

Decadal scale variation in phosphate concentration in the Oyashio and Kuroshi-Oyashio Transition waters, western North Pacific from 1955 to 2010

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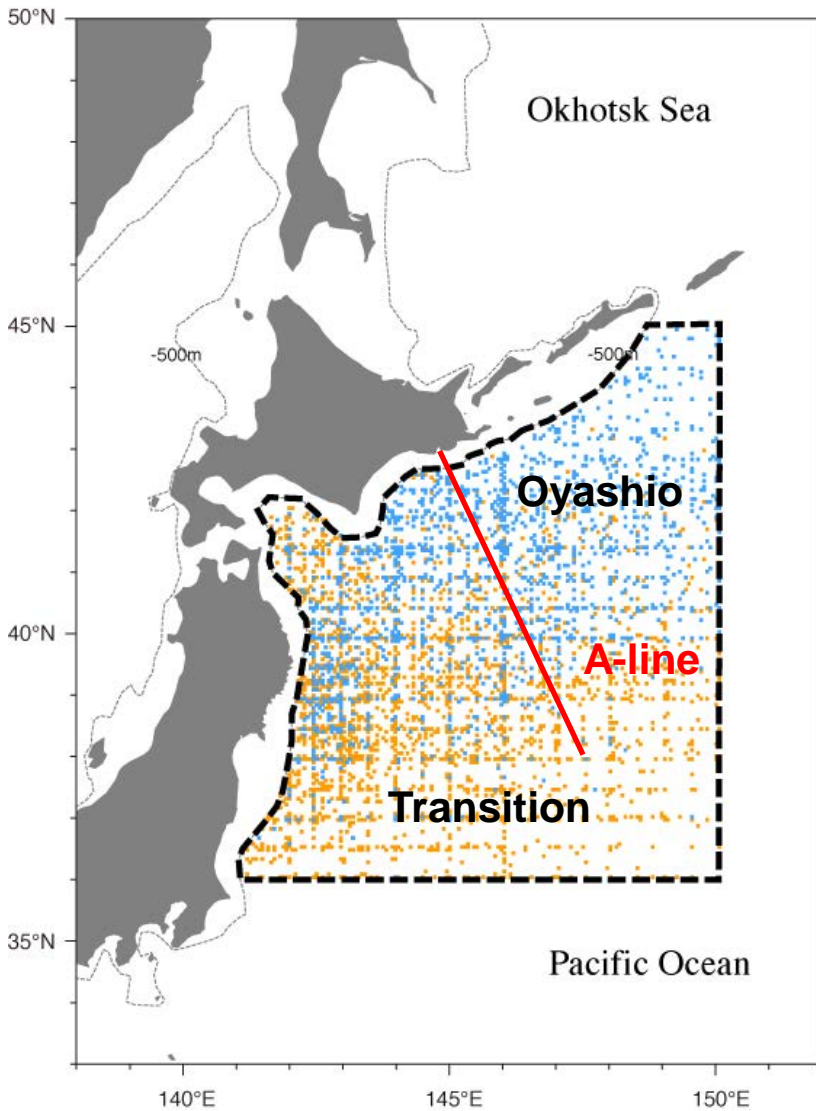
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In our previous study (Tadokoro et al. 2009), we reported decadal scale variation of the phosphate concentration in the Oyashio and Kuroshio-Oyashio Transition waters from 1955 to 2000. In this presentation, we will extend the time series until 2010 to reveal the recent change of phosphate concentration.

Outline

- 1 Phosphate change from 1955 to 2010**
- 2 Temperature and salinity changes in AR4 (2007) and AR5 (2013)**
- 3 Changes of nutrients in the other areas of North Pacific**
- 4 Summary**

Data & Methods



Period 1951-2010

Data WOD2009, A-line, JMA
nutrients, temperature
salinity

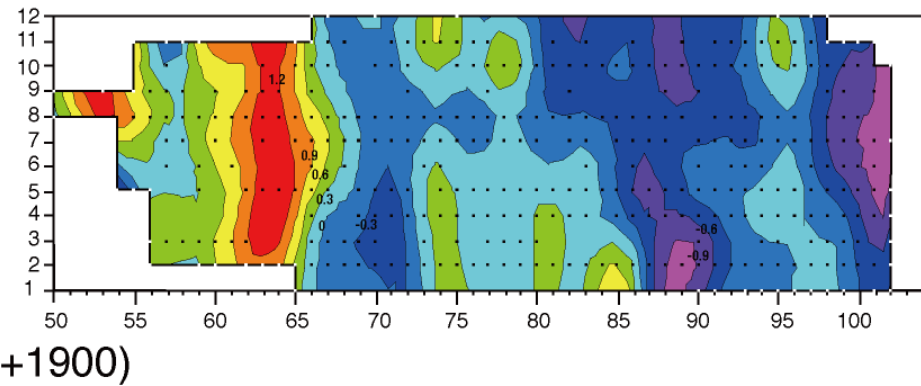
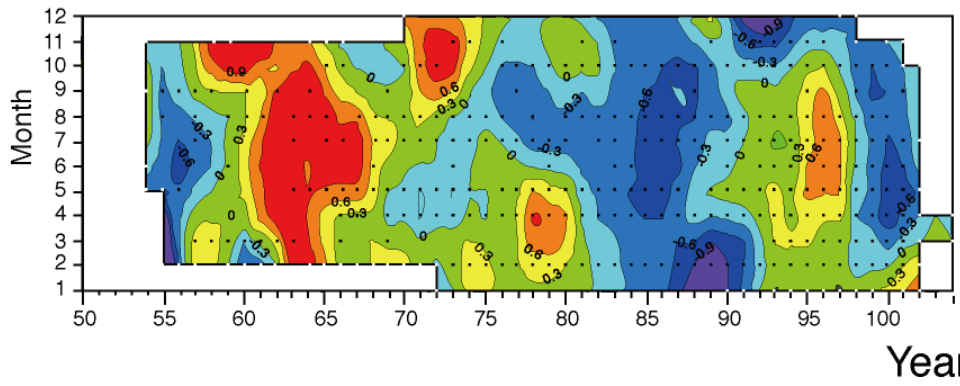
Criteria Oyashio >5 degree C
Transition 5-15 degree C
at 100m depth Kawai (1972)
bottom depth >500m

Variation in PO₄ (monthly normalized value) 1955-2002 (previous study)

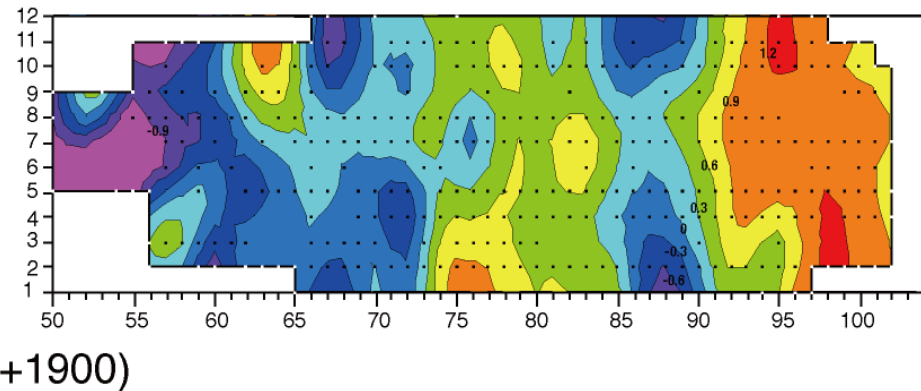
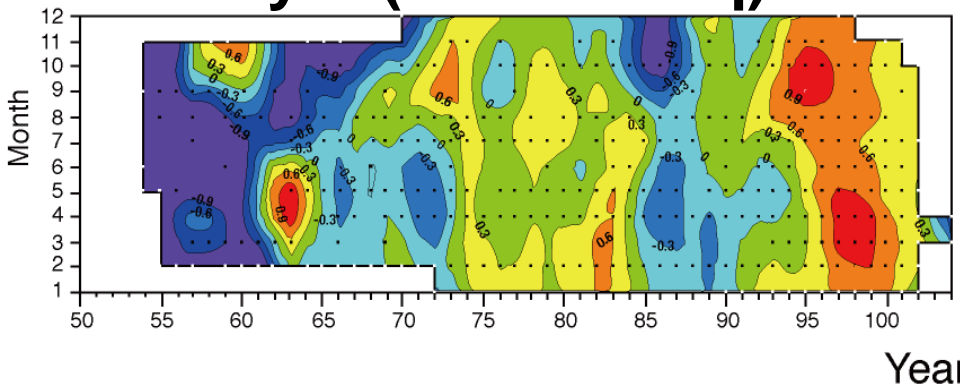
Oyashio

Transition

Surface layer (0m)

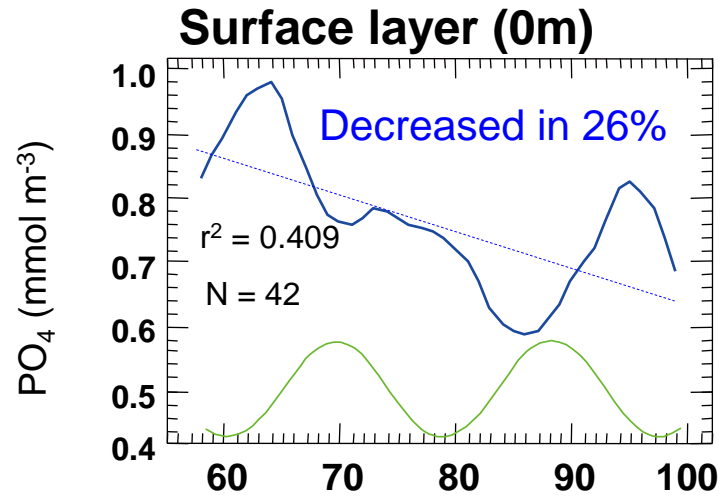


Mid-layer (26.7-26.8sq)

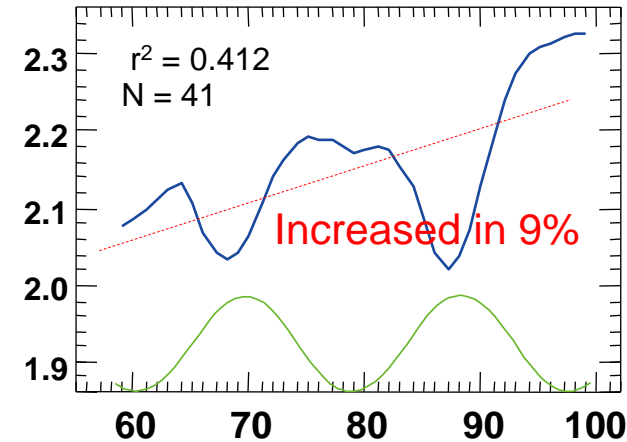
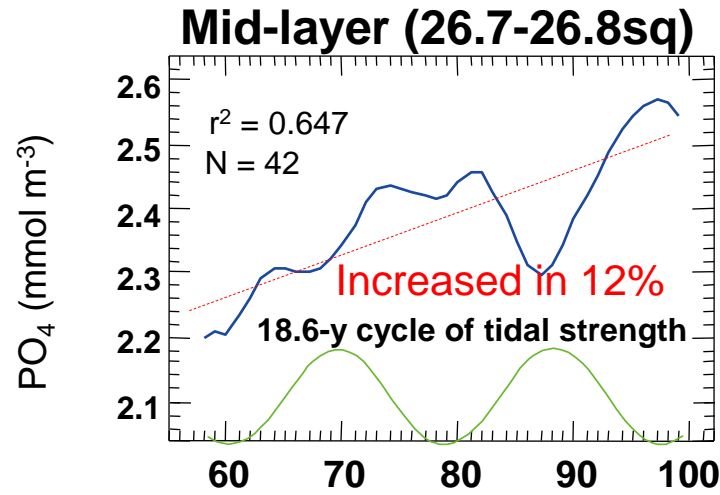
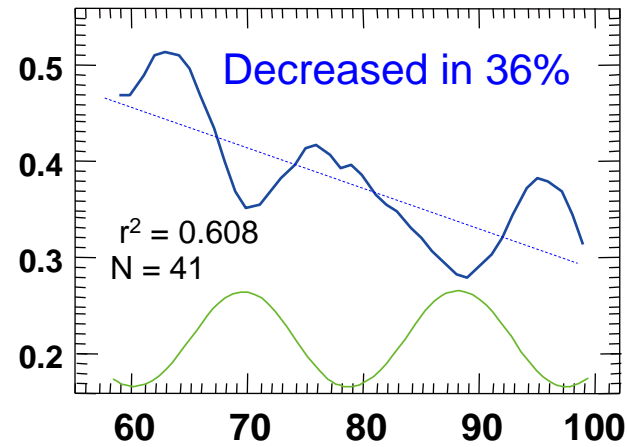


Variations in annual mean value from 1955 to 2000

Oyashio



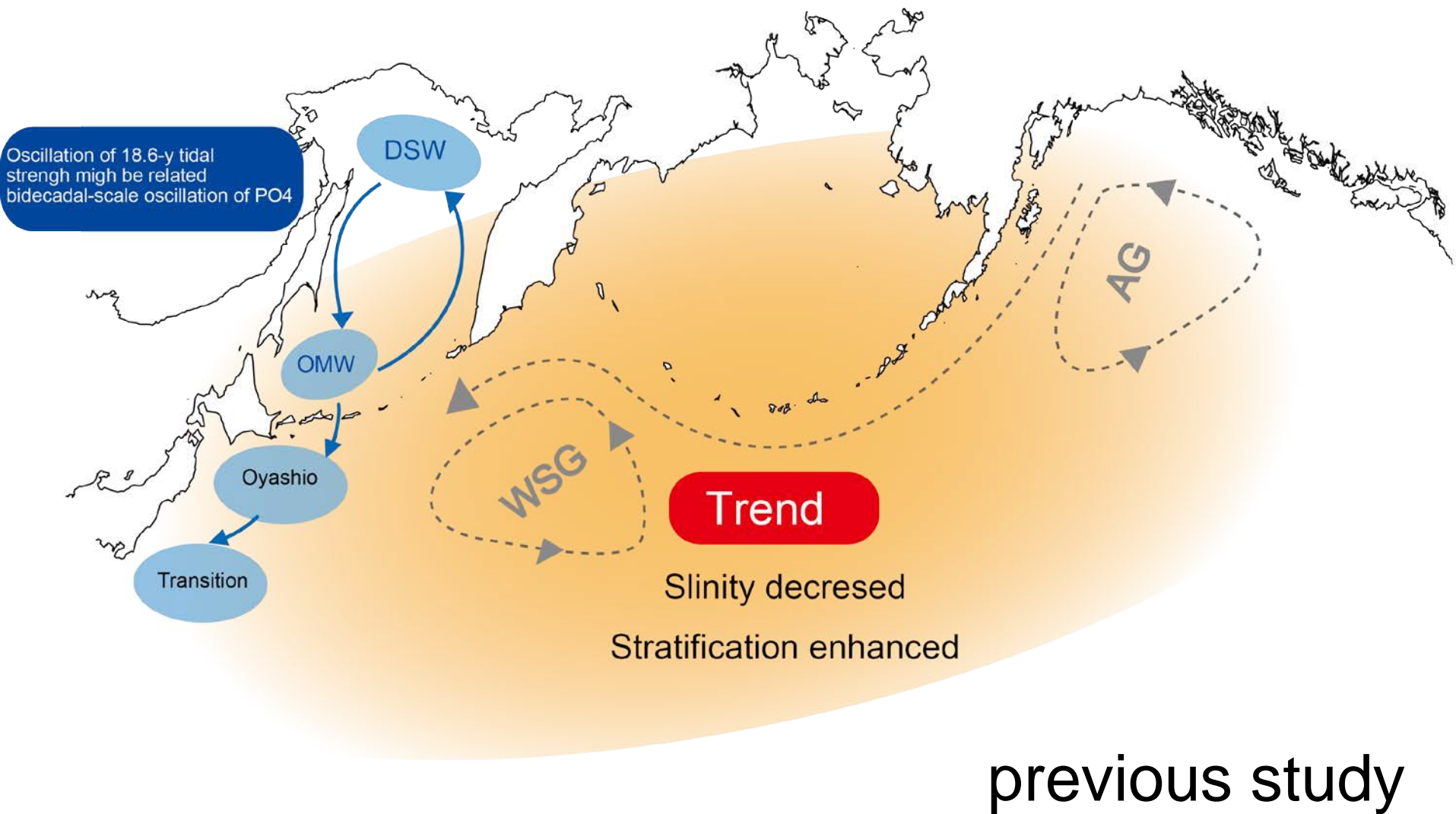
Transition



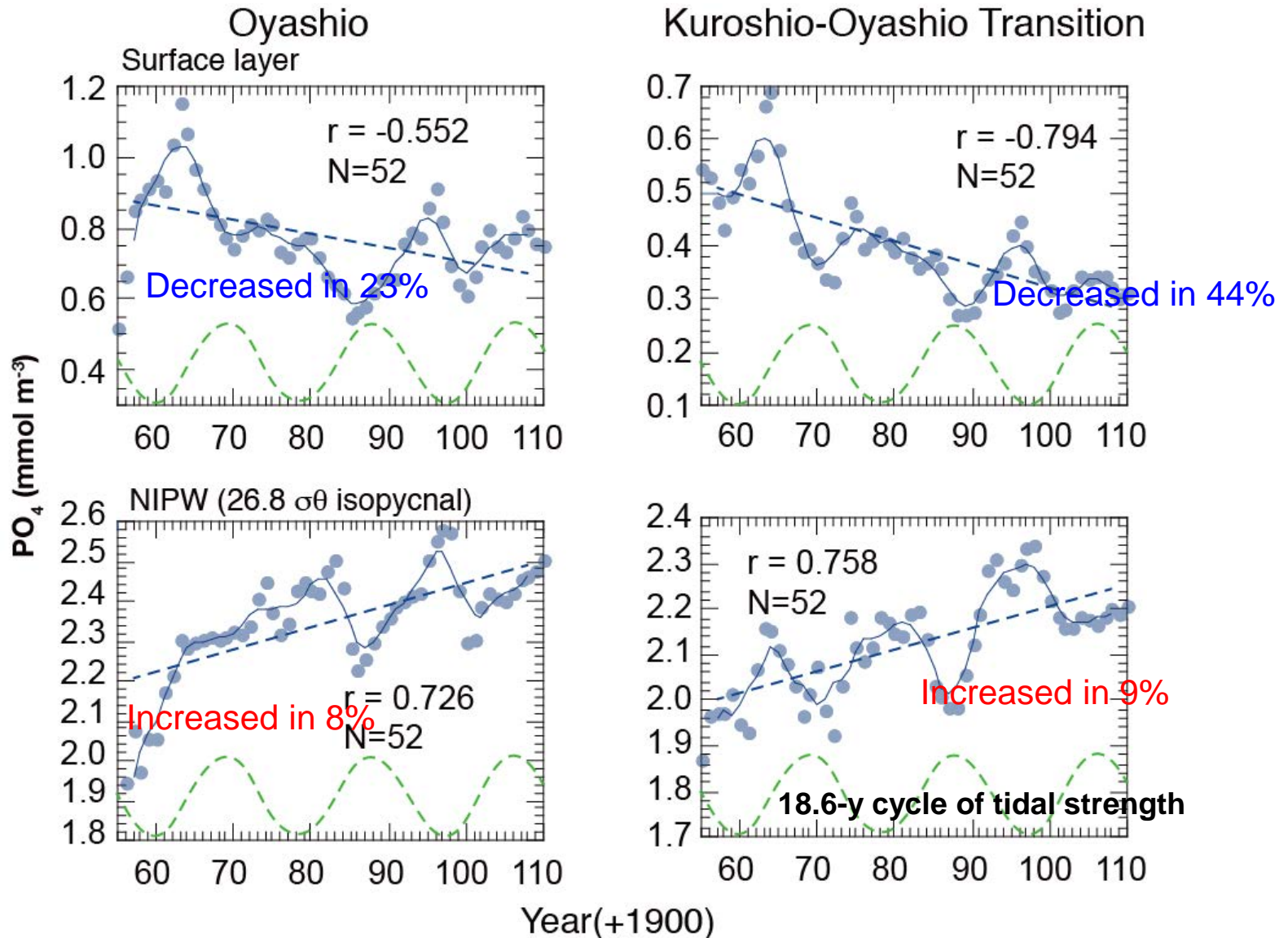
Year(+1900)

previous study

Hypothesis: Mechanisms of the phosphate change



Variations 1955 to 2010

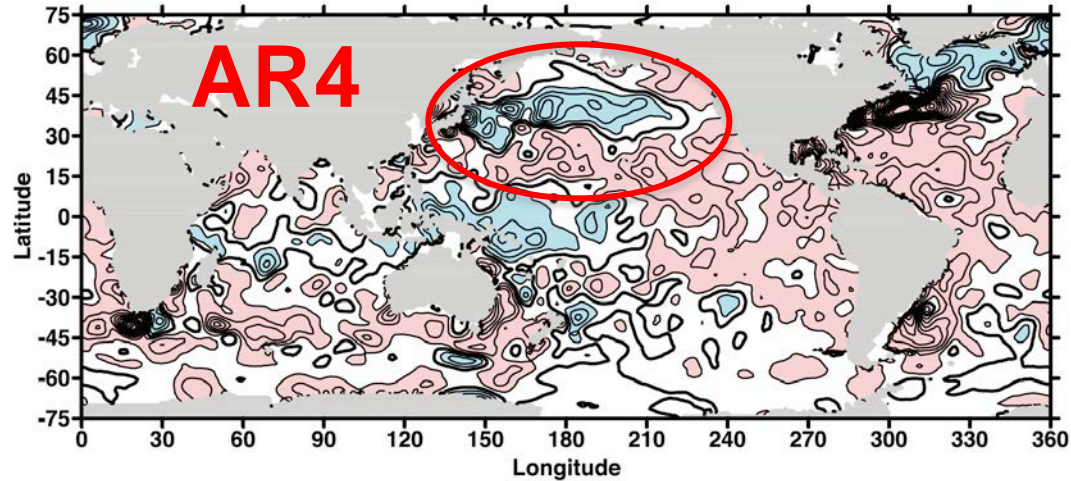


New data supported our hypothesis.

Temperature and salinity change in AR4 (2007) and AR5 (2013)

Temperature change

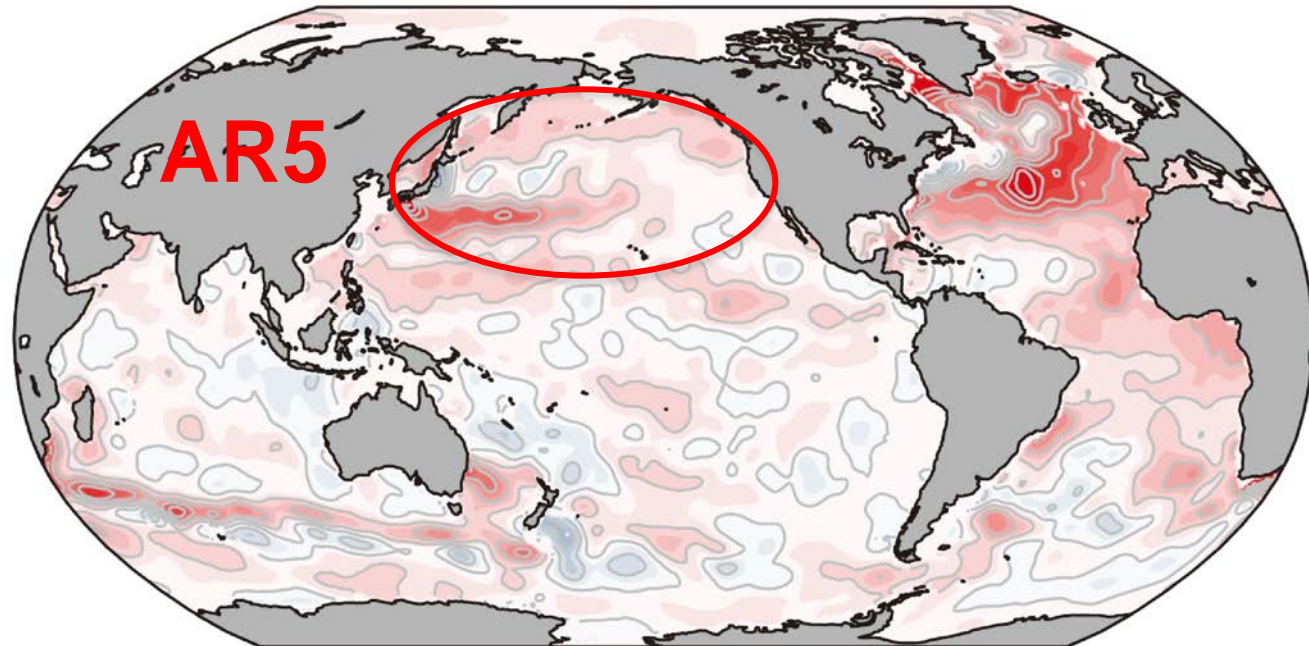
1955-2003



XBT and MBT biases introduced spurious warming in the 1970s and cooling in the early 1980s in the analyses assessed in AR4.

Figure 5.2. Linear trends (1955–2003) of change in ocean heat content per unit surface area ($W m^{-2}$) for the 0 to 700 m layer, based on the work of Levitus et al. (2005a). The linear trend is computed at each grid point using a least squares fit to the time series at each grid point. The contour interval is $0.25 W m^{-2}$. Red shading indicates values equal to or greater than $0.25 W m^{-2}$ and blue shading indicates values equal to or less than $-0.25 W m^{-2}$.

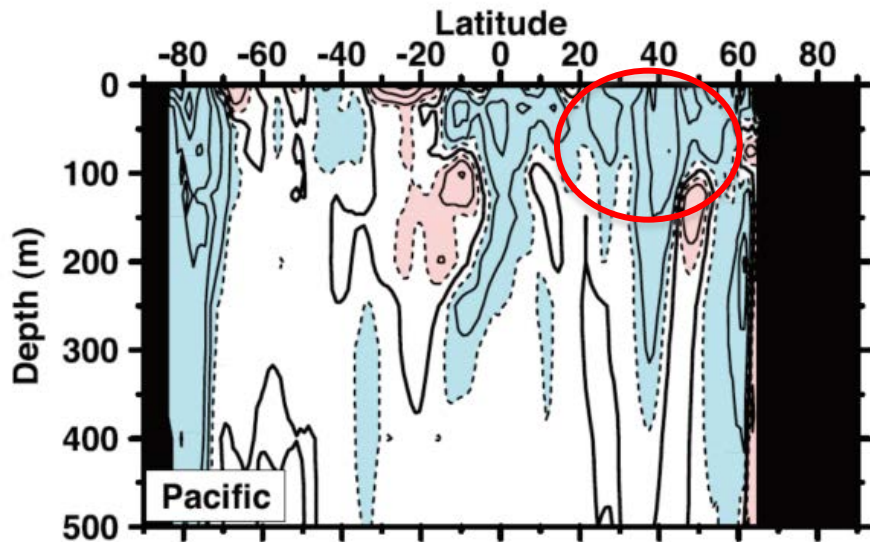
1971-2010



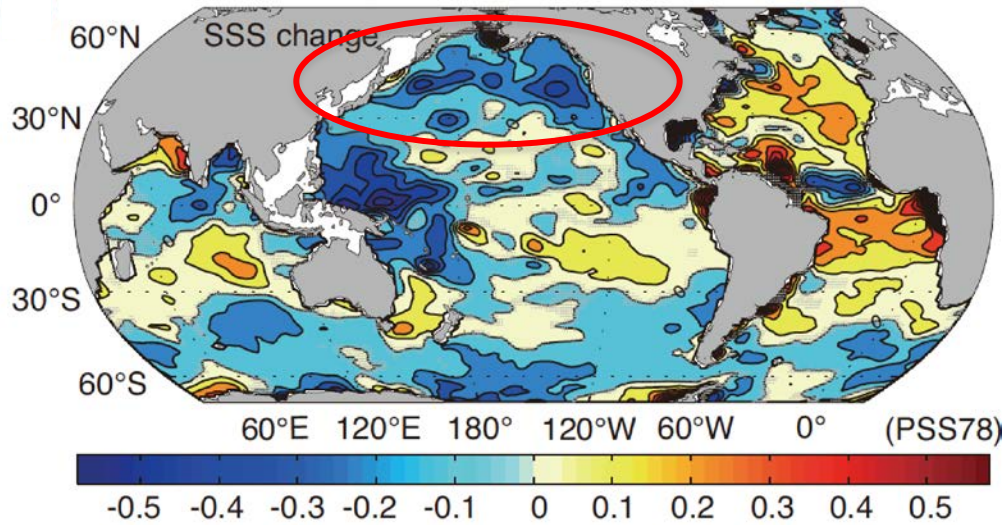
After removing XBT and MBT data, surface temperature increased in the broad area of North Pacific.

Salinity change

AR4



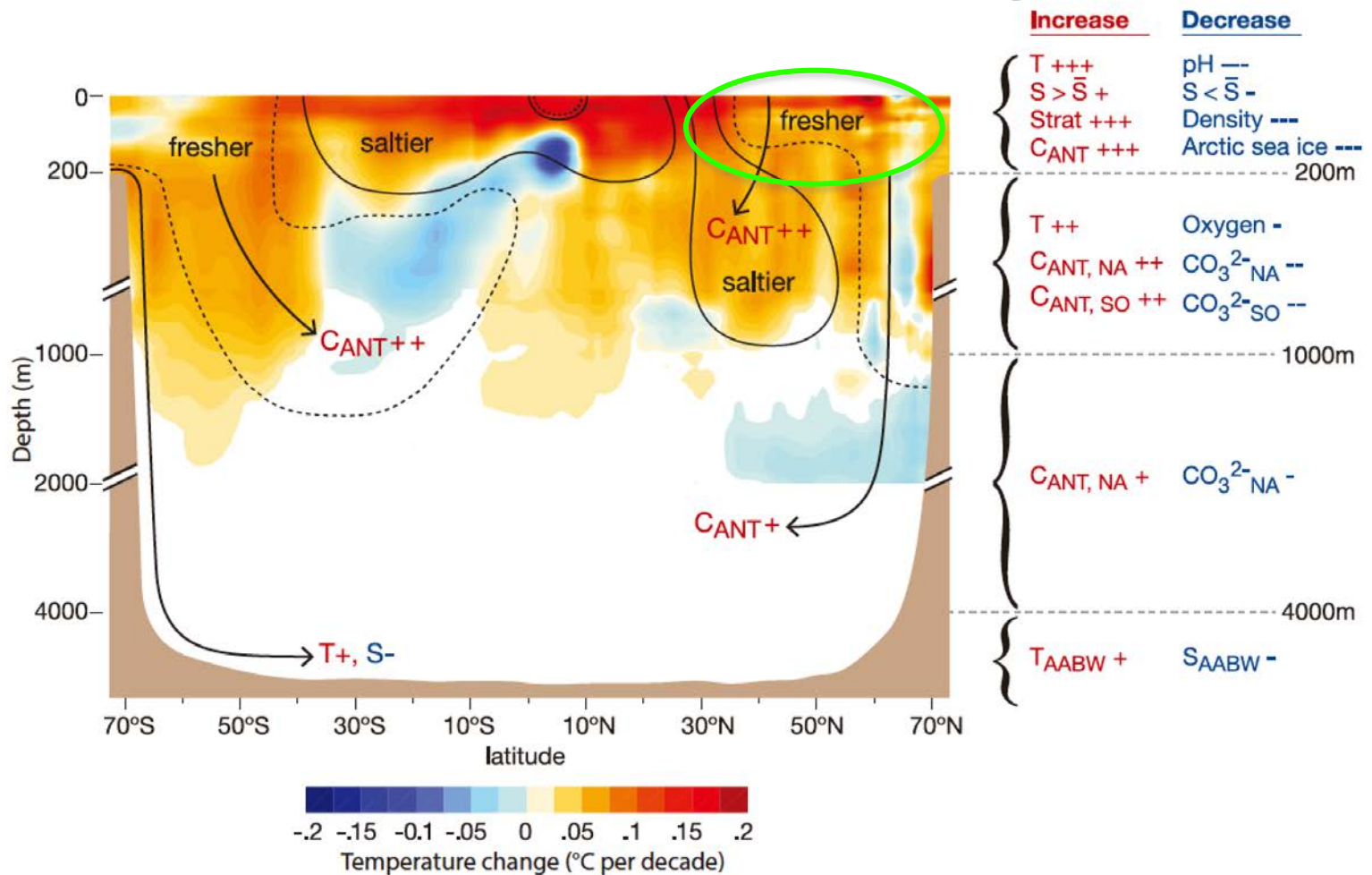
AR5



The 58-year (2008 minus 1950)

Salinity of surface layer decreased broad area of the North Pacific.

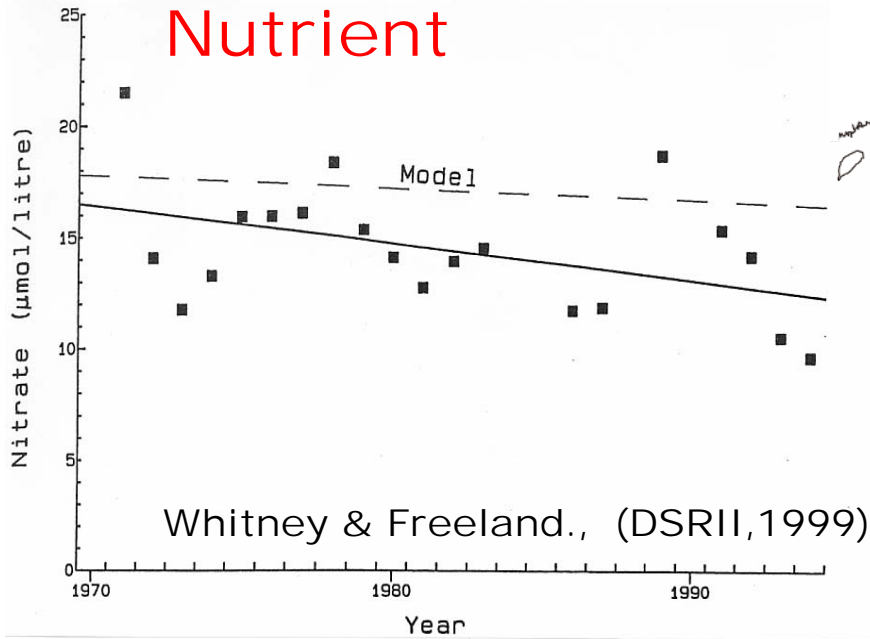
Schematic of TS change



Stratification will be enhanced due to change temperature and salinity. Those might be cause of the decreasing of the nutrients supply from mid-layer to surface layer due to decrease the vertical water exchange.

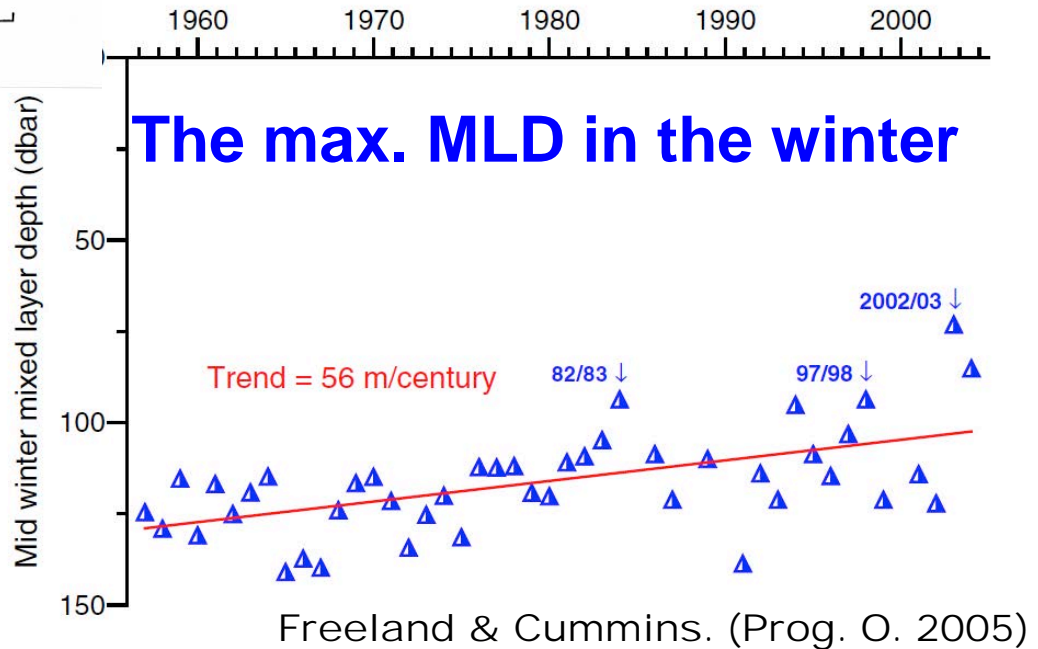
Change in nutrients variation in the other areas of North Pacific

Gulf of Alaska



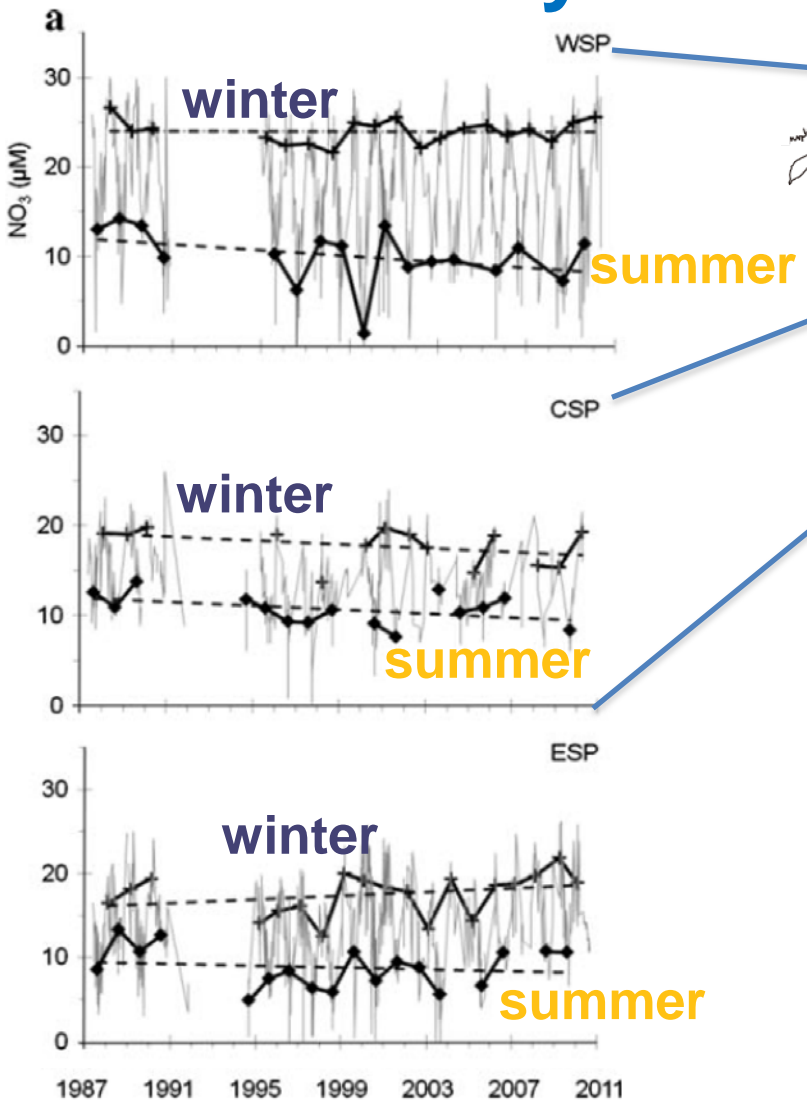
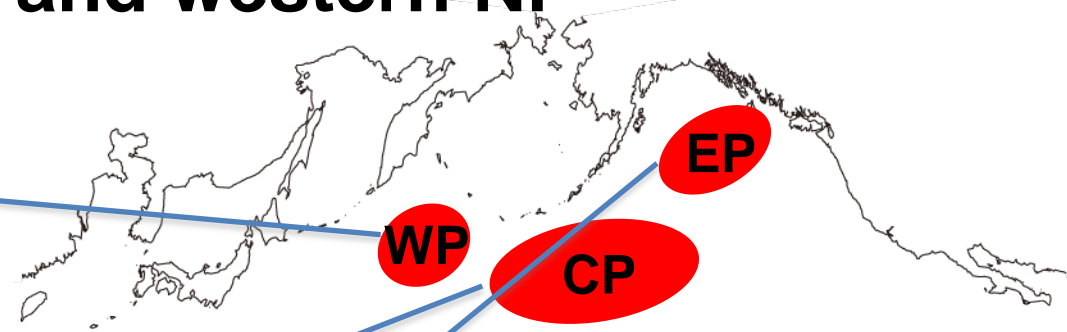
Winter NO_3 in surface layer

Winter NO_3 represented decrease trend from 1970s.

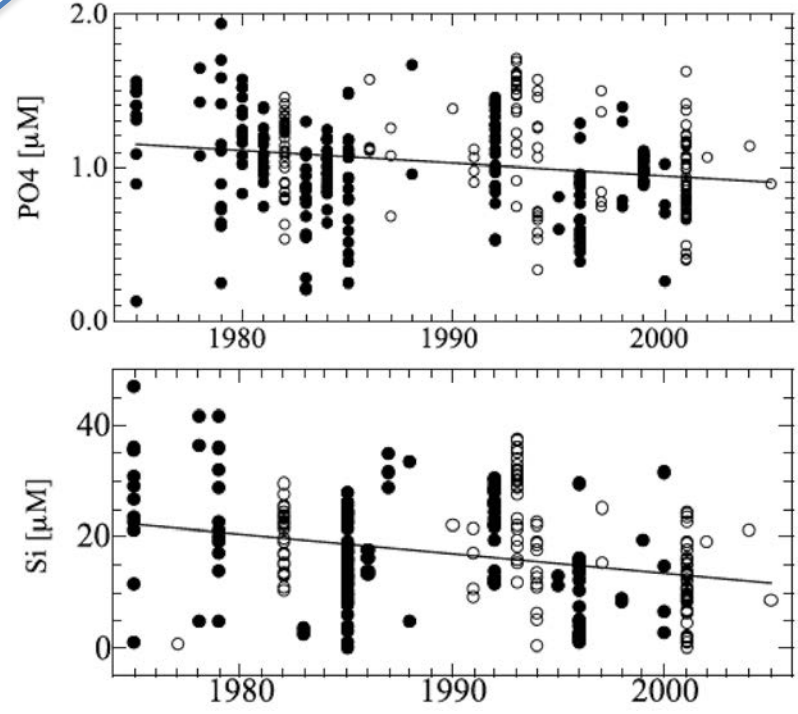


Gulf of Alaska, Central and western NP

Surface layer



Western to Eastern Pacific



Whitney et al., 2013

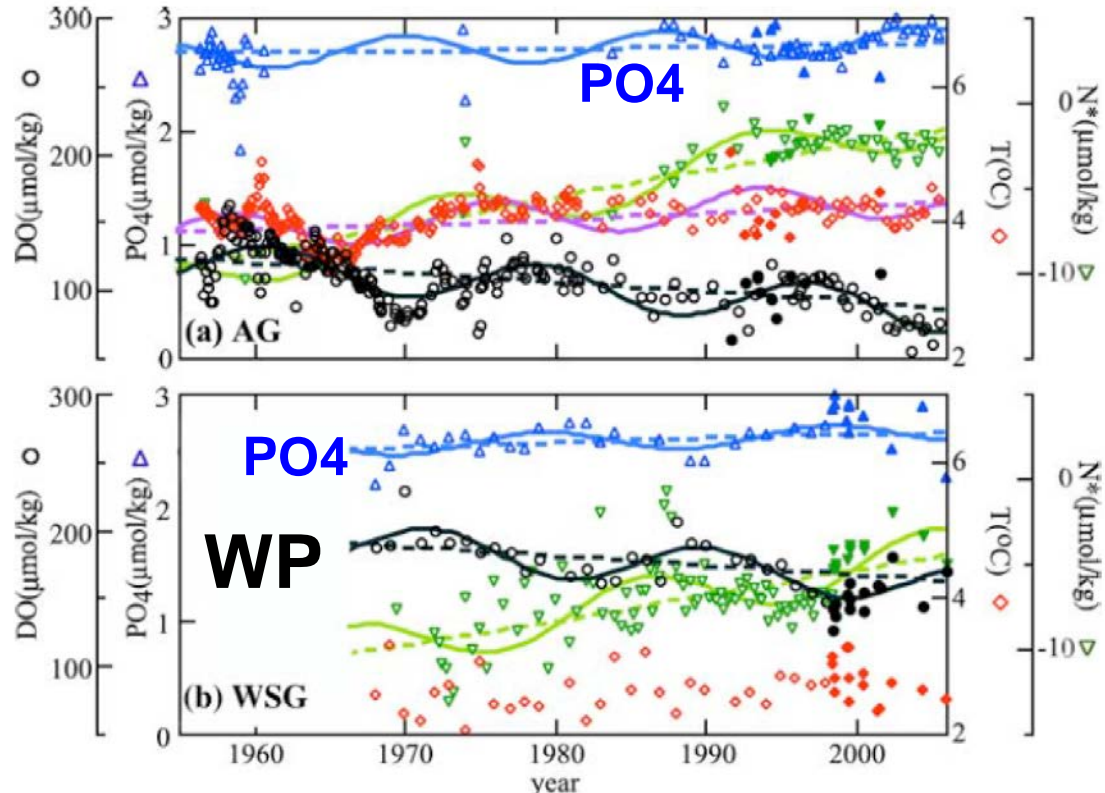
Ono et al., 2008

Gulf of Alaska, Central and western NP

Mid layer



EP



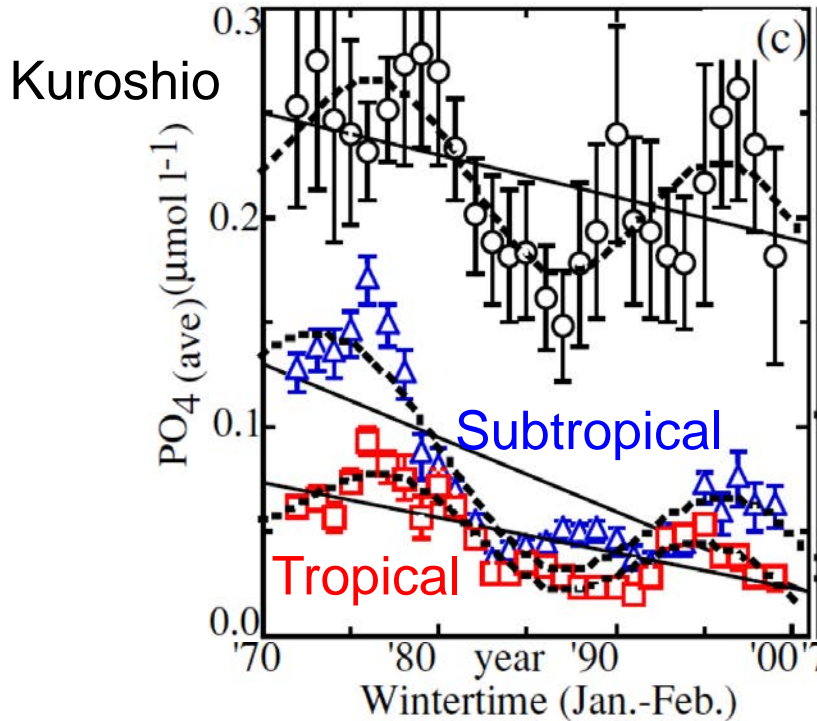
Kuroshio, Subtropical and Tropical waters

Surface layer

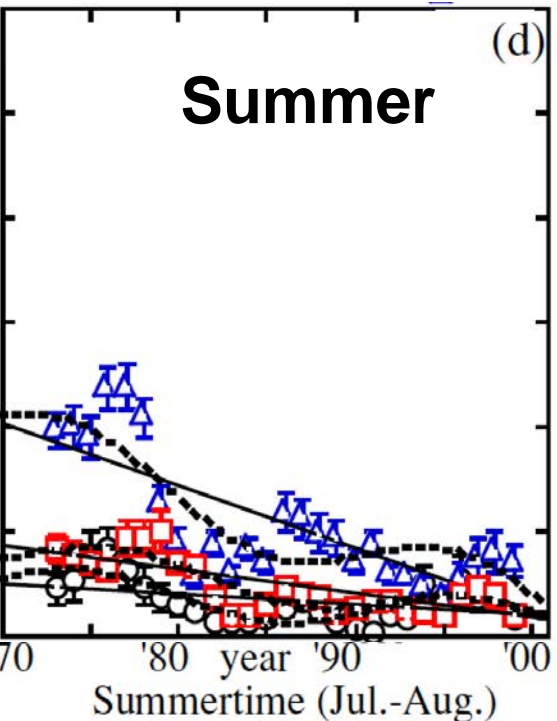


- Kuroshio
- Subtropical
- Tropical

Winter

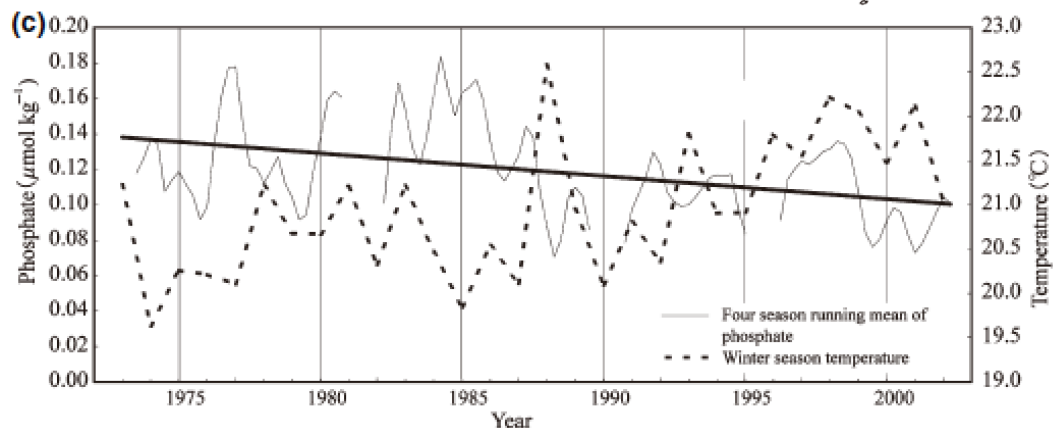


Summer



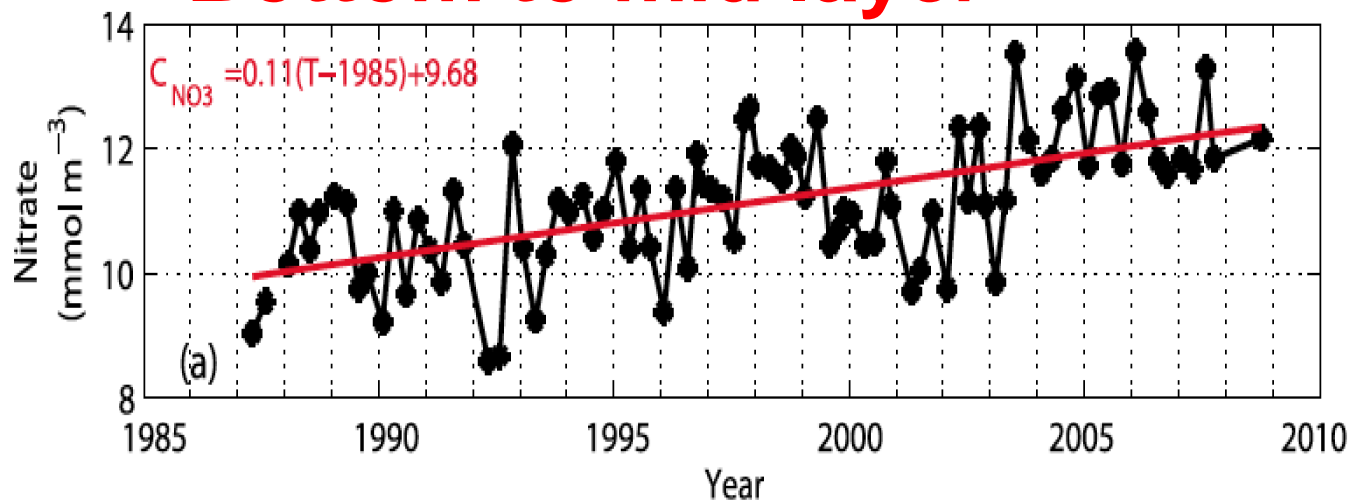
East China Sea

Surface layer



Aoyama et al., 2008

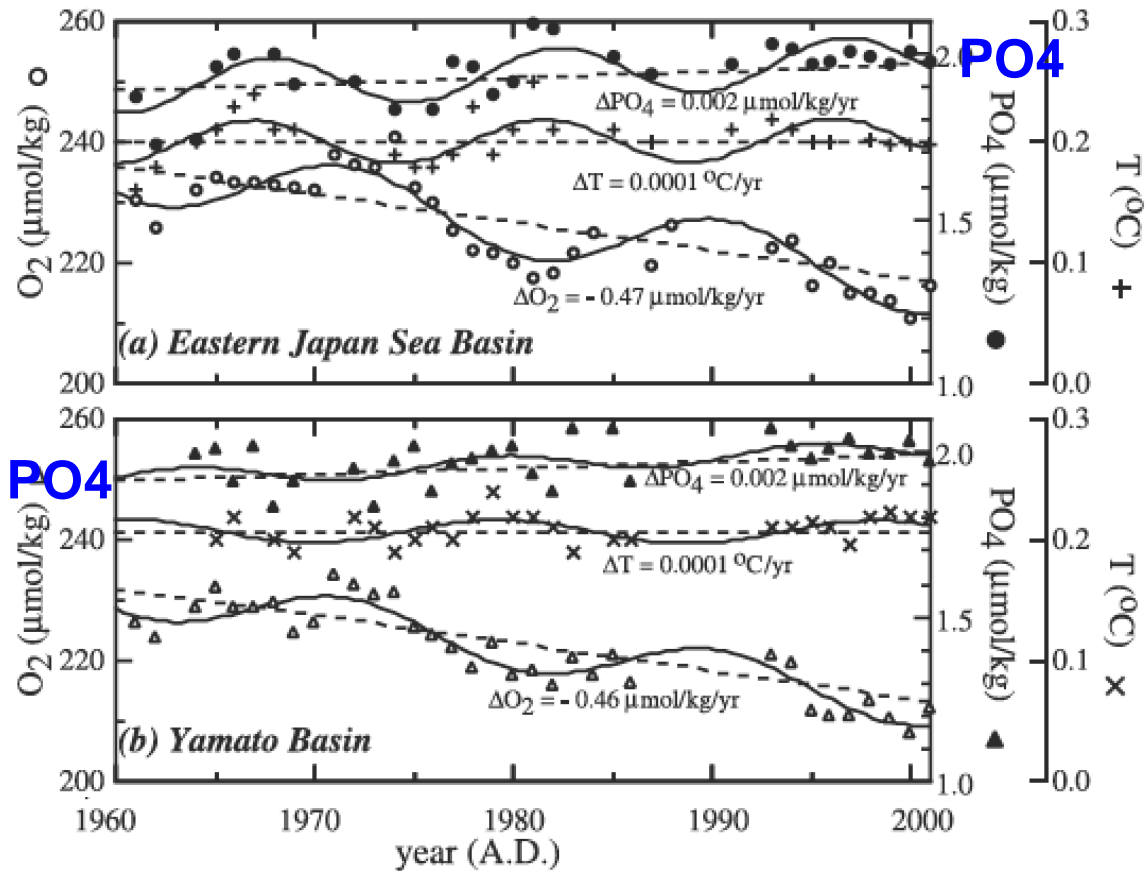
Bottom to mid layer



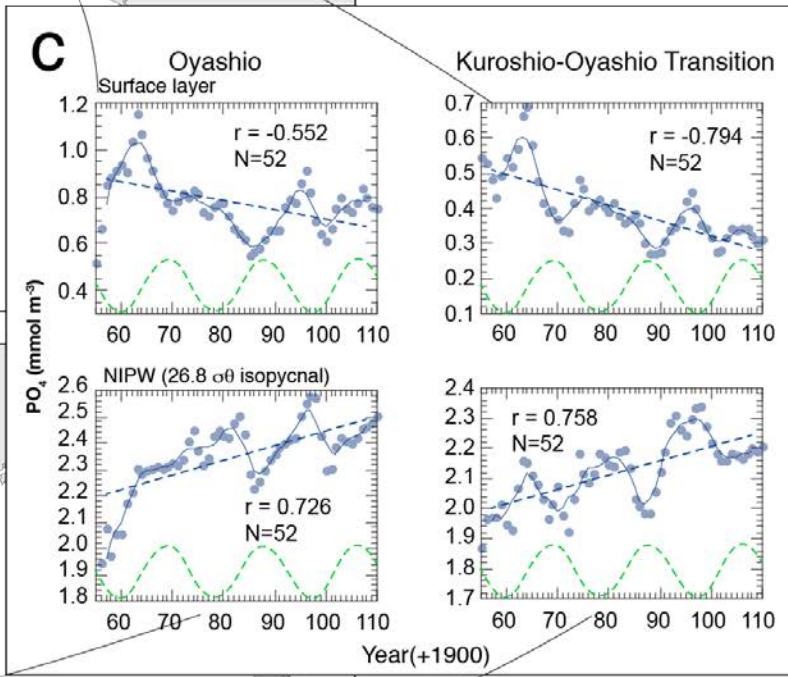
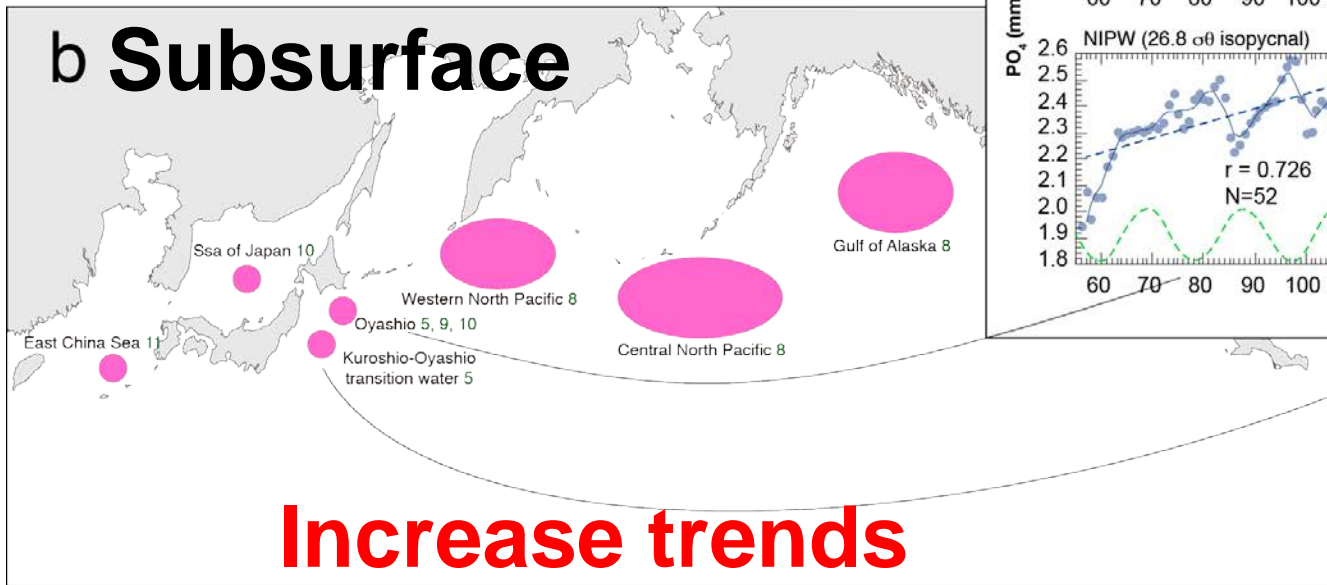
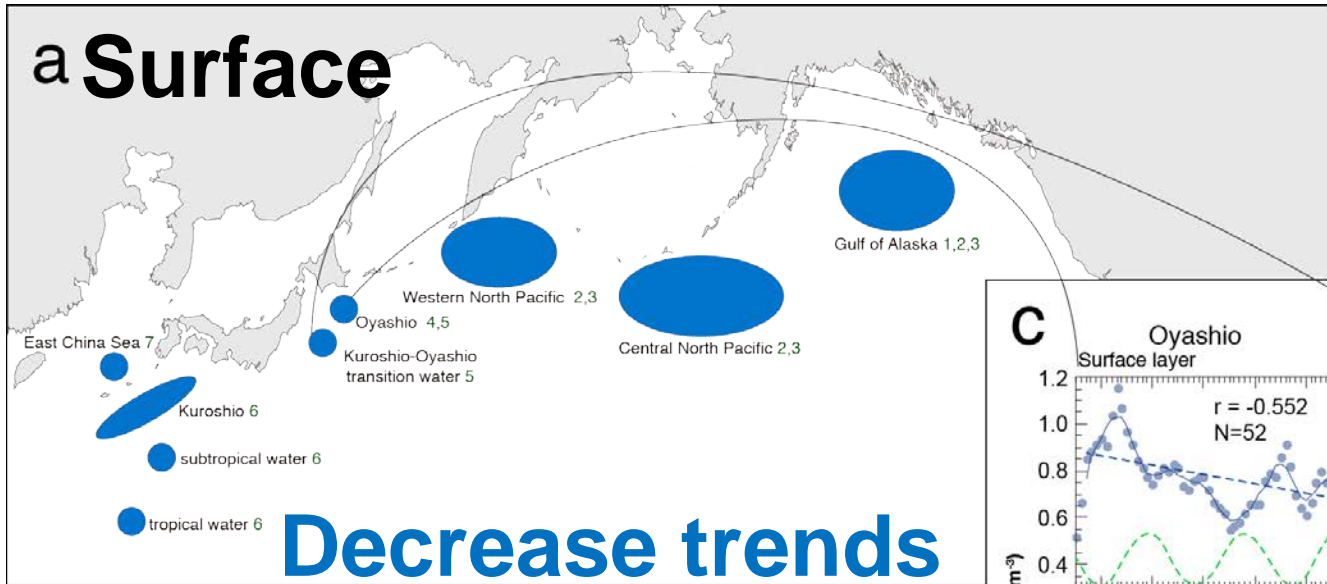
Guo et al., 2012

Sea of Japan

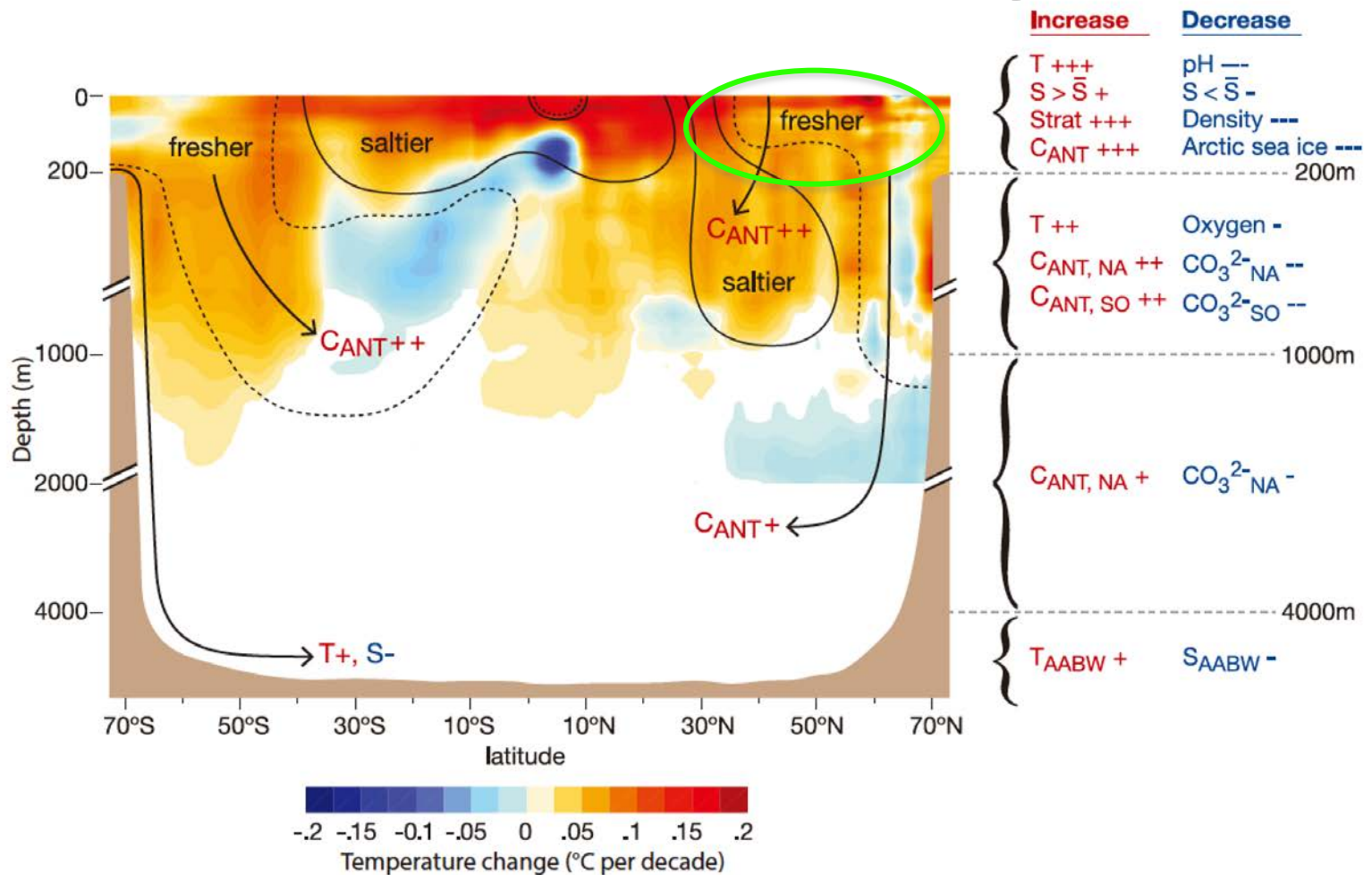
Mid layer



Summary of the nutrient trends



Schematic of TS change



Change in temperature and salinity might decrease of the nutrients supply from mid-layer to surface layer in the broad area of North Pacific.

Summary

- 1 Extended data until 2010 also represented the trend and bidecadal scale oscillation in the Oyashio and Kuroshio-Oyashio transition waters.
- 2 AR5 reported the increase trend of temperature and decrease trend of salinity in the surface layer in the North Pacific.
- 3 In the broad area of North Pacific, many studies reported the decreasing and increasing trends of nutrients in the surface and subsurface layer, respectively. Enhancement of the stratification might decrease nutrient supply from subsurface to surface layer in broad areas of the North Pacific.