Interdecadal Variation of The Lower Trophic Ecosystem in the Northern Pacific between 1948 and 2002

– in a 3-D implementation of the NEMURO model

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Object of This Study

Many marine ecosystem studies have focus on Regime shifts.

-Venrick *et al.*, 1987; Roemmich and McGowan, 1995; Chai *et al.*, 2003; Sugimoto and Tadokoro, 1997; Hare and Mantua, 2000 etc…..

The climate regime shift of the 1970s plays an important role in the lower trophic ecosystem change, especially in the Northwestern Pacific and Bering Sea.

We investigated the interdecadal changes in dynamics of the lower trophic ecosystem related to climate regime shift and ENSO.

Model Background

Physical model: **CCSR Ocean Component Model (COCO) 3.4**
(developed at Center for Climate System Research, University of Tokyo)

Biological model: **NEMURO**

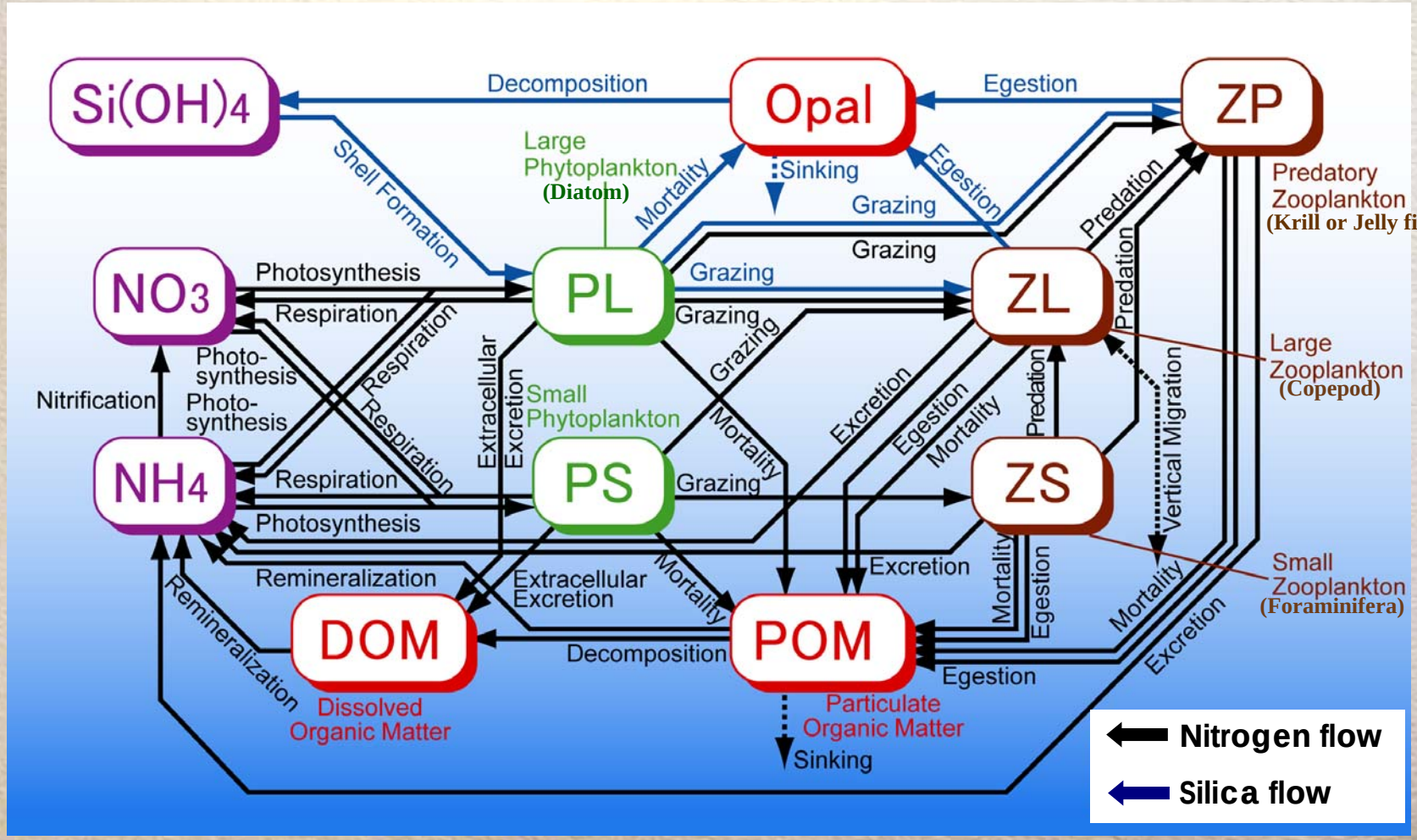
***Configuration* (same as Aita *et al.*, 2003)**

Horizontal resolution : 1 degree * 1degree (360x180).
Vertical resolution : 54 levels from the surface to the bottom (5000m).
5m for all layers within upper 100m.
Mixed layer processes: Noh and Kim turbulent closure scheme.

Boundary conditions (daily surface forcing)

NCEP 6-hourly dataset from 1948 to 2002
: Sea surface temperature
: Fresh water flux
: Surface wind stress
: Solar radiation
Nitrate and Silicate concentrations: WOA 1998

NEMURO developed by PICES Model Task Team



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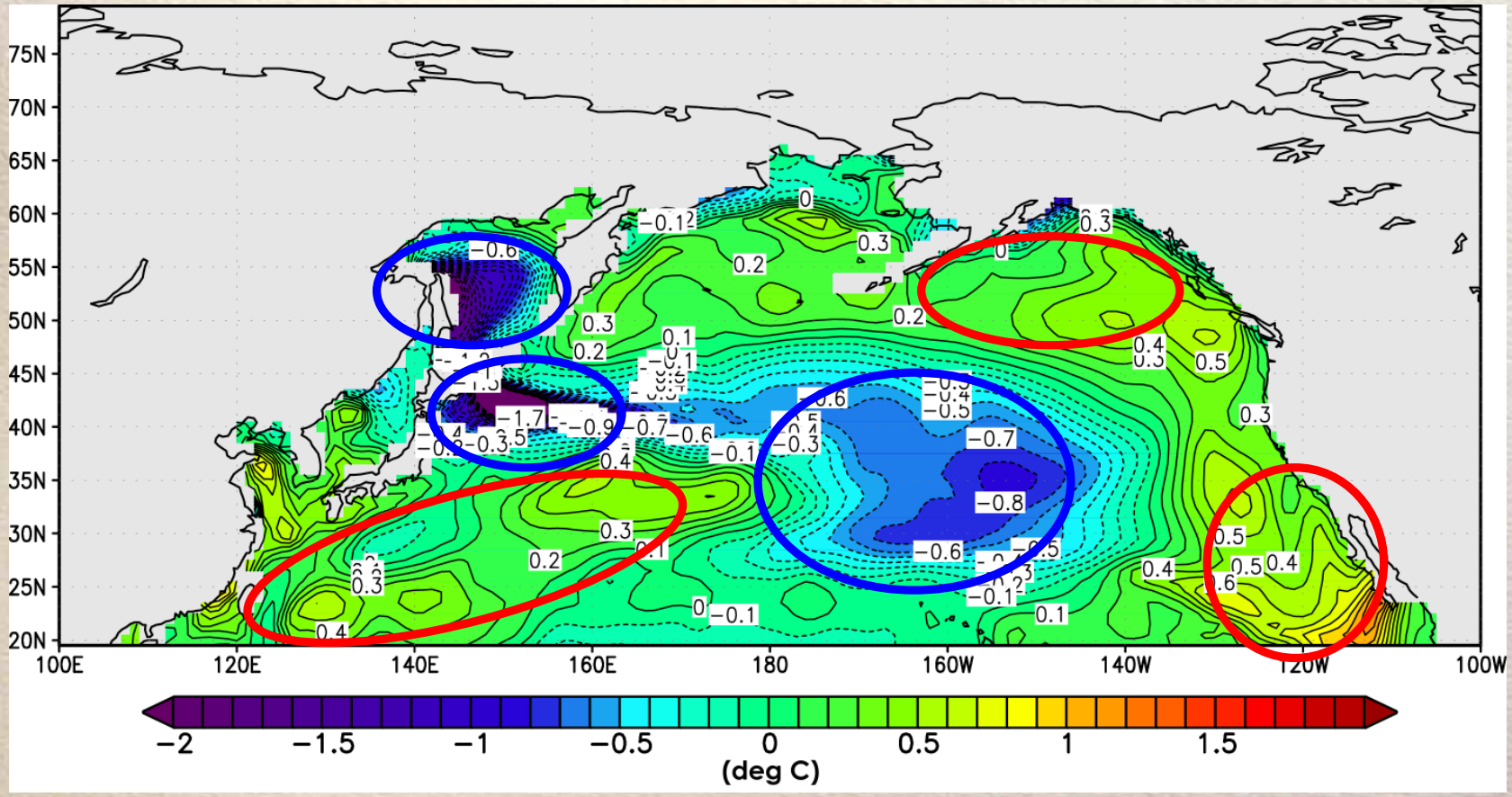
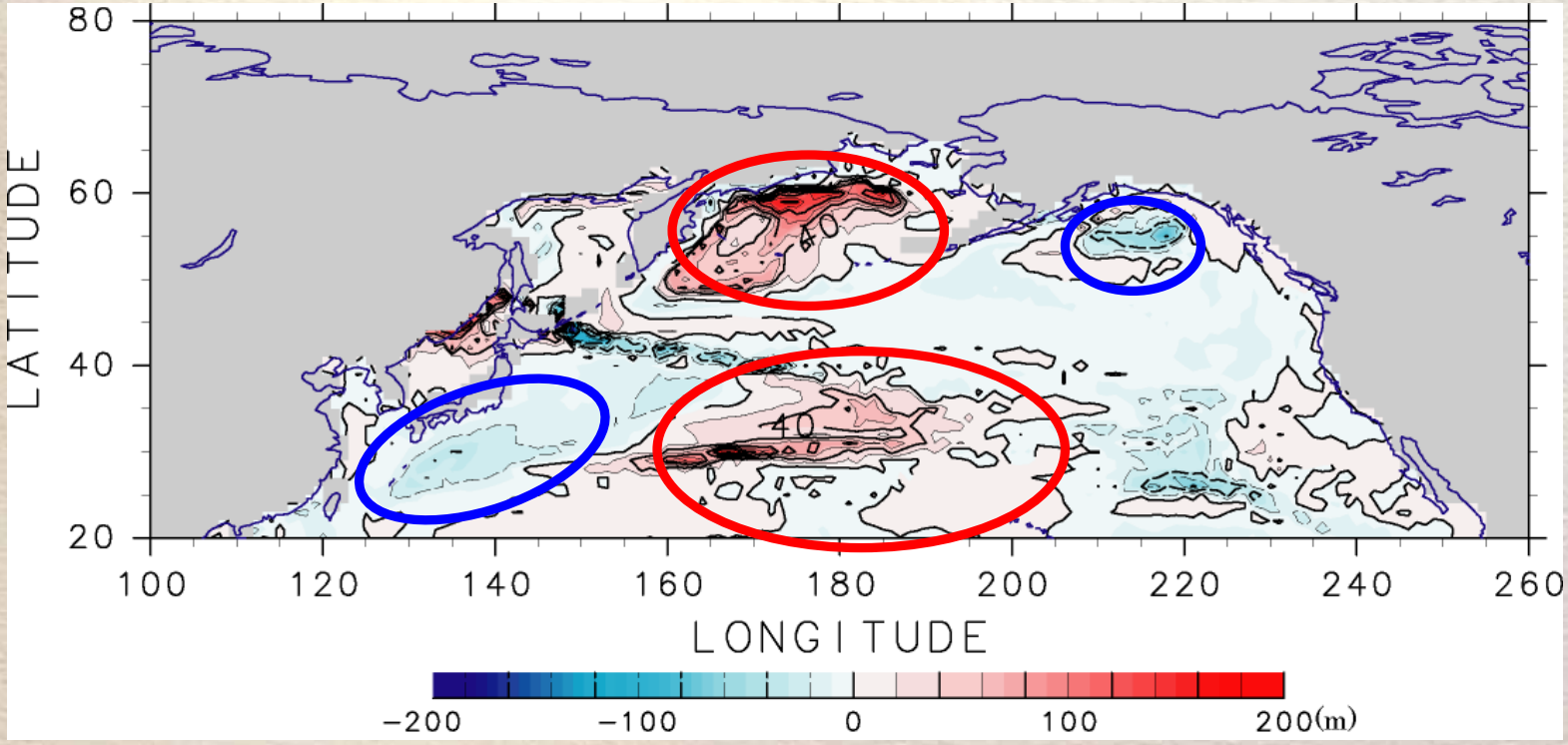
Difference of Sea Surface Temperature (1977-2000minus1952-1975)

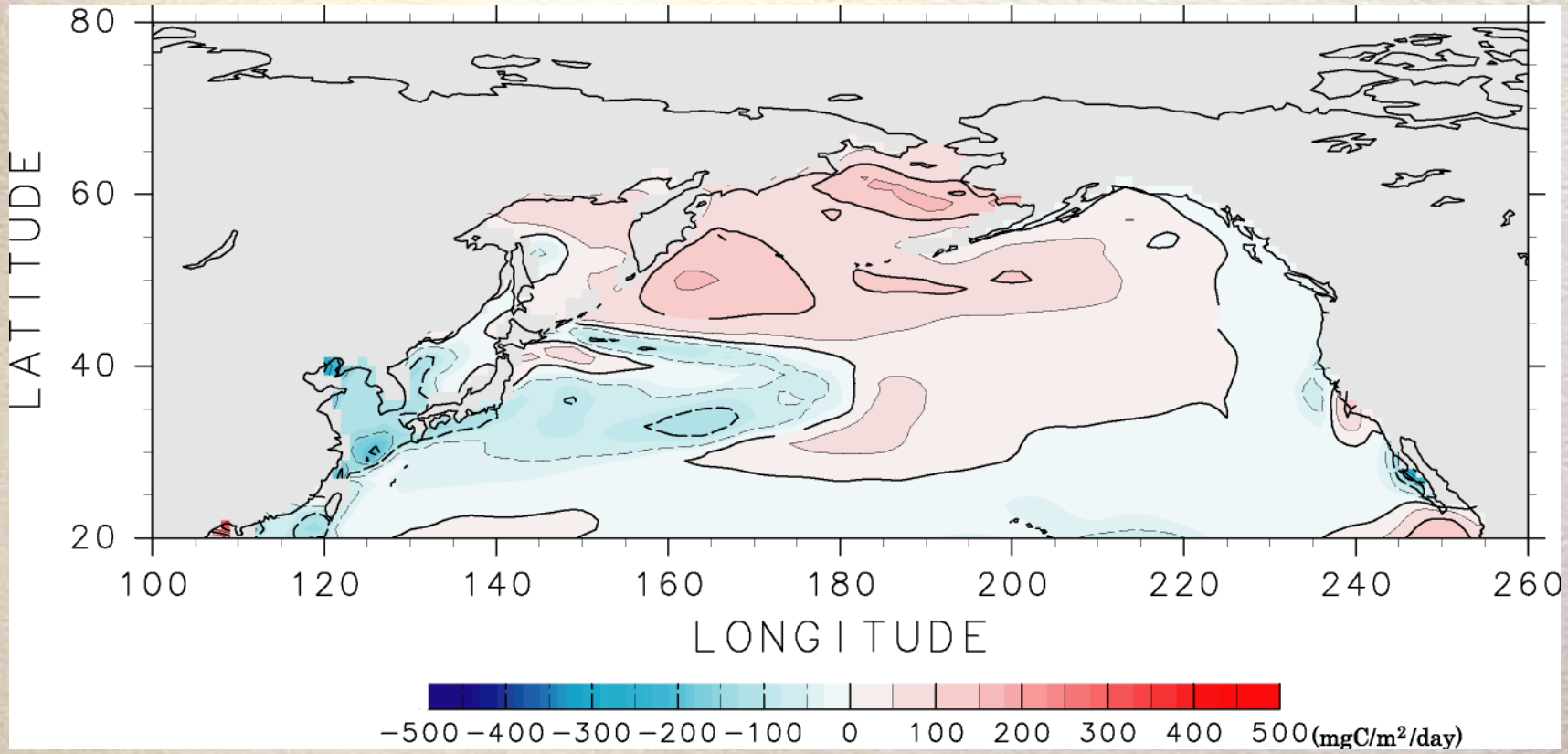


Difference of mean winter (Jan-Feb-Mar) MLD (1977-2000 minus 1952-1975)

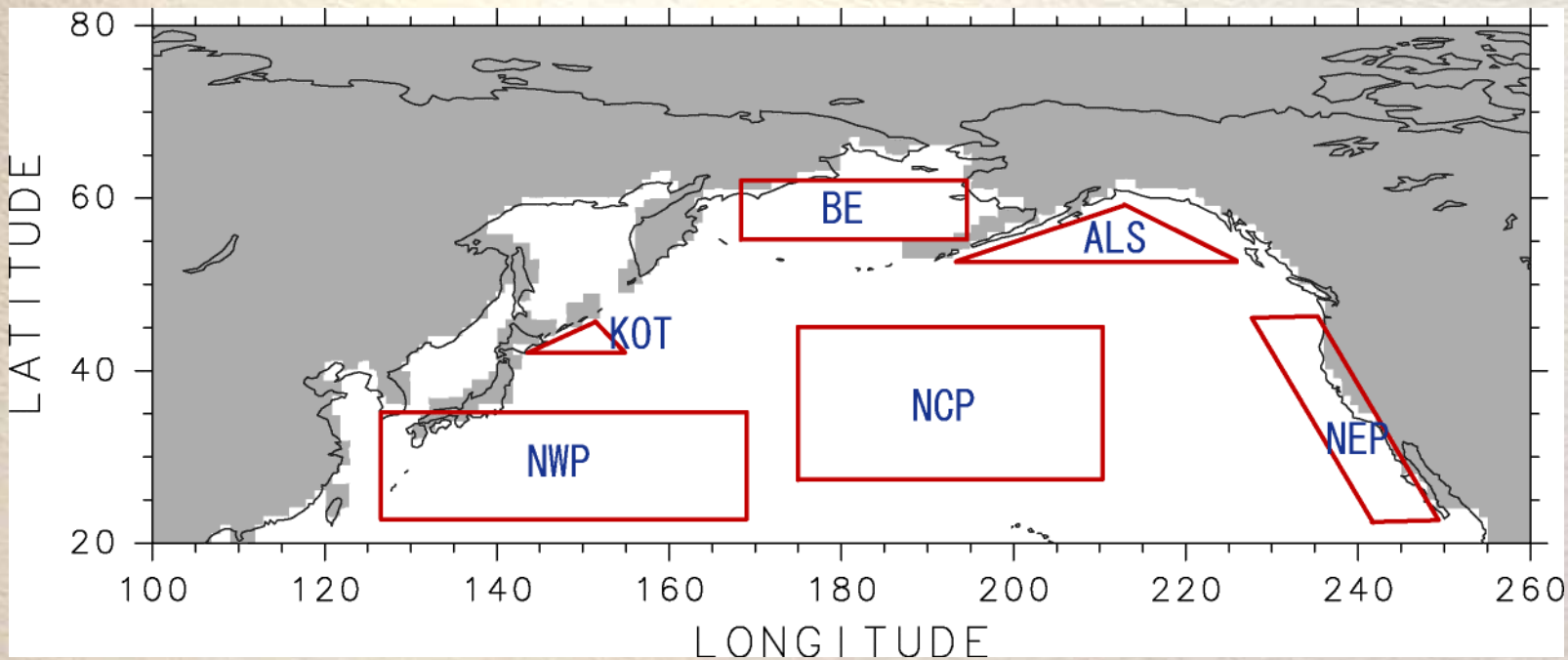


MLD = the depth where potential density (σ t) was 0.125kg/m^3 higher than surface value.

Annual mean of Primary Production
1977-2000 minus 1952-1975

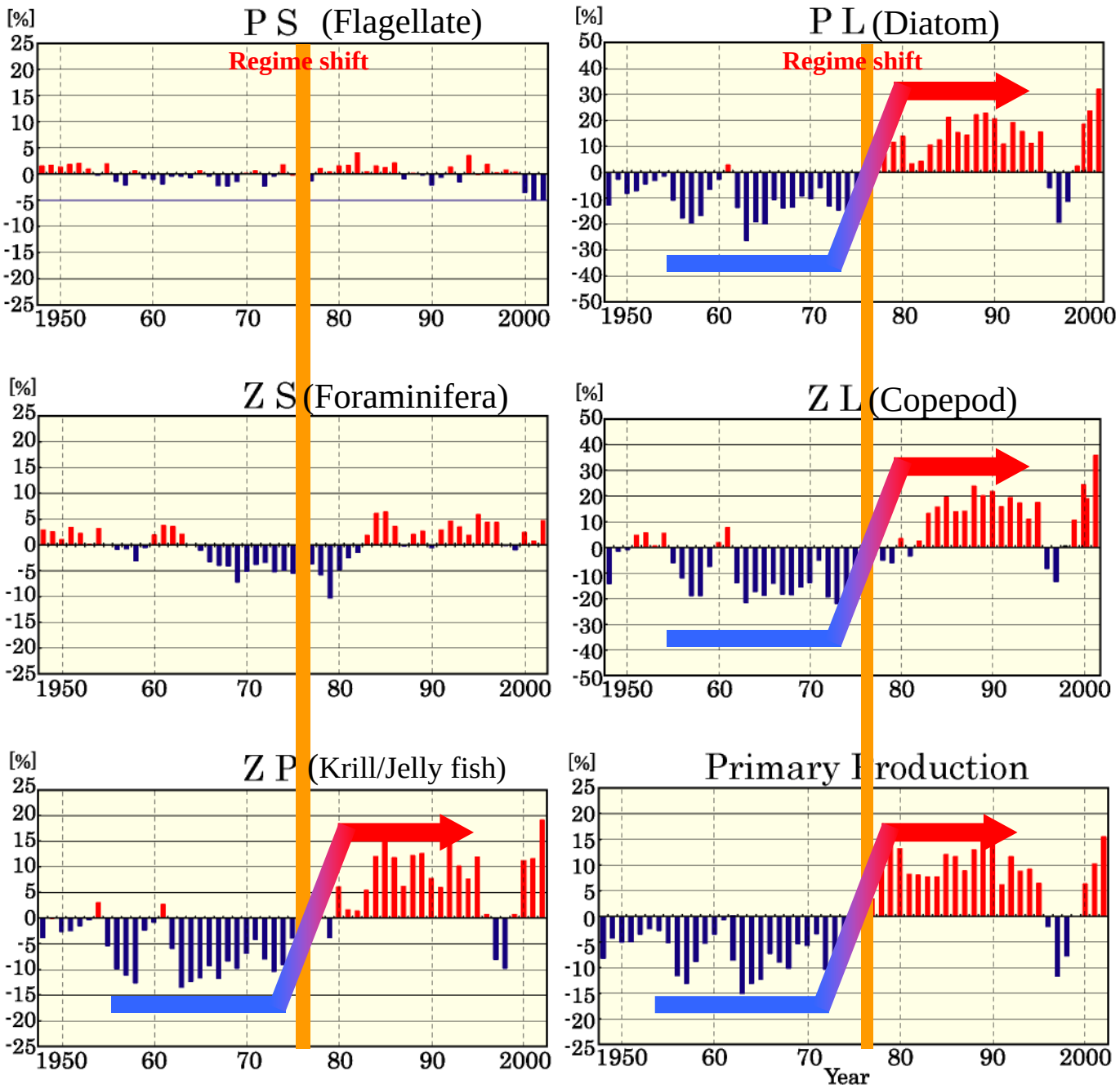


Location map of the North Pacific



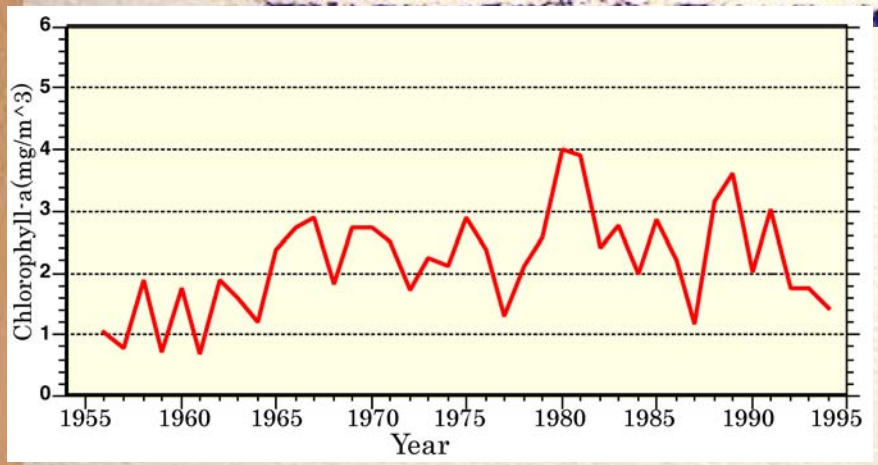
B E

(Bering Sea)

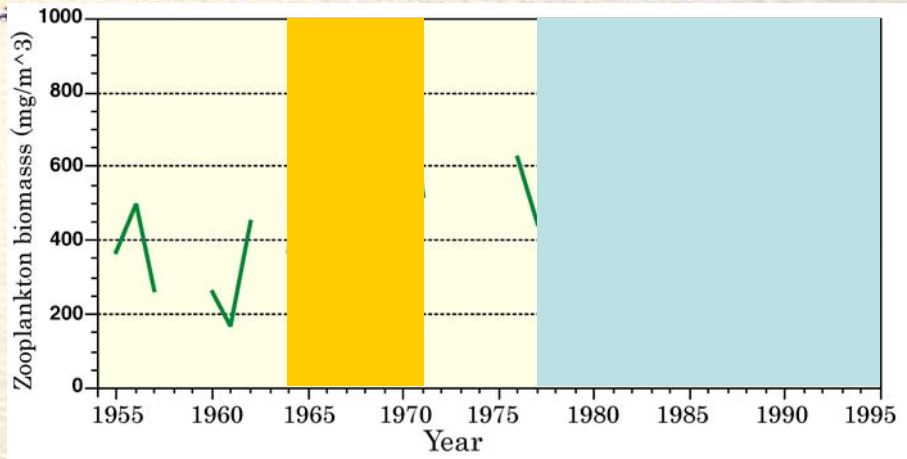


Observation data at Eastern Bering Sea (Sugimoto and Tadokoro, 1997)

Annual mean of Chlorophyll-a



Annual mean of macro zooplankton



The data above form Sugimoto and Tadokoro(1997) show a decrease in zooplankton biomass after 1977. Hare and Mantua(2000) found a similar decrease after 1977, when stock of many fish also increased.

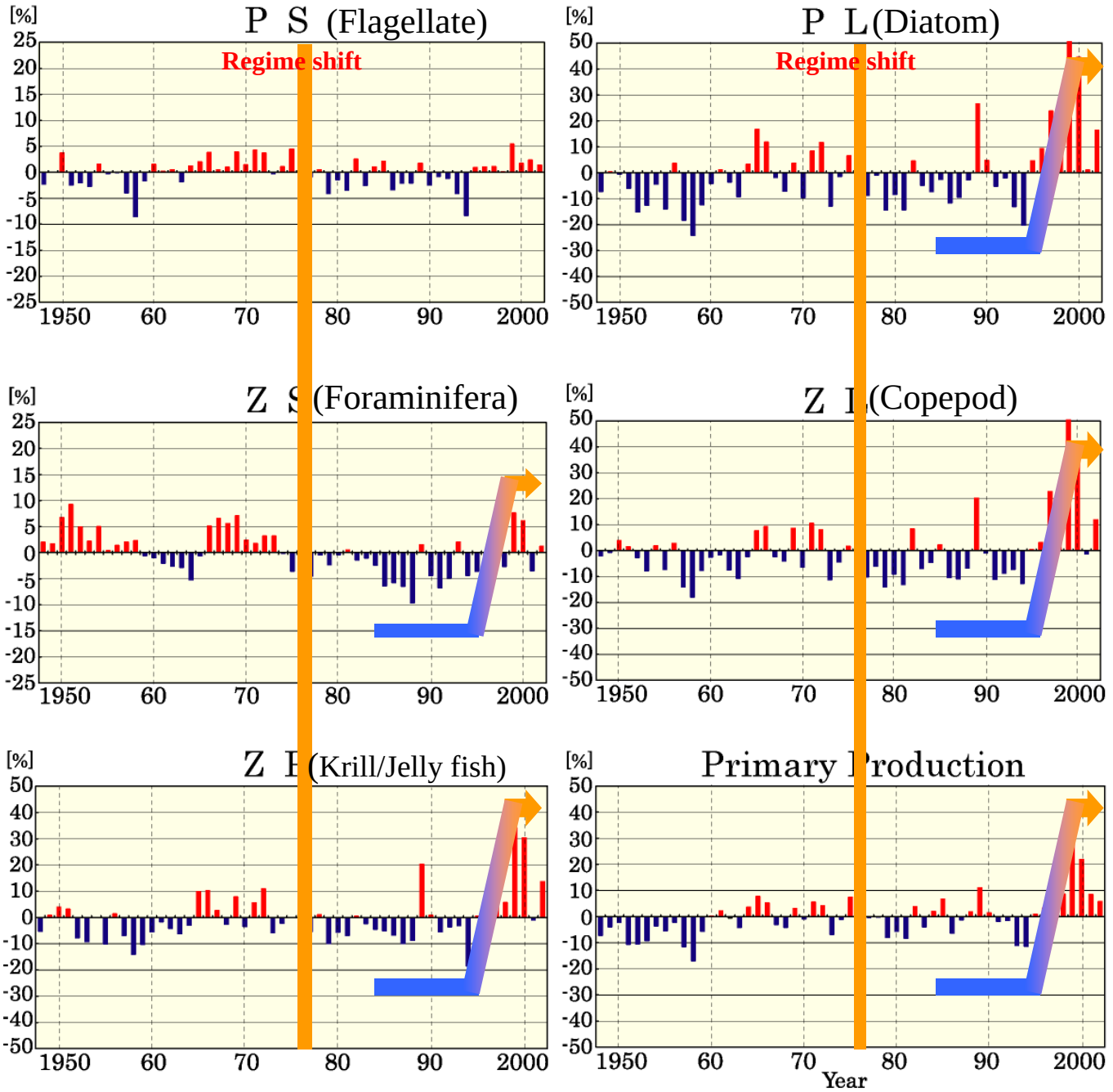
Our model does not include fish grazing explicitly. In therefore lacks top-down control of zooplankton.

Simulated zooplankton biomass increased after 1977.

This suggest that top-down control reduced zooplankton biomass there.

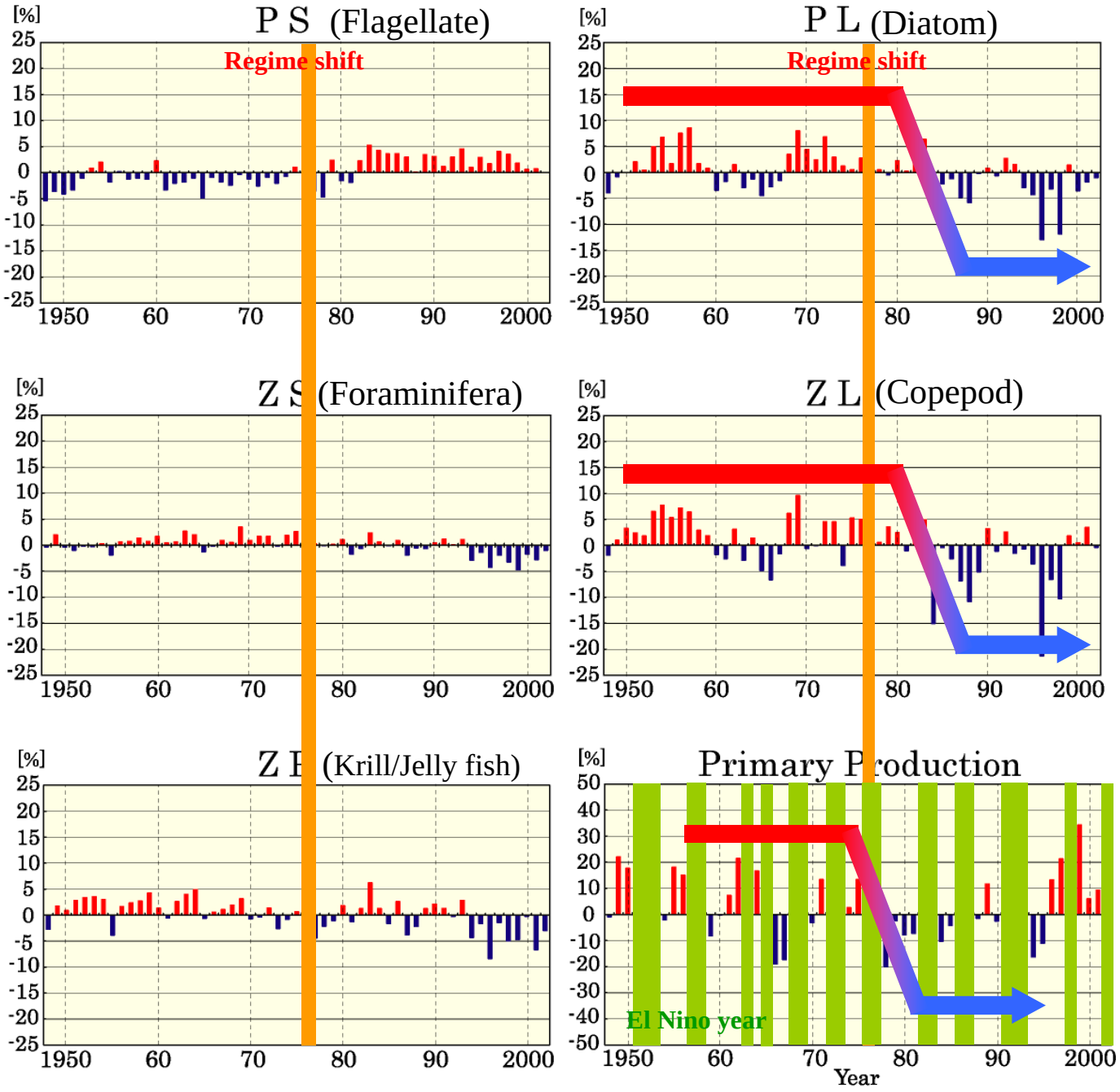
ALS

(Gulf of Alaska)



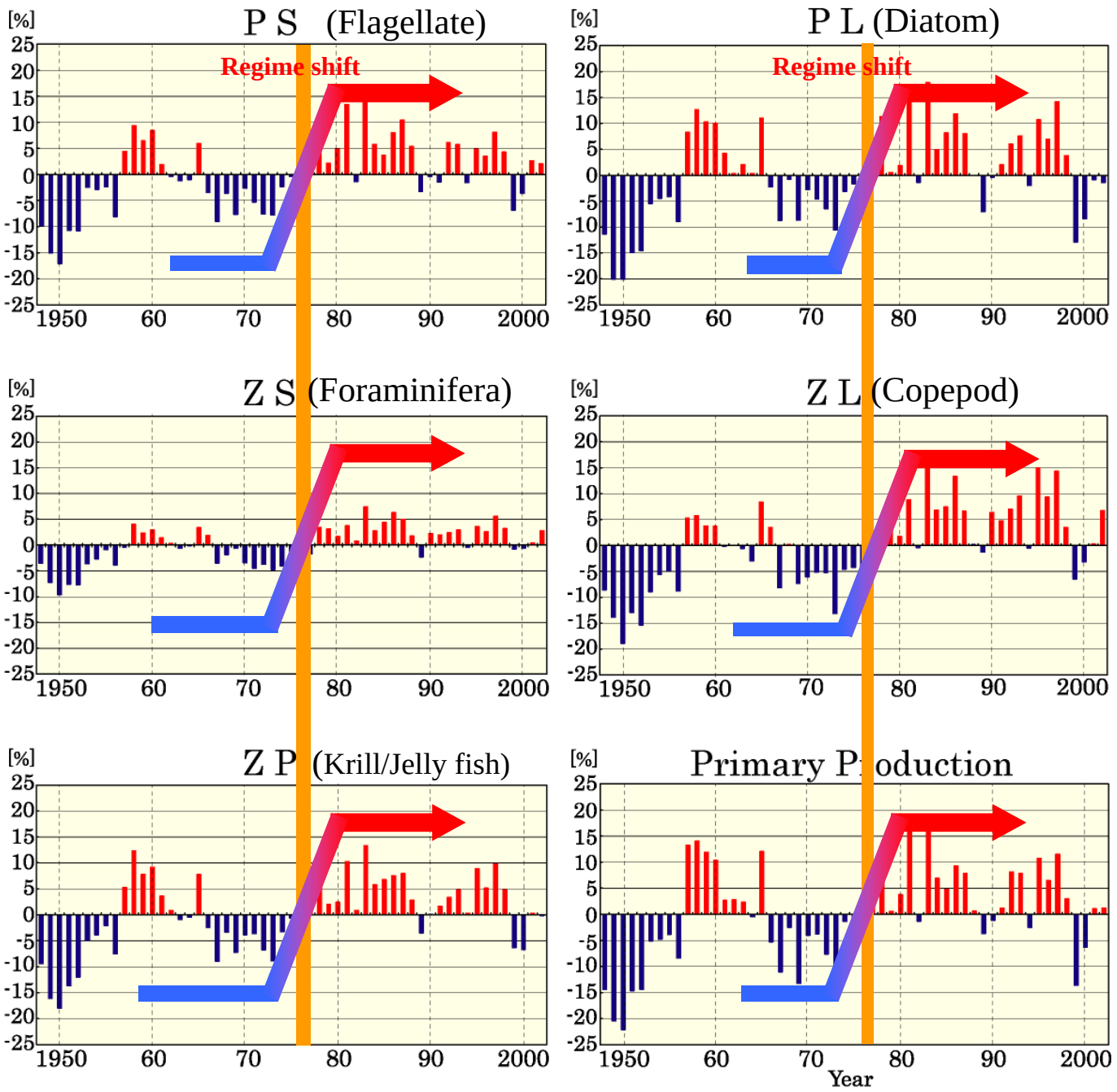
NEP

(Off California)



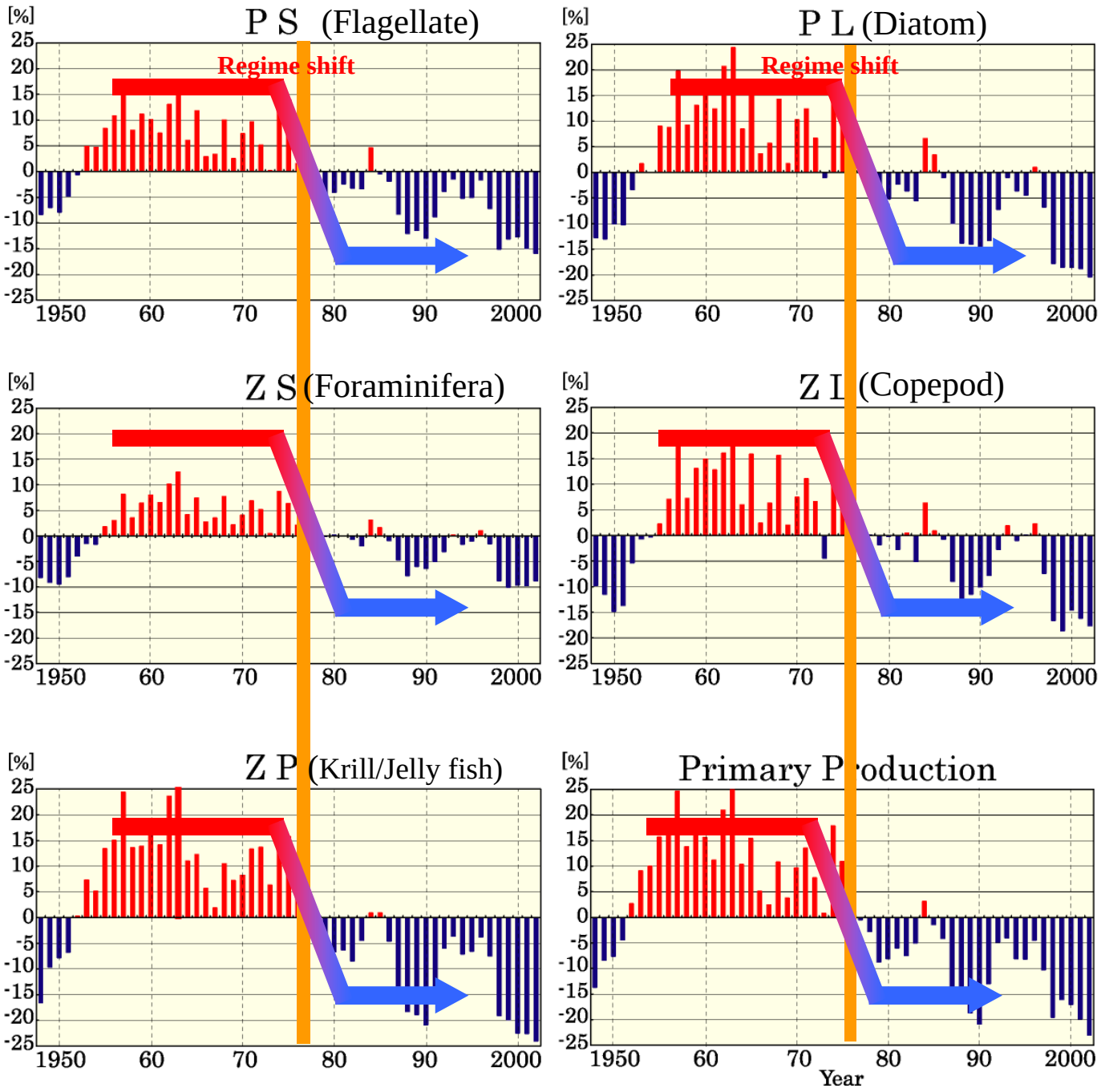
NCP

(North Central Pacific)



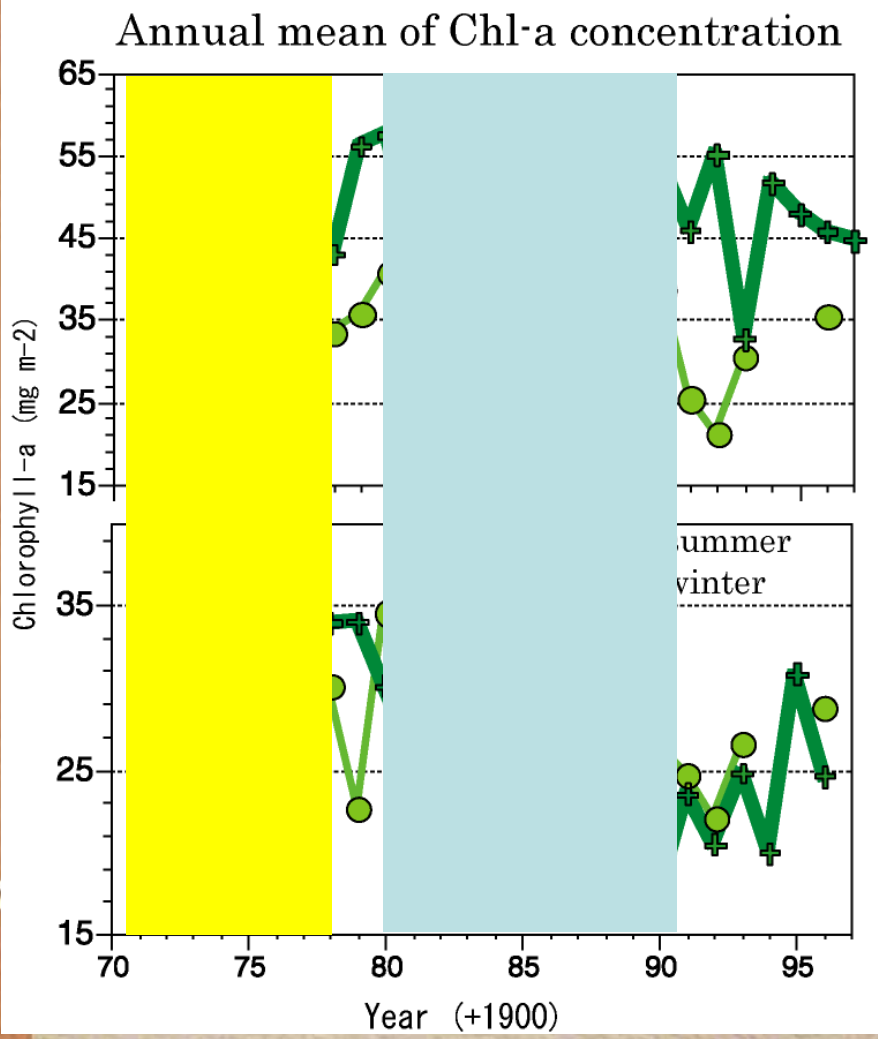
NWP

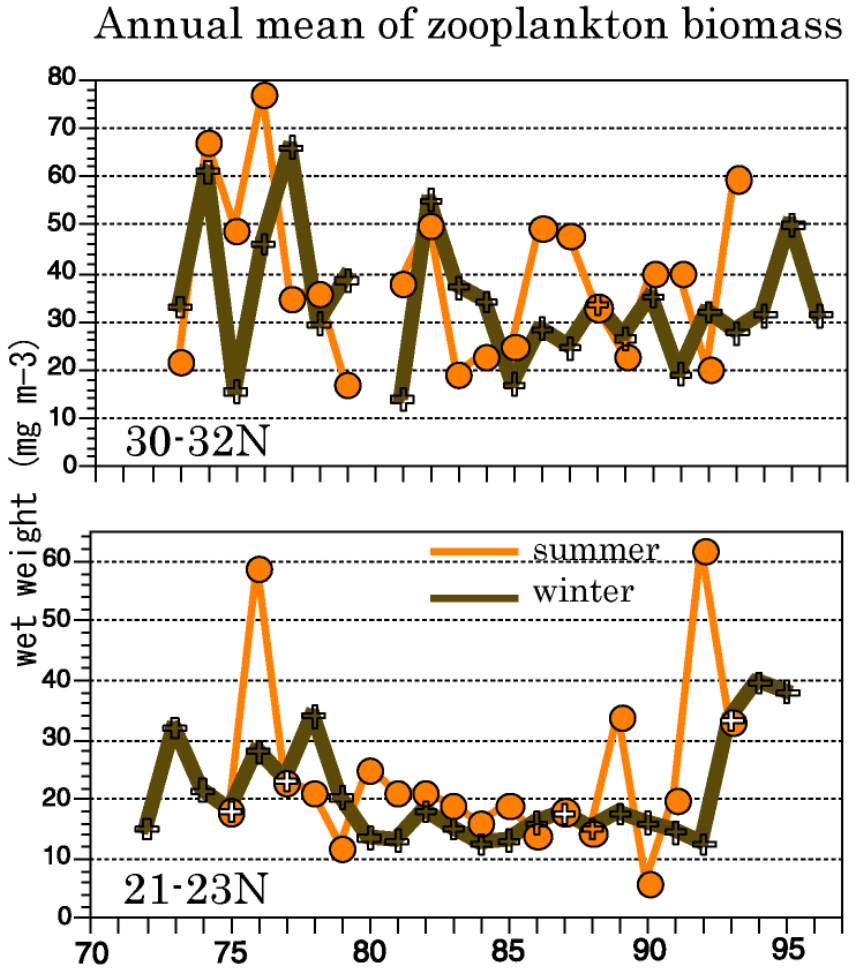
(North Western Pacific)



Observation data at North western Pacific

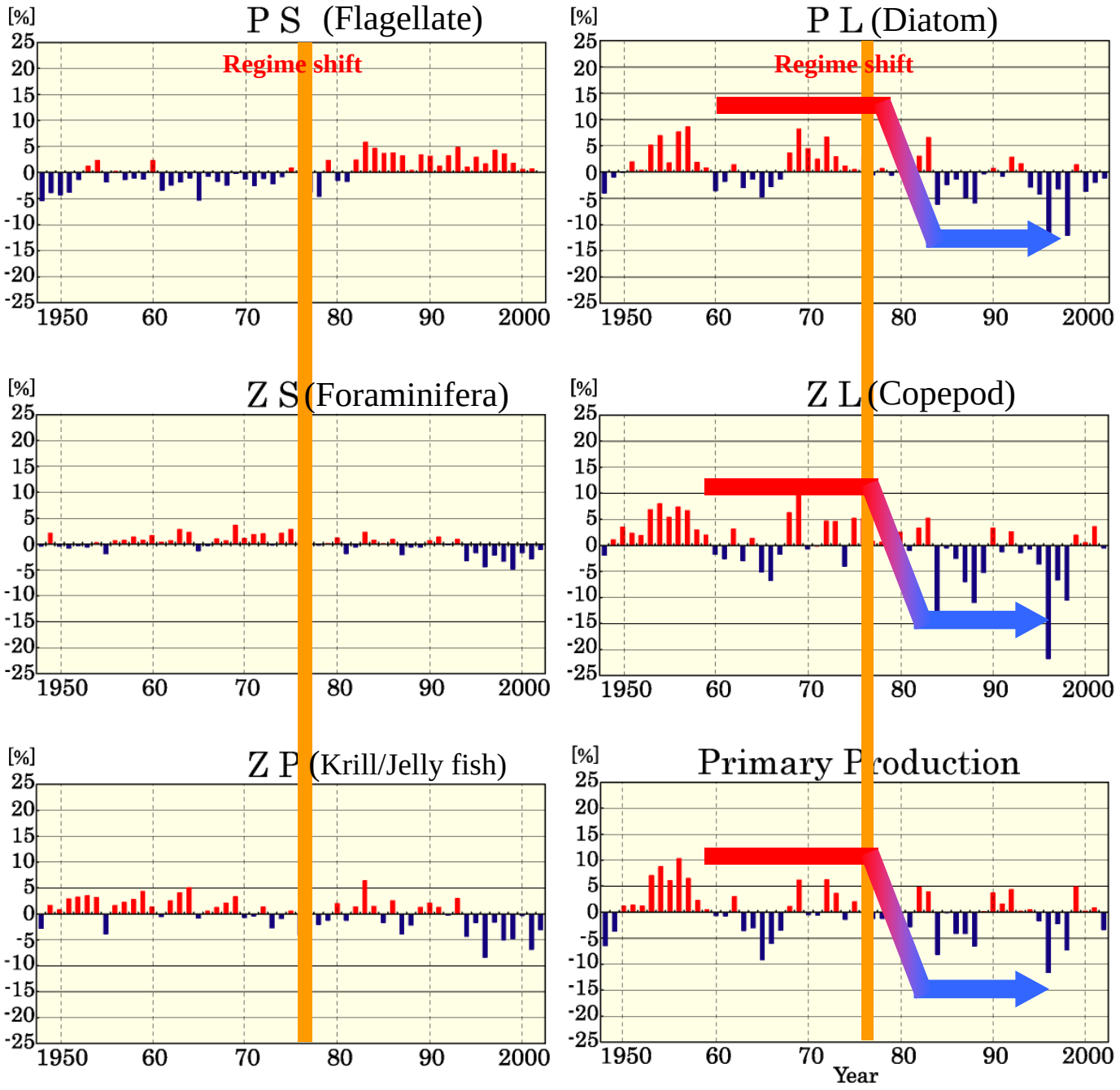
(Sugimoto and Tadokoro, 1998)





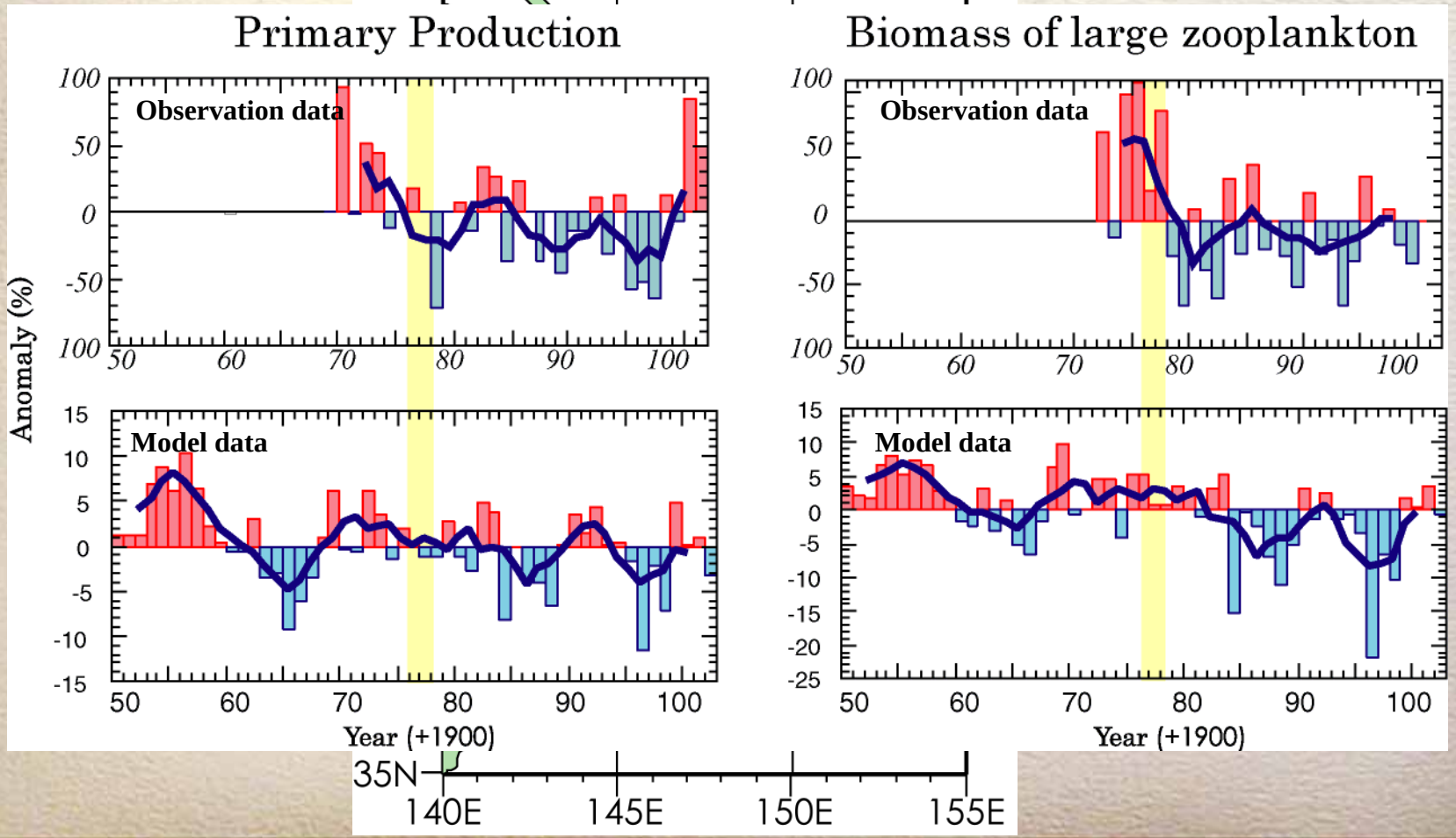
KOT

(Kuroshio-Oyashio Transition)



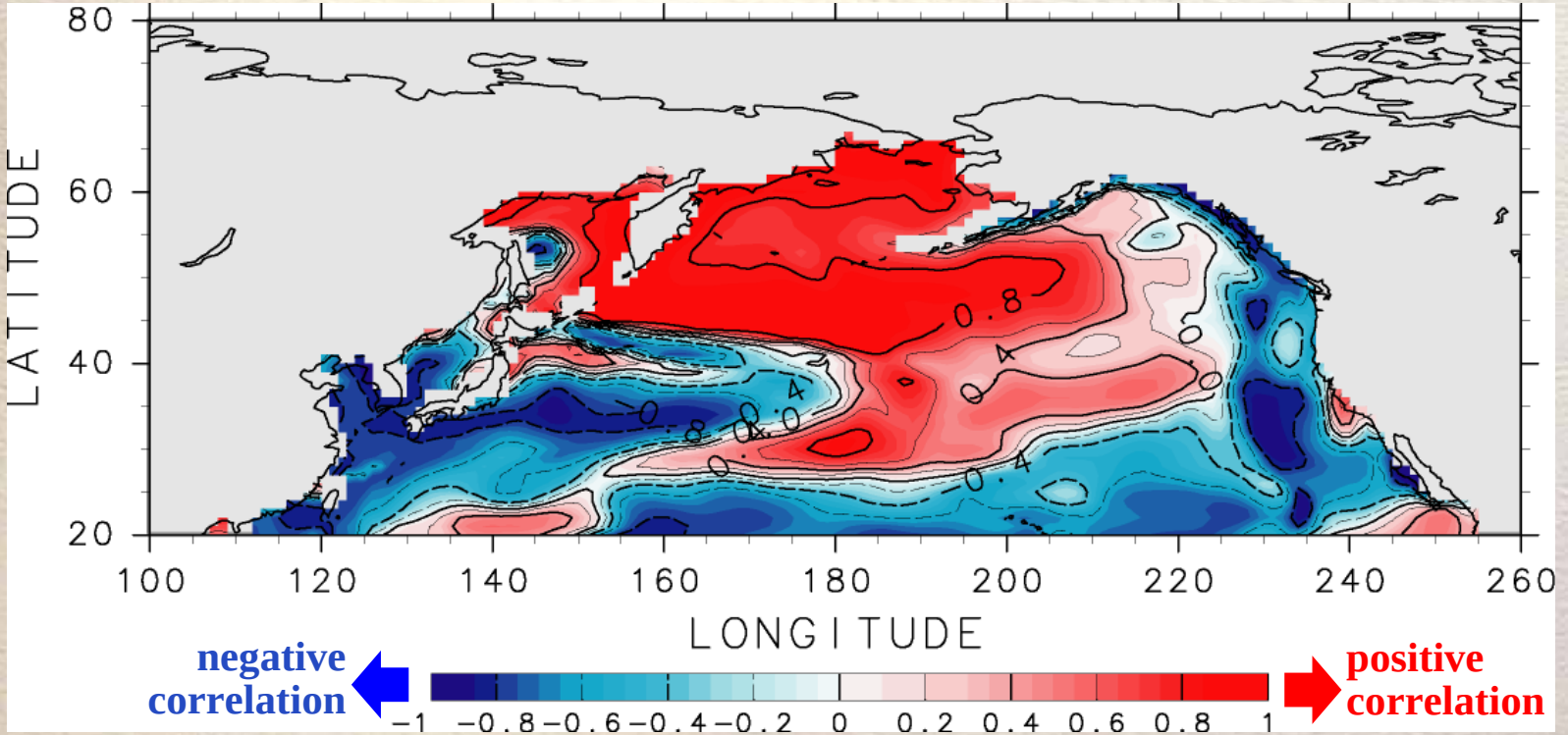
Anomaly of annual averaged at PH-line (41.5N) and KOT

Ono *et al.*,2002, Tadokoro 2004, Tadokoro *et al.* 2004



Correlation between PDO and Primary Production

(7years running mean)

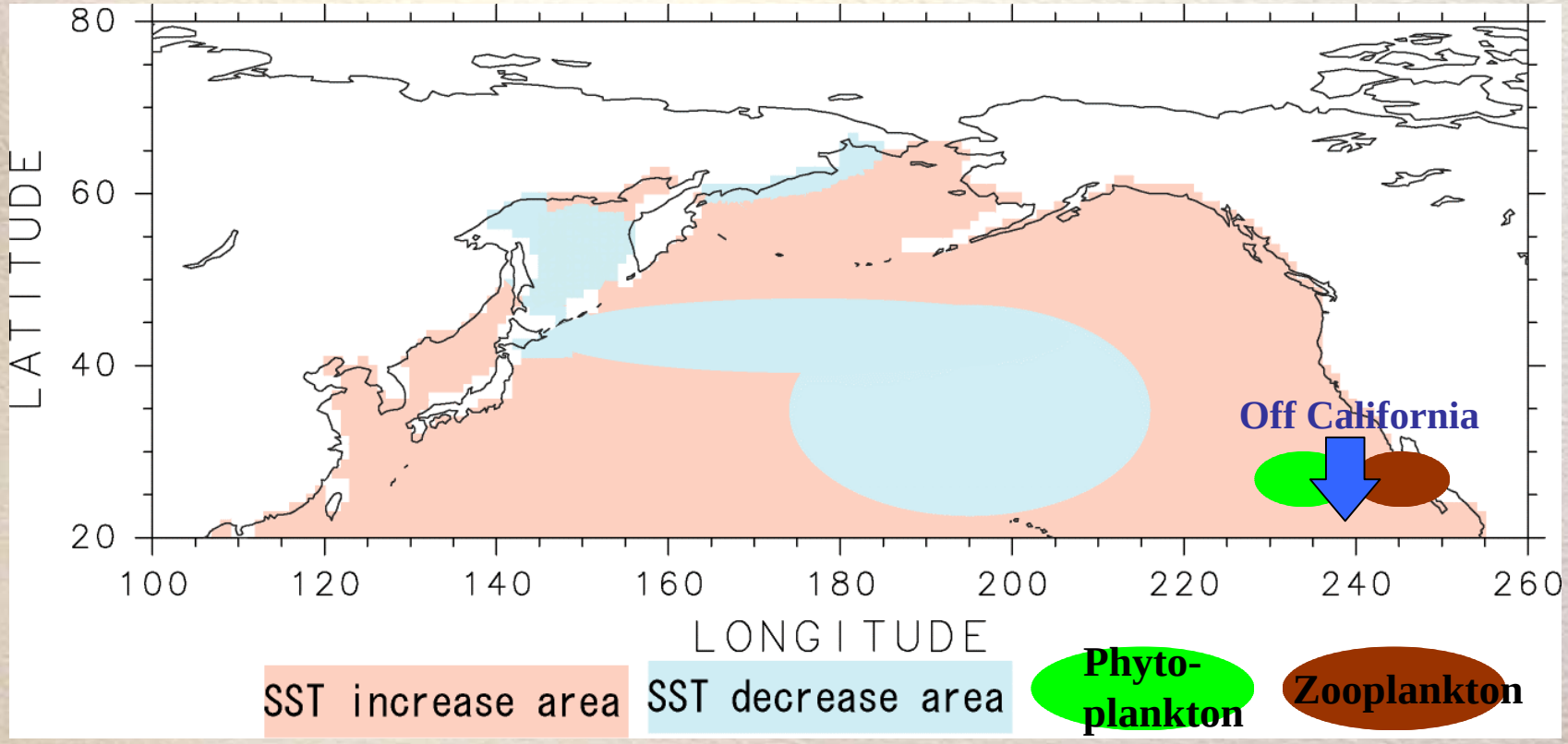


Summary

We simulated the effect of physical regime shift in the late 1970s and ENSO on the lower trophic ecosystem in the North Pacific, using a three dimensional physical biological (3D-NEMURO) model.

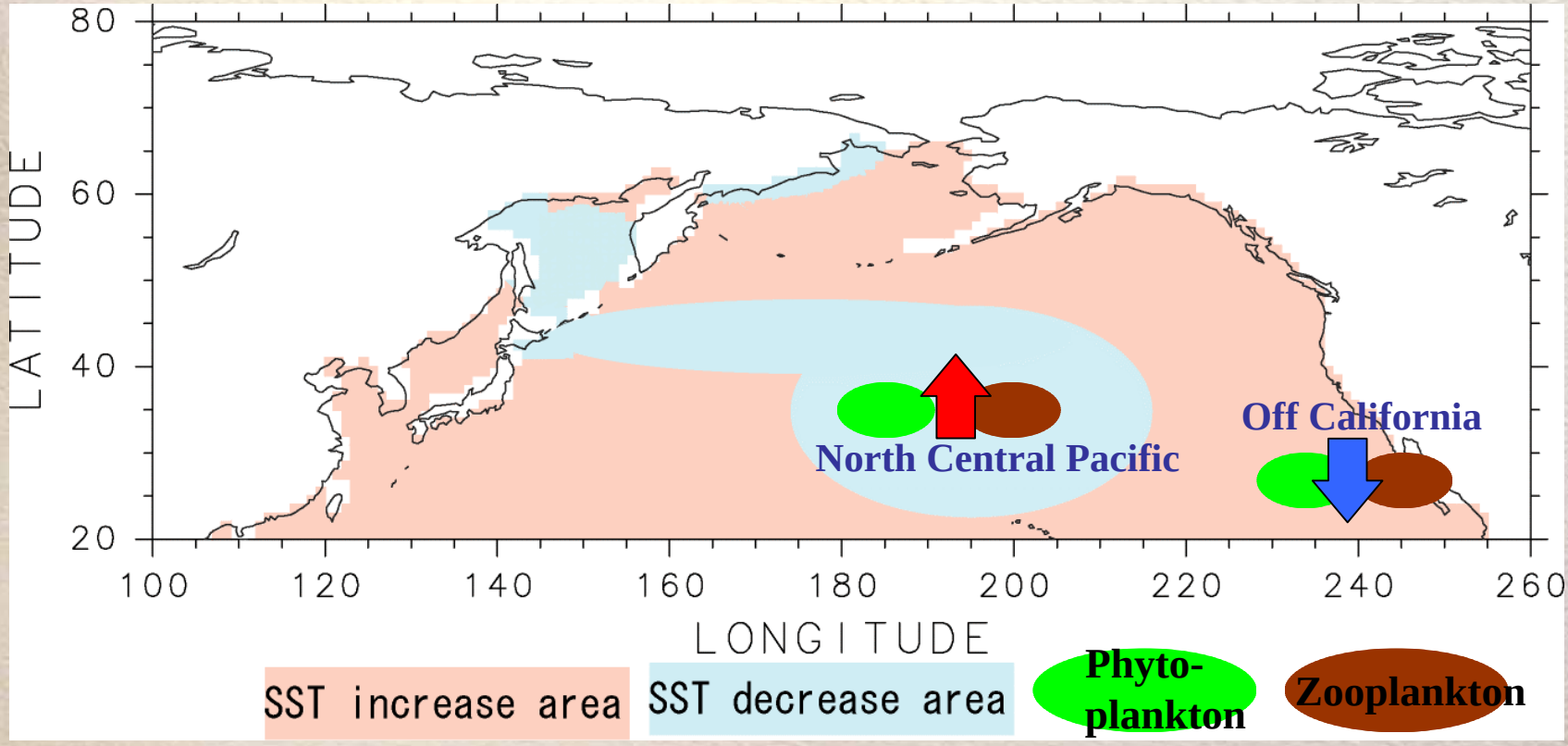
The simulation results showed that inter decadal changes of biomass of phytoplankton, zooplankton and primary production correlate with PDO.

Summary



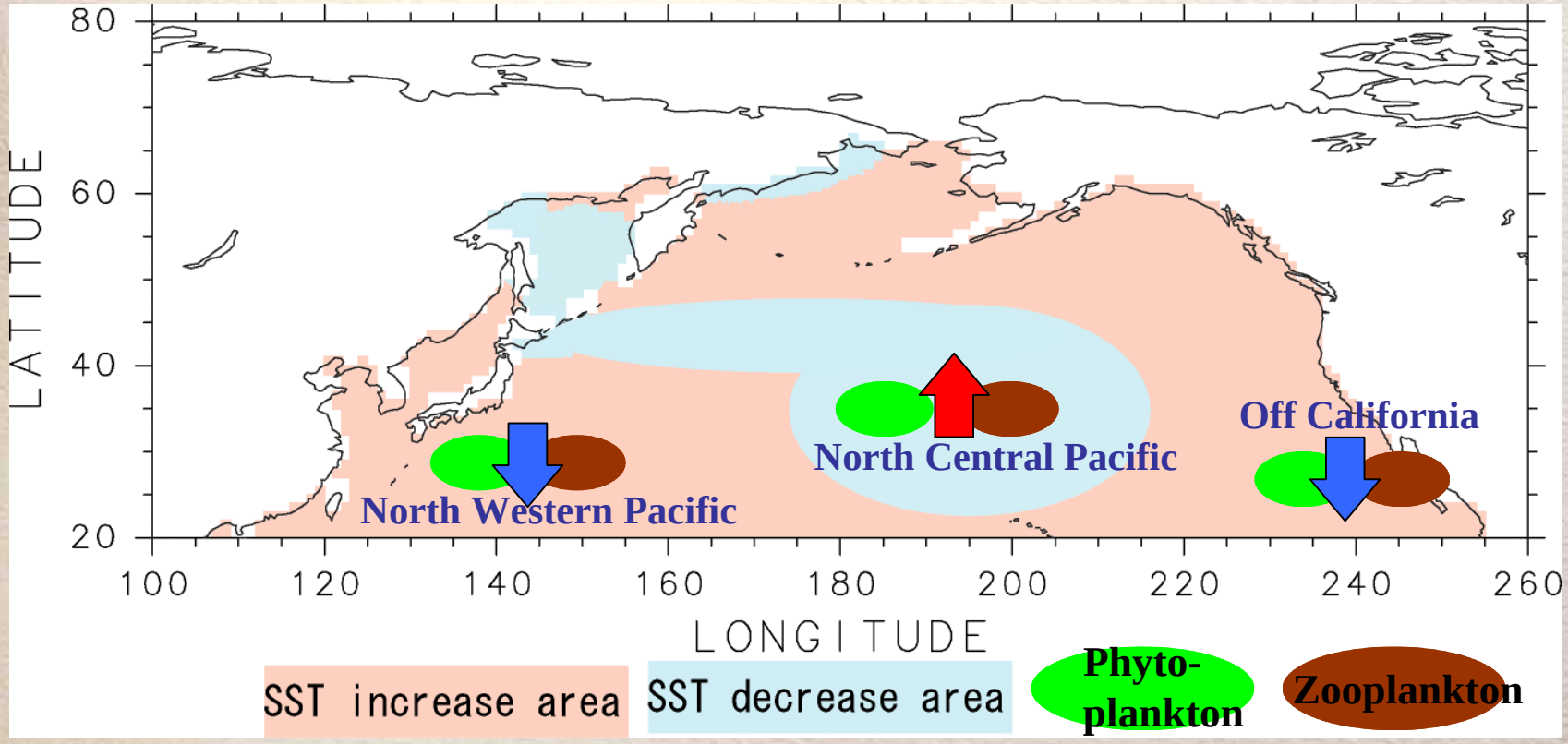
Simulated biomass of phytoplankton and zooplankton decreased because of higher sea surface temperature, and also influenced by ENSO.

Summary



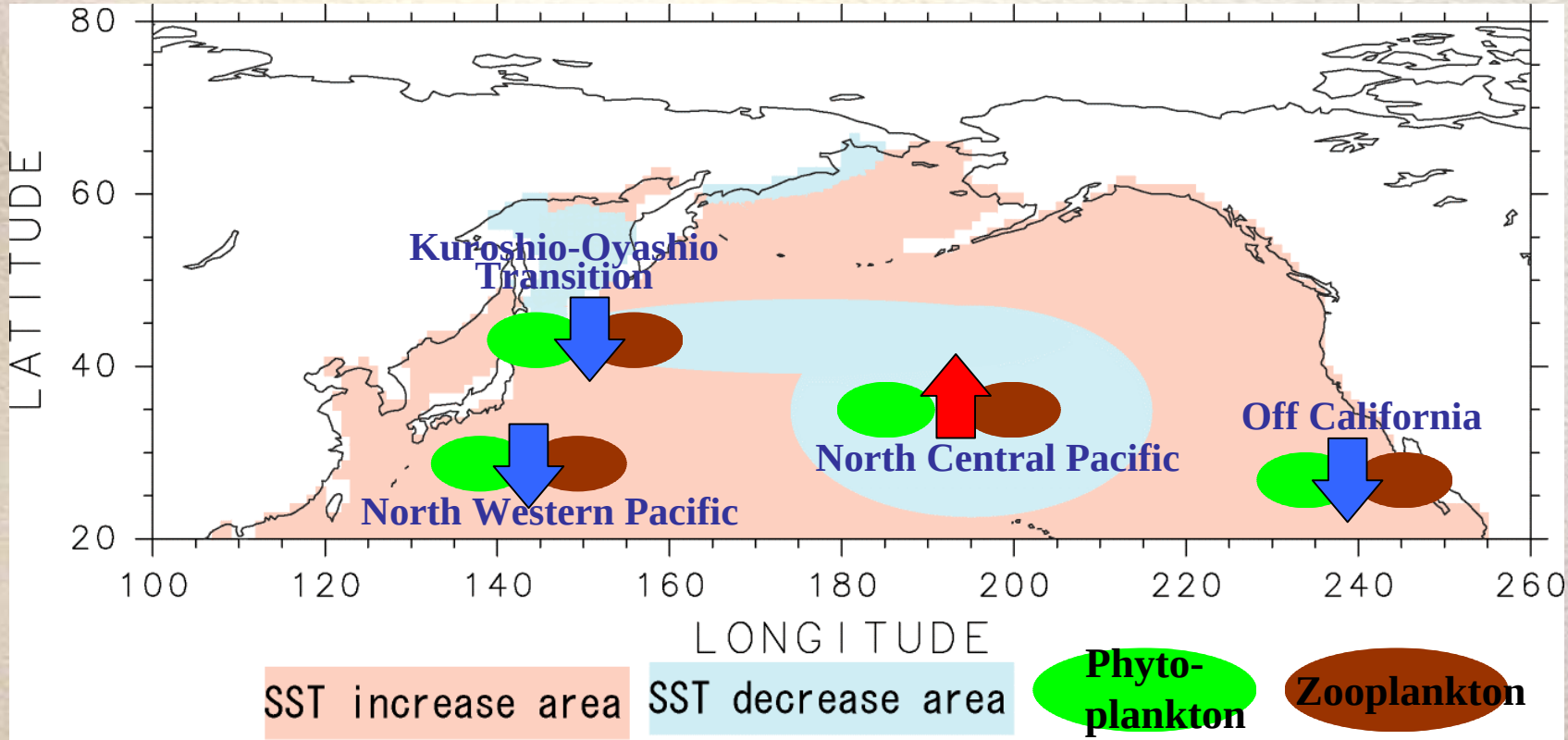
MLD deepened, increasing nutrient supply; this increased the biomass of phytoplankton and zooplankton.

Summary



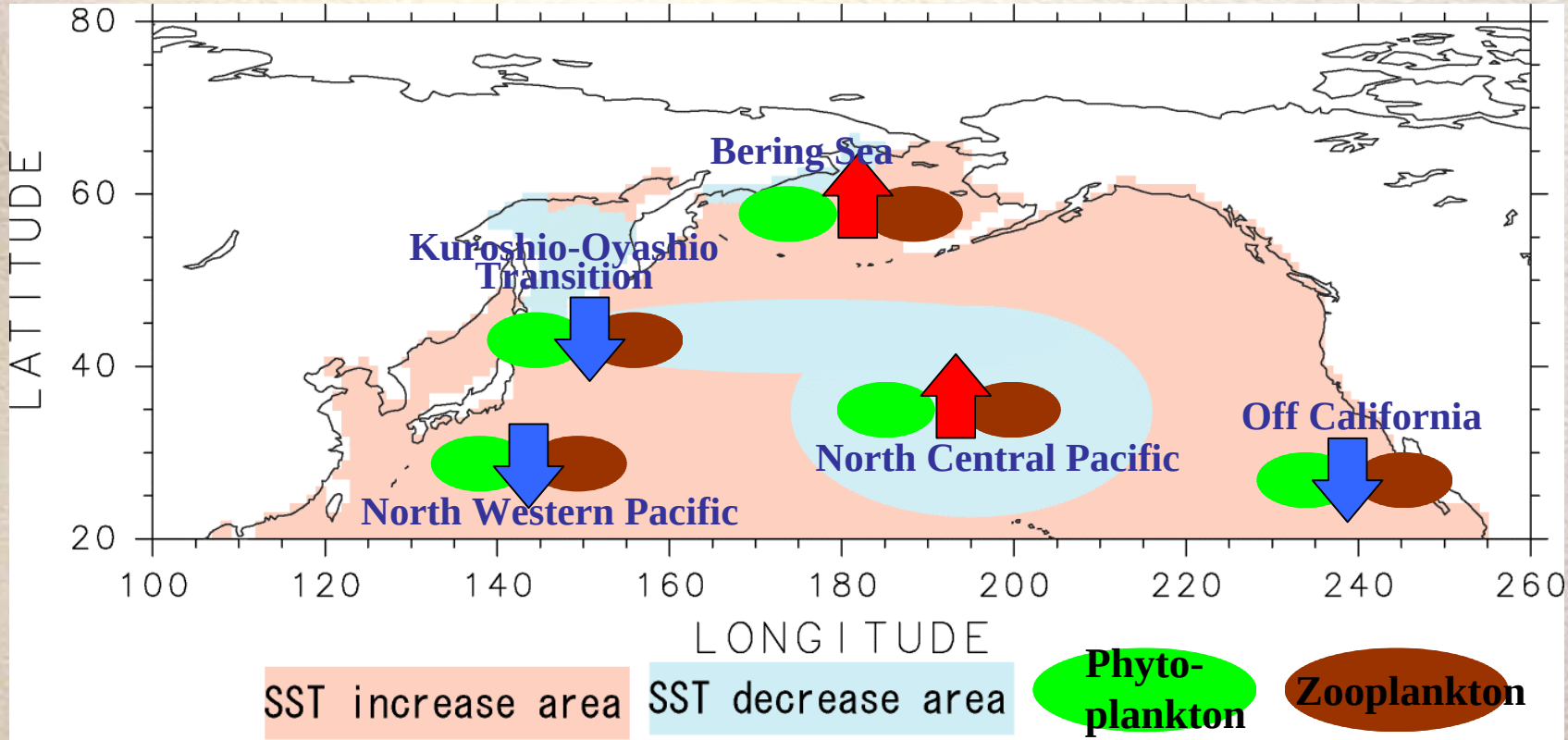
In the North Western Pacific the opposite happened.

Summary



The strengthened advection of low-density water caused a decreased in MLD, which reduced production in this region.

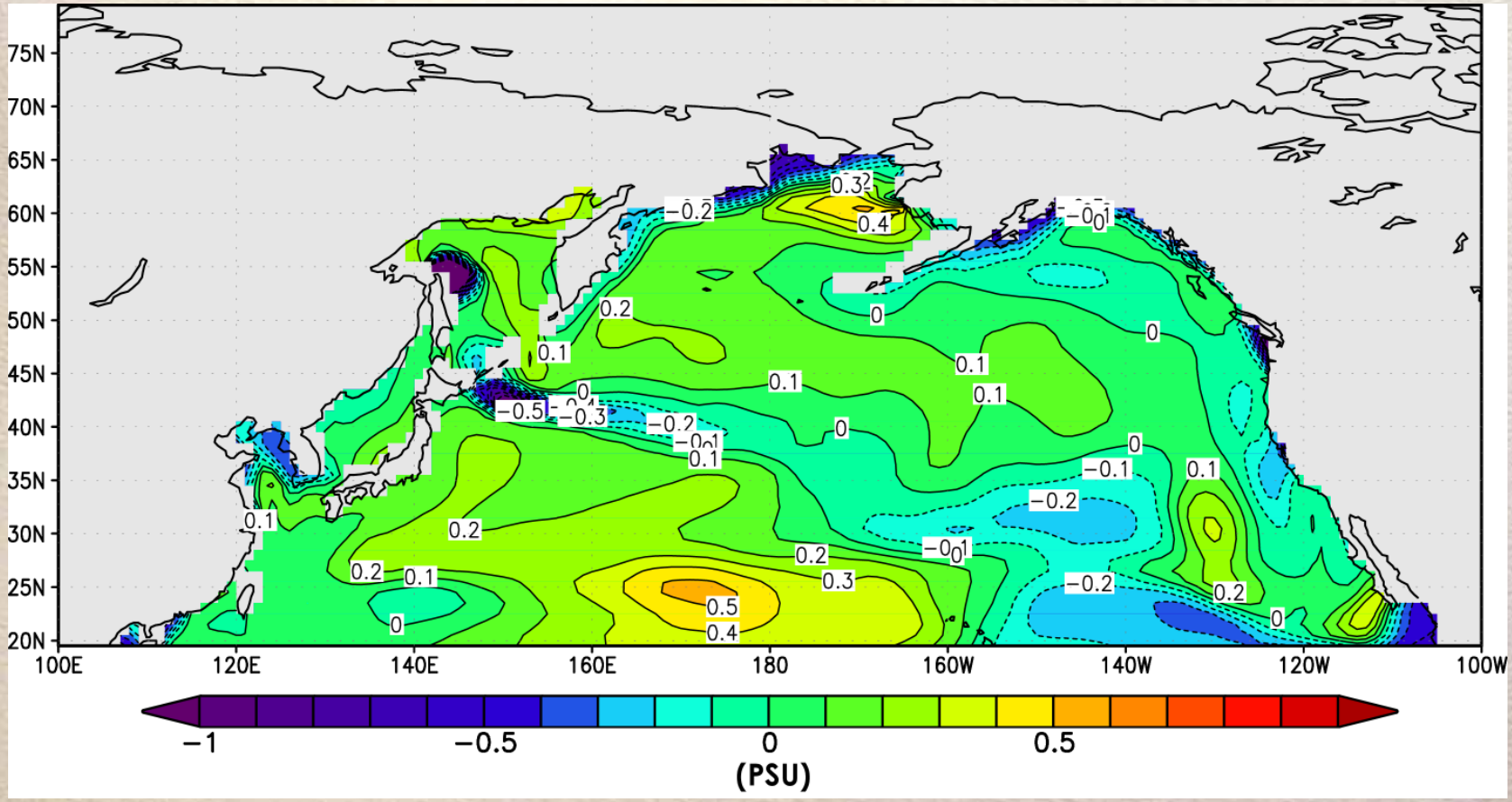
Summary

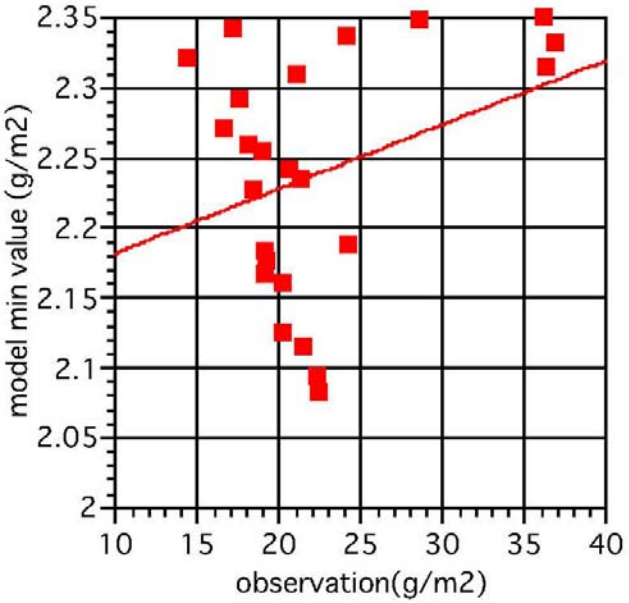


The mixed layer deepened in our model, causing increases in biomass of phytoplankton and zooplankton and primary production. This is contrary to the observations, but it also suggests that top-down control may have dominated in this area.

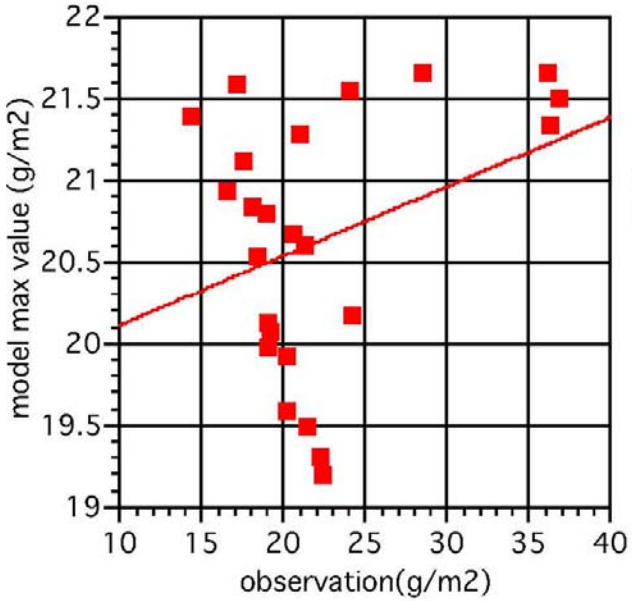
hosoku

SSS (1977-2000 minus 1952-1975)





f(x) = 0.0045904979736576*x + 2.13601671374082
R^2 = 0.109359827787252



f(x) = 0.0423124160786909*x + 19.6885018837621
R^2 = 0.109359827809705

Annual mean of the PDO 1948-2002

(Pacific Decadal Oscillation index)