

Changes in stratification in the North Pacific and implications for primary productivity

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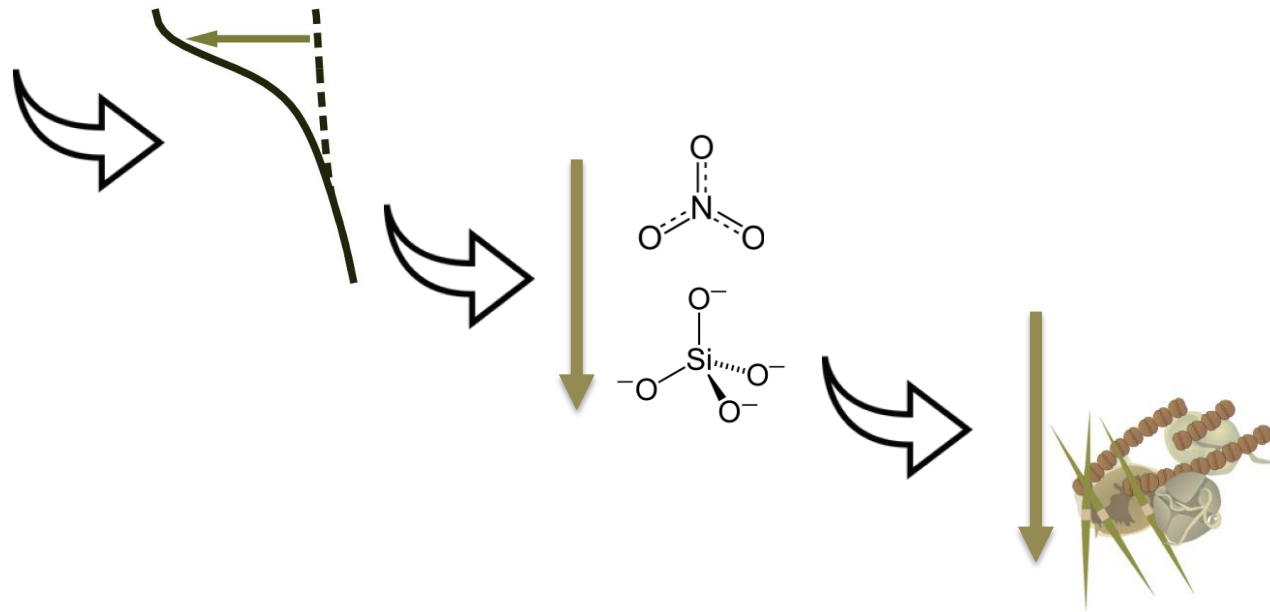
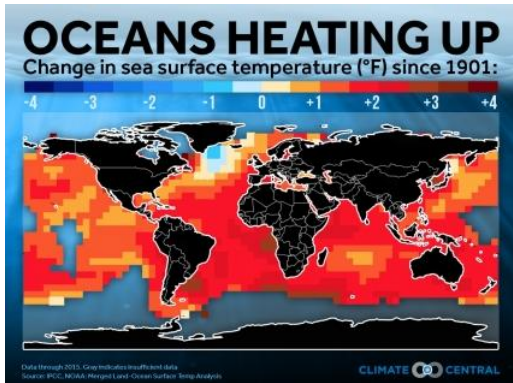


Fisheries and Oceans Pêches et Océans
Canada Canada

The **Big** Question

(How) Will increasing upper-ocean heat content change marine ecosystems?

The **Big** Idea

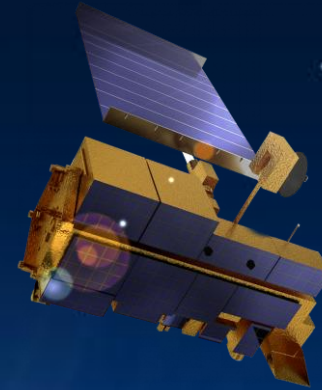
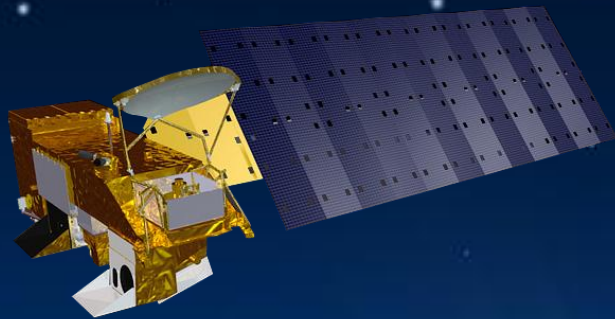


Upper ocean
heating up

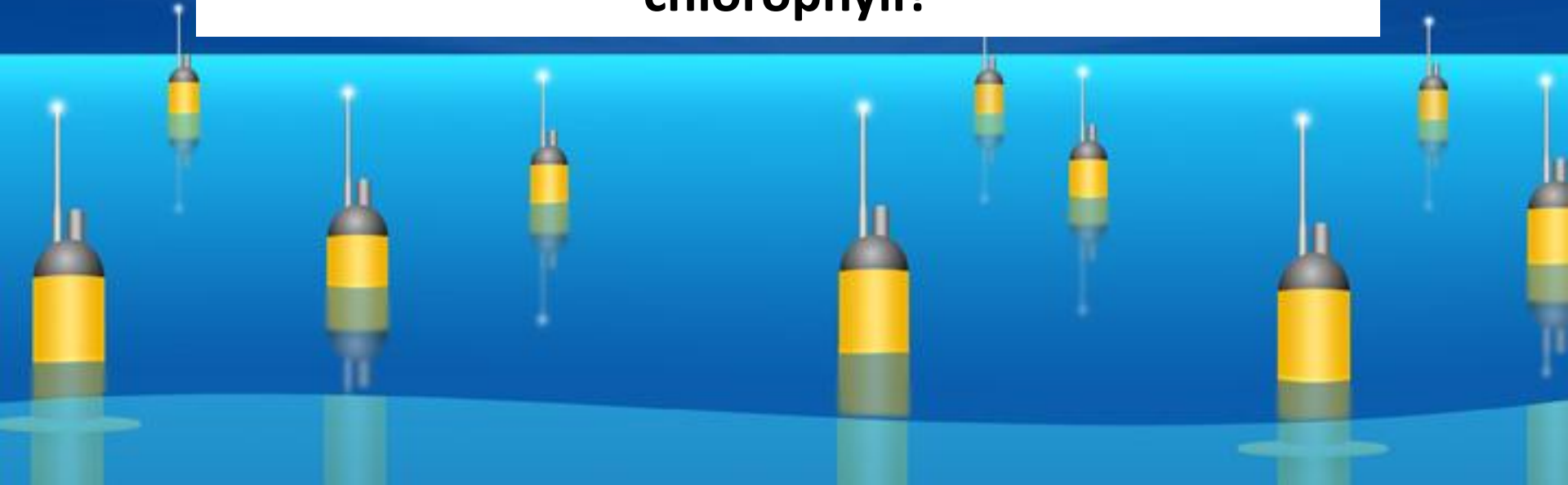
Stratification
increasing

Less nutrients
at surface

Less primary
productivity

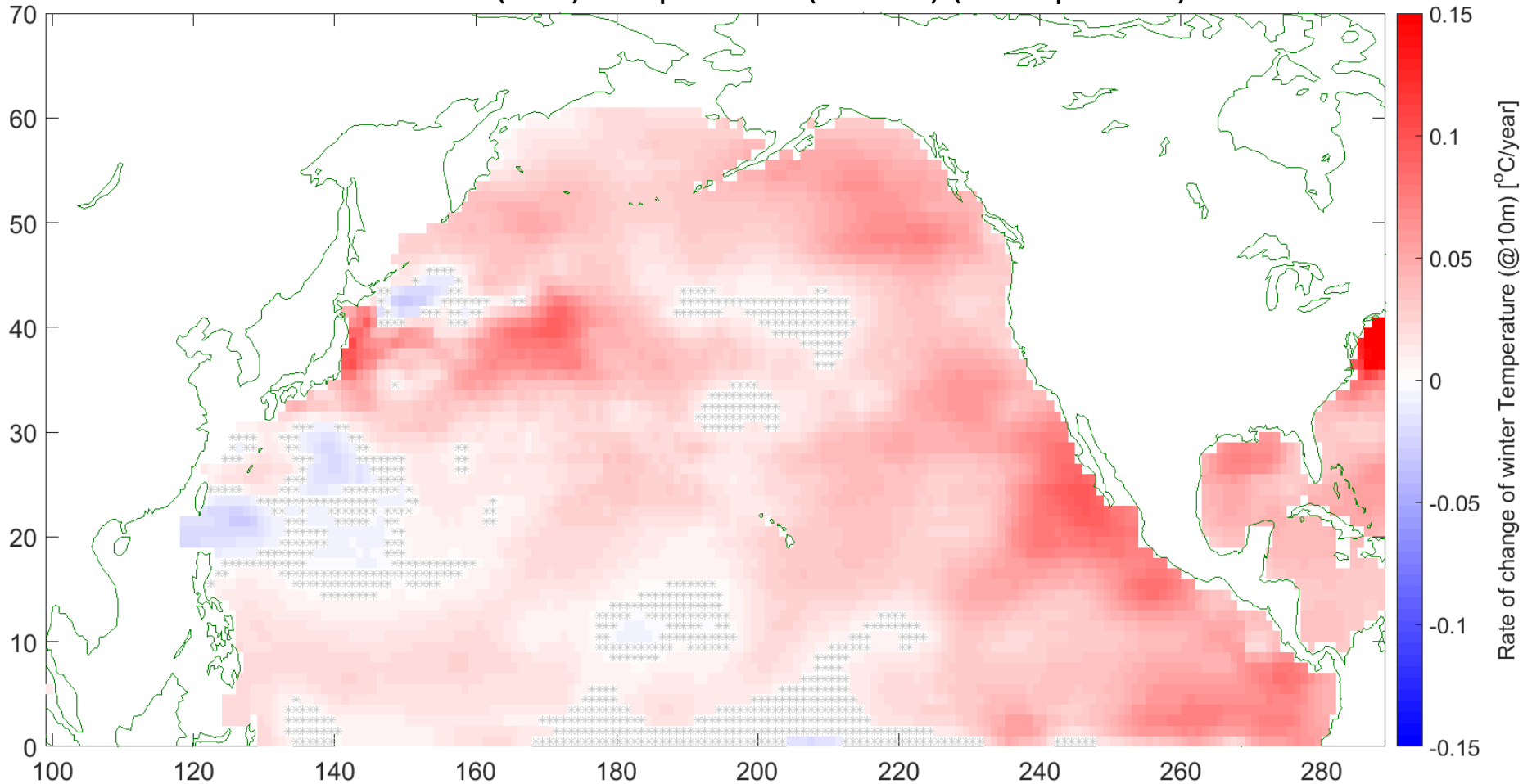


Given almost 2 decades of combined Argo and ocean color data in the North Pacific, has the observed increase in upper ocean temperature led to observable trends in stratification and chlorophyll?



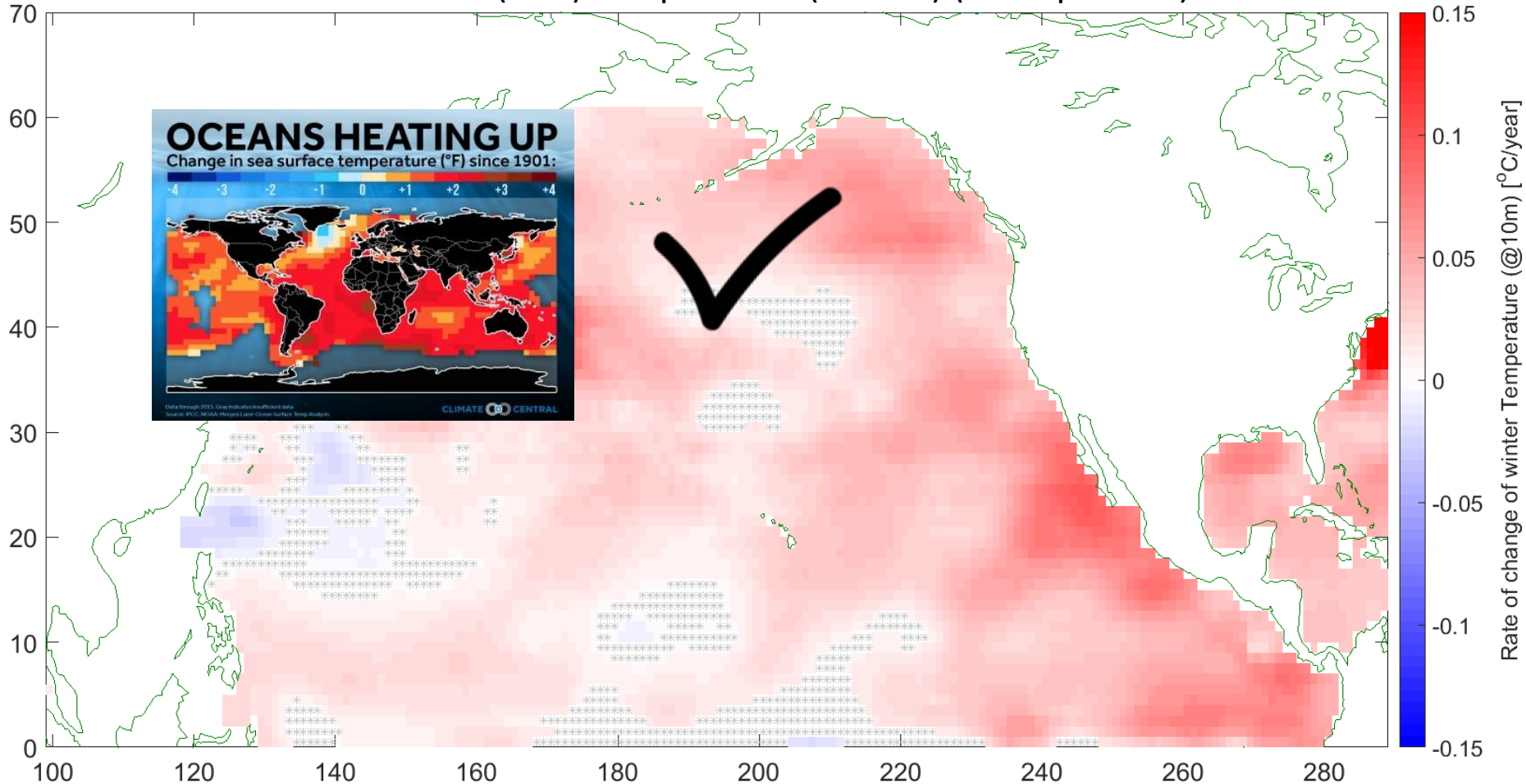
Argo: Surface Temperature

Trend in winter (JFM) Temperature (at 10m) (2001-present)



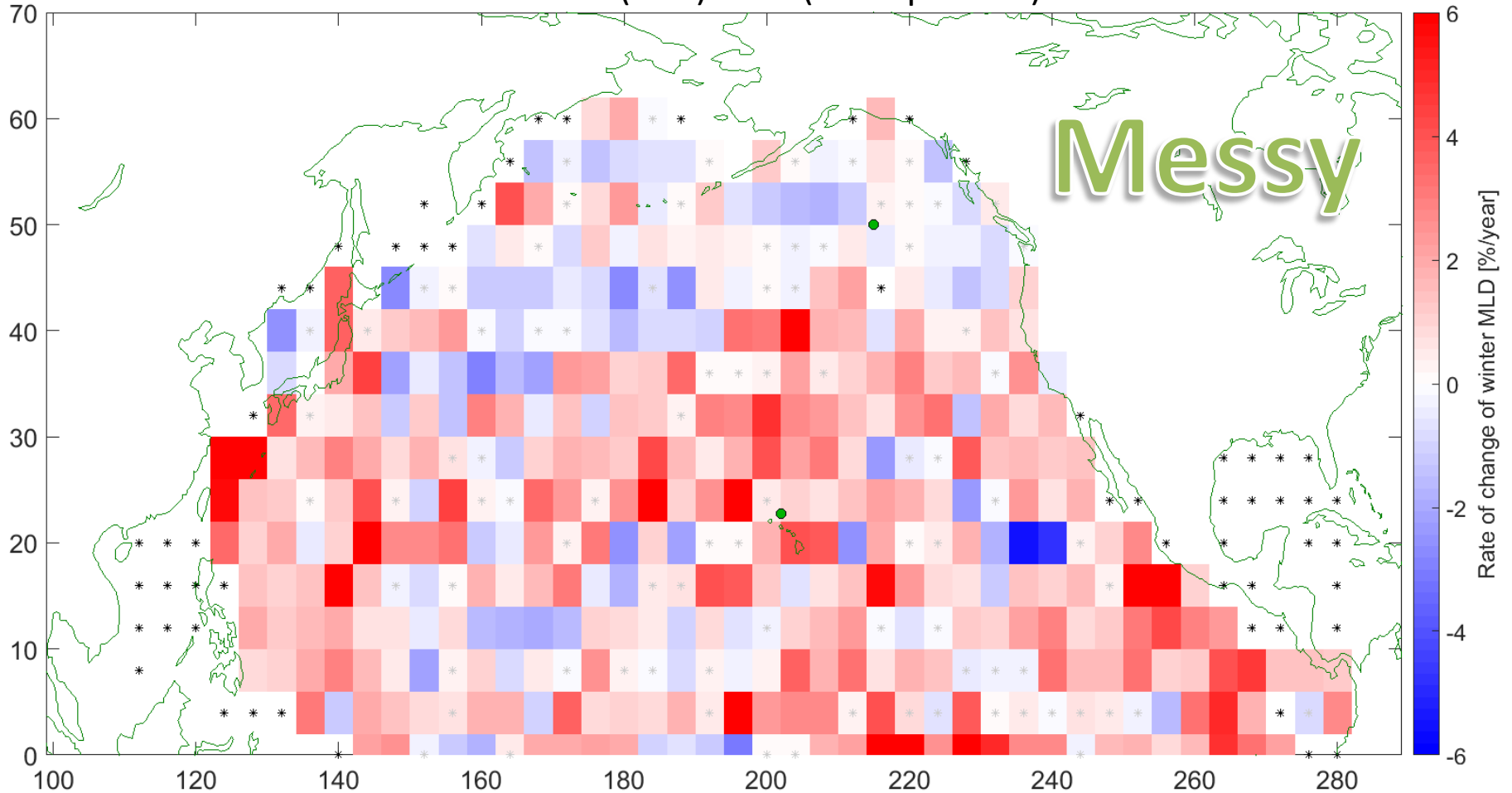
Argo: Surface Temperature

Trend in winter (JFM) Temperature (at 10m) (2001-present)



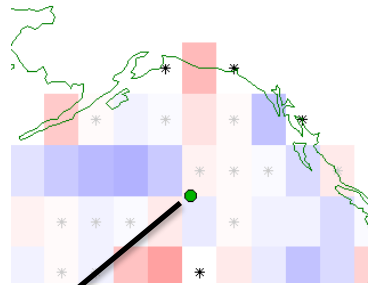
Argo: Mixed layer depth

Trend in winter (JFM) MLD (2001-present)

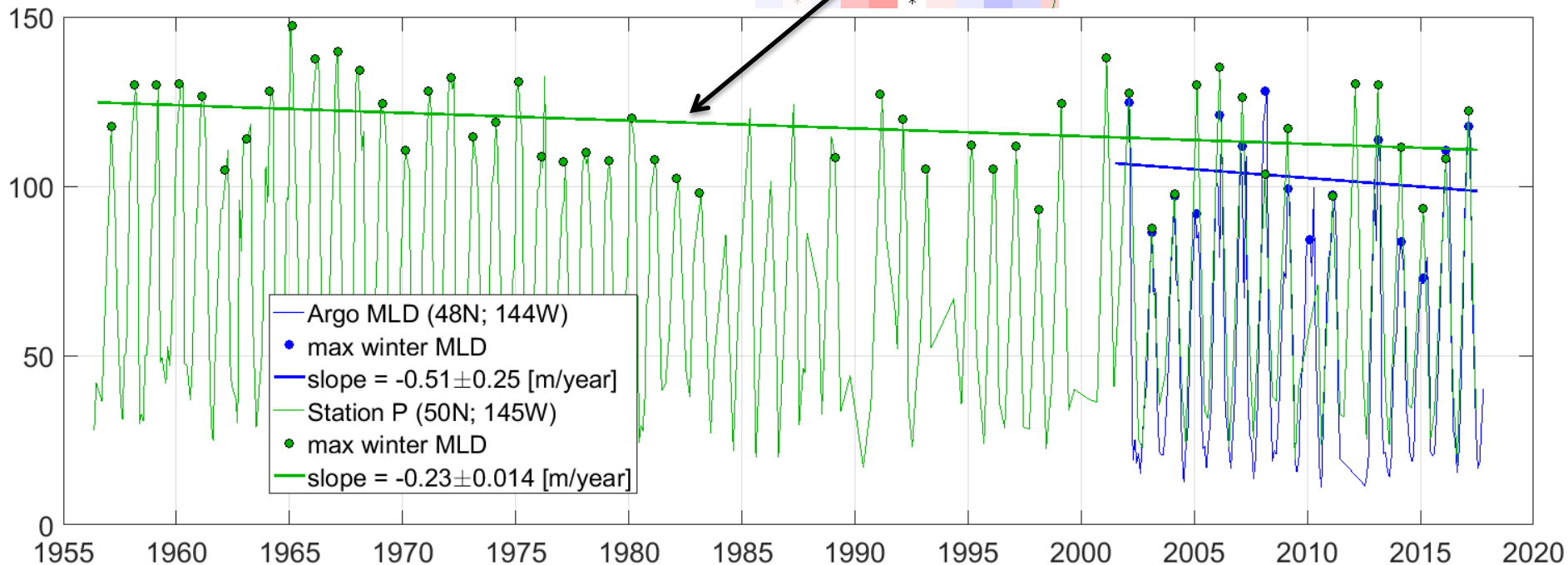


Argo: Mixed layer depth

- Large interannual variability
- Floats not always present (esp. in earlier years)
- Need long timeseries to distinguish trend

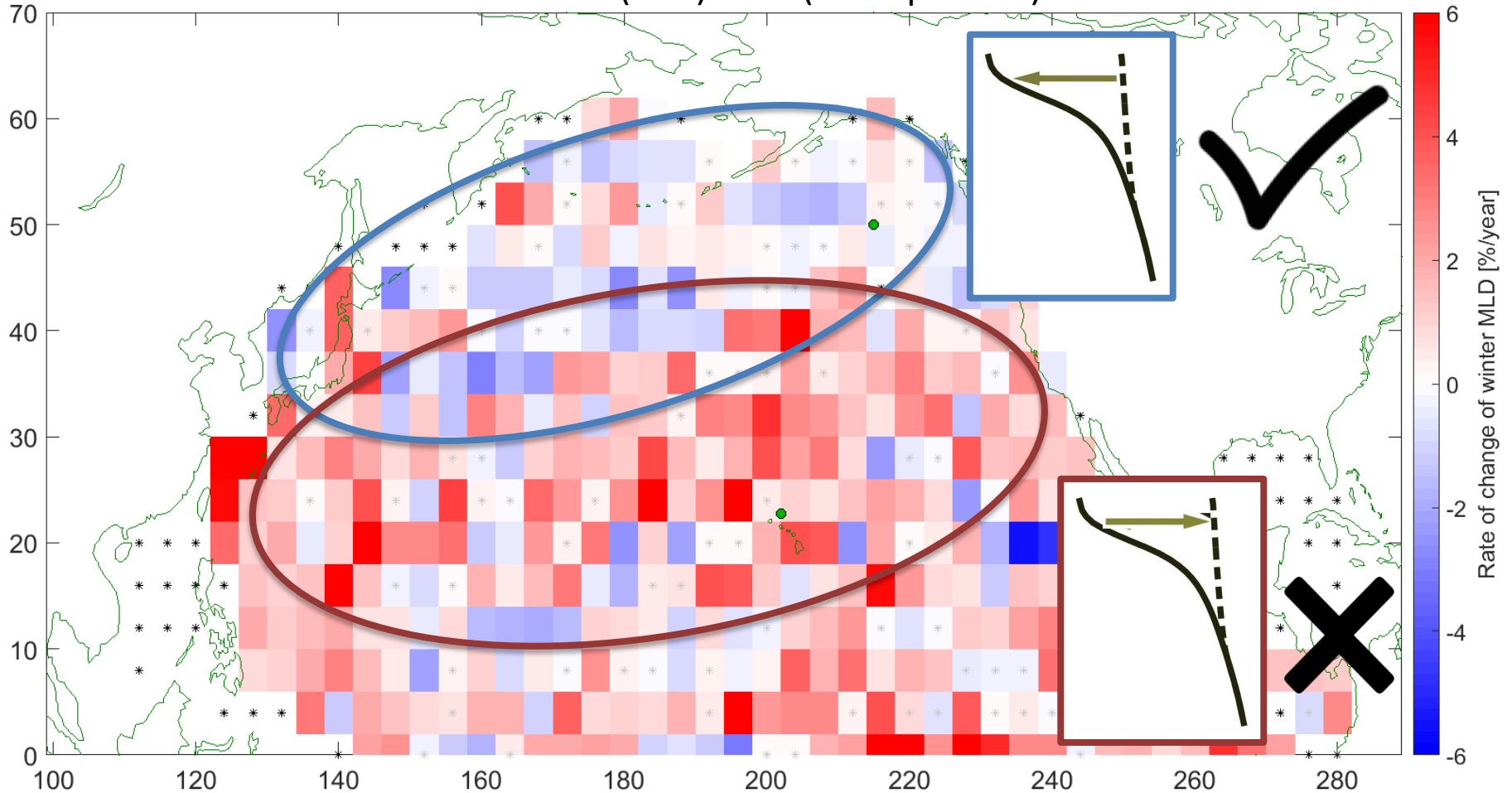


Messy



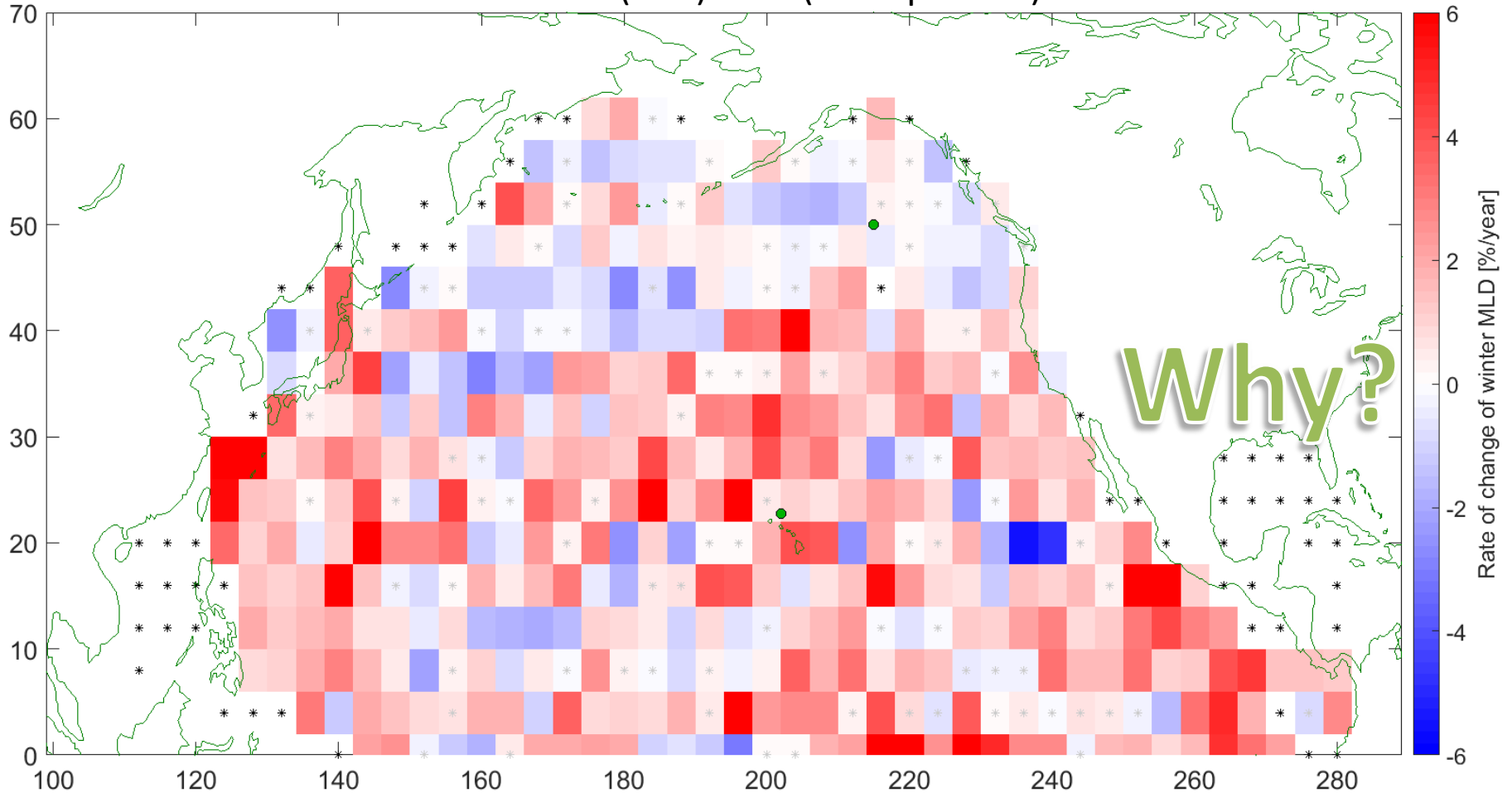
Argo: Mixed layer depth

Trend in winter (JFM) MLD (2001-present)



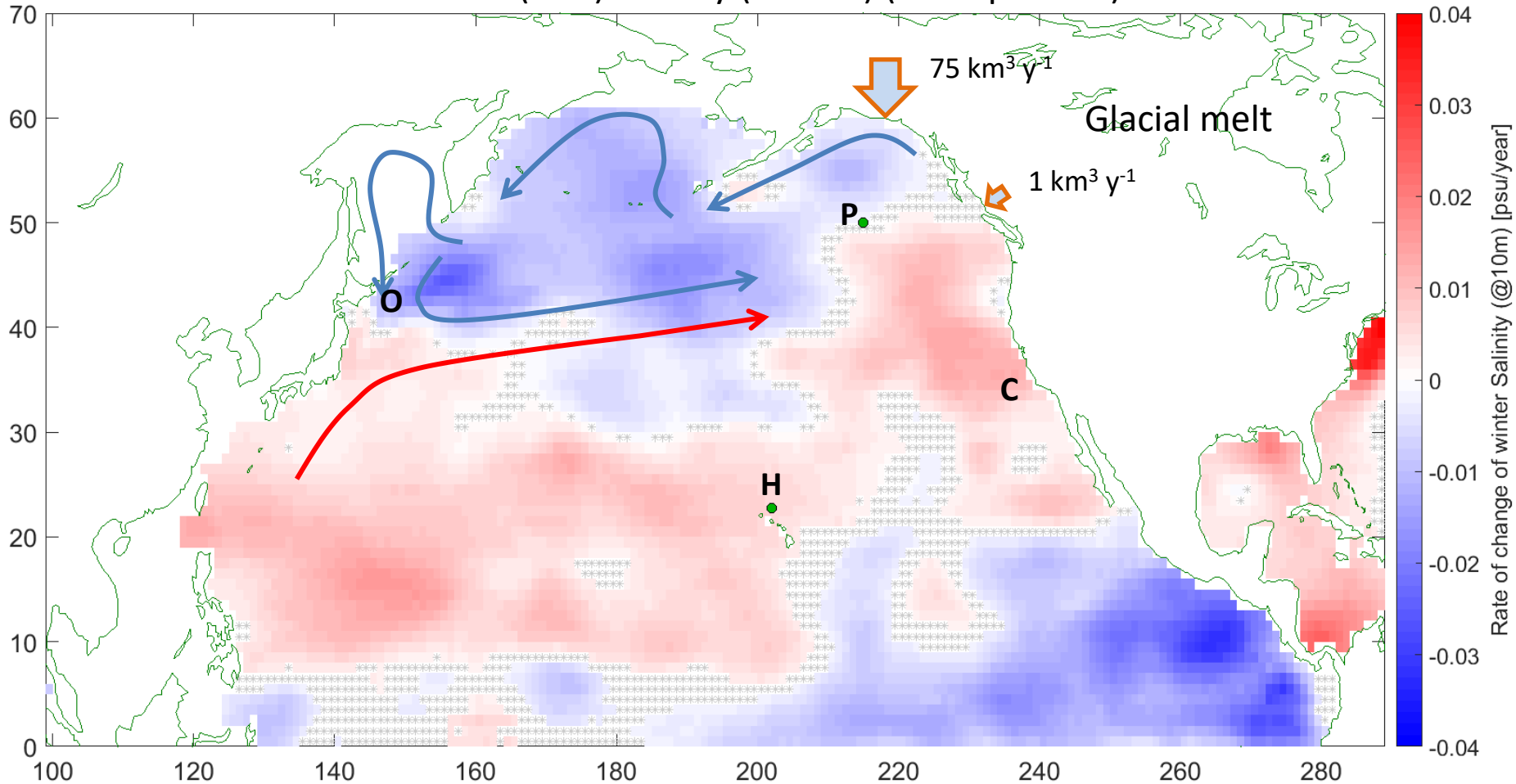
Argo: Mixed layer depth

Trend in winter (JFM) MLD (2001-present)

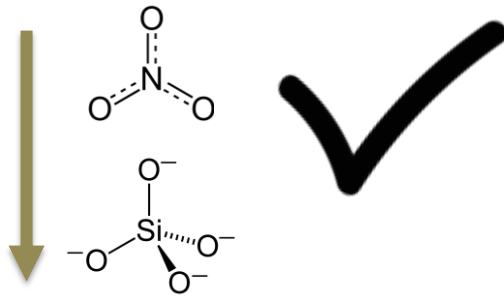
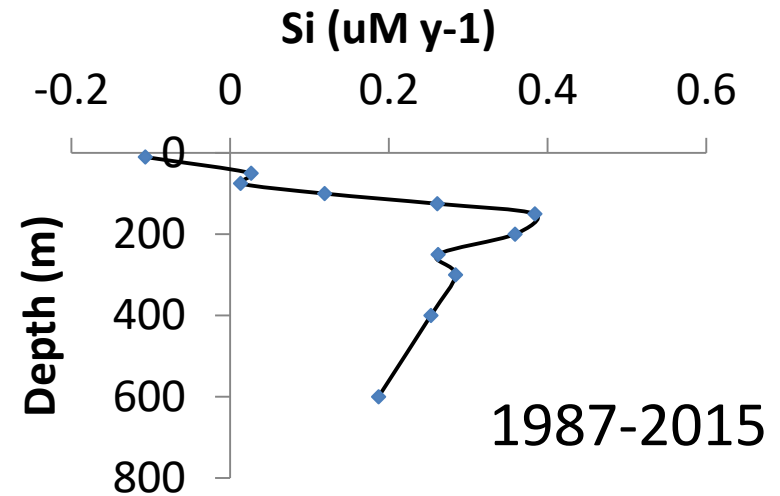
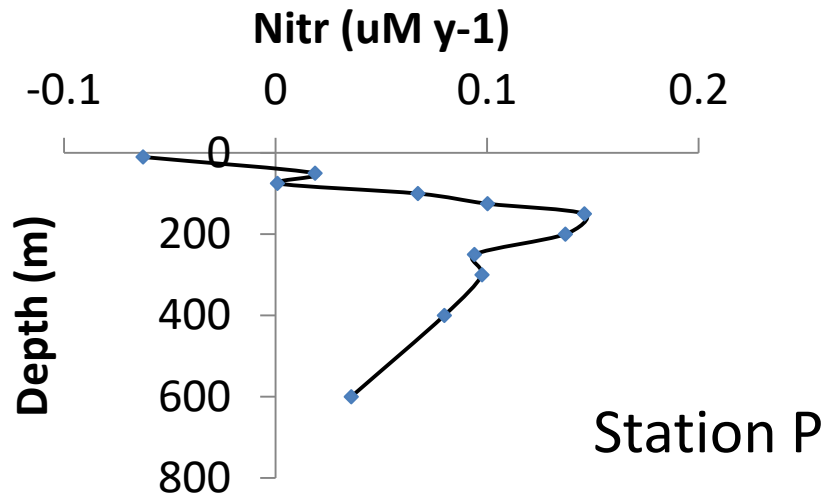


Argo: Surface Salinity

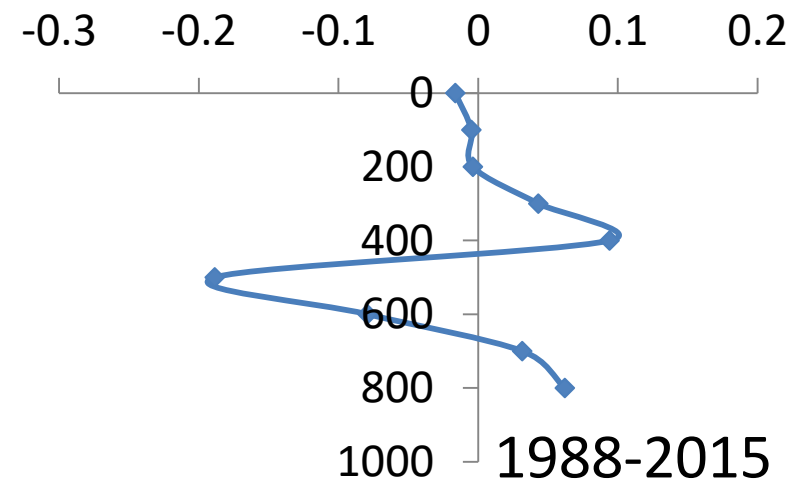
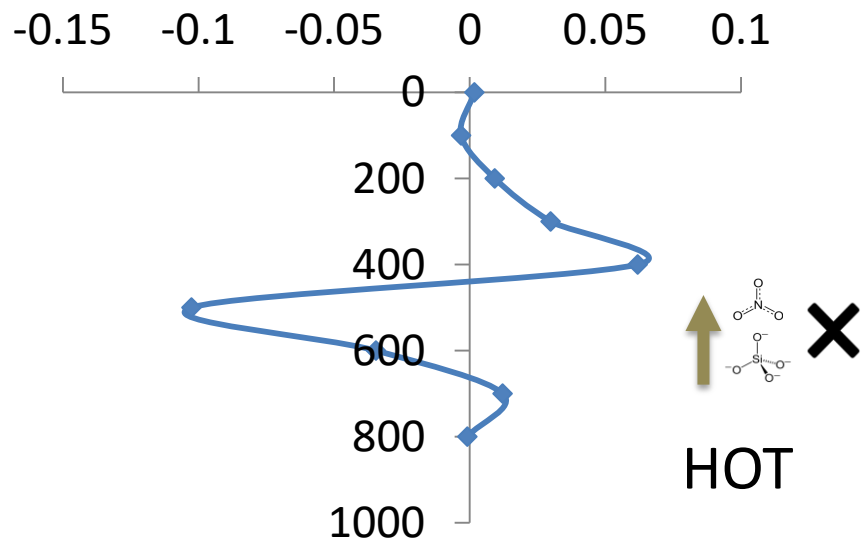
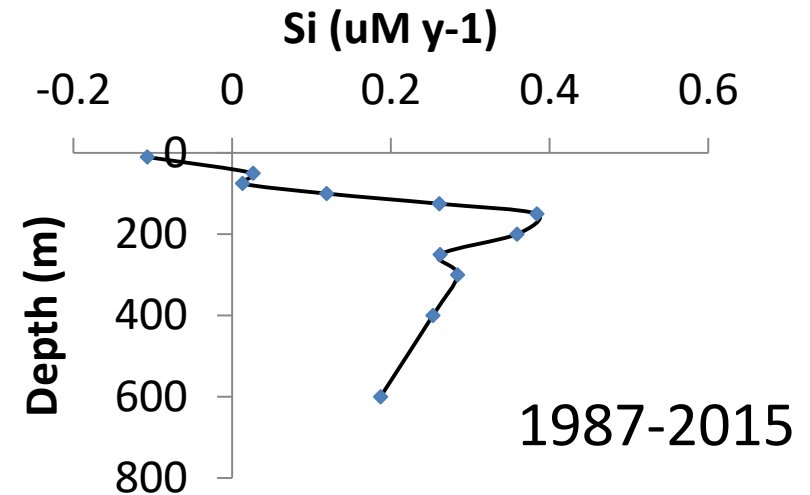
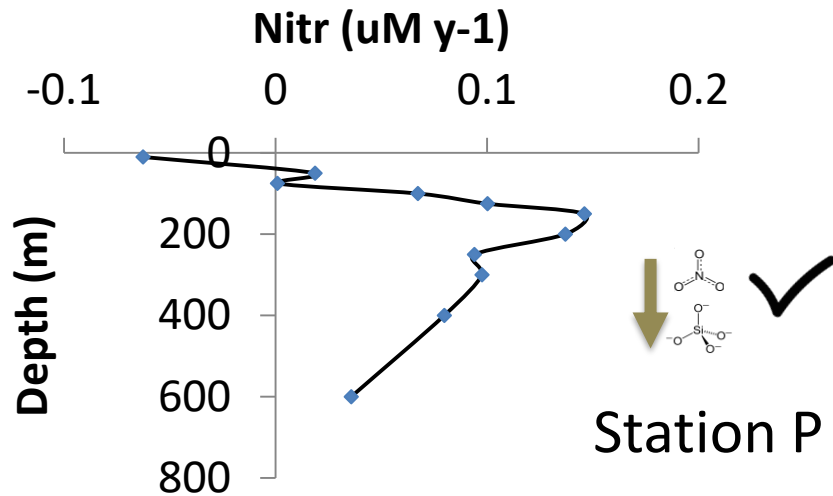
Trend in winter (JFM) Salinity (at 10m) (2001-present)



Nutrient trends (fixed station)

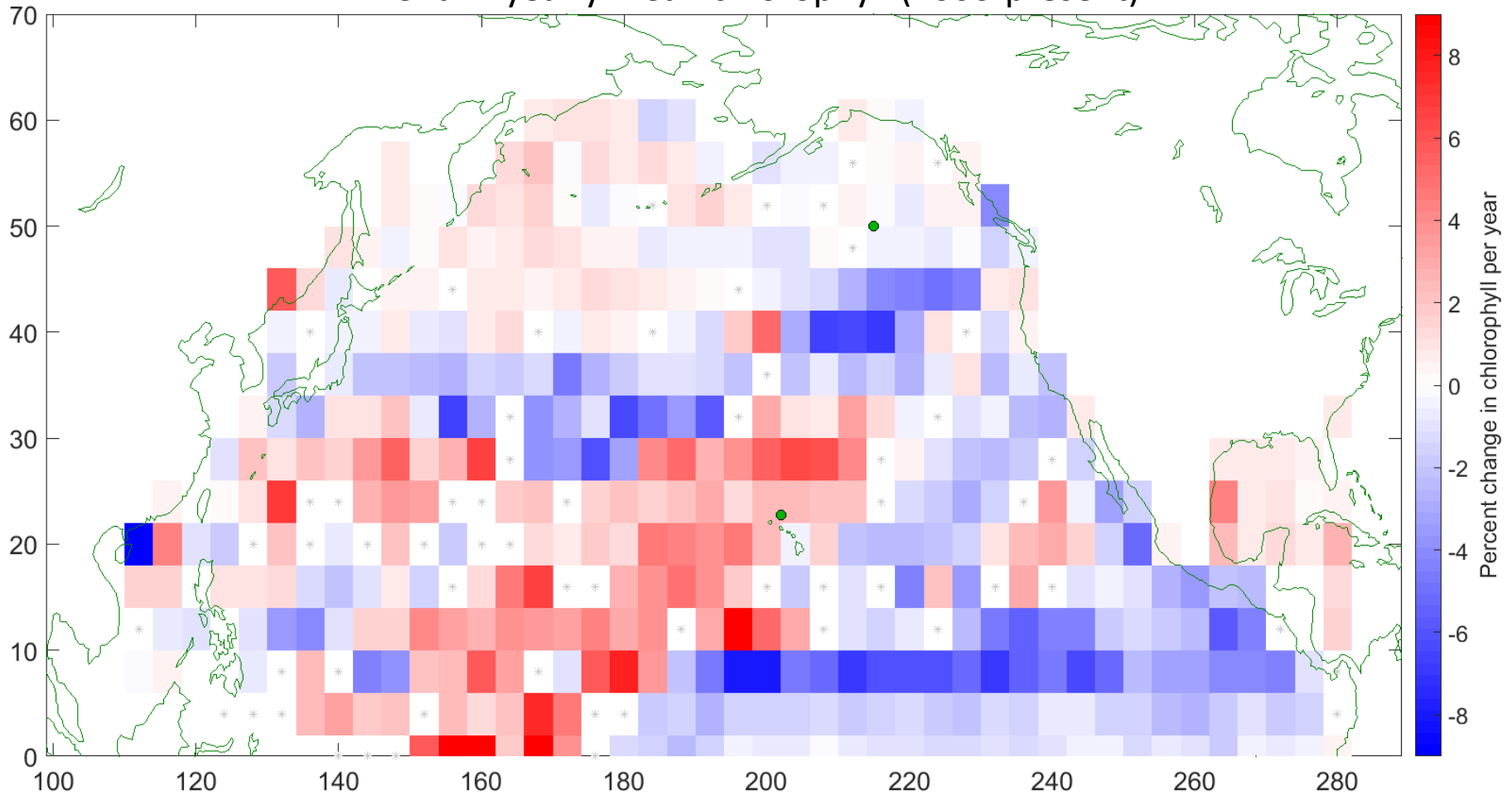


Nutrient trends (fixed station)



Terra MODIS: Chlorophyll

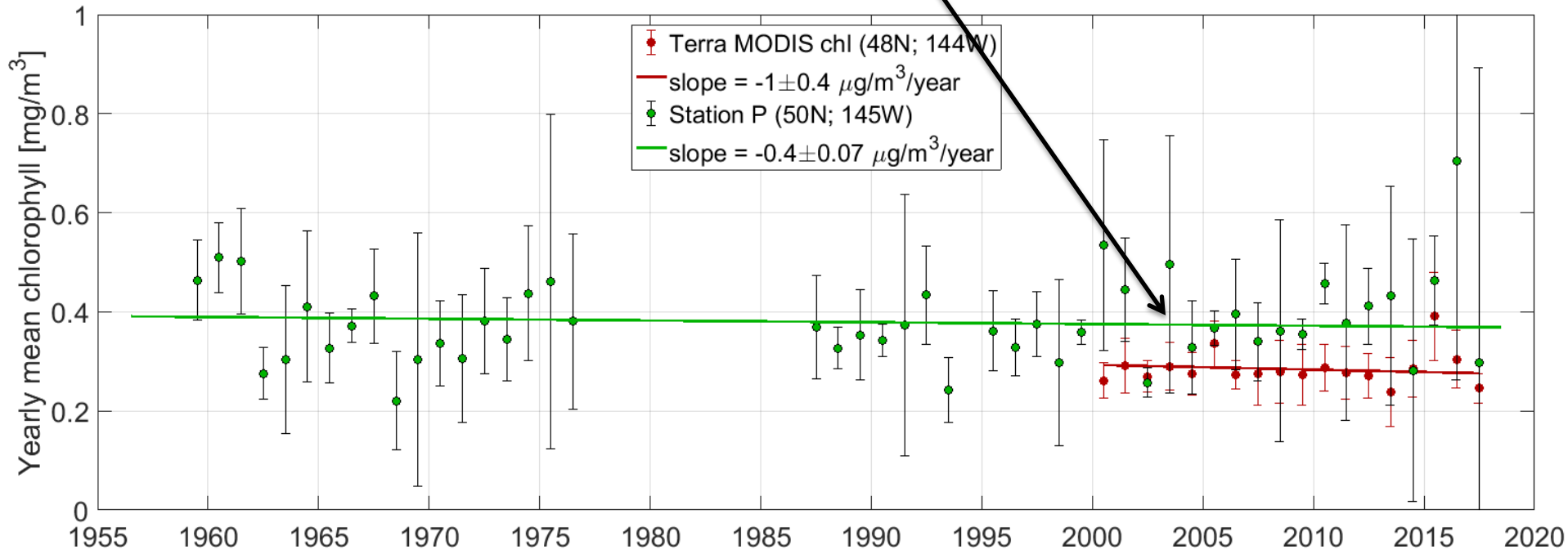
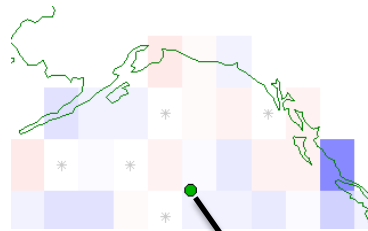
Trend in yearly mean chlorophyll (2000-present)



Terra MODIS: Chlorophyll

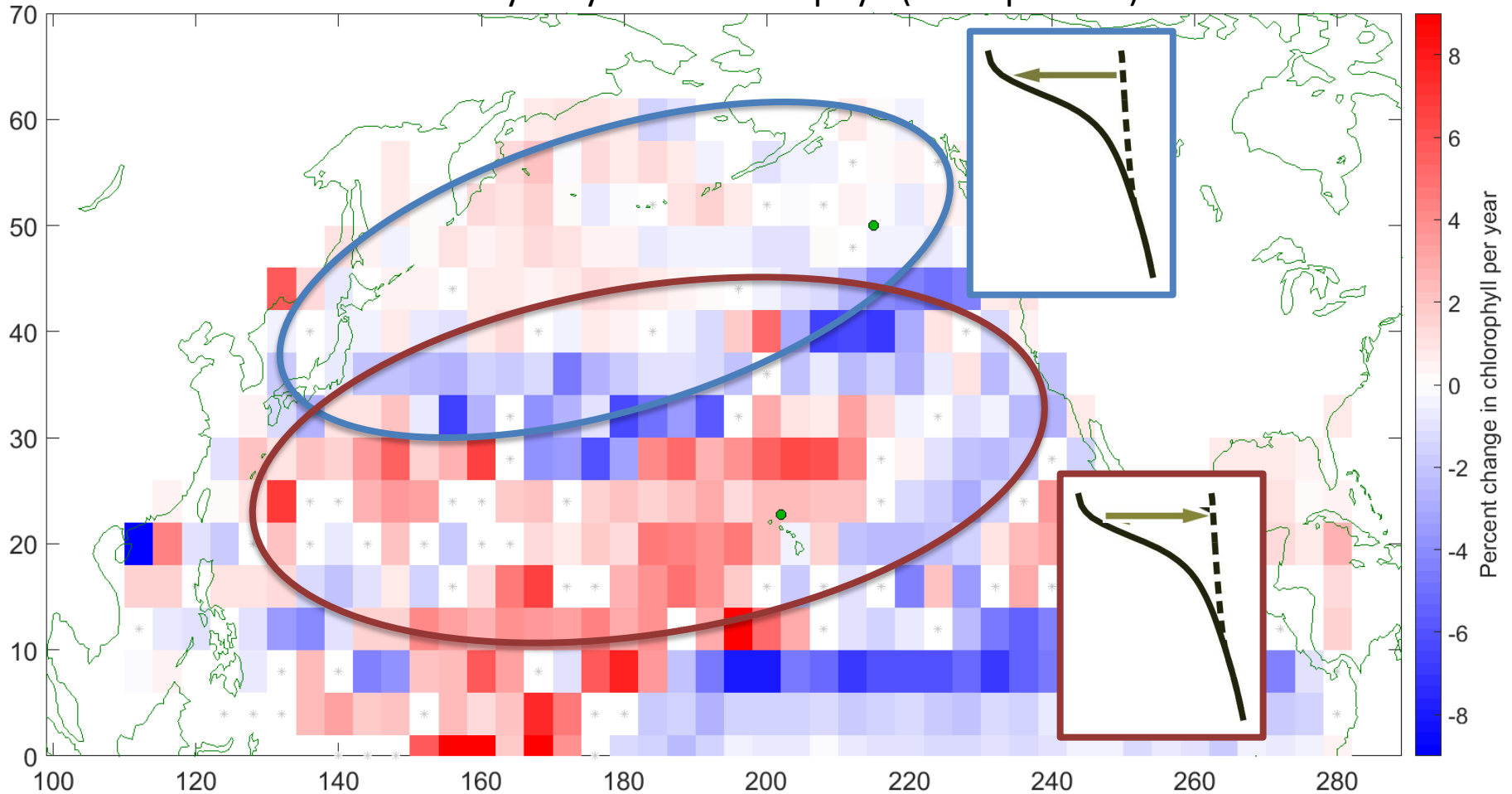
- Large interannual variability
- Trend is small
- Need long timeseries to distinguish trend

Also messy



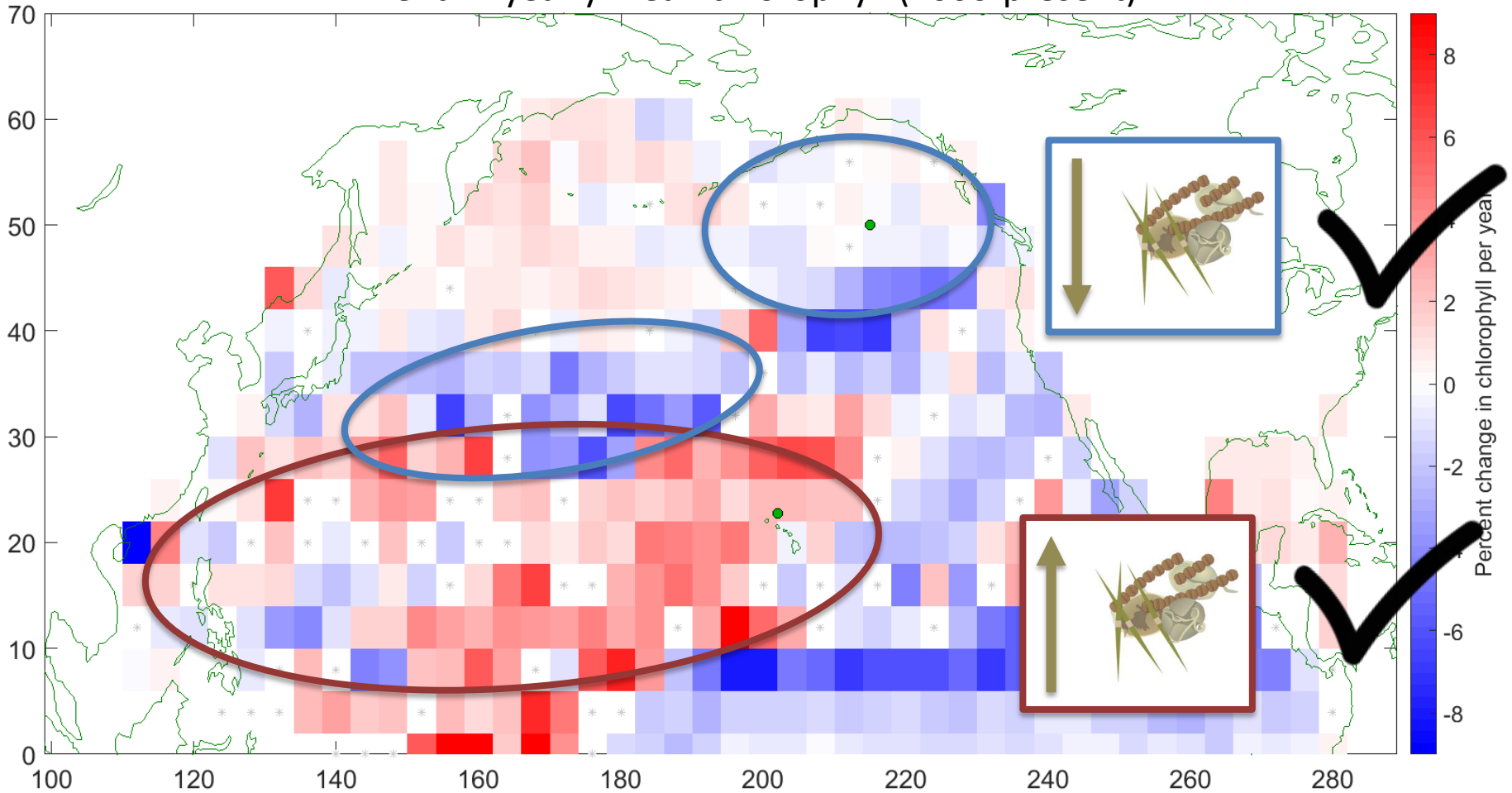
Terra MODIS: Chlorophyll

Trend in yearly mean chlorophyll (2000-present)



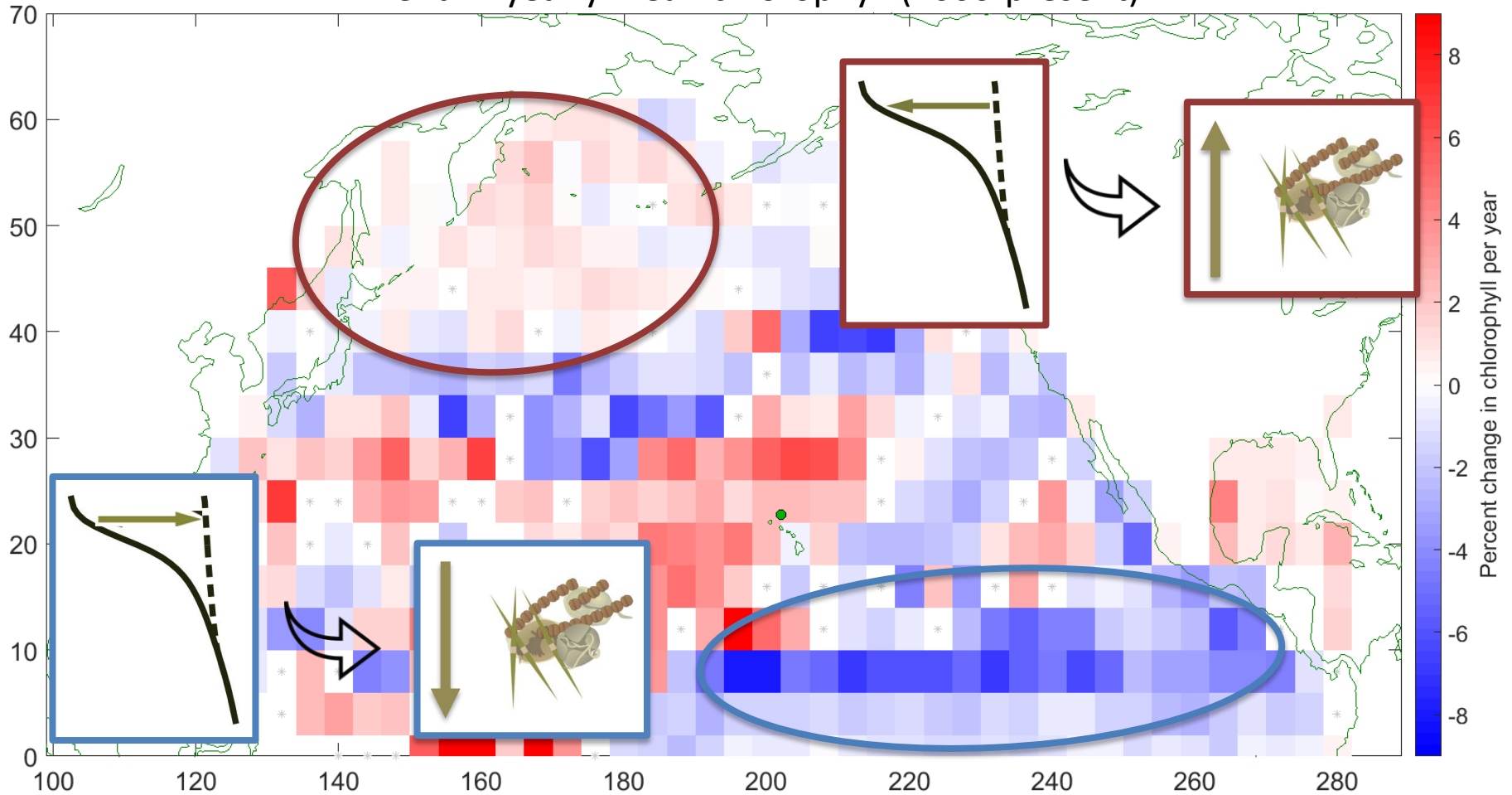
Terra MODIS: Chlorophyll

Trend in yearly mean chlorophyll (2000-present)



Terra MODIS: Chlorophyll

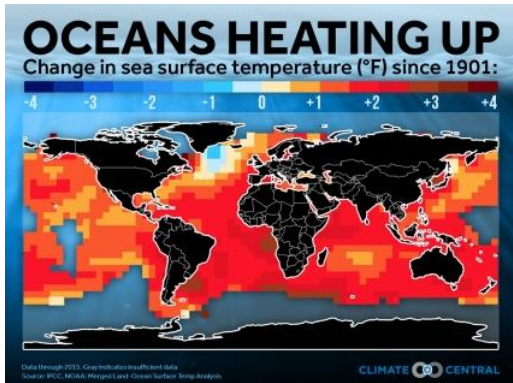
Trend in yearly mean chlorophyll (2000-present)



Summary:

The **Big** Idea

Story is complicated



**Sometimes
(salt is also
important)**

Upper ocean heating up

Stratification increasing

Not always
(e.g. HOT)

Less nutrients
at surface

Not always
(e.g. NWP
and EEP)

Not sure
(few data)

Less primary productivity

Summary

- Need longer timeseries
- Story is complicated
 - Big idea seems to hold in the eastern subarctic and western (sub-)tropical Pacific, but trends in both MLD and chlorophyll are opposite
 - Big idea seems not to hold in the western subarctic (MLD↓, CHL↑) and eastern equatorial Pacific (MLD↑, CHL↓)

Acknowledgements

- The teams that maintain the Line P and Hawaii Ocean Time-series
- JAMSTEC Argo group for the MILA GPV and MOAA GPV data products

