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S2. Decadal changes in carbon biogeochemistry in the North Pacific
(October 30, 15:20-15:40, S2-4137)

Remote reemergence of winter SST anomalies and spring chlorophyll-a concentration in the central North Pacific

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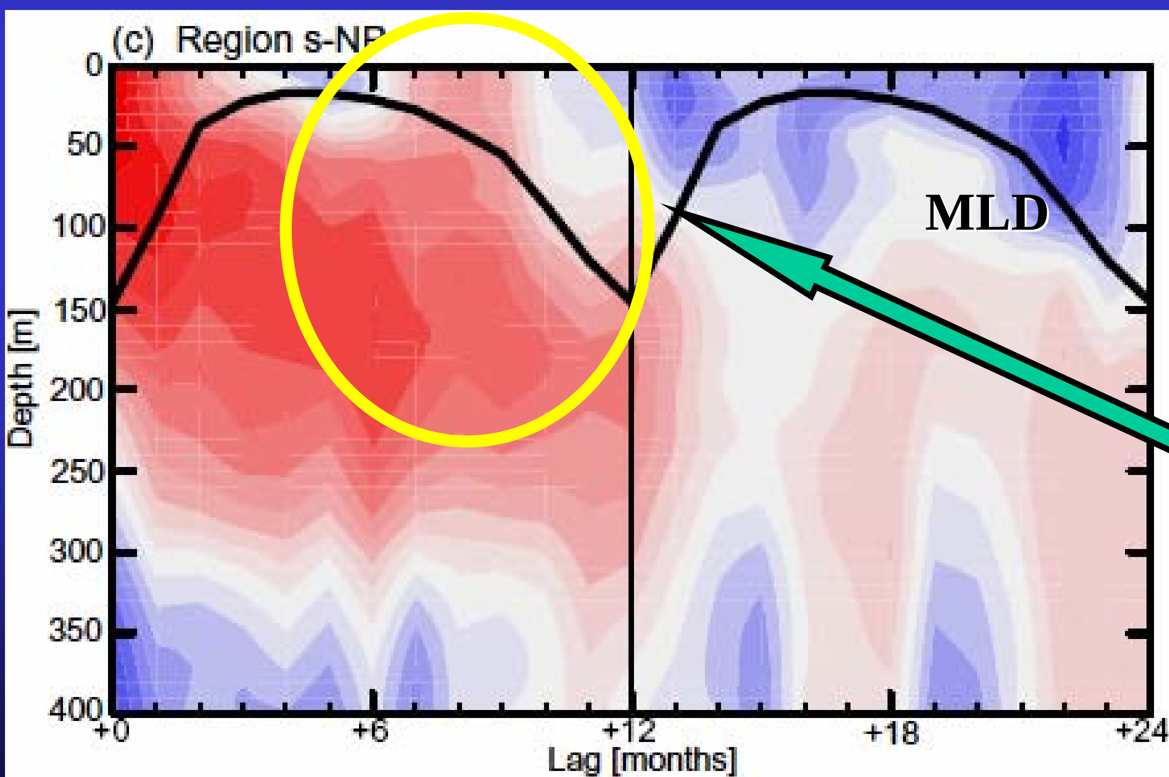
We try to interpret Chl-a concentration from the viewpoints of the oceanic physical conditions such as winter mixed layer depth and temperature etc. Here, we report the influence of 'reemergence' process of the North Pacific Mode Water (NPSTMW) on Chl-a concentration.

1. Reemergence mechanism: co-located type and remote type
2. Influence of two types of reemergence on Chl-a concentration

What is reemergence mechanism

'Reemergence' : reappearance of SST anomalies in cooling season, which are set in the mixed layer in the previous winter

Pioneering work : Namias & Born (1970, 1974)
North Pacific : Alexander & Deser (1995), Alexander *et al*. (1999)
Hanawa & Sugimoto (2004), Sugimoto & Hanawa (2005)
North Atlantic : Watanabe and Kimoto (2000), Timlin *et al*. (2002)



Lag correlation coefficients between anomalies of winter SST and the subsurface layer temperature in the NPSTMW formation area.

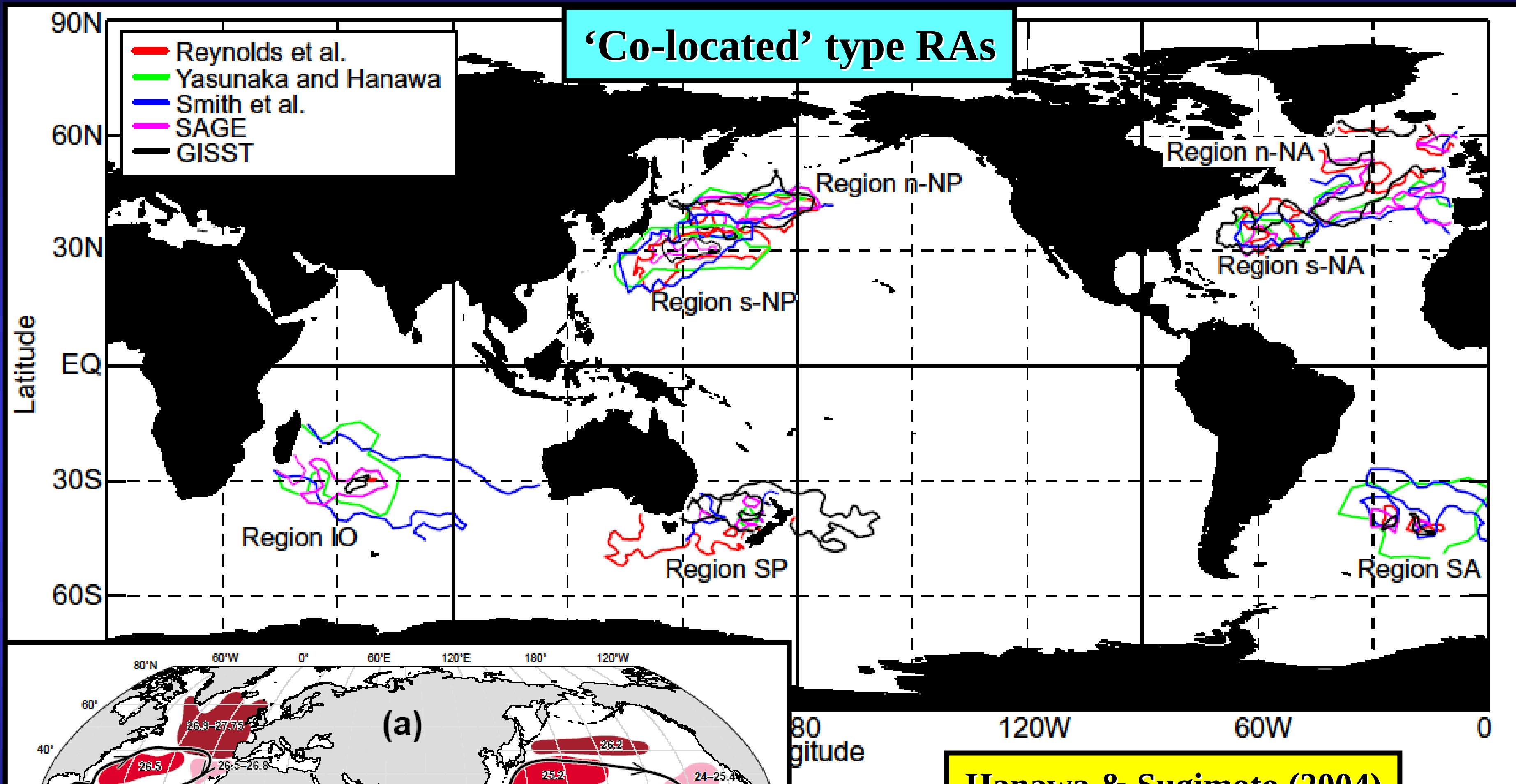
reemergence signal

Hanawa & Sugimoto (2004)

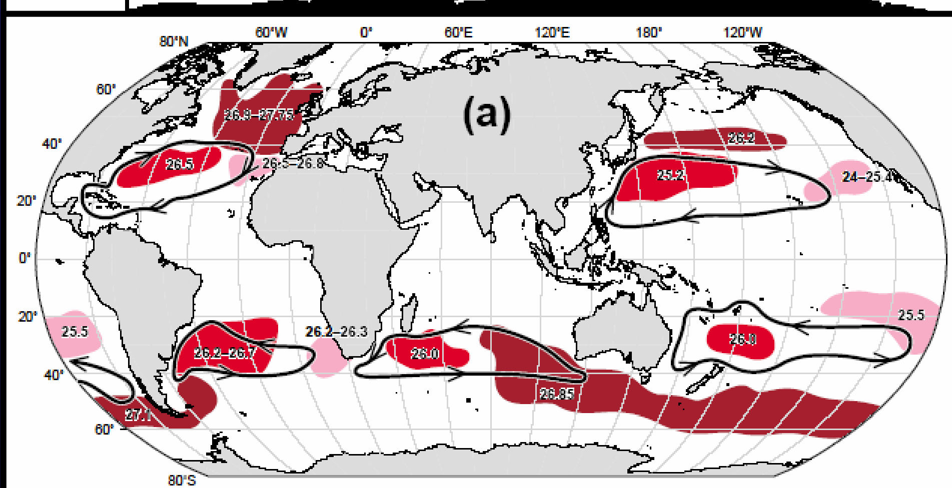
MLD: mixed layer depth

‘Co-located’ 7 reemergence areas (RAs)

‘Co-located’ type RAs



Hanawa & Sugimoto (2004)



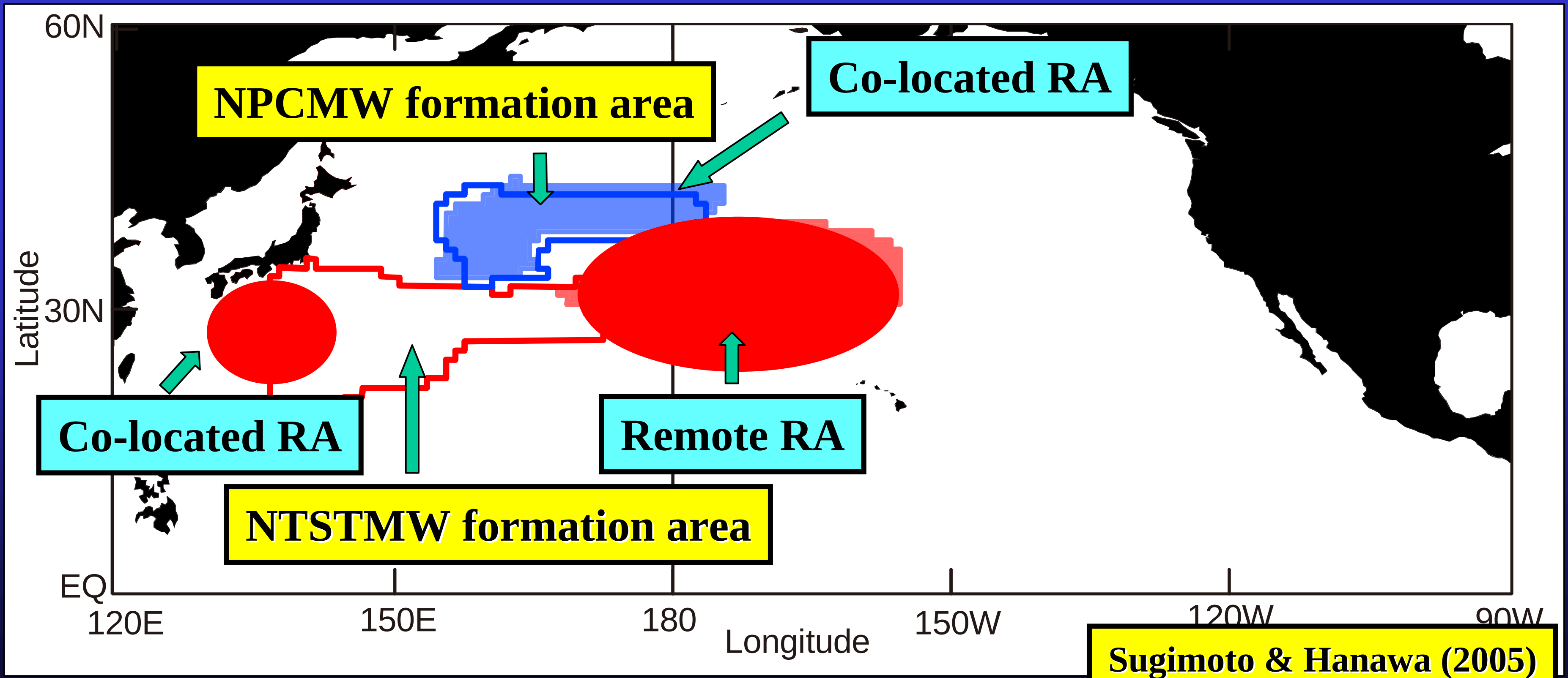
Mode water distributions in the world ocean

Hanawa & Talley (2001)

'Remote' reemergence area

Since the NPSTMW is formed in the Kuroshio recirculation region, part of NPSTMW is transported to the central Pacific in one year. Reemergence of NPSTMW also occurs in this region ('remote' reemergence).

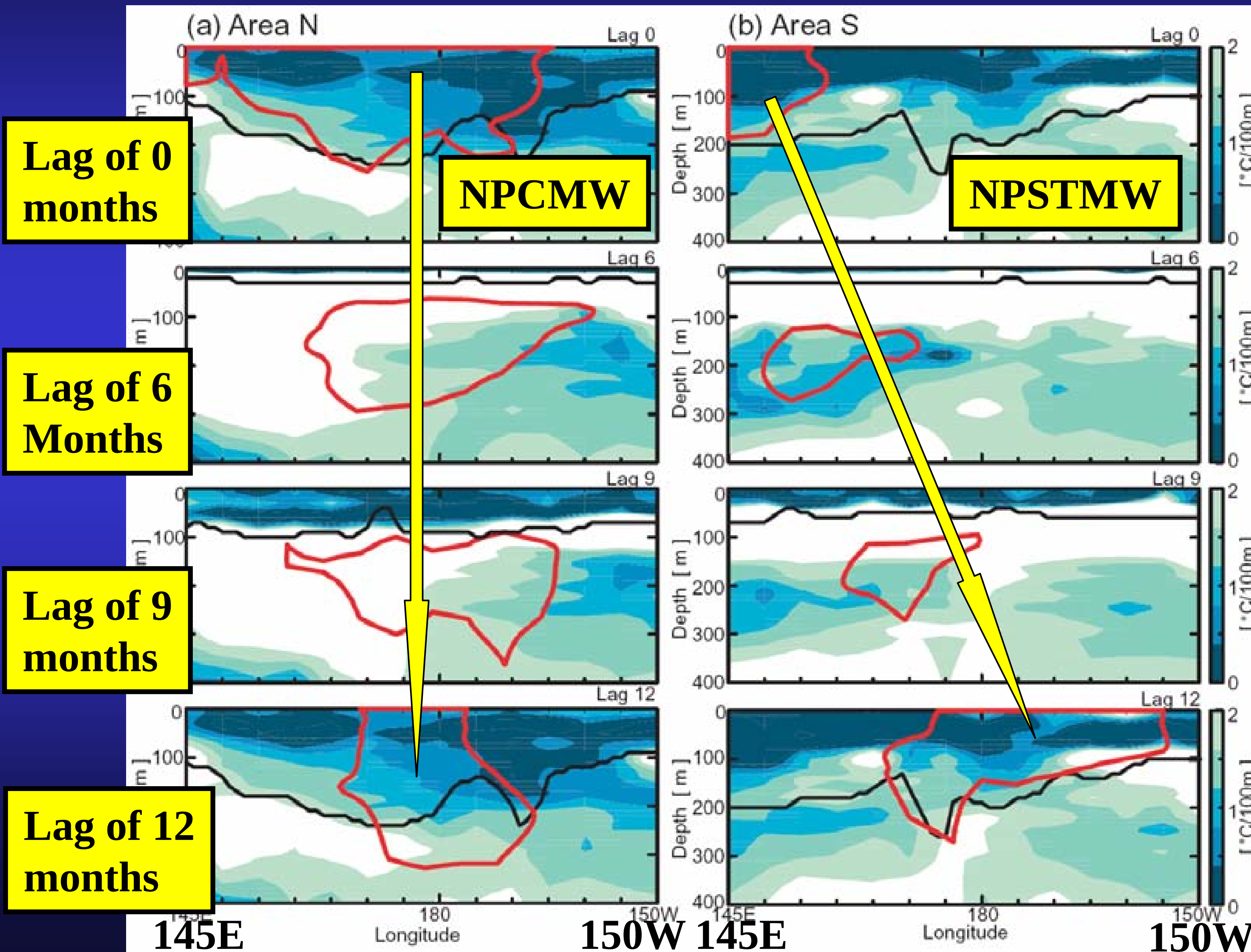
NPSTMW : co-located RA and remote RA
NPCMW : co-located RA
NPESTMW: reemergence does not occur (see Sugimoto & Hanawa, 2005, 2007)



Sugimoto & Hanawa (2005)

Tracing of signal in the subsurface layer

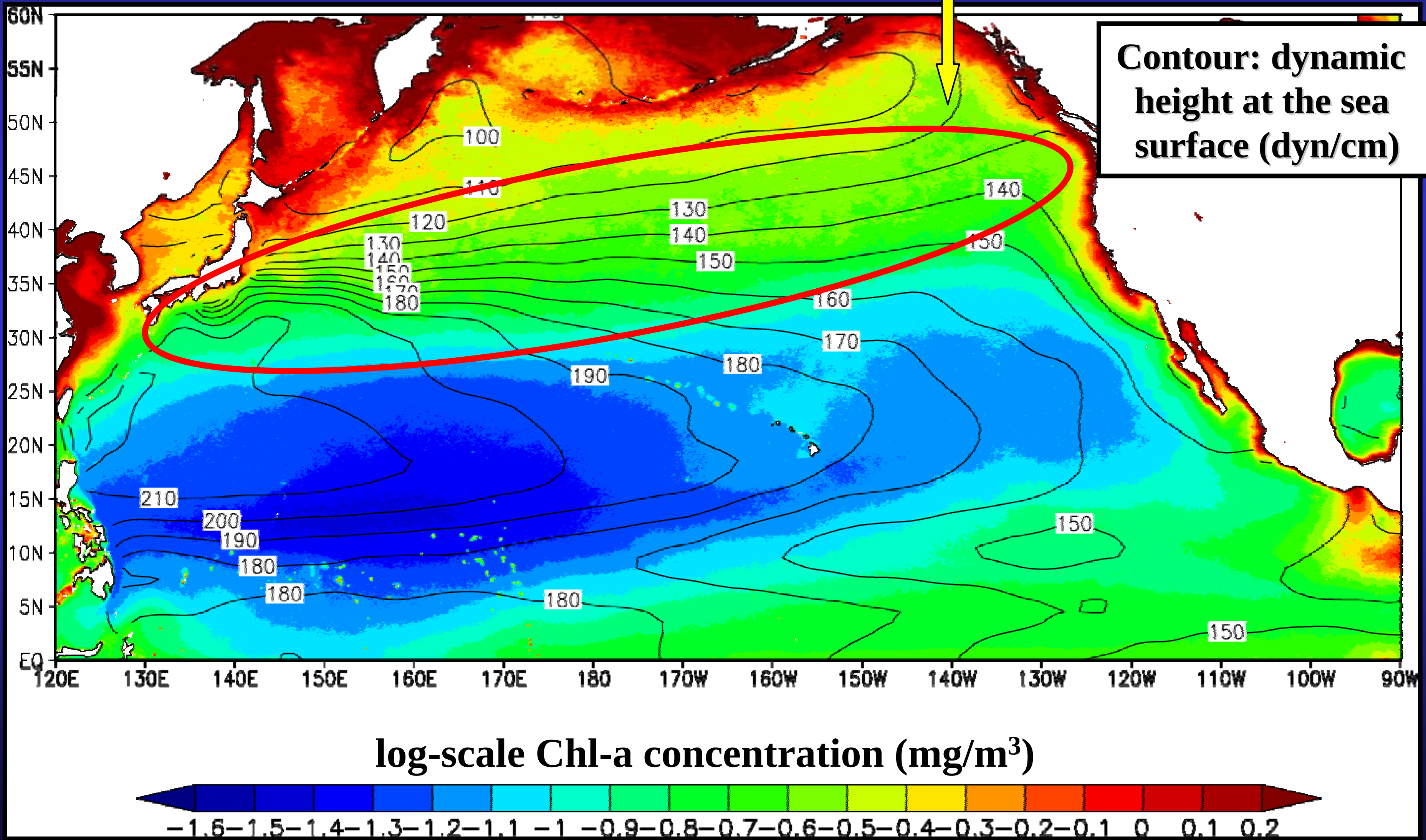
Co-located reemergence | **Remote reemergence**



Red line:
high *R* layer
Black line:
mixed layer depth (MLD)
Shading:
T-gradient

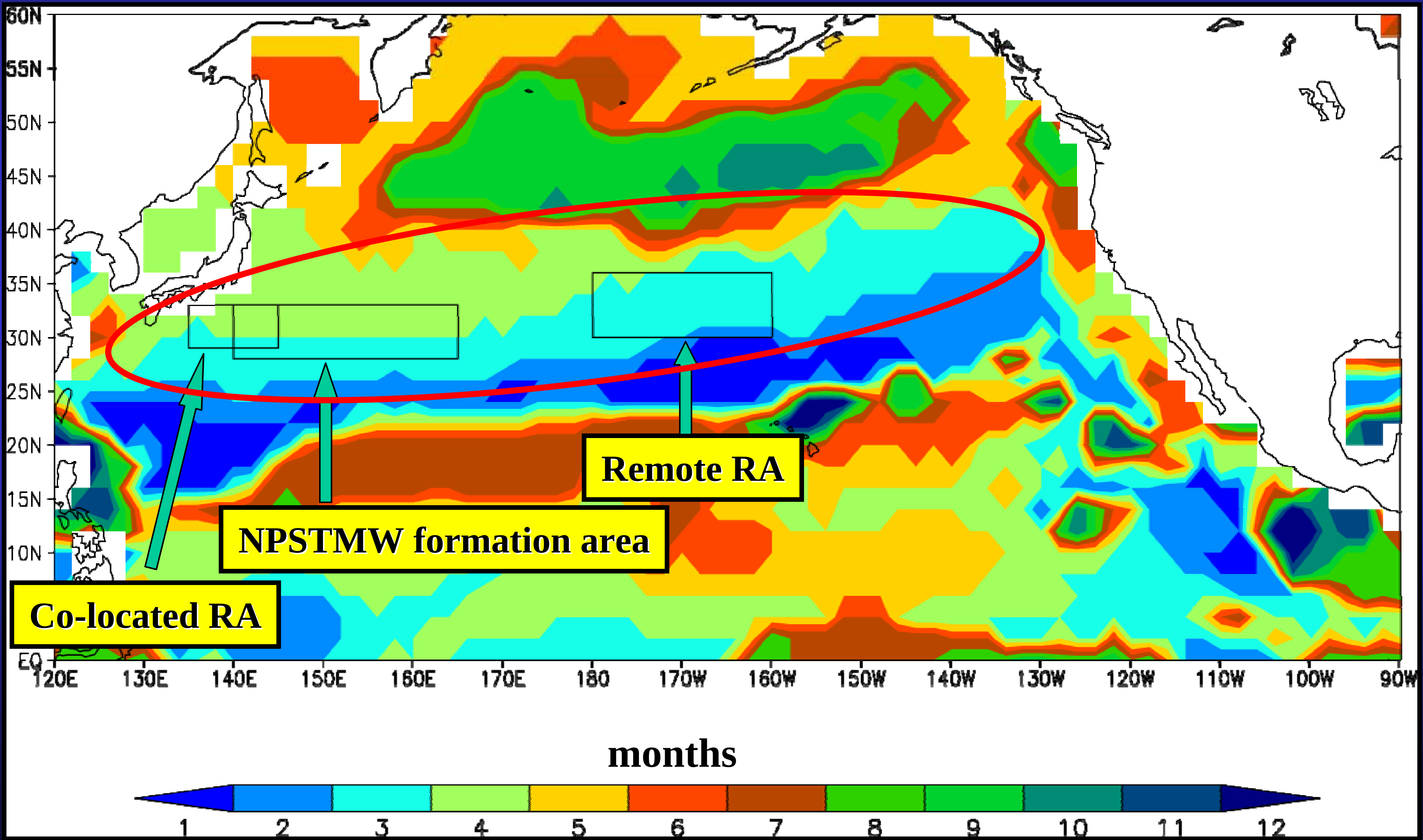
Climatology of SeaWiFS Chl-a concentration (1998-2005)

Yearly mean Chl-a concentration in the northern subtropical gyre is the same order as that in the southern subpolar gyre.



Distribution of months having the highest Chl-a concentration

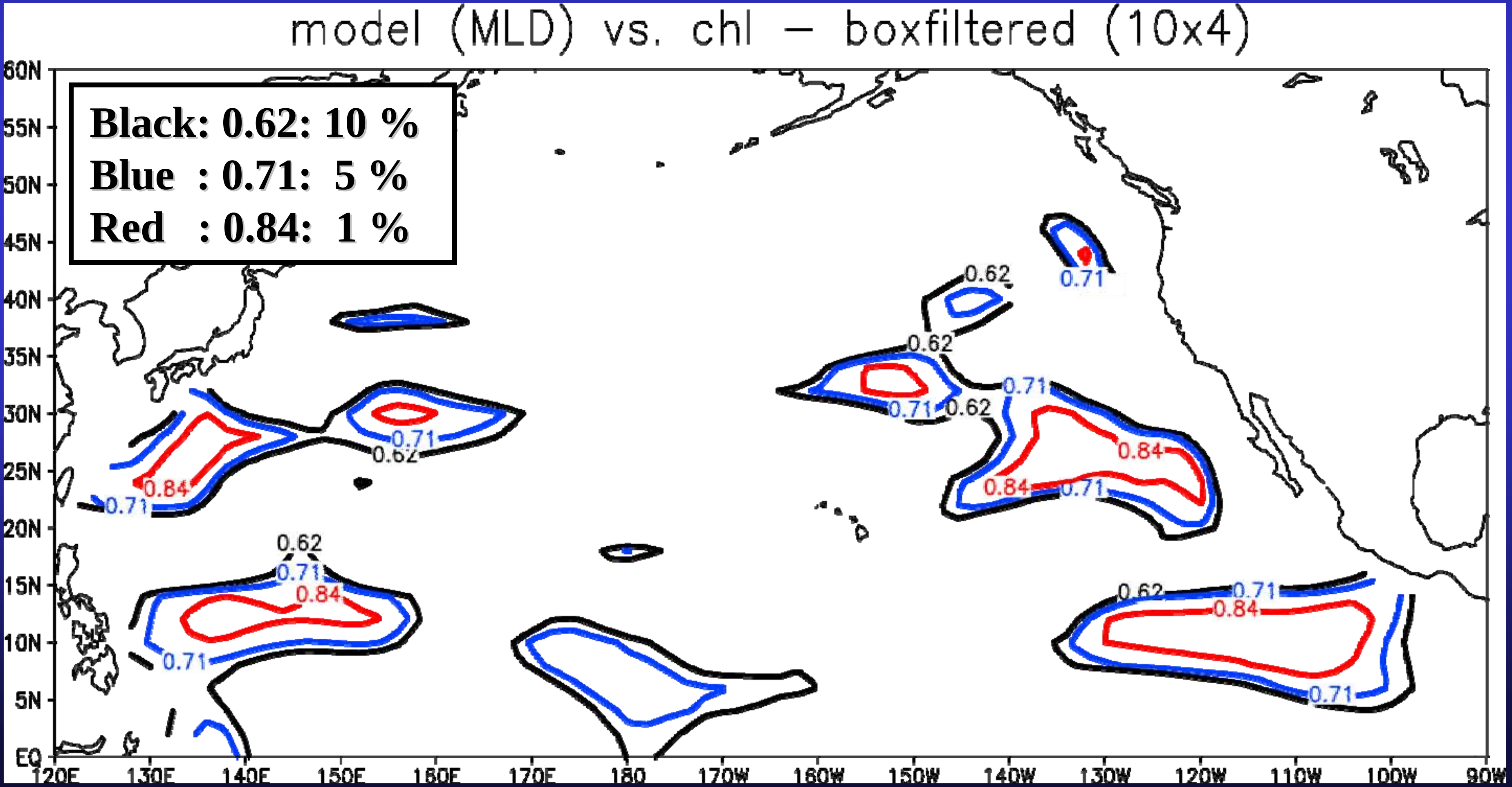
Month of the highest Chl-a concentration is March or April in the northern subtropical gyre and southern subpolar gyre in the North Pacific (25N-40N).



Winter MLD and spring Chl-a

First, the relationship between winter MLD and spring Chl-a concentration is searched. In several regions, spring (March and April) Chl-a concentrations are well explained by winter MLD only.

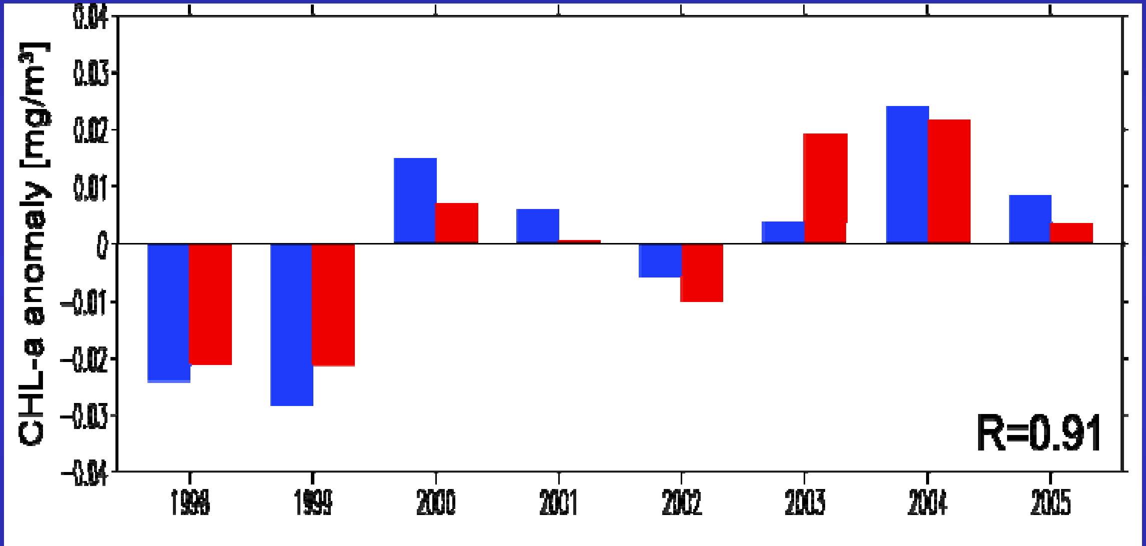
Correlation coefficients between winter MLD and spring Chl-a



Spring Chl-a concentration in the NPSTMW formation area

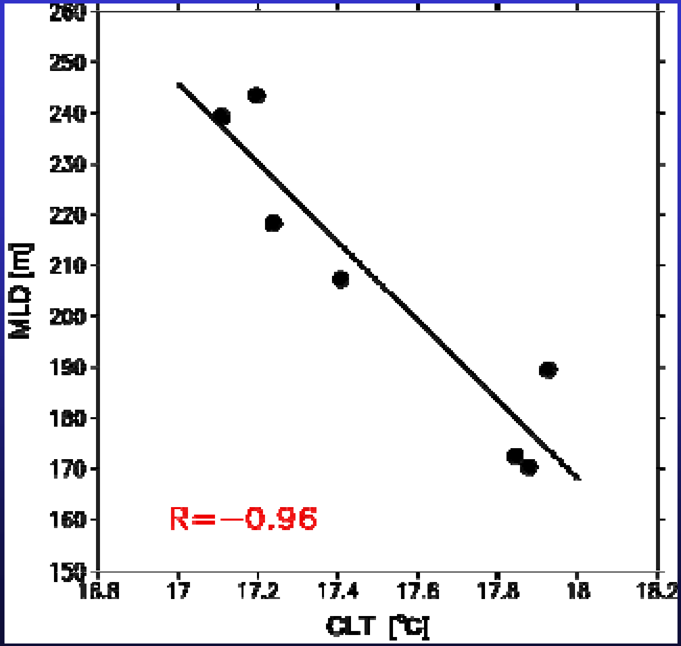
Single regression model using winter MLD to explain the spring Chl-a concentration. Correlation coefficient is 0.91.

Chl-a anomaly (March and April) = Const x MLD (0, NPSTMW) + error



NPSTMW formation area: [28N-34N, 140E-165E]
Blue: observation
Red : model result

Development of mixed layer means enhanced entrainment of the lower nutrient-rich water. This causes the higher spring Chl-a concentration in the NPSTMW area.

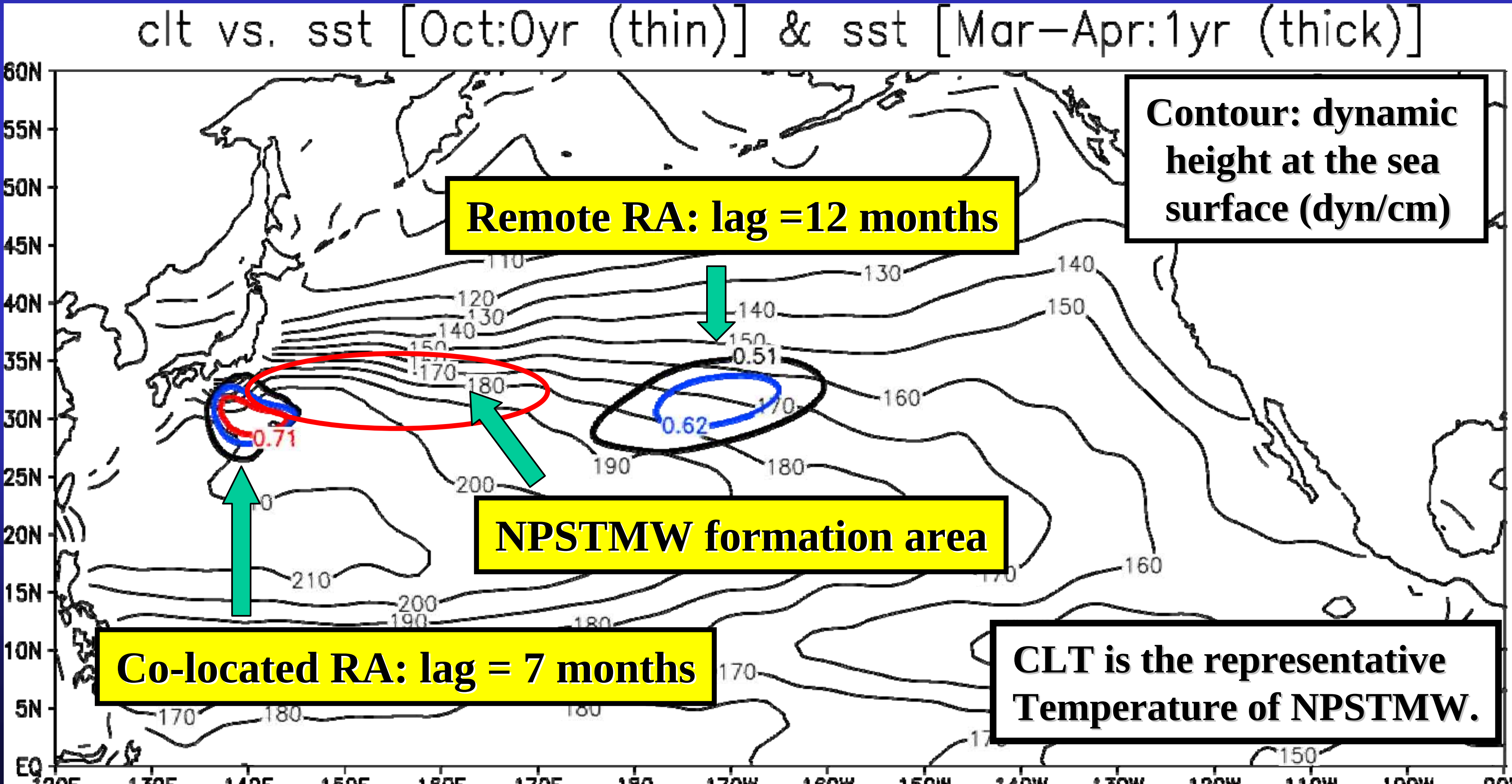


Relationship between MLD and core layer temperature (CLT)

Reemergence areas of NPSTMW using 1998-2005 data

Using NPSTMW core layer temperature (CLT) during the study period, co-located and remote RAs are examined. As expected, it is found that NPSTMW has two types of RAs.

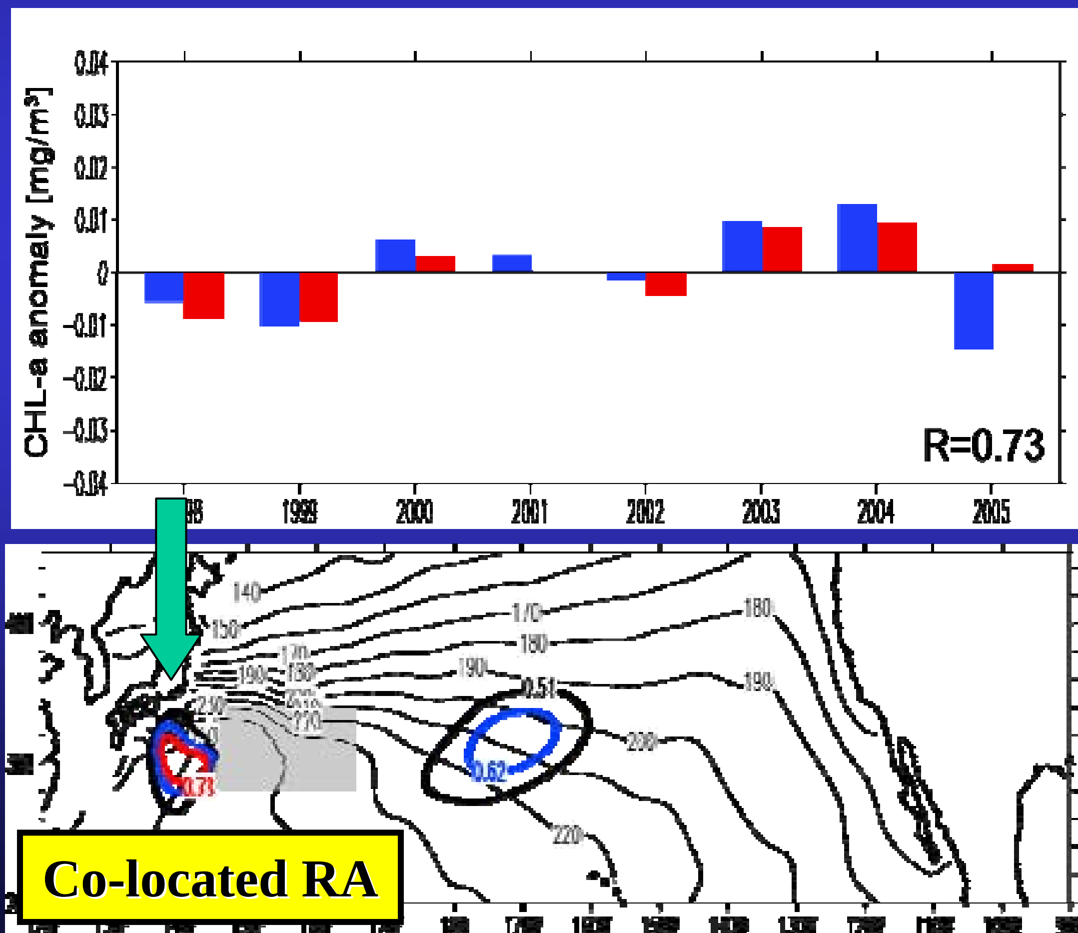
Correlation coefficients between anomalies of NPSTMW CLT and SST



Chl-a in autumn in the NPSTMW co-located RA

Single regression model using winter MLD to explain the autumn Chl-a concentration. Correlation coefficient is 0.73.

Chl-a anomaly (September and October) = Const x MLD (0, NPSTMW) + error



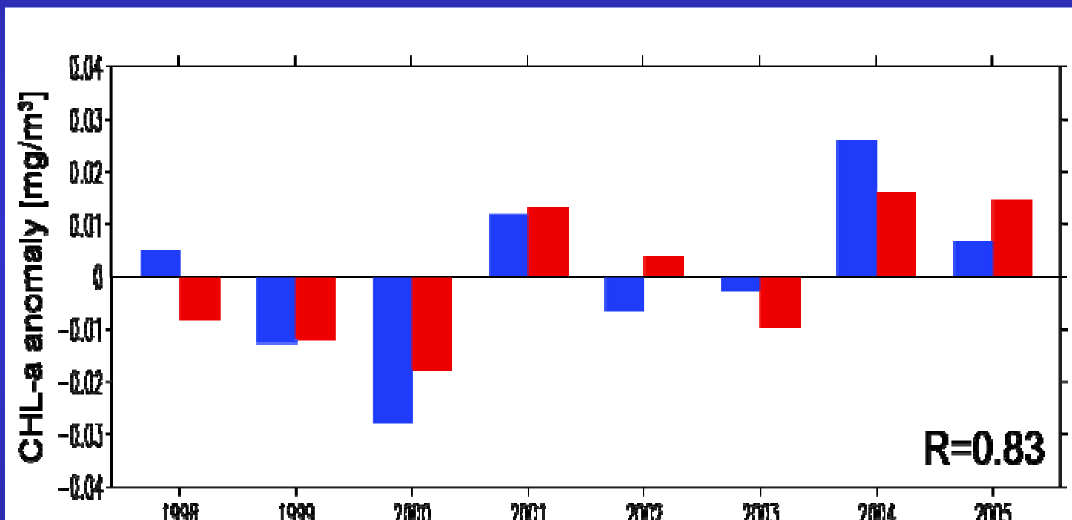
Co-located NPSTMW RA :
[29N-34N, 135E-145E]
Blue bar: observation
Red bar: model result

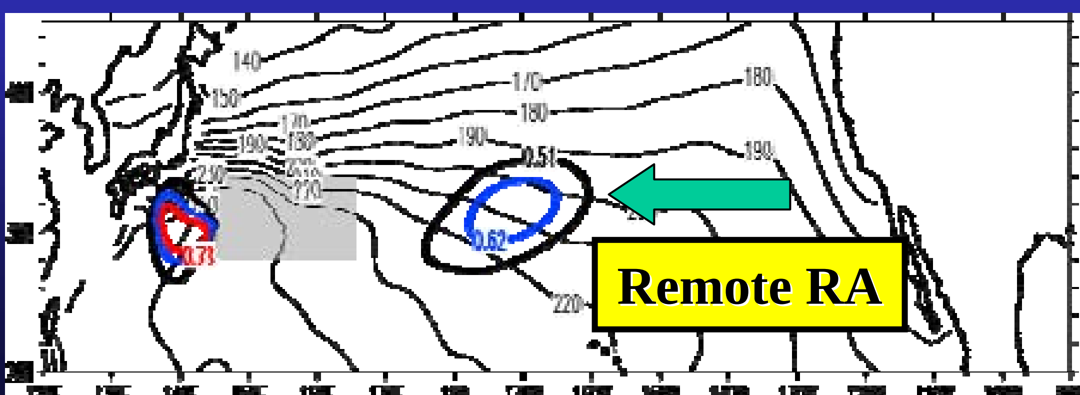
Autumn Chl-a in the NPSTMW co-located RA is affected or governed by physical condition in the NPSTMW formation area in winter.

Chl-a in the next spring in the NPSTMW remote RA

Multiple regression model using winter MLD to explain the spring Chl-a concentration. Correlation coefficient is 0.83 exceeding 95% significance level.

$$\text{Chl-a anomaly (March and April)} = 1.55 \times 10^{-2} \times \text{MLD}(-1, \text{NPSTMW}) - 0.45 \times 10^{-2} \times \text{MLD}(0, \text{remote RA}) + \text{error}$$





Remote NPSTMW RA: [28N-34N, 180-160W]

Blue bar: observation

Red bar : model result

In the NPSTMW remote RA, spring Chl-a is affected or governed mostly by the physical condition in the previous winter in the NPSTMW formation area.

Time dependent nature of NPSTMW remote reemergence phenpmenon

Remote reemergence does not necessarily occur always. Remote reemergence has a 20-year periodicity depending on the spin-up/spin-down of subtropical gyre.

Correlation coefficients between Anomalies of NPSTMW CLT in the previous year and SST with 15-year window.

Therefore, degree of influence of remote reemergence on Chl-a might also have a time-dependent nature; a 20-year oscillation.

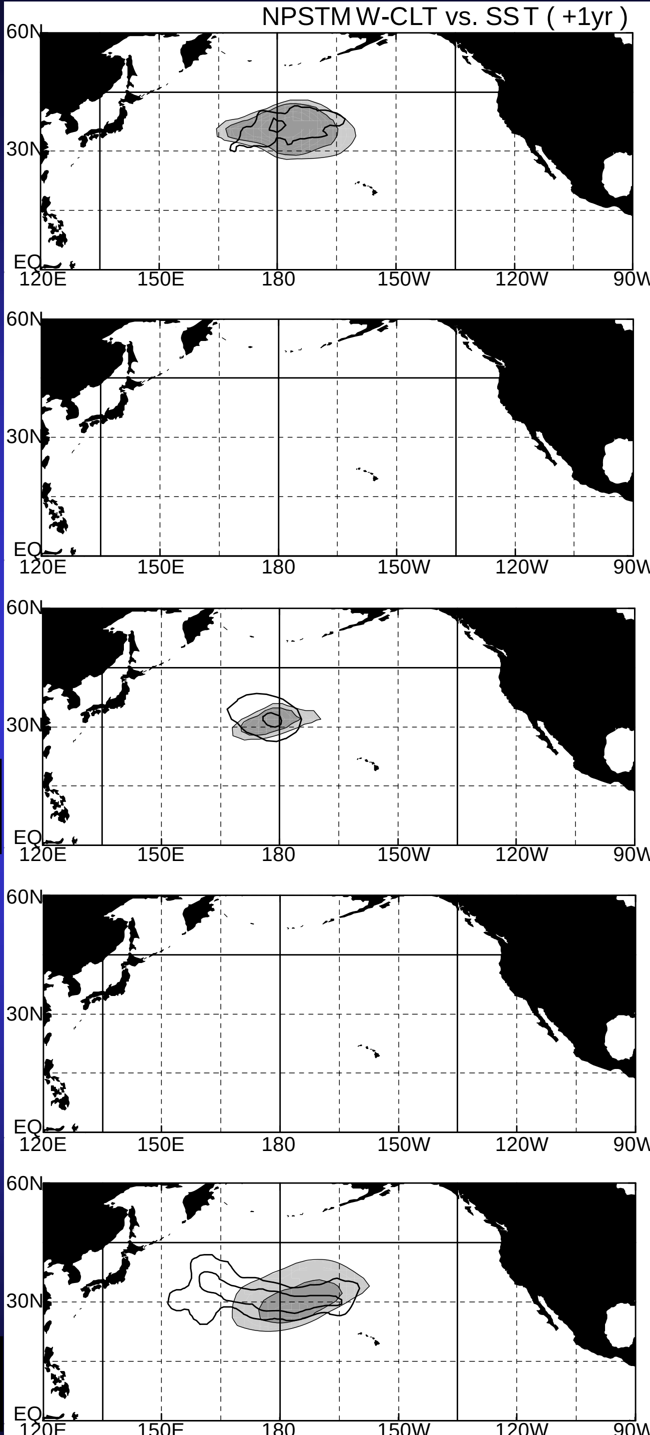
I: 1940-54

II: 1950-64

III: 1960-74

IV: 1970-84

V: 1980-94



Summary

In the present study, by using satellite derived Chl-a concentration data and winter MLD data, we tried to interpret the variations of Chl-a concentration in the North Pacific.

(A) Spring (March and April) Chl-a in the NPSTMW formation area can be explained by just previous winter MLD.

(B) Autumn (September and October) Chl-a in the NPSTMW co-located RA can also be explained by winter MLD in the NPSTMW formation area.

(C) Next spring (March and Spring) Chl-a in the NPSTMW remote RA can also be explained by winter MLD in the previous year in the NPSTMW formation area.