International Group for Marine and Ecological Time Series (IGMETS)

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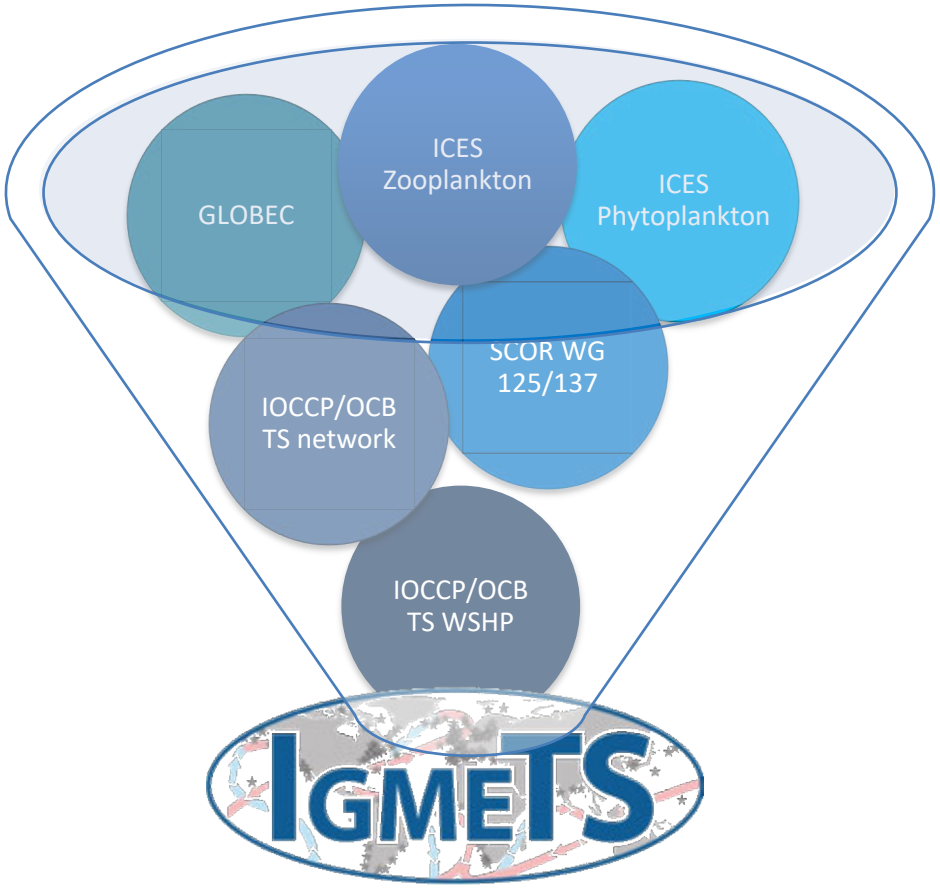
Time Series Investigators and Participants

International Group for Marine Ecological Time Series

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



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

- Started in 2014 as a means to assess global and regional ocean changes through ship-based, biogeochemical time series.
- **C**ombining multiple TS enables assessment of regional and global variability via large spatial-scale analyses.
- **I**t builds on a series of previous activities
- **T**his effort:
  - Brings together, for the first time, >340 ship-based TS worldwide to obtain a global view of changing oceans at different time intervals.
  - Highlights the importance of continued sampling by existing marine time series to improve information on changing marine ecosystems.
  - Builds a metadata directory of all known ecological / biogeochemical / plankton time series efforts around the world.
- **I**GMETS 2020 in progress

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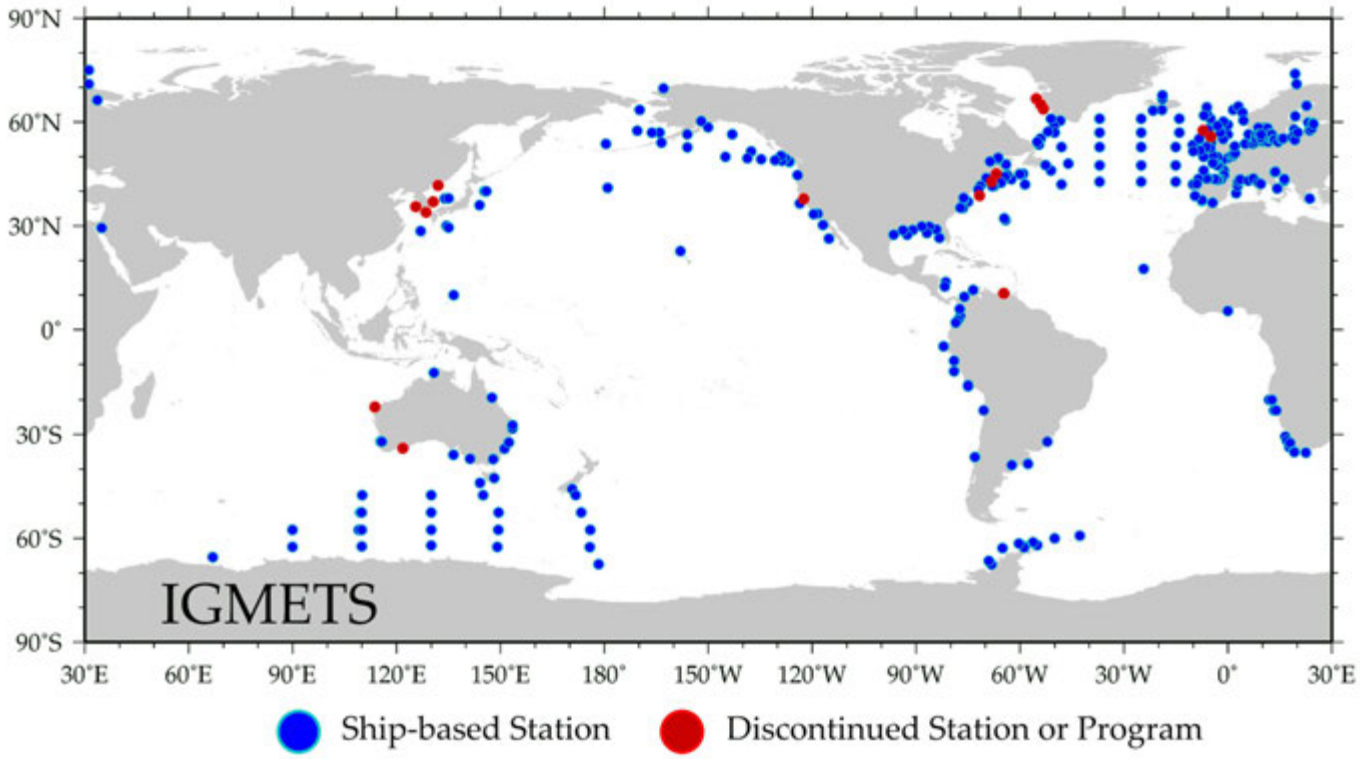
IGMETS Vision:

- Encourage the use of already-established common metadata standards and formats to further facilitate cost-efficiency of new and existing sampling programs.
- 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.



Map showing Time Series sites involved in the 2017 IGMETS assessment.

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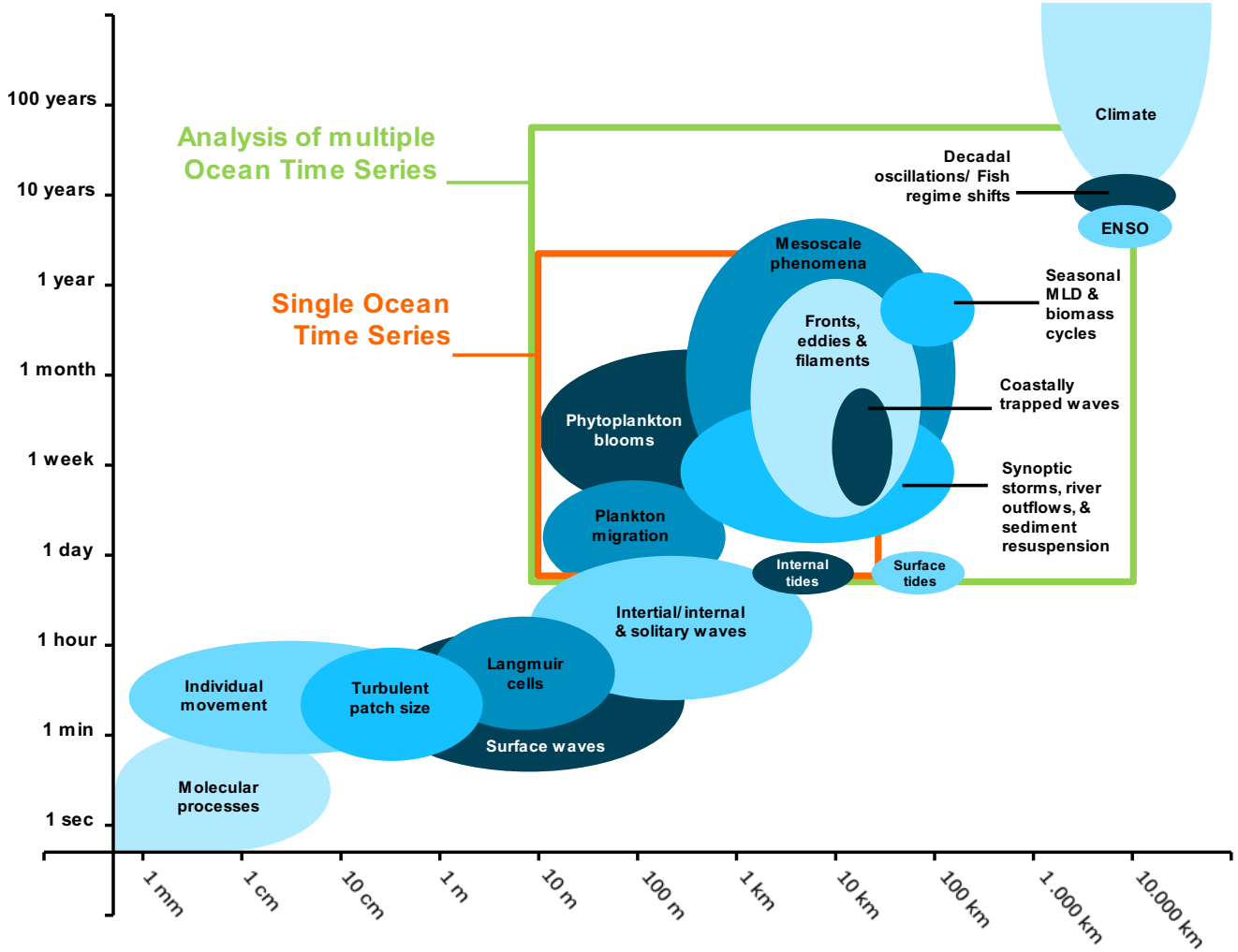
SINGLE TIME SERIES ANALYSIS

- Identification of temporal patterns
- Understanding of local processes
- Establishment of local baselines

JOINT TIME SERIES ANALYSIS

- Identification of temporal and spatial patterns
- Establishment of regional baselines
- Separation of stressors
- Understanding of regional and global processes
- Projection and forecasting



Adapted from Dickey 2002

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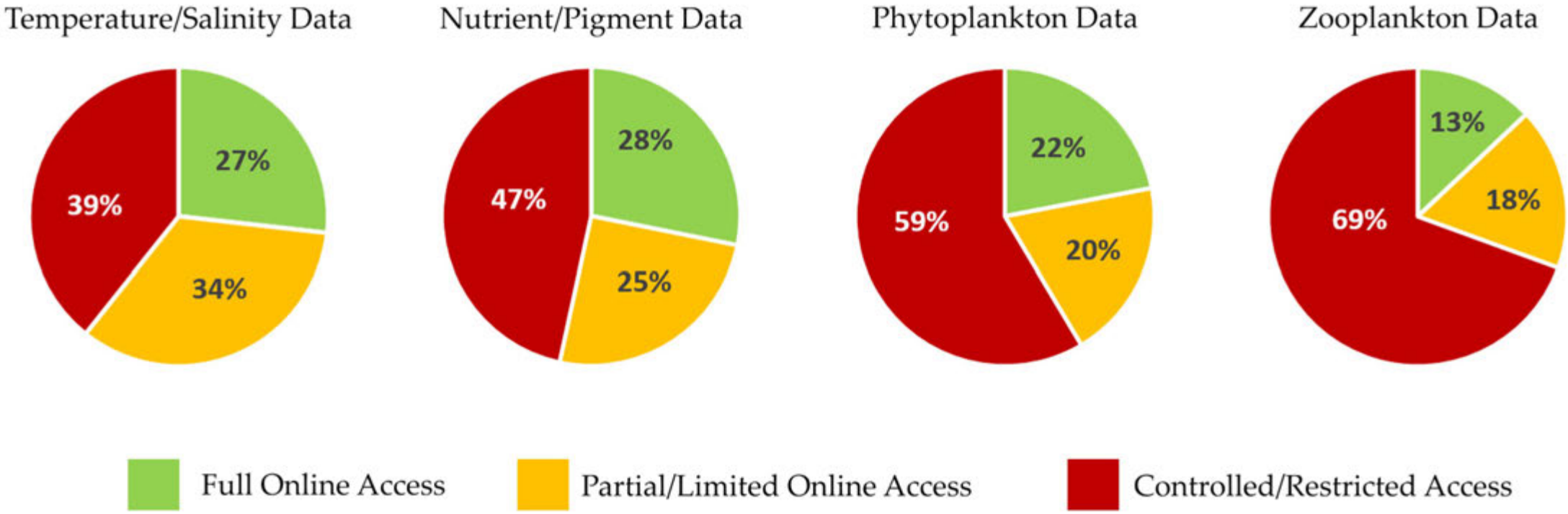
How has IGMETS worked RE: data?

- Very sensitive topic.
- Did not seek to publish or release raw data, but rather products → advantageous to PIs.



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Products from IGMETS 2017

- Discovery map (http://igmets.net/)
- Report
- Web tools:
  I. Metadatabase (http://igmets.net/2017/metabase)
  II. Explorer (http://igmets.net/2017/explorer)

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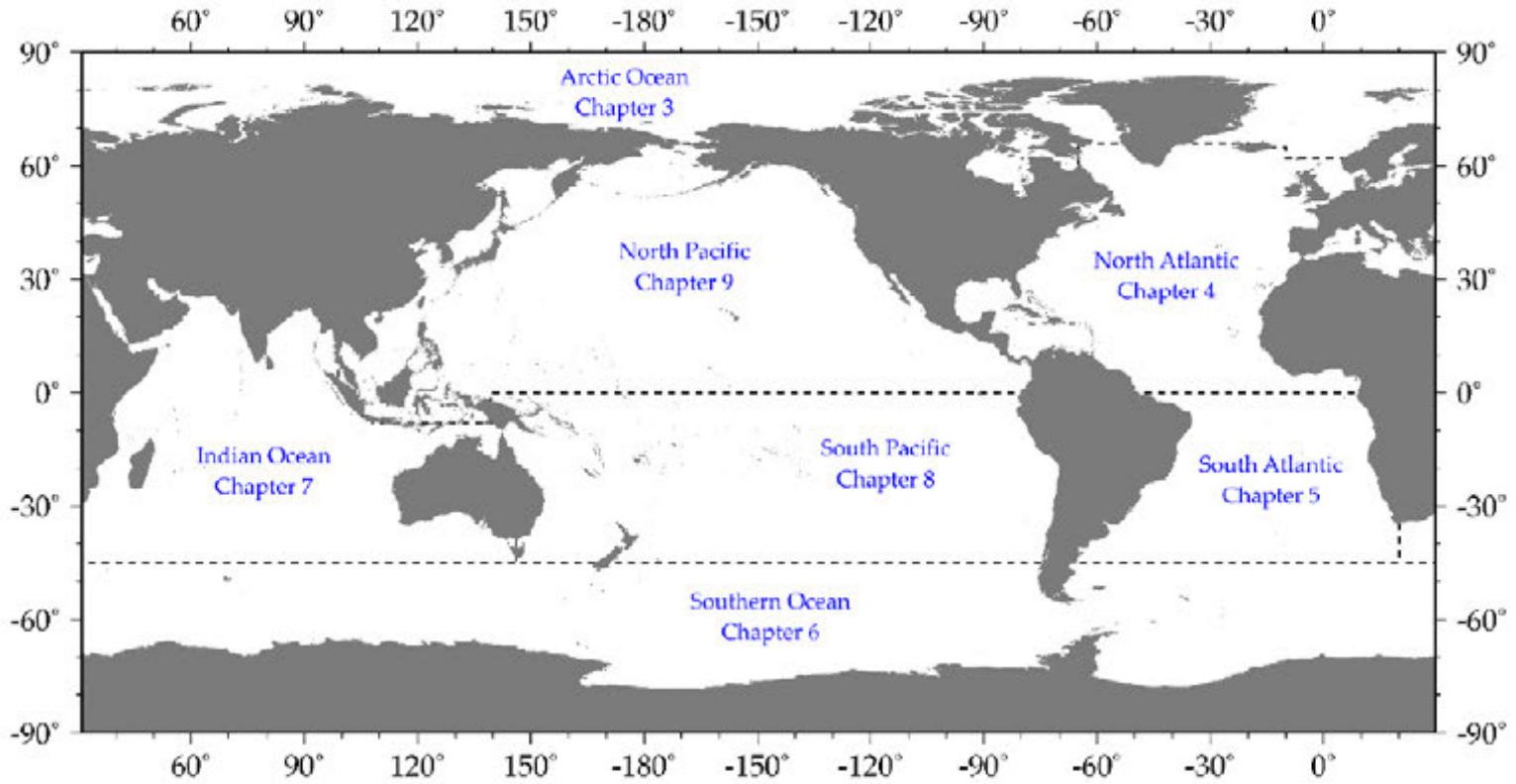
Analysis and synthesis of global marine ecological changes as seen through biogeochemical and plankton time series.

- Types of analyses
  - Divided the world into regions



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

- Types of analyses
  - Struggle with disparity of methods and reporting metrics
  - Unitless trends
  - Significance with non-parametric seasonal Mann-Kendall test
  - Time windows
  - Trend maps for in situ and satellite data

Table 2.1. Year-span and minimum year requirements for the IGMETS time-windows.

IGMETS time-window	Year-span	Minimum year requirement
"TW05" (5 years)	2008–2012	4 of 5
"TW10" (10 years)	2003–2012	8 of 10
"TW15" (15 years)	1998–2012	12 of 15
"TW20" (20 years)	1993–2012	16 of 20
"TW25" (25 years)	1988–2012	20 of 25
"TW30" (30 years)	1983–2012	24 of 30

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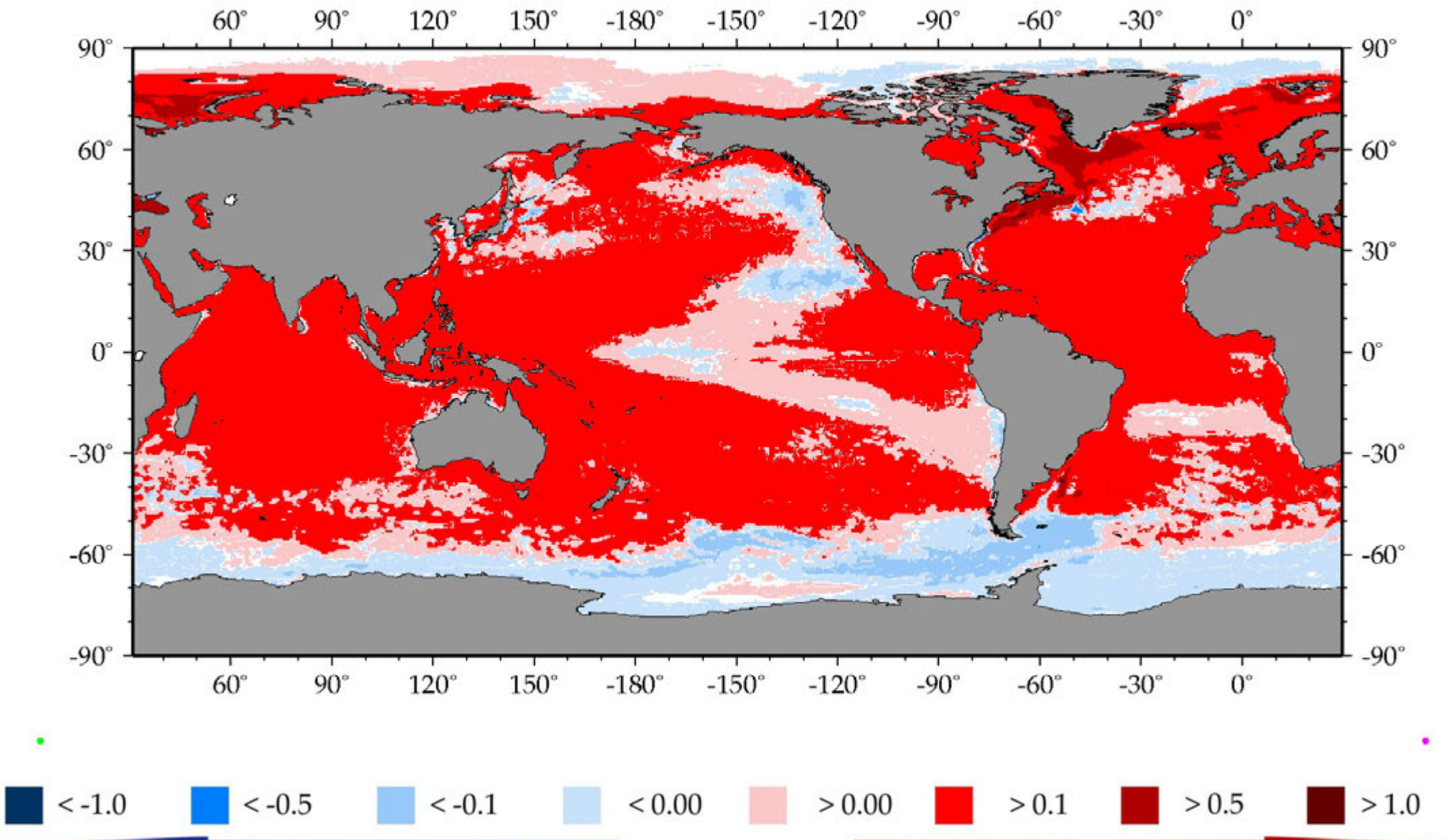
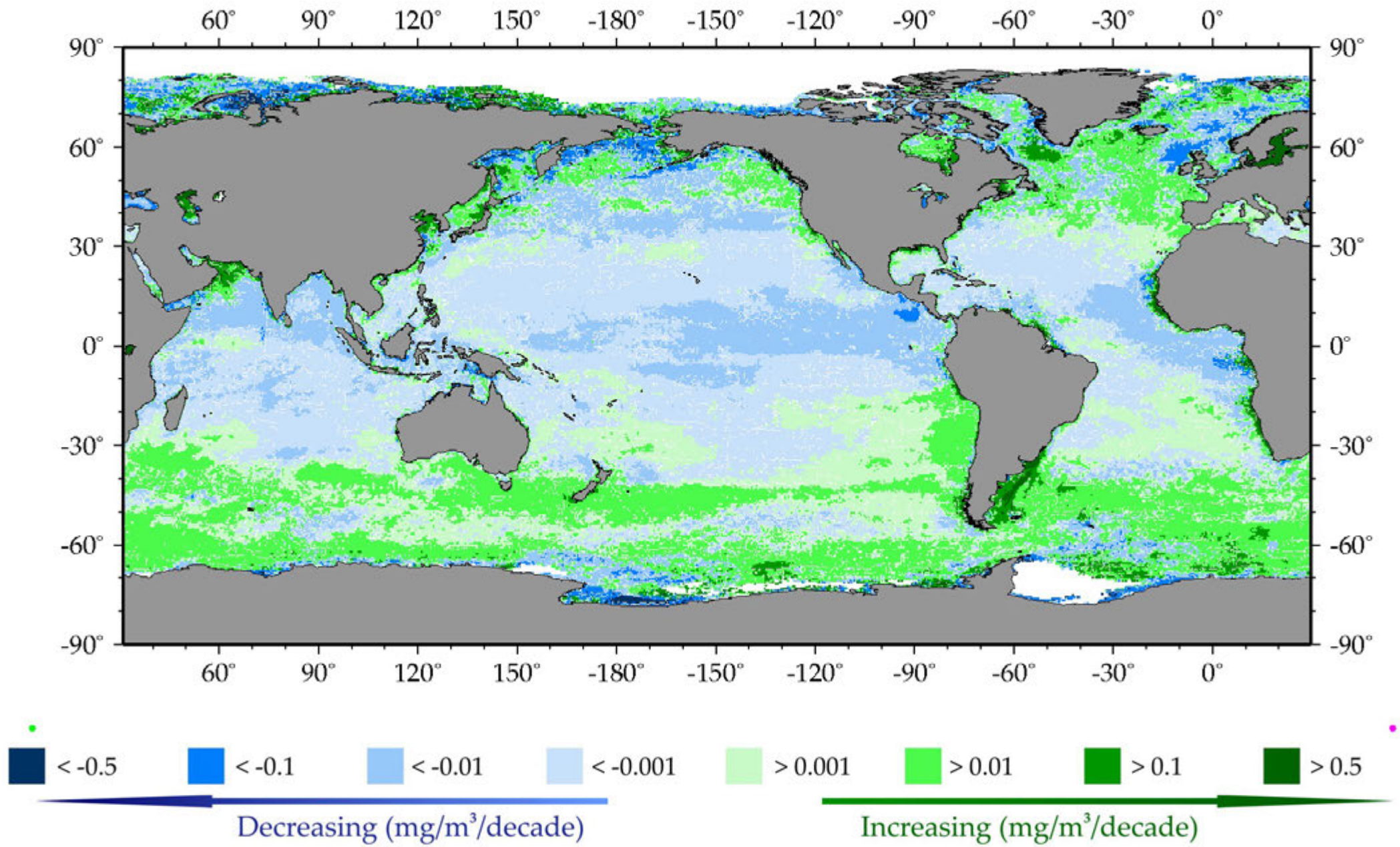
- Types of analyses
  - Spatio-temporal frequency table

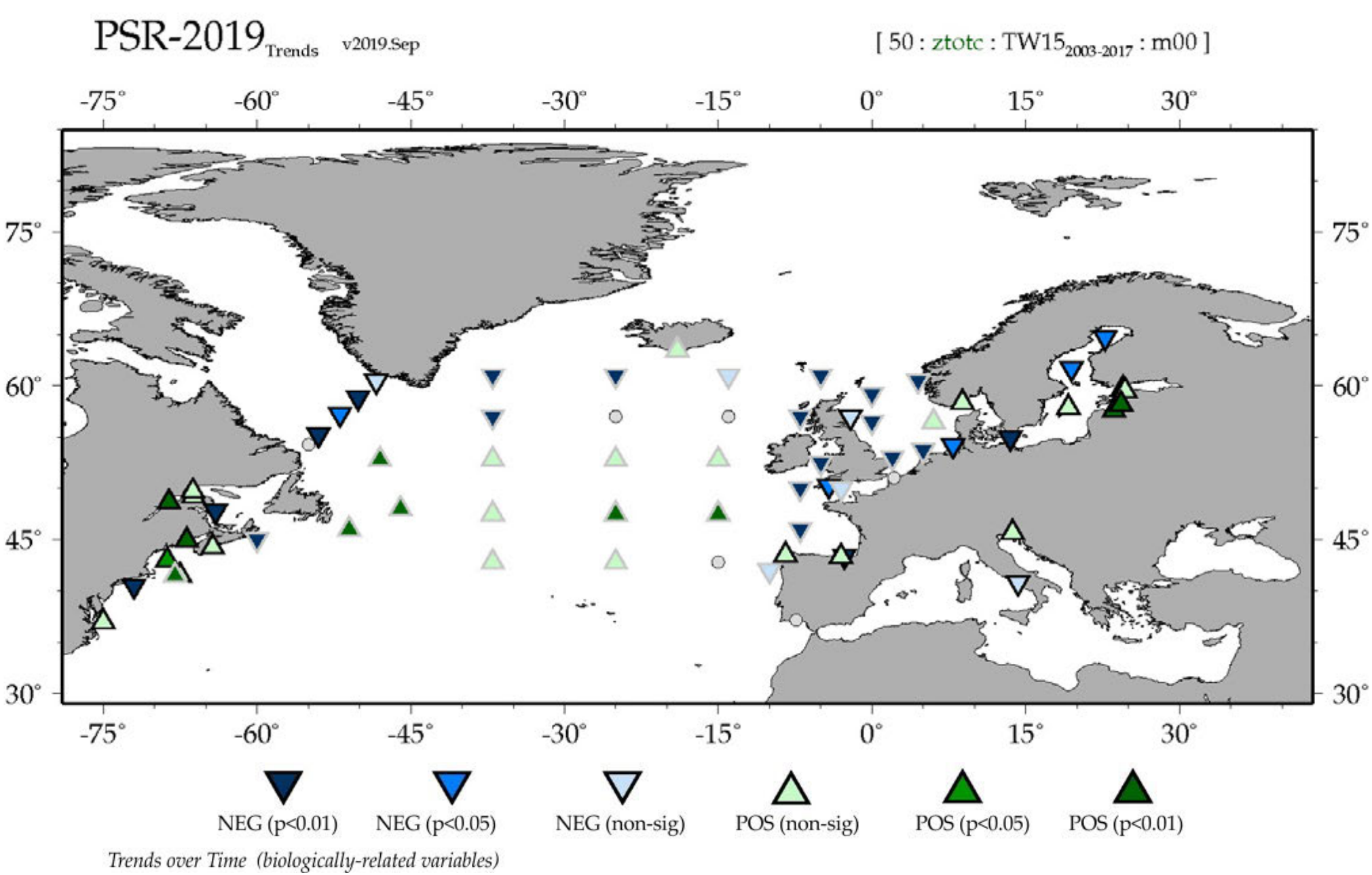
Latitude-adjusted SST data field surface area = 46.1 million km²	5-year (2008–2012)	10-year (2003–2012)	15-year (1998–2012)	20-year (1993–2012)	25-year (1988–2012)	30-year (1983–2012)
Area (%) w/ increasing SST trends ($p < 0.05$)	**52.5%** (*13.3%*)	**50.3%** (*14.6%*)	**76.8%** (*54.8%*)	**95.7%** (*87.4%*)	**98.1%** (*95.0%*)	**99.1%** (*97.3%*)
Area (%) w/ decreasing SST trends ($p < 0.05$)	47.5% (*18.6%*)	49.7% (*15.5%*)	23.2% (*7.1%*)	4.3% (*1.1%*)	1.9% (*0.6%*)	0.9% (*0.3%*)
> 1.0°C decade^{-1} warming ($p < 0.05$)	13.5% (*8.1%*)	3.4% (*3.3%*)	0.9% (*0.9%*)	0.7% (*0.7%*)	0.1% (*0.1%*)	0.0% (*0.0%*)
0.5 to 1.0°C decade^{-1} warming ($p < 0.05$)	18.0% (*4.6%*)	5.0% (*4.1%*)	5.4% (*5.4%*)	10.0% (*10.0%*)	9.2% (*9.2%*)	6.7% (*6.7%*)
0.1 to 0.5°C decade^{-1} warming ($p < 0.05$)	17.0% (*0.6%*)	27.3% (*7.1%*)	**56.3%** (*47.4%*)	**77.1%** (*74.3%*)	**83.3%** (*82.5%*)	**86.7%** (*86.4%*)
0.0 to 0.1°C decade^{-1} warming ($p < 0.05$)	4.1% (*0.0%*)	14.6% (*0.2%*)	14.2% (*1.2%*)	8.0% (*2.4%*)	5.4% (*3.2%*)	5.6% (*4.2%*)
0.0 to –0.1°C decade^{-1} cooling ($p < 0.05$)	3.9% (*0.0%*)	13.1% (*0.1%*)	10.0% (*0.2%*)	2.6% (*0.1%*)	1.3% (*0.1%*)	0.7% (*0.1%*)
–0.1 to –0.5°C decade^{-1} cooling ($p < 0.05$)	13.3% (*0.7%*)	29.2% (*8.7%*)	12.4% (*6.1%*)	1.4% (*0.8%*)	0.6% (*0.4%*)	0.2% (*0.1%*)
–0.5 to –1.0°C decade^{-1} cooling ($p < 0.05$)	15.7% (*6.6%*)	6.7% (*6.1%*)	0.7% (*0.6%*)	0.2% (*0.2%*)	0.1% (*0.1%*)	0.0% (*0.0%*)
> –1.0°C decade^{-1} cooling ($p < 0.05$)	14.6% (*11.3%*)	0.6% (*0.6%*)	0.2% (*0.2%*)	0.0% (*0.0%*)	0.0% (*0.0%*)	0.0% (*0.0%*)

Time window satellite SST 30 years, 1988-2017



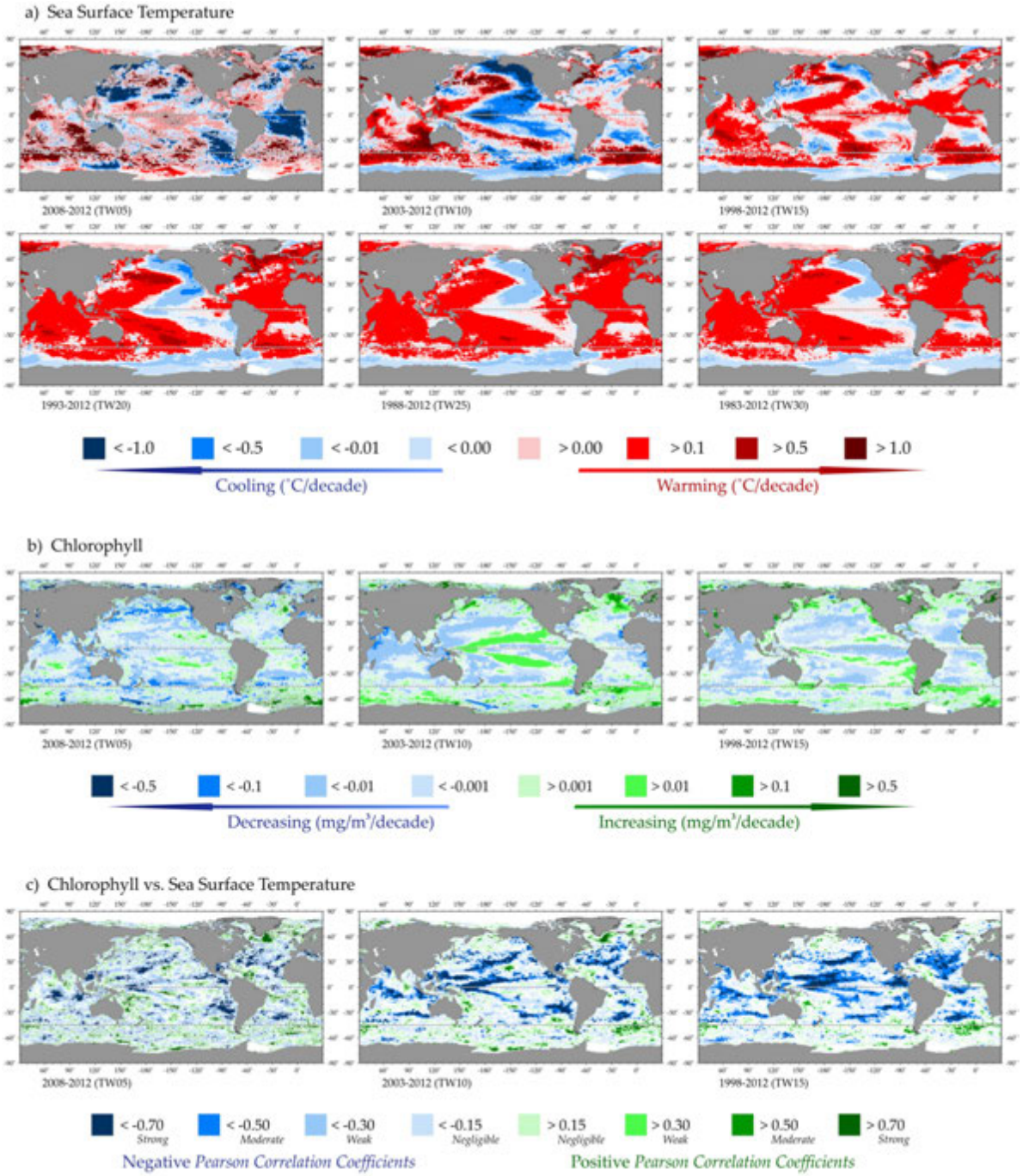
Time window satellite Chla 20 years, 1998-2017




PSR-2019 Trends v2019.Sep
[50 : ztotc : TW15 2003-2017 : m00]
-75°
-60°
-45°
-30°
-15°
0°
15°
30°
75°
60°
45°
30°
NEG (p<0.01)
NEG (p<0.05)
NEG (non-sig)
POS (non-sig)
POS (p<0.05)
POS (p<0.01)
Trends over Time (biologically-related variables)

Notable Results from 2017

- Generalized warming trend (30 ys)
- Regional differences/time window
- Chla trends variable by region
- Shifts in biology/ biogeochemical cycling
- Indian Ocean
- Paucity of situ measurements
- Area Experiencing largest changes



Please note…

- Most ship based ecological time series are concentrated in coastal ocean. **Large gap in open ocean**.
- Coastal zones in North America and Europe are being monitored; lack of biogeochemical time-series in other coastal regions around the world
- A more **globally distributed network of time-series observations over multiple decades** is needed to differentiate between natural and anthropogenic variability.