaluation of representativeness of discrete sampling
  - . Indicators based on relative signal patterns
  - . Evidence-based research
  - . Observations – integrated indicators approach
  - . Funding to maintain and extend time-series of observations

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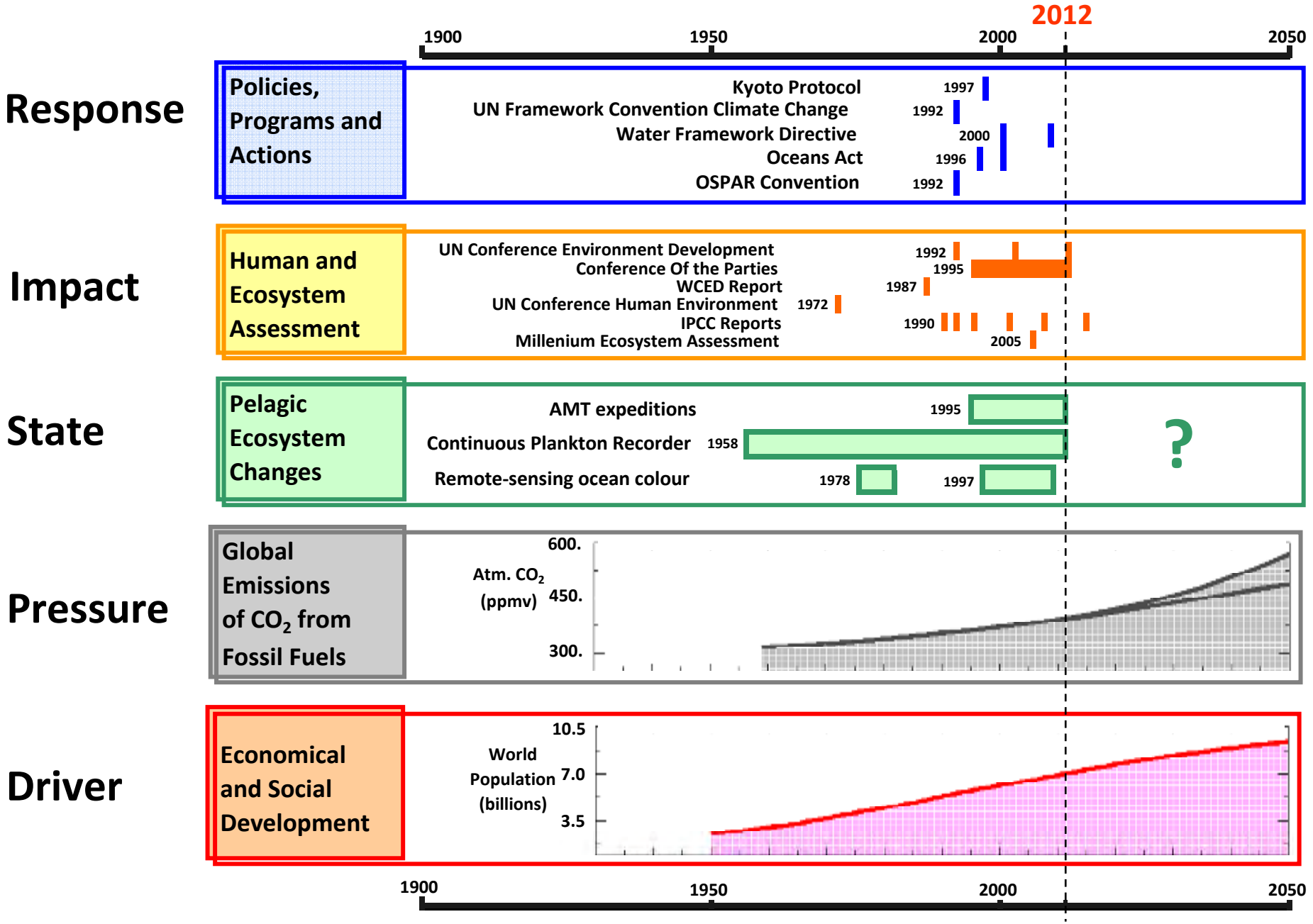
Perspectives



Acknowledgments

Antony Walne, David Johns, Bob Brewin, Ana Queiros, Stéphane Saux Picart, Nick Stephens, Momme Bütenschon, Yuri Artioli, Stefano Ciavatta

IPCC Data Distribution Centre
Atmospheric CO2 concentrations
http://www.ipcc-data.org/ancilliary/tar-isam.txt

NOAA ESRL DATA
http://www.esrl.noaa.gov/gmd/ccgg/trends/mlo.html#mlo

World Population Prospects: The 2010 Revision
United Nations, Department of Economic and Social Affairs, Population Division
http://esa.un.org/unpd/wpp/Excel-Data/population.htm

Feldman, G. C., C. R. McClain, Ocean Color Web, SeaWiFS
Reprocessing 2010, NASA Goddard Space Flight Center. Eds. Kuring, N., Bailey, S. W.
http://oceancolor.gsfc.nasa.gov/

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