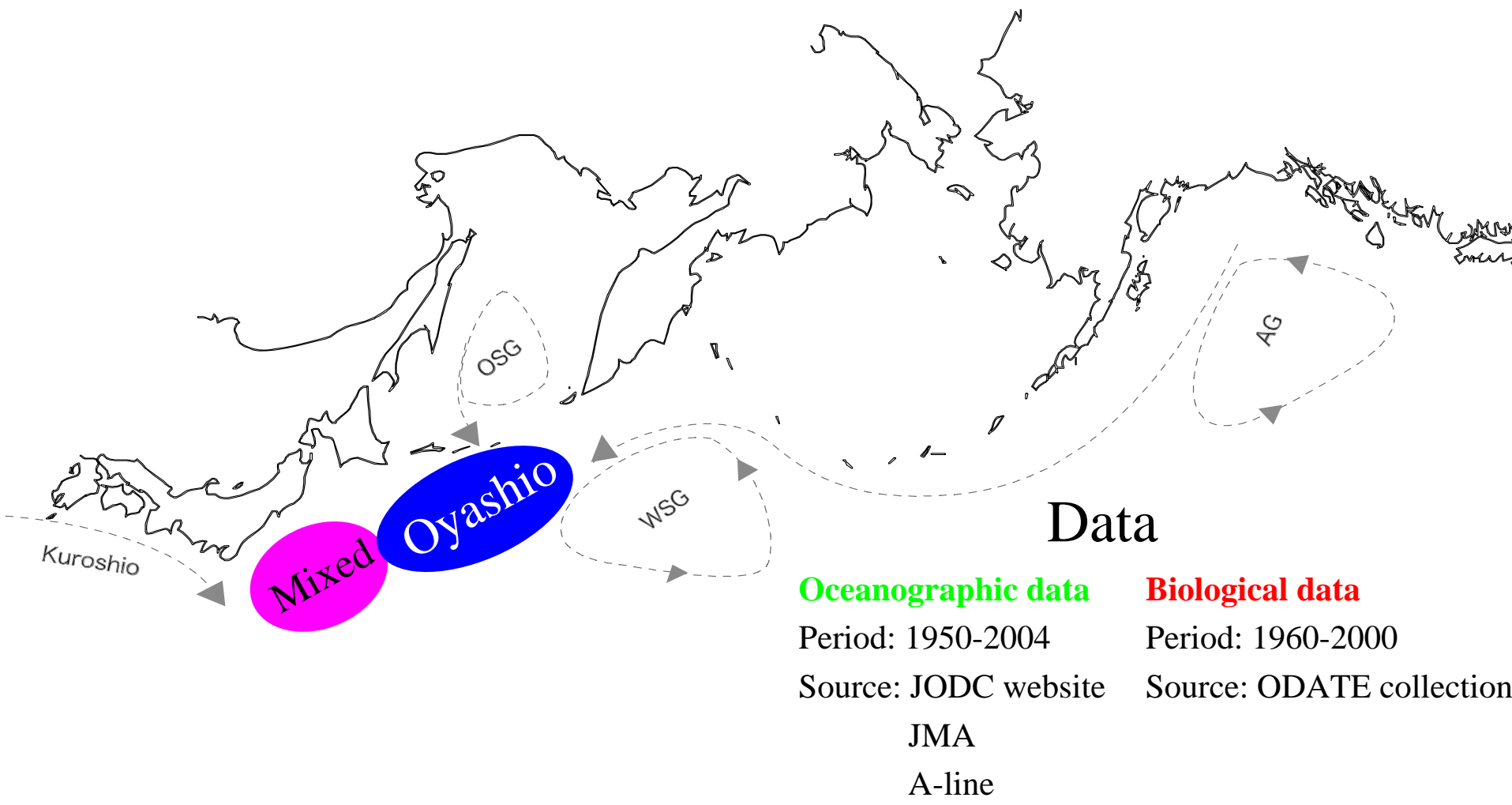




Trends and bidecadal oscillations in PO_4 concentration in the Oyashio and Kuroshio-Oyashio Mixed waters

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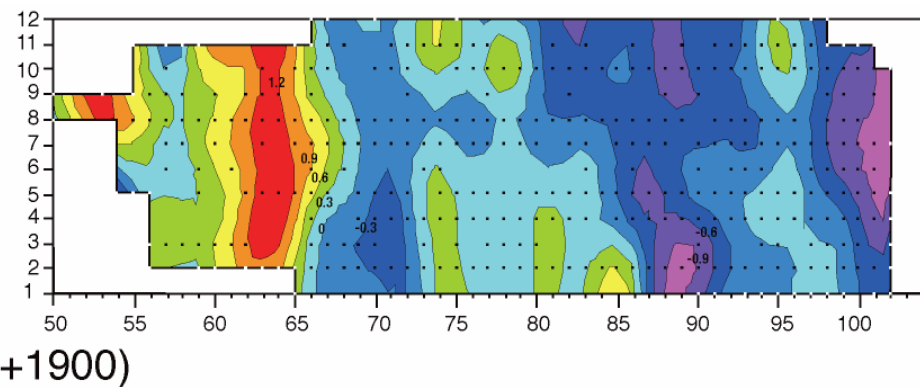
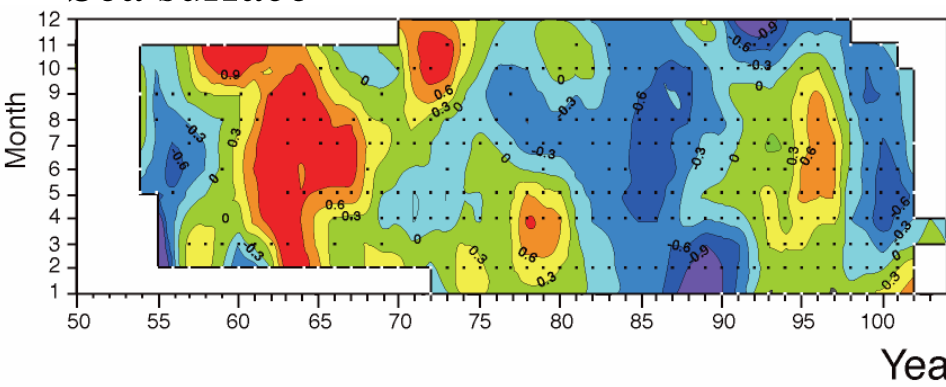


Variations in PO_4 concentration (normalized value)

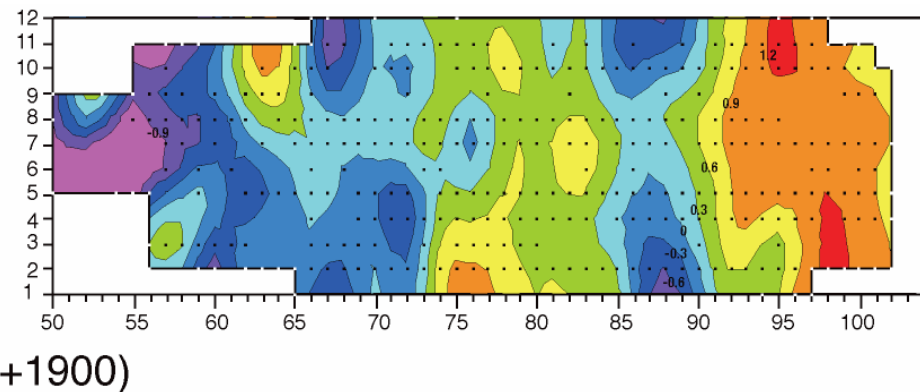
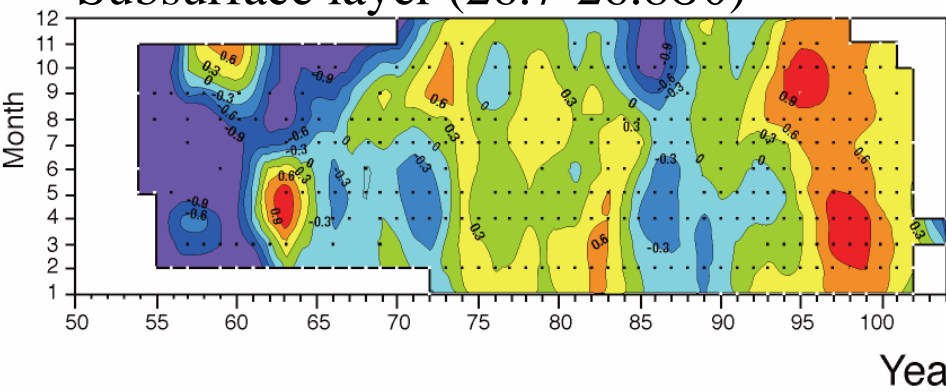
Oyashio

Mixed

Sea surface



Subsurface layer (26.7-26.8 σ_θ)

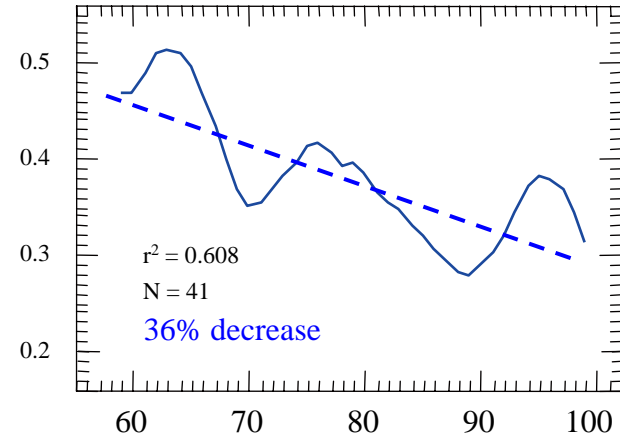
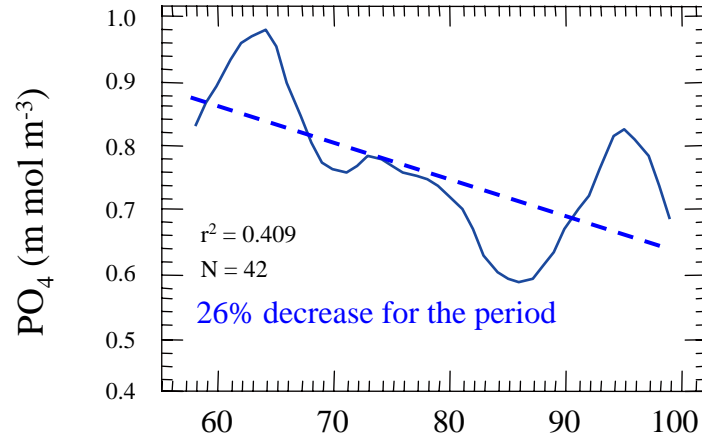


Variations in annual mean PO_4

Oyashio

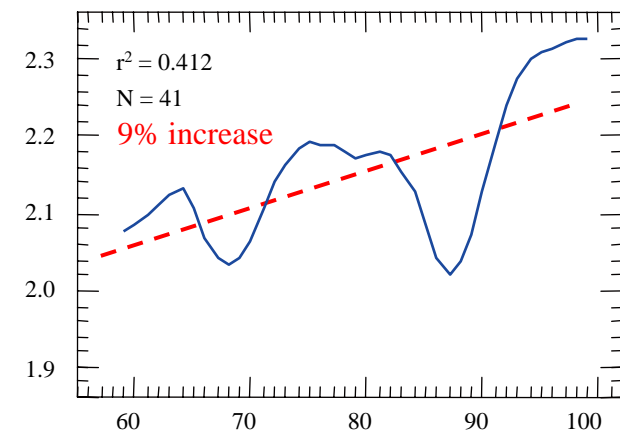
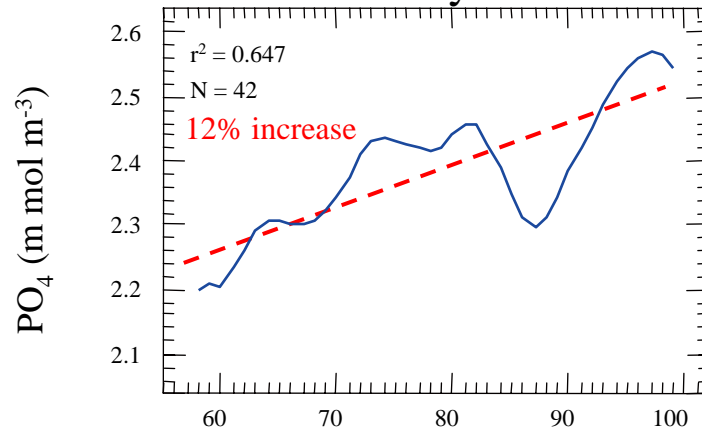
Mixed

Sea surface



Year(+1900)

Subsurface layer



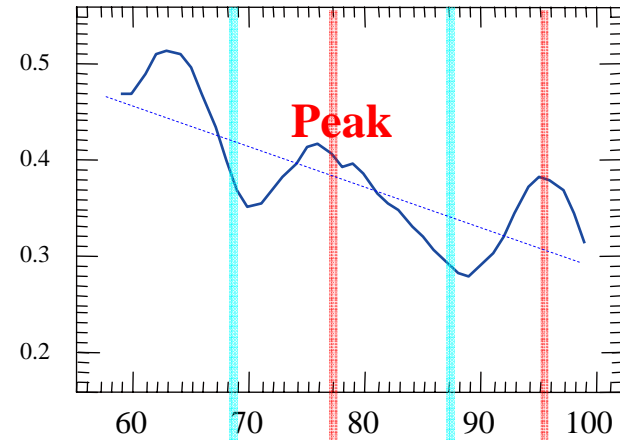
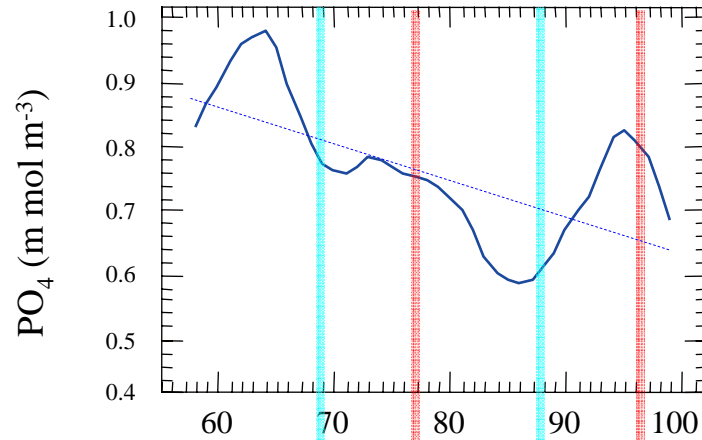
Year(+1900)

Variations in annual mean PO_4

Oyashio

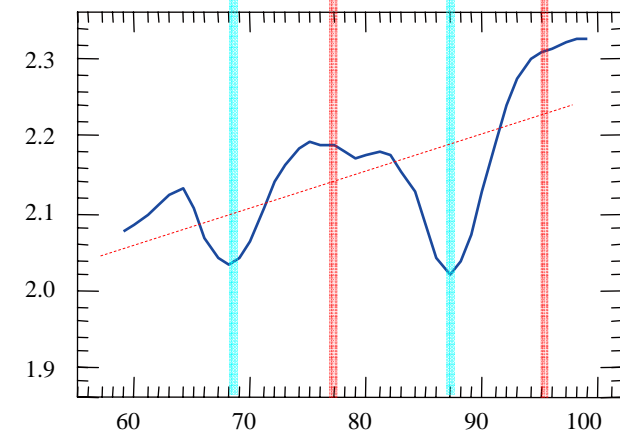
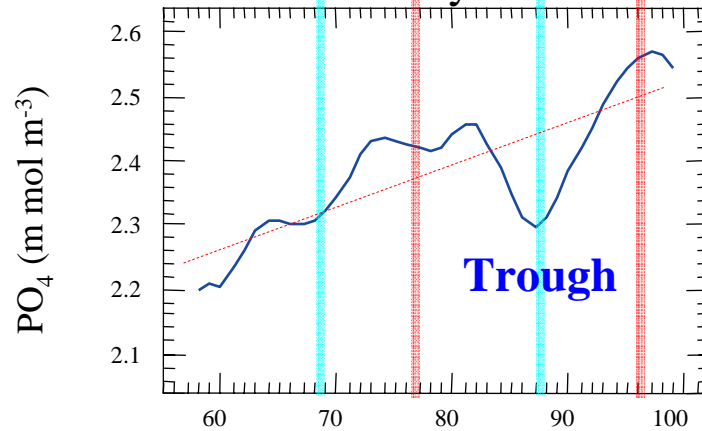
Mixed

Sea surface



Year(+1900)

Subsurface layer



Year(+1900)

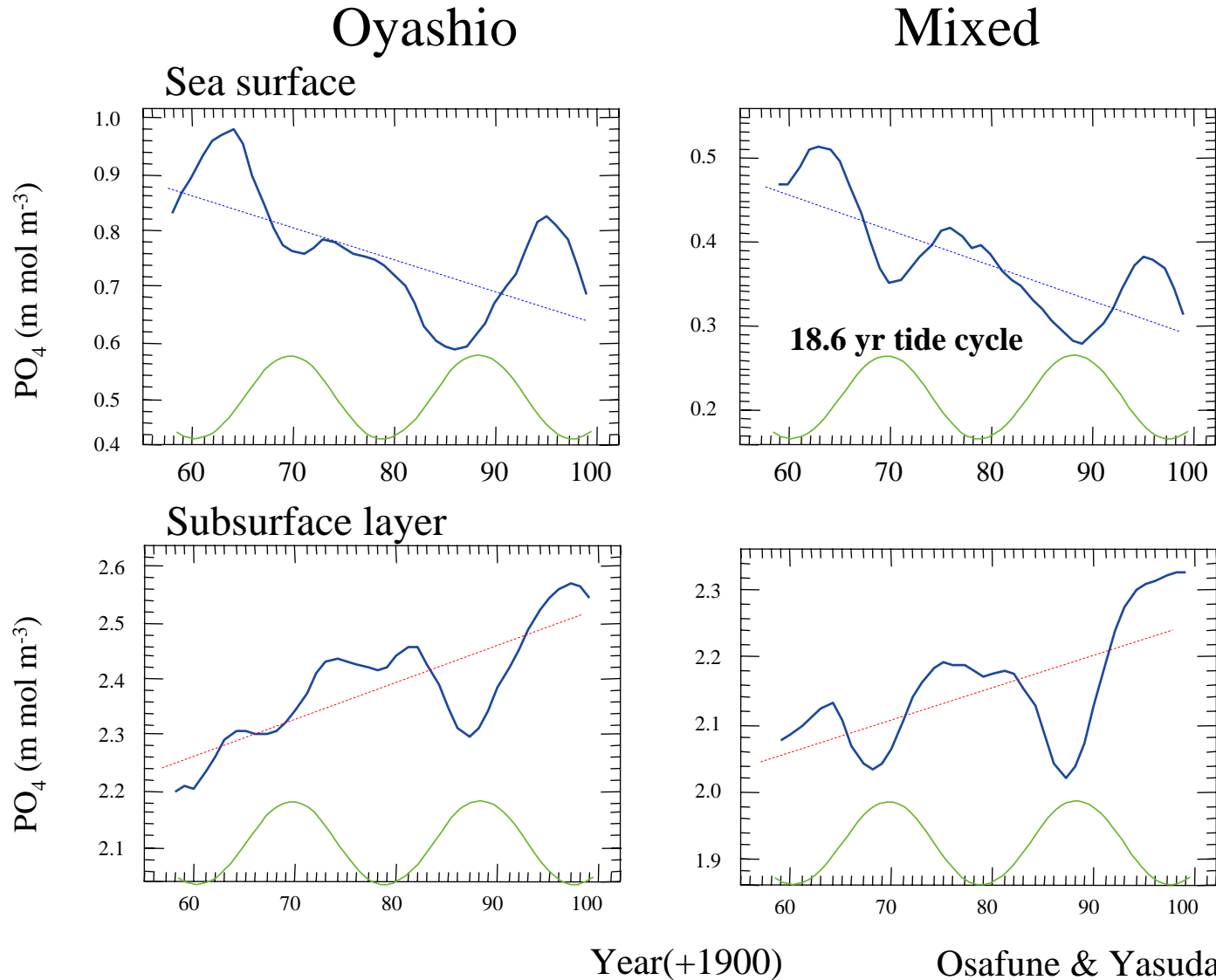
Relationship between surface and subsurface layer

Bidecadal oscillations: **Synchronous**

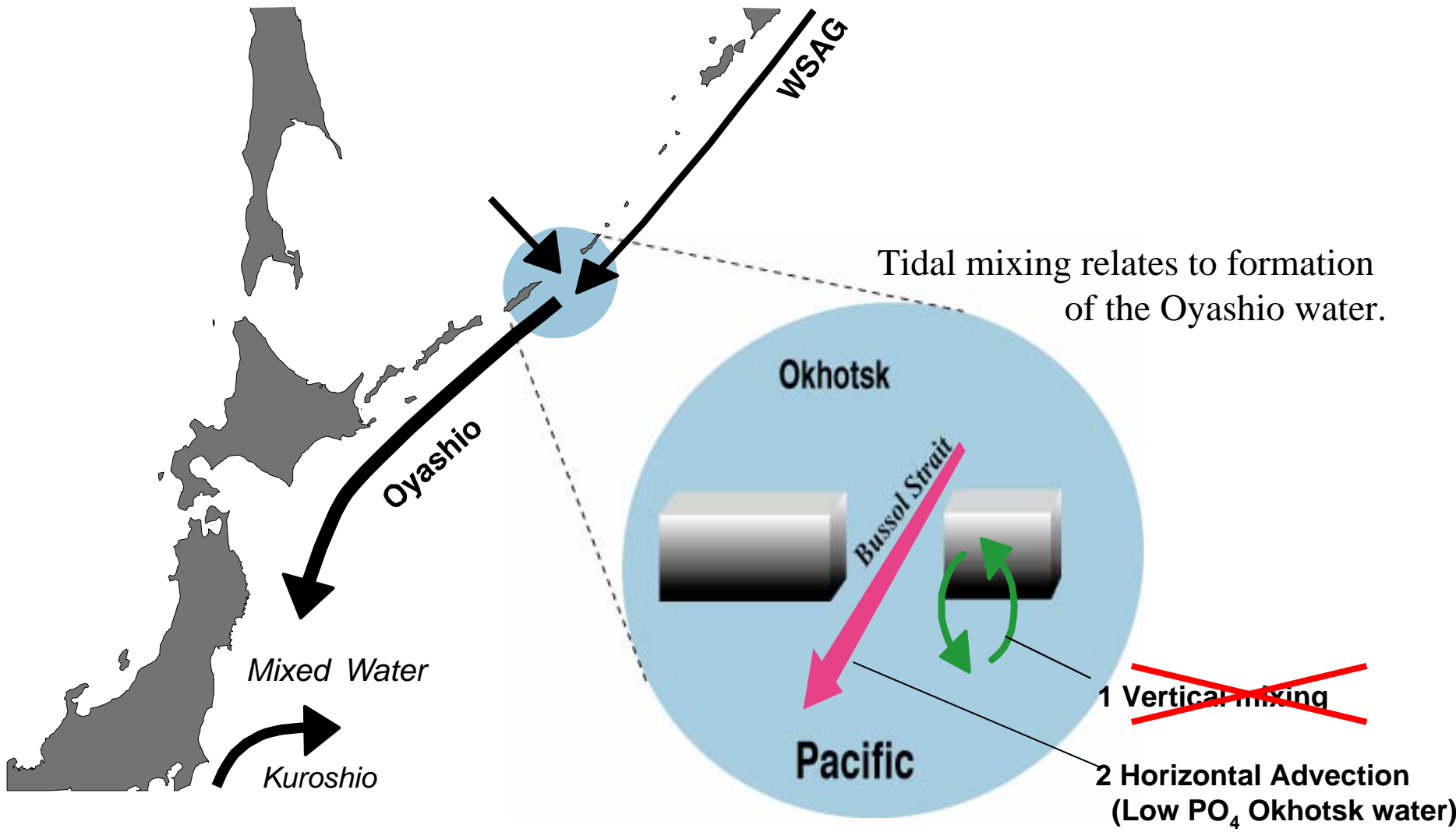
Bidecadal oscillations

After removing trend component:

Bidecadal components negatively correlated to 18.6 year tidal oscillation caused by lunar cycle.



Hypothesized process of PO_4 oscillations caused by 18.6 yr tide cycle

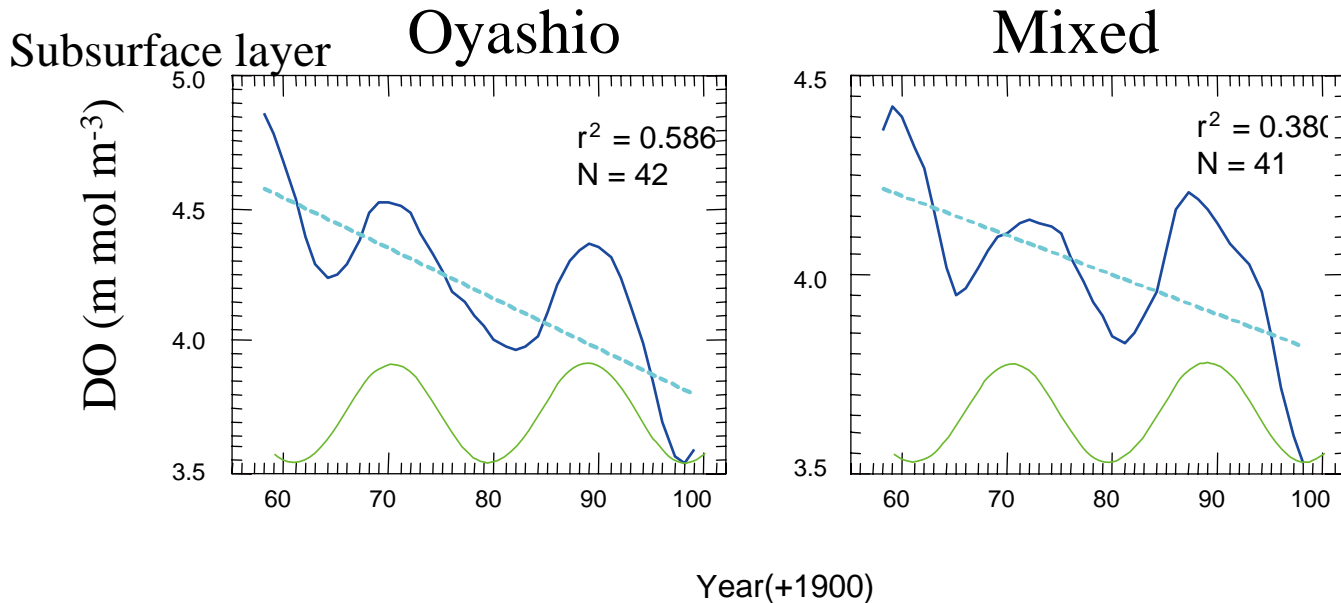


Relationship between surface and subsurface layer

Trends:

Inverse

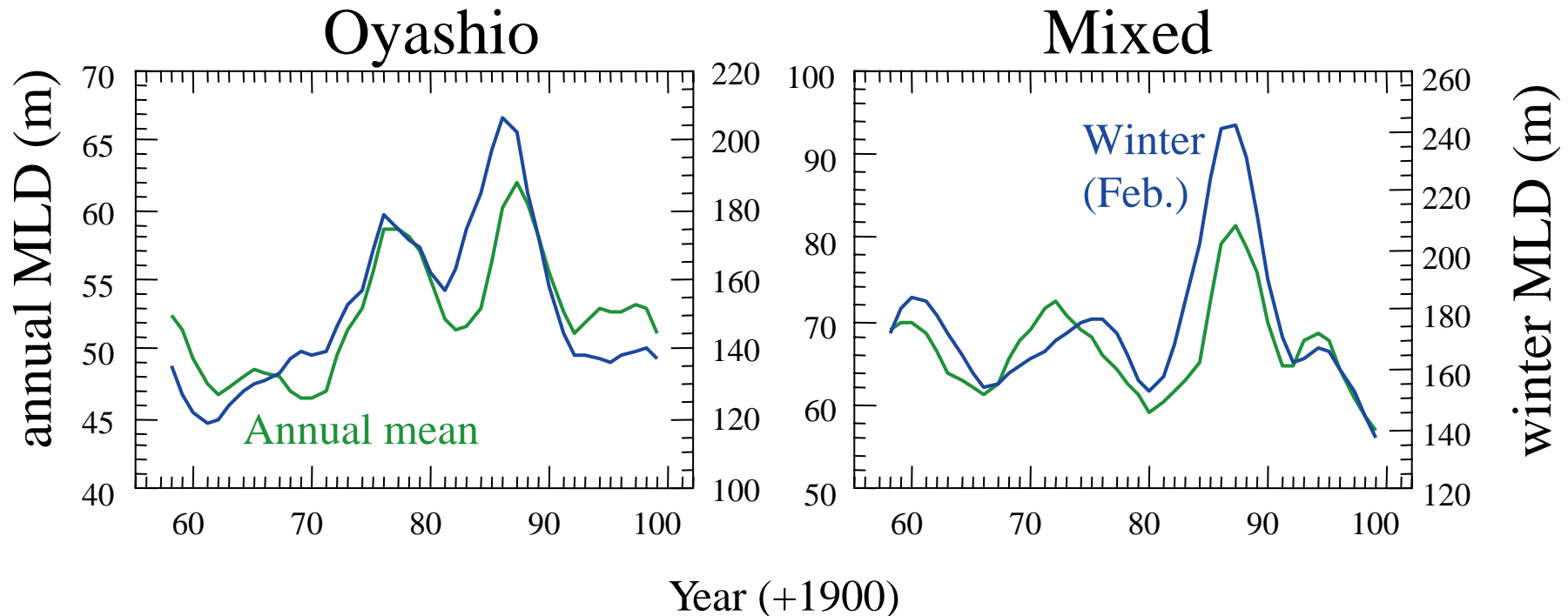
➔ The relationship imply **decreasing of water exchange** between surface and subsurface layer.



Oxygen trends also corroborate above process.

Variations in MLD

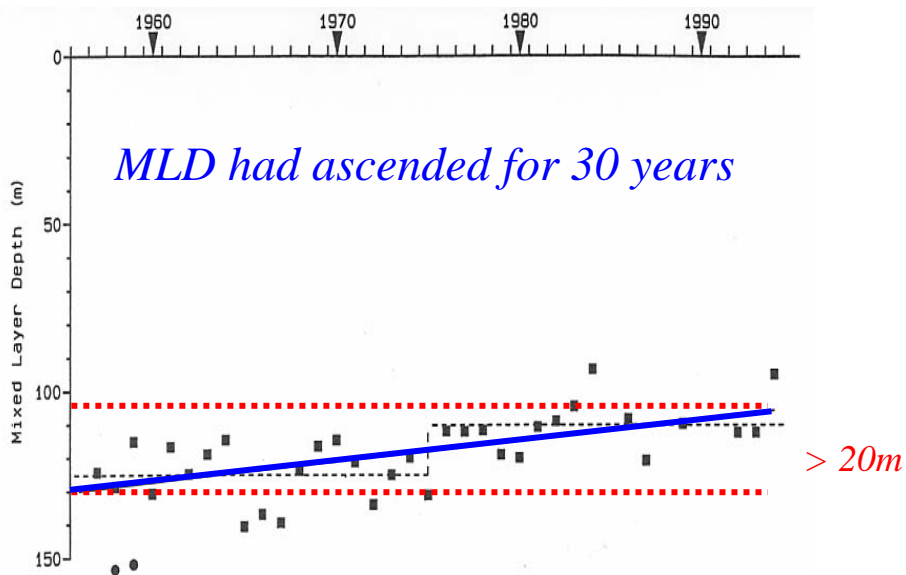
No trends



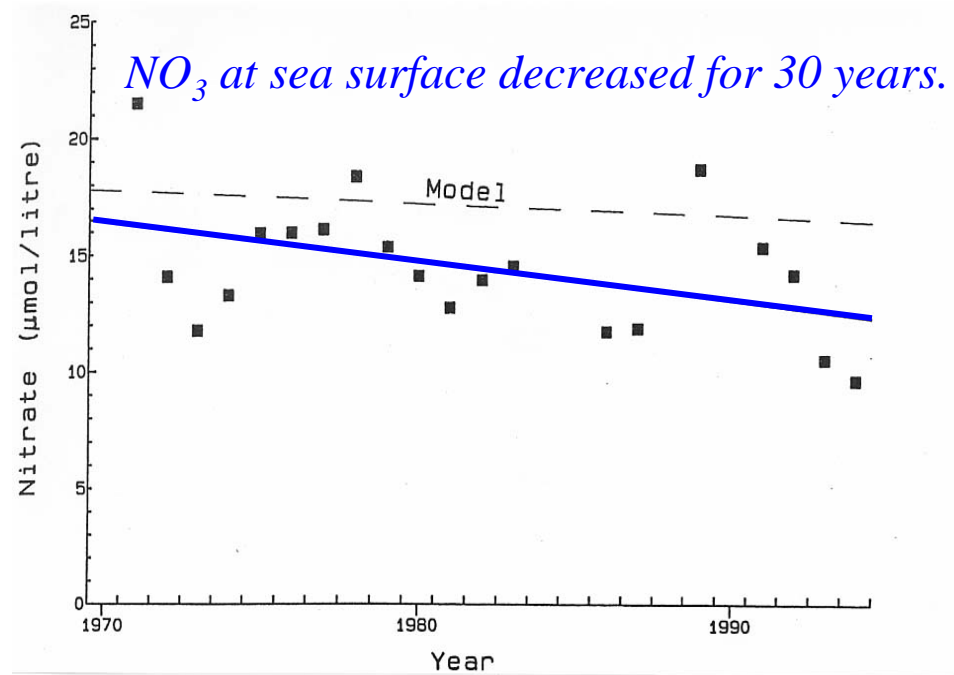
Some studies reported to the enhancement of stratification of upper layer in the western subarctic and Alaskan Gyre (Polovina et al. 1995, Freeland et al. 1998).

Enhancement of stratification in the Alaskan Gyre

MLD in winter



Surface NO_3 in winter



Freeland et al. (1997)

Hypothesized process for decadal scale variations in PO_4

Bidecadal Scale Oscillation

18.6 yr cycle of tide

Horizontal advection

Okhotsk

Pacific

Oyashio &
Mixed water

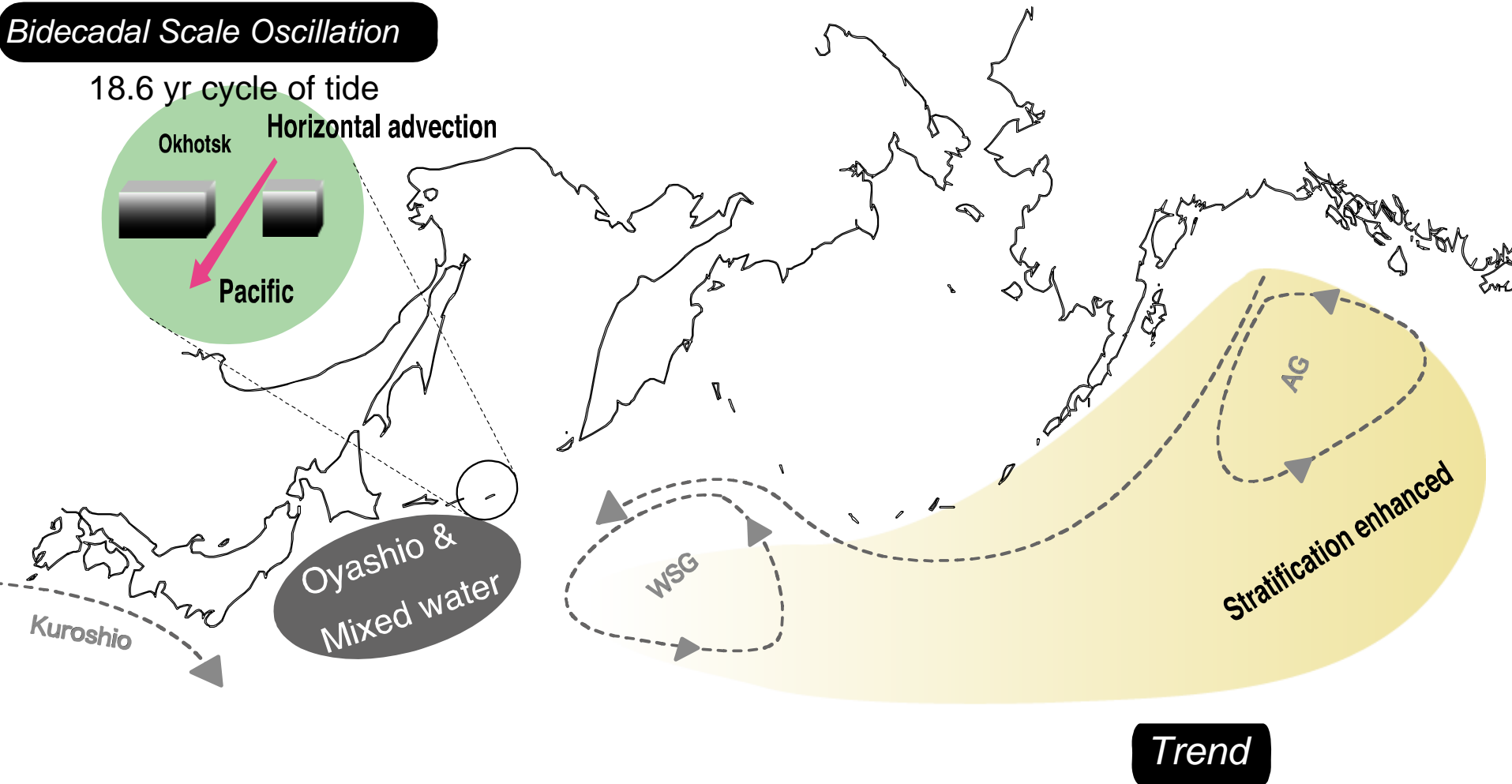
Kuroshio

WSG

AG

Stratification enhanced

Trend



Effect to the ecosystem

Neocalanus plumchrus

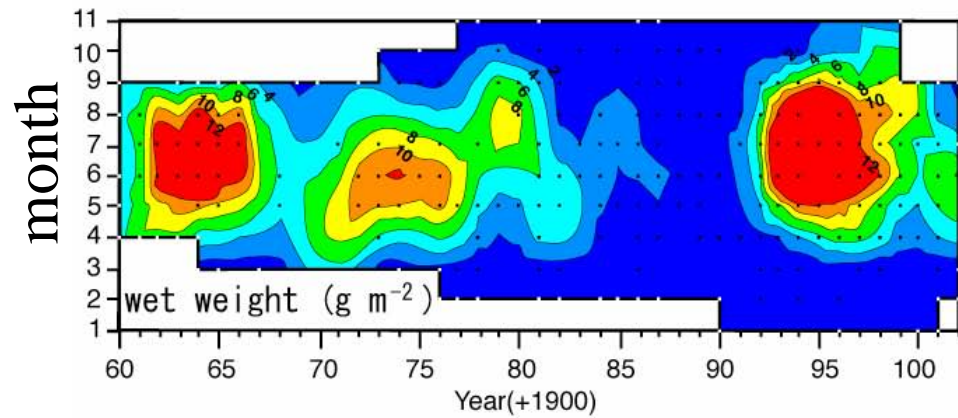
Predominant mesozooplankton in upper layer during summer.



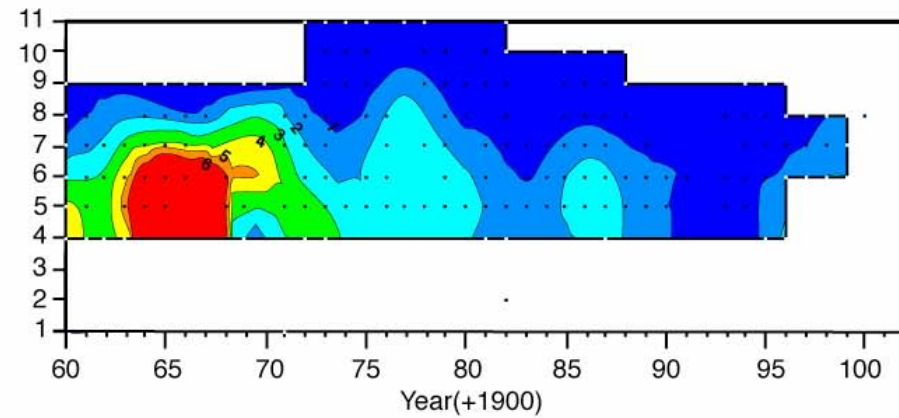
Feed on phytoplankton & microzooplankton.

Interannual variations in *N. plumchrus* biomass

Oyashio

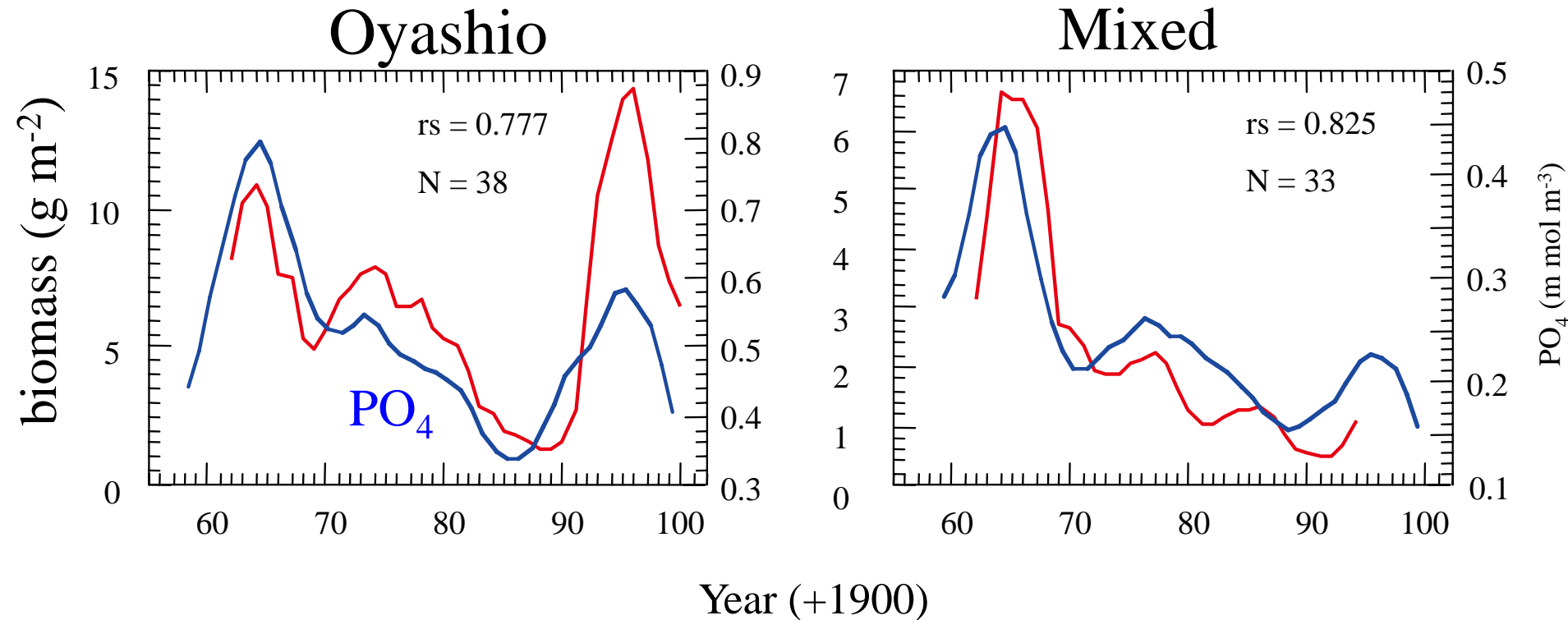


Mixed



Relation between annual mean value of *N. plumchrus* and PO_4

N. Plumchrus biomass had significant relationship with PO_4 .



Those relationships suggests the change in PO_4 affect *N. plumchrus* biomass due to change the primary productively.

Summary

1. Trends and bidecadal scale oscillations were observed in PO_4 concentration in the Oyashio and Mixed waters.
2. Bidecadal scale oscillations might related to the 18.6 yr oscillation of the tidal mixing caused by lunar cycle.
3. Trends might related to the enhancement of the stratification in upper layer of the upstream of the Oyashio and Mixed water.
4. Variations in PO_4 might affect *N. plumchrus* biomass due to change the primary productivity.