

北海道大学
HOKKAIDO UNIVERSITY

Nov. 8, 2016, 14:45-15:05

S11 (Advances in ...)

PICES 2016 Annual Meeting

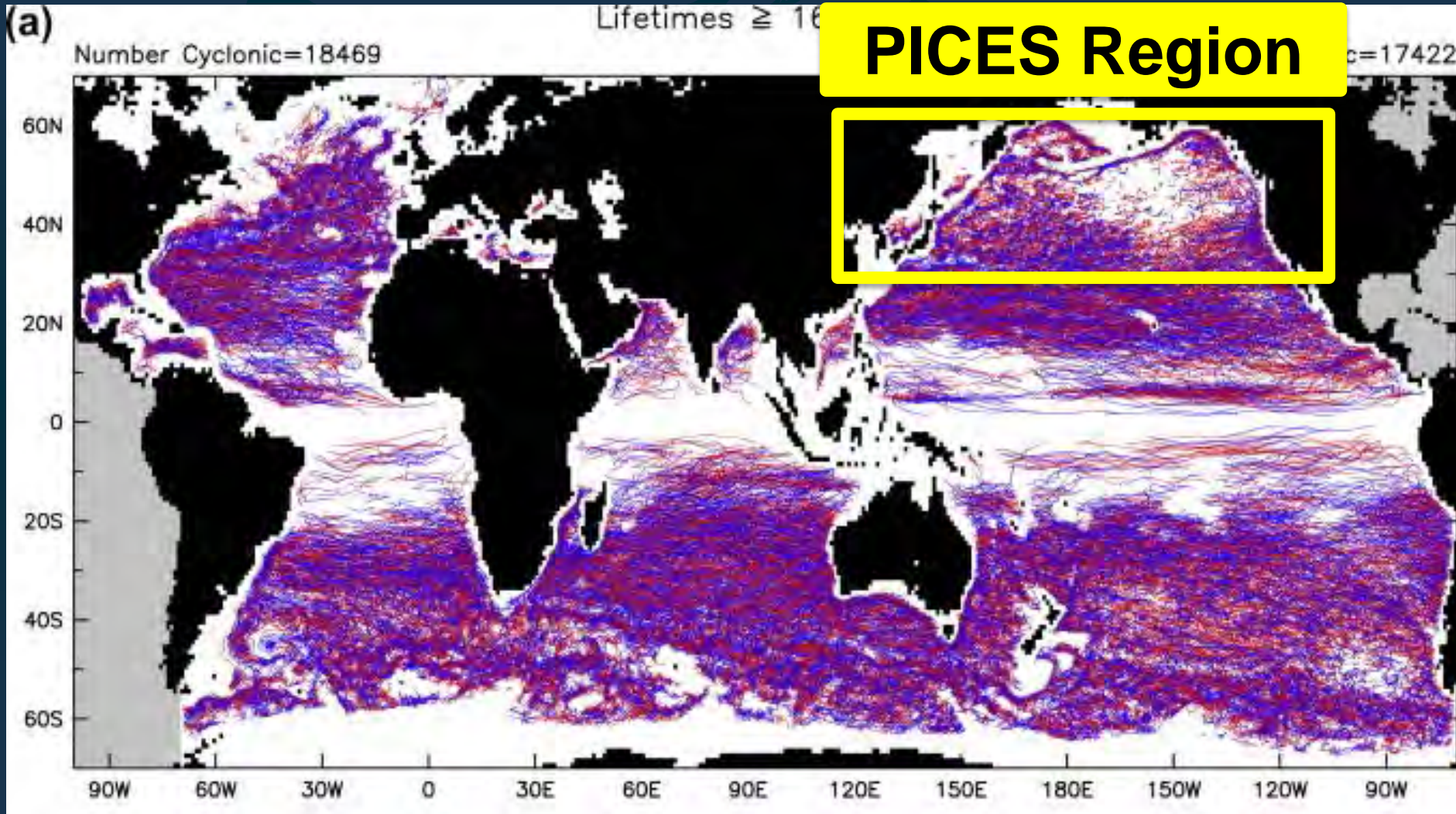
Omni Hotel, San Diego, USA

Studies on mesoscale eddies in the subarctic North Pacific

Hiromichi Ueno

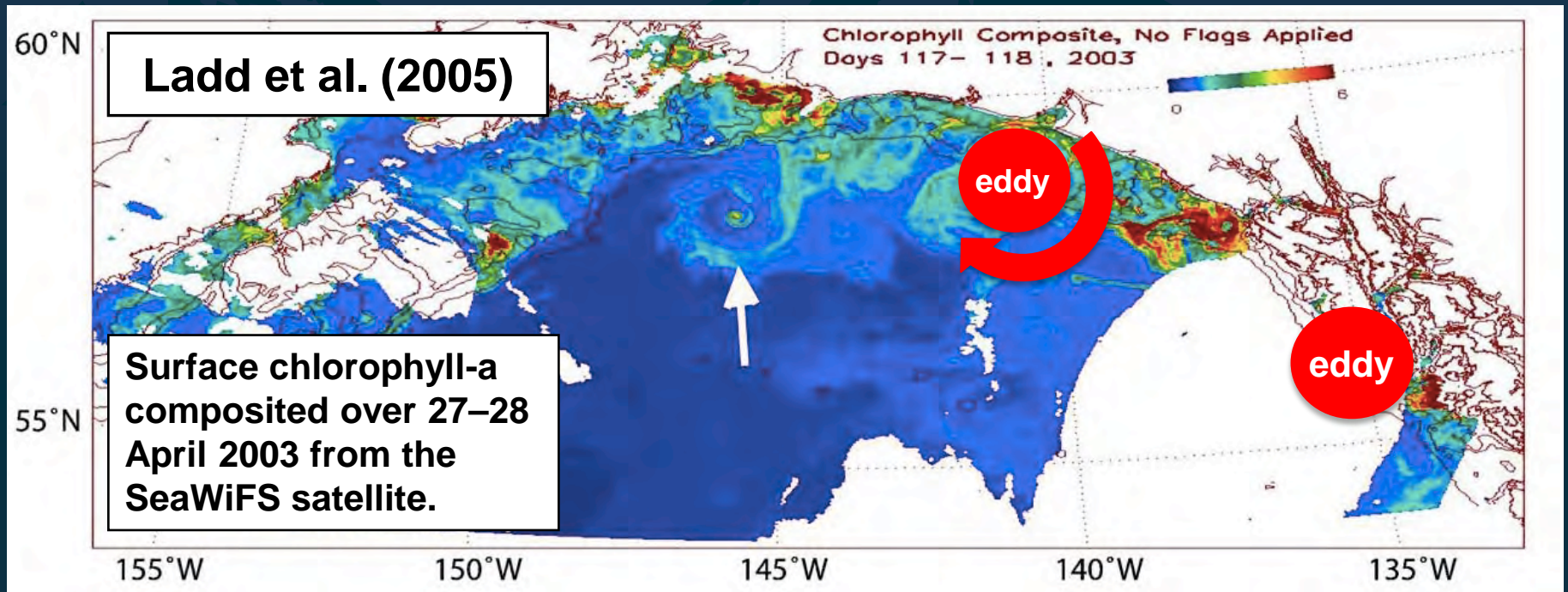
Hokkaido University, JAPAN

Mesoscale eddies are ubiquitous phenomena over the world ocean.



Chelton et al. (2011)

Mesoscale eddies play an important role in the heat/material transport and marine ecosystem.



Eddies in GoA: **heat, freshwater, macro- & micro-nutrient & biota exchange** between shelf & off-shore regions by

- Containing shelf water at the eddy center & propargating offshore
- Advection in the outer ring of the eddy.

(Crawford et al., 2005; Okkonen et al., 2003, Ladd et al., 2005; ...)

*The Second PICES Workshop
on the Okhotsk Sea
and Adjacent Areas*

November 9-12, 1998

Nemuro, Japan

Physical oceanography of the Okhotsk Sea
Physical oceanography of the Kuril region
and La Perouse/Soya Strait: Basin to
basin interaction

Synoptic/mesoscale eddies

~~Interannual variations and the regime shifts~~

To receive the Final Announcement
for this workshop, please contact the
PICES Secretariat a.s.a.p.

How was PICES
involved in
mesoscale
eddies?

Announcement
about 2nd PICES
Workshop on
PICES Press
in July 1998

10th PICES Annual Meeting, Victoria, 2001

POC/BIO/FIS Topic Session

The physics and biology of eddies, meanders and rings in the PICES region. Convenors: William R. Crawford (Canada), Jeffrey J. Polovina (U.S.A.) and Takashige Sugimoto (Japan).

Selected papers from the session were published in a special issue of *Journal of Oceanography* in 2002.

Physical Characteristics of Haida Eddies

WILLIAM R. CRAWFORD*

Institute of Ocean Sciences, Fisheries and Oceans Canada, Sidney, B.C., V8L 4B2, Canada

(Received 5 November 2001; in revised form 25 March 2002; accepted 26 March 2002)

Haida Eddies are anti-cyclonic features that form in winter along the eastern conti-

Behavior of Warm-Core Rings in a Double-Gyre Wind-Driven Ocean Circulation Model

SACHIHIKO ITOH* and TAKASHIGE SUGIMOTO

Ocean Research Institute, University of Tokyo, Minamidai, Nakano-ku, Tokyo 164-8639, Japan

(Received 15 November 2001; in revised form 15 March 2002; accepted 16 March 2002)

Numerical experiments have been performed to understand the movement of warm-core rings in the Kuroshio-Oyashio Transition region, considering the double-gyre

W9 POC/BIO Workshop

Mesoscale eddies and their roles in North Pacific ecosystems

*Co-Convenors: Kyung-Il Chang (Korea), William R. Crawford (Canada), Shin-ichi Ito (Japan)
Vyacheslav Lobanov (Russia)*

Friday, October 23 (9:00-18:00)

9:00 *Introduction by Convenors*

9:05 **Carol Ladd, Elizabeth Atwood, William Crawford, Phyllis Stabeno and Frank Whitney (Invited)**
Eddies in the Gulf of Alaska (W9-5588)

9:35 **William Crawford and Nick Bolingbroke**
Cross-shelf exchange by mesoscale eddies in the northeast Pacific Ocean (W9-5656)

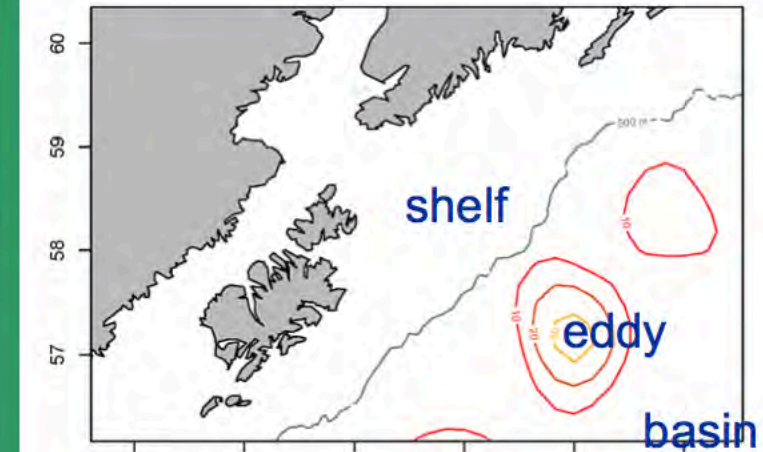
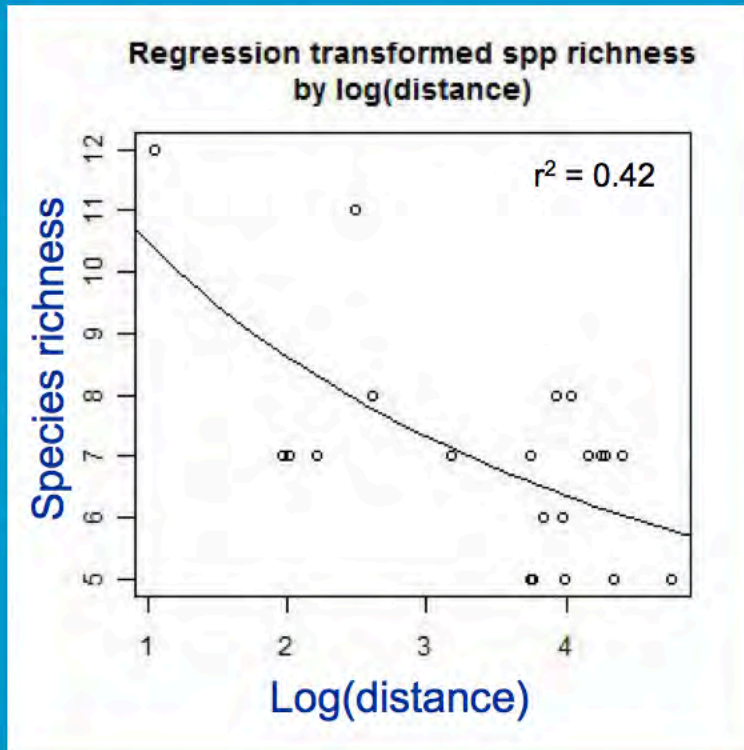
9:55 **Vincent Combes, Emanuele Di Lorenzo and Enrique N. Curchitser**
Interannual and decadal variations in eddy-induced cross-shelf transport in the Gulf of Alaska (W9-5598)

10:15 **Hiromichi Ueno, William Crawford and Hiroji Onishi**
Impact of Alaskan Stream eddies on chlorophyll distribution in the central subarctic North Pacific (W9-5792)

Larval fish in eddies

From PICES website

- Young eddies in Eastern GOA
 - Species richness increases from eddy edge towards center



Dr. Ladd discussed impact of eddies on ecosystem as well as their physical properties in the GoA.

- Gradients in species richness across eddies (sometimes positive, sometimes negative)

November 4

Last Friday

W8

submesoscale

B]

Mesoscale and submesoscale processes in the North Pacific:
History and new challenges

Convenors:

Kyung-Il Chang (Korea)

Hiromichi Ueno (Japan)

Annalisa Bracco (USA)

8:55

Introduction by Workshop Convenors

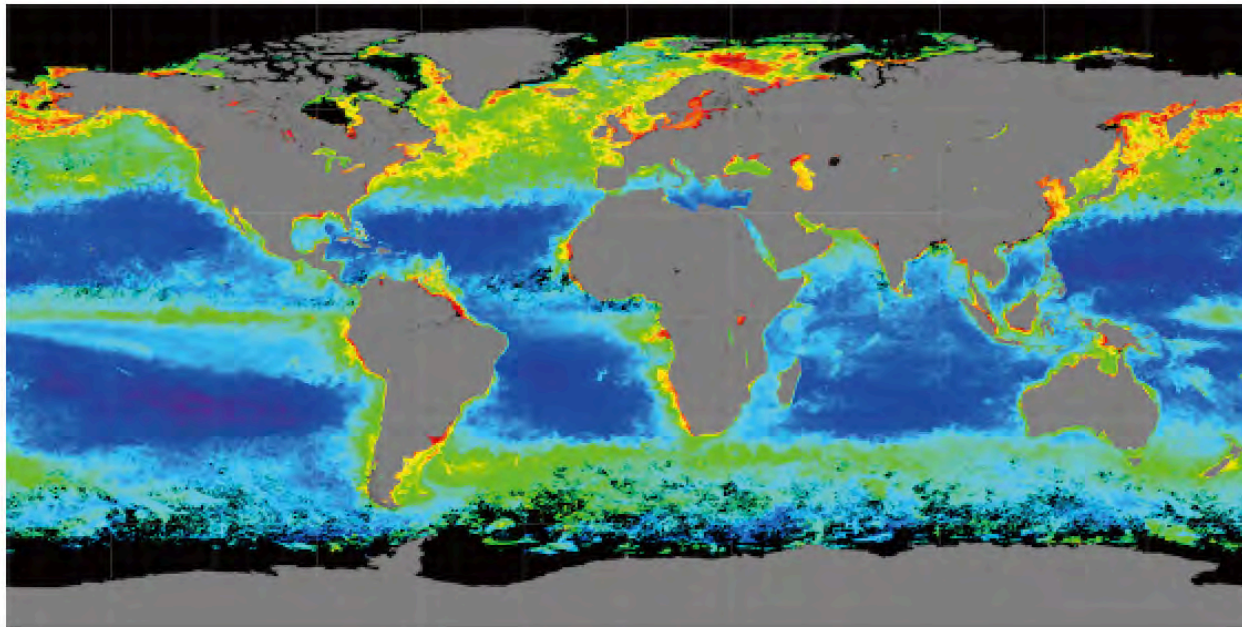
9:00

Sachihiko Itoh (Invited)

Finescale variability of isopycnal salinity in the southern Ocean
System

Life in a Patchy World:

Submesoscale dynamics and phytoplankton growth in the oligotrophic North Pacific



Naomi M. Levine

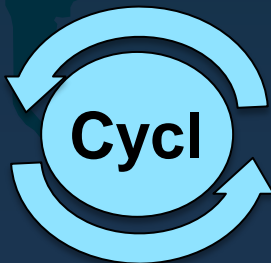
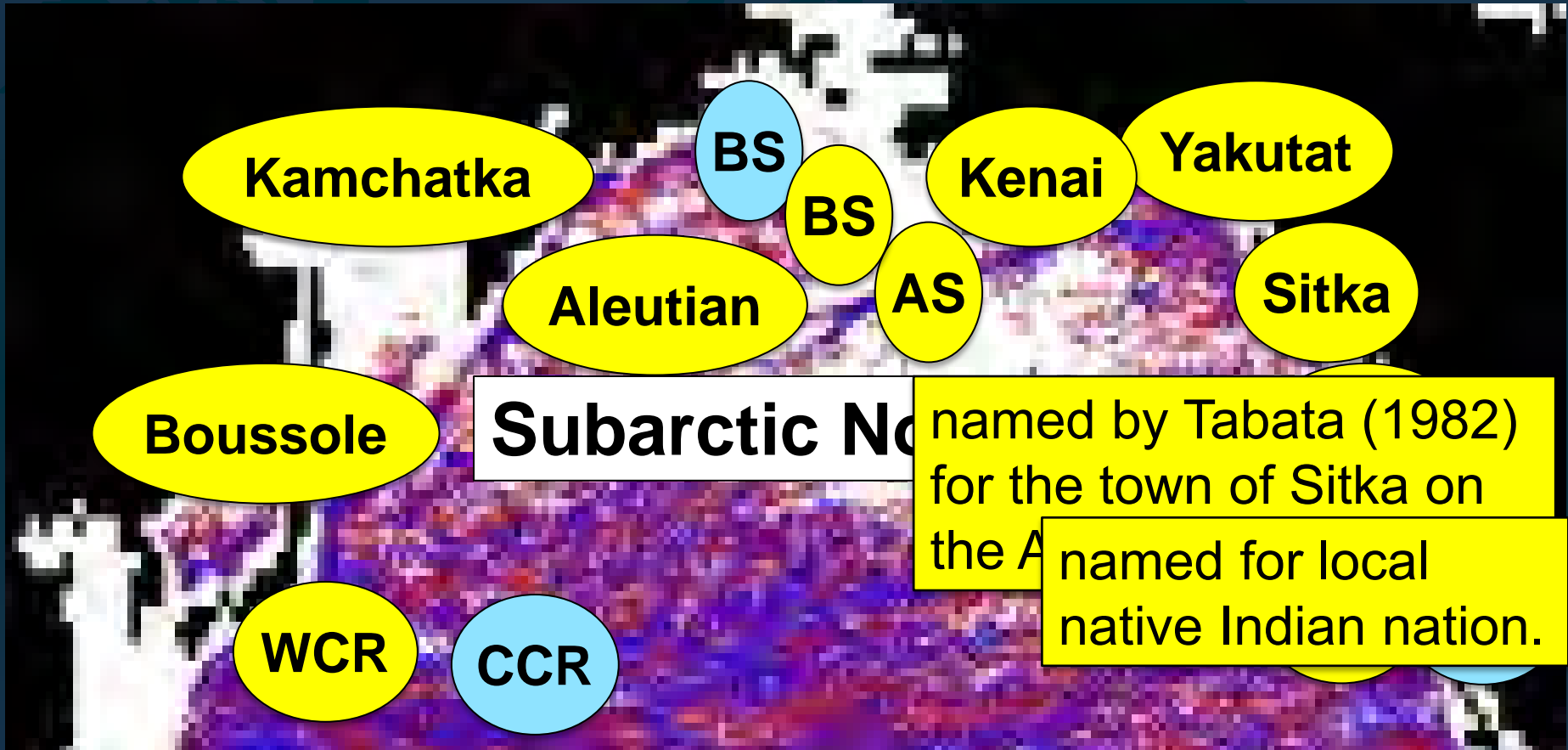
sos.noaa.gov

Xiao Liu

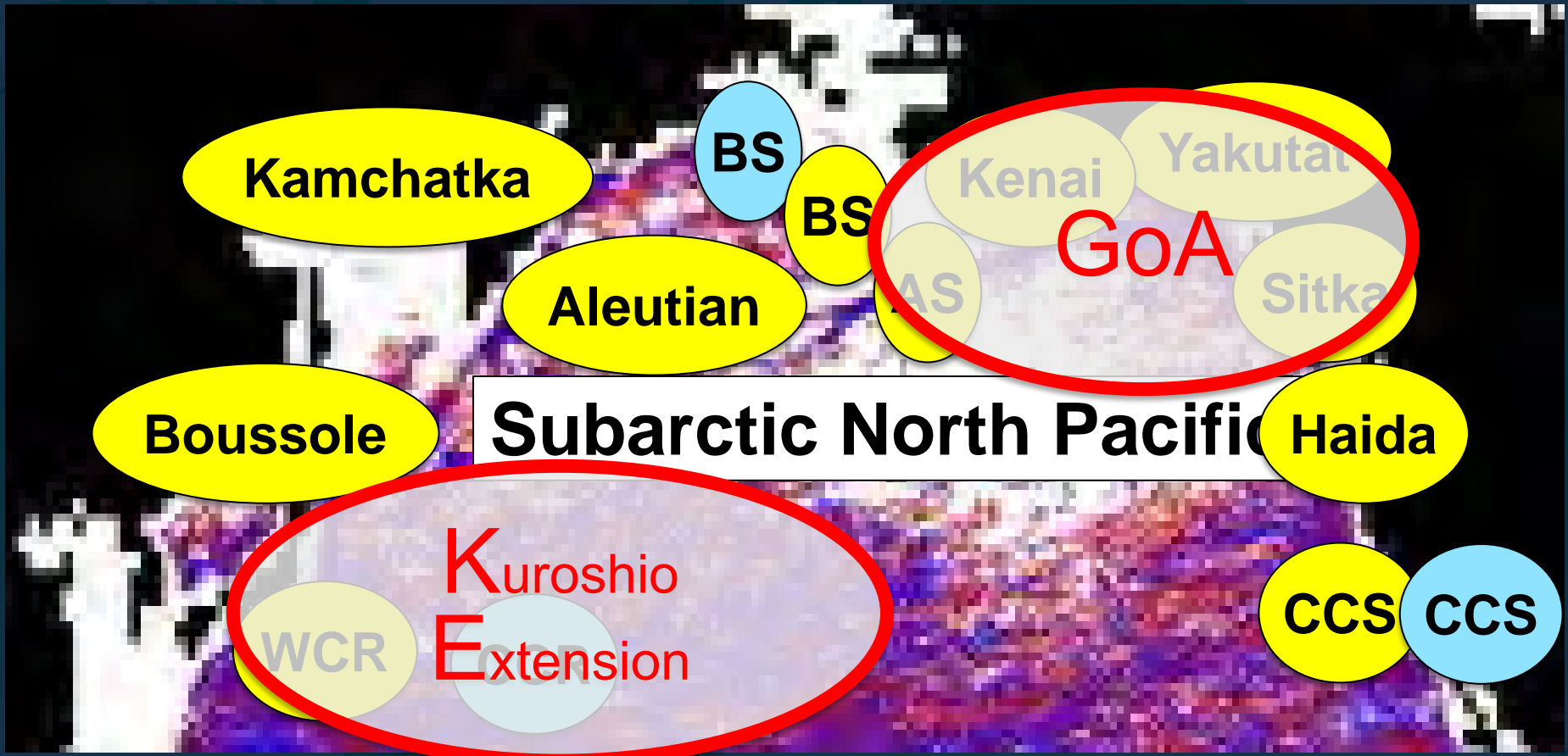
Marine and Environmental Biology
University of Southern California



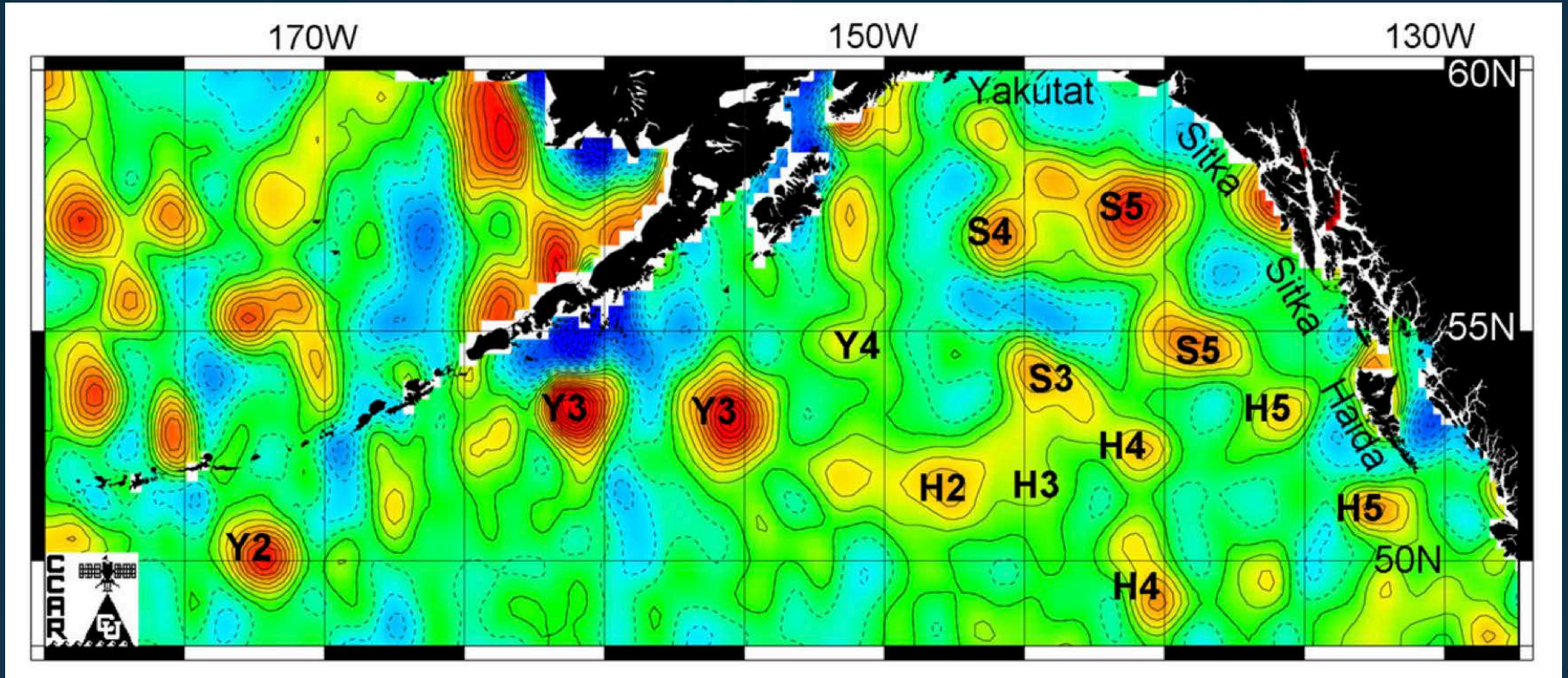
In the PICES region, especially in the subarctic NP, many eddies are named based on their formation area.



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As for GoA, details will be discussed by Dr. Crawford.

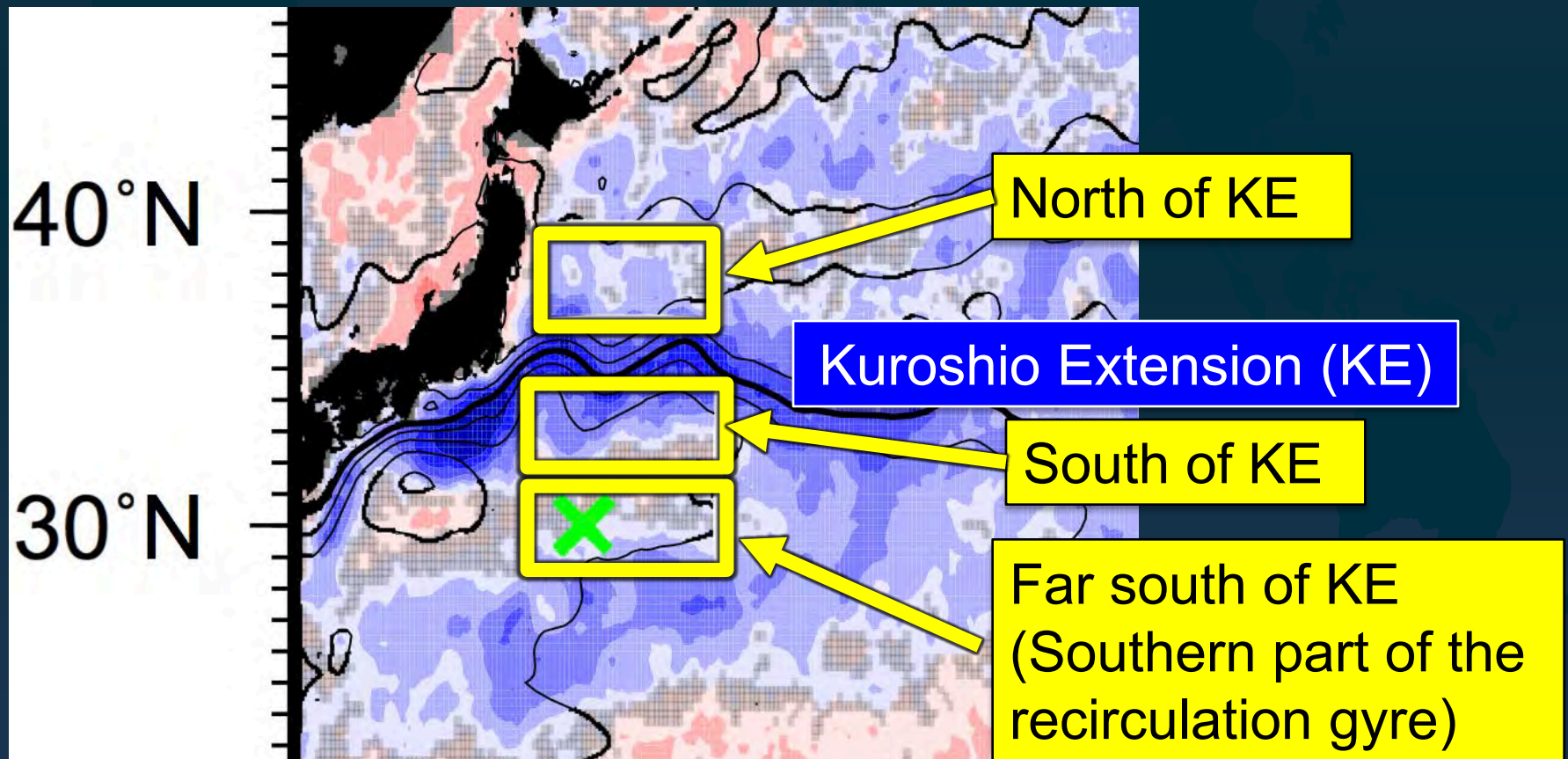


Crawford et al. (2007)

Mesoscale eddy effects on temporal variability of surface chlorophyll *a* in the Kuroshio Extension

Shinya Kouketsu¹ · Hitoshi Kaneko² · Takeshi Okunishi³ · Kosei Sasaoka¹ ·
Sachihiko Itoh² · Ryuichiro Inoue¹ · Hiromichi Ueno⁴

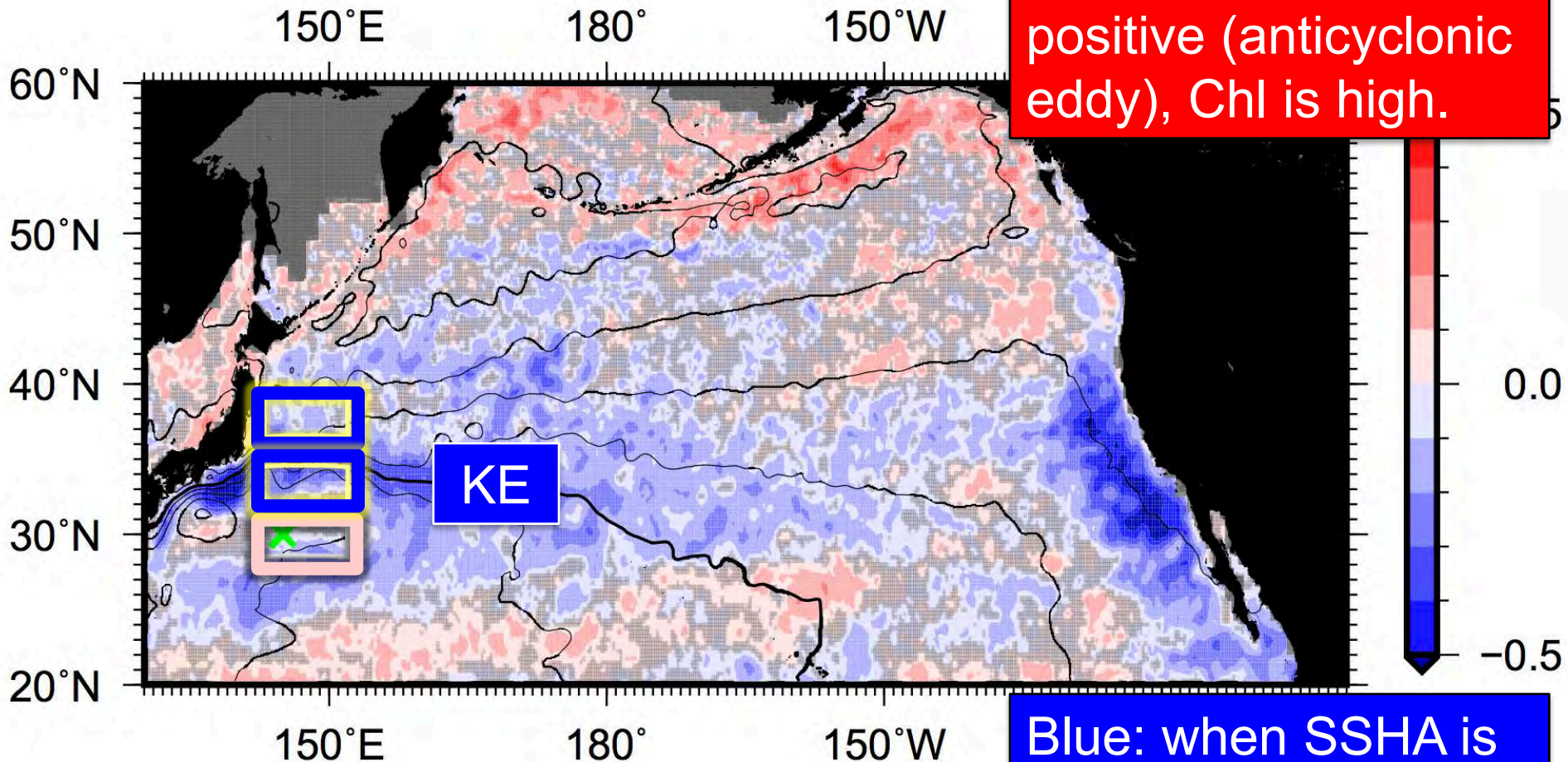
J. Oceanography, 2015



Correlation between SSHA and Chl

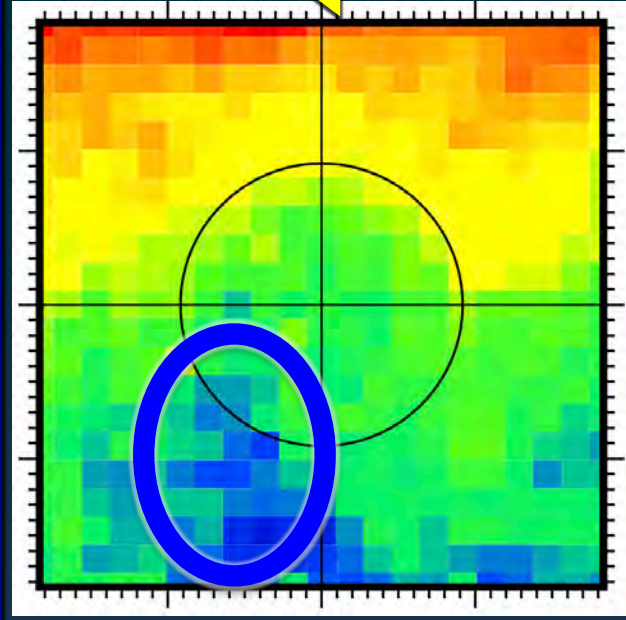
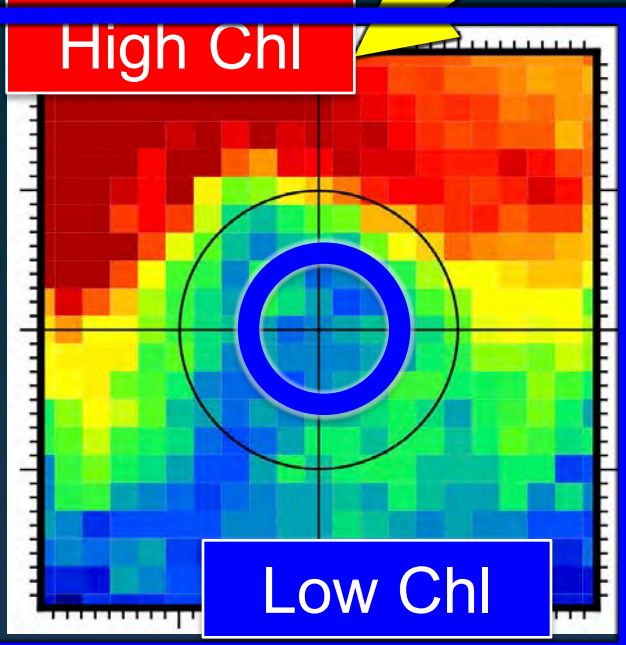
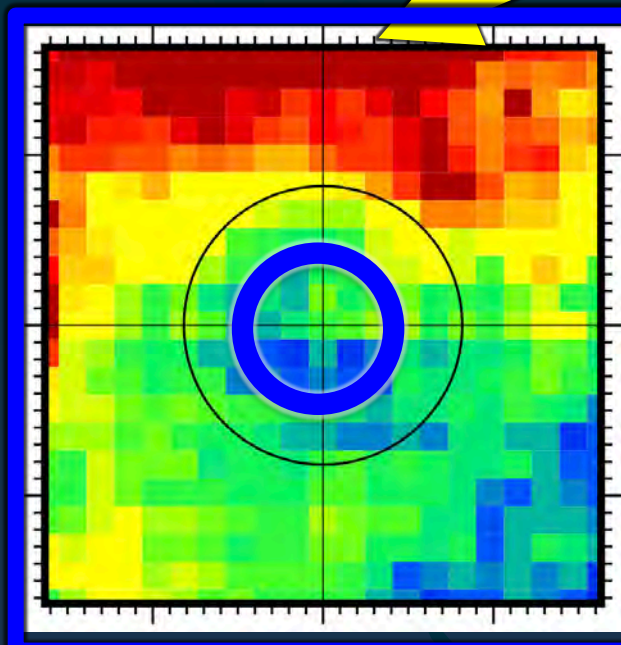
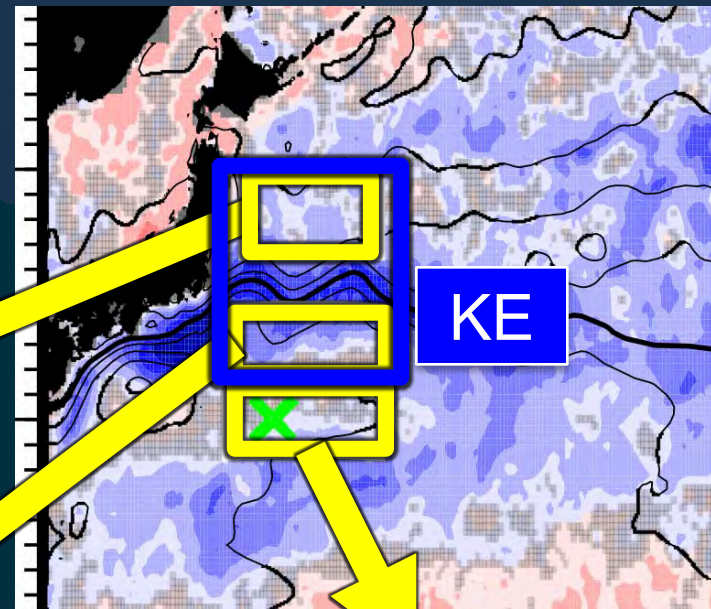
Red: when SSHA is positive (anticyclonic eddy), Chl is high.

Blue: when SSHA is positive (anticyclonic eddy), Chl is low.



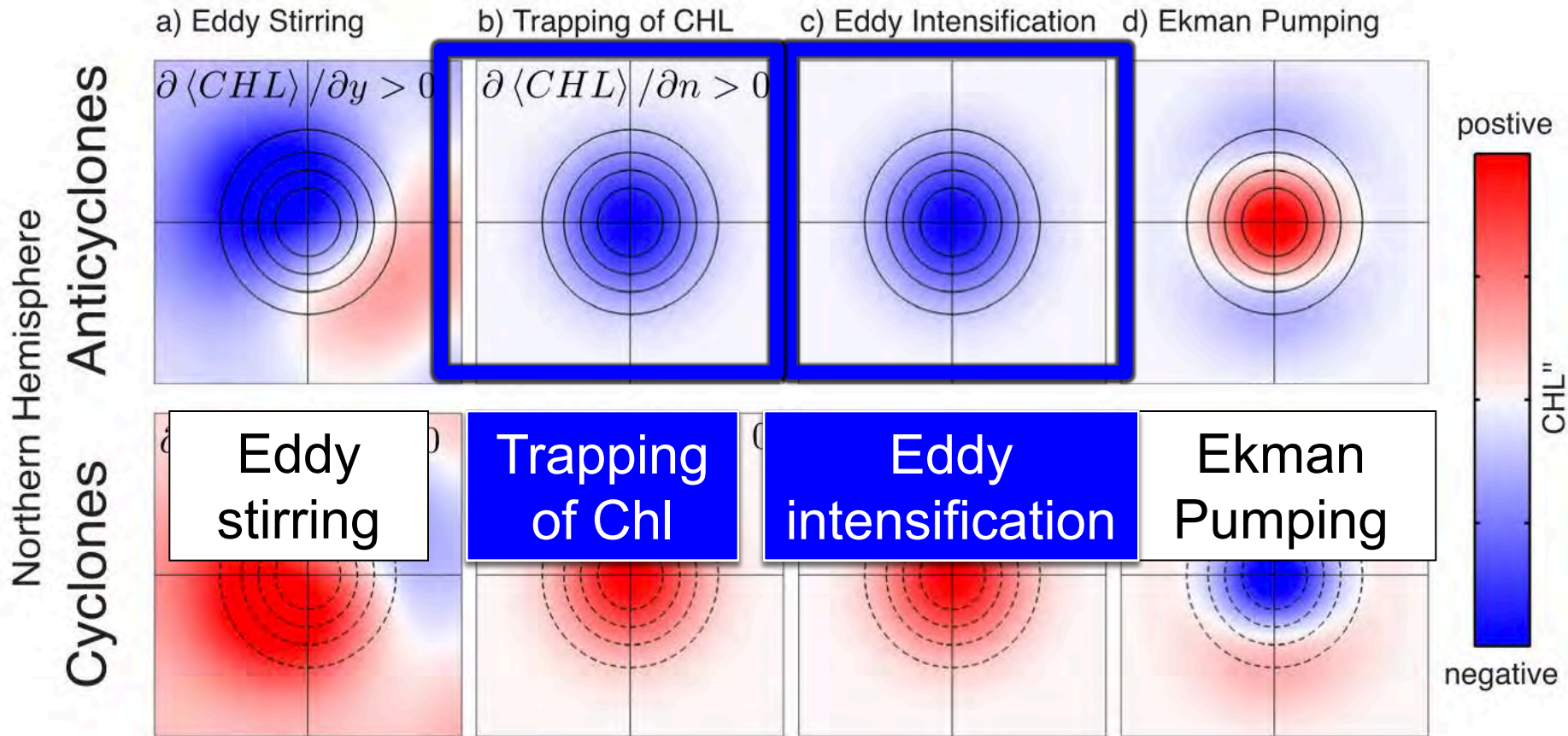
Chl composite around eddies

Anticyclonic eddies in October



What causes these relations and the difference?

Mechanisms by Which Mesoscale Eddies Influence Phytoplankton Spatial Structure



Gaube et al.

(2014)

Anticyclonic eddy

Sea Surface

Chl can be low.

Isopycnals



Downwelling due to eddy intensification can explain low Chl at the eddy center.

Trapping of Chl can also explain low Chl at the anticyclonic-eddy center.

Pinet (2010)

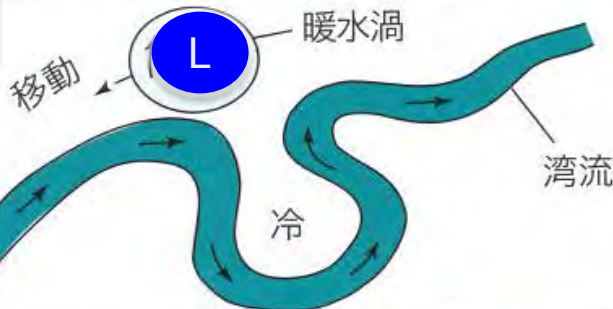
Week 1

High Chl

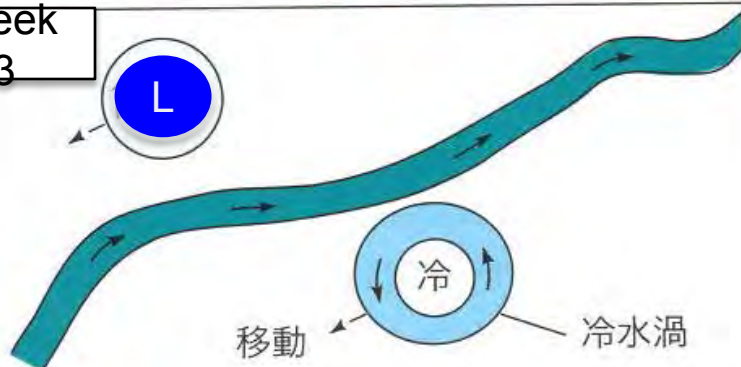
KE

Low Chl

Week 2



Week 3



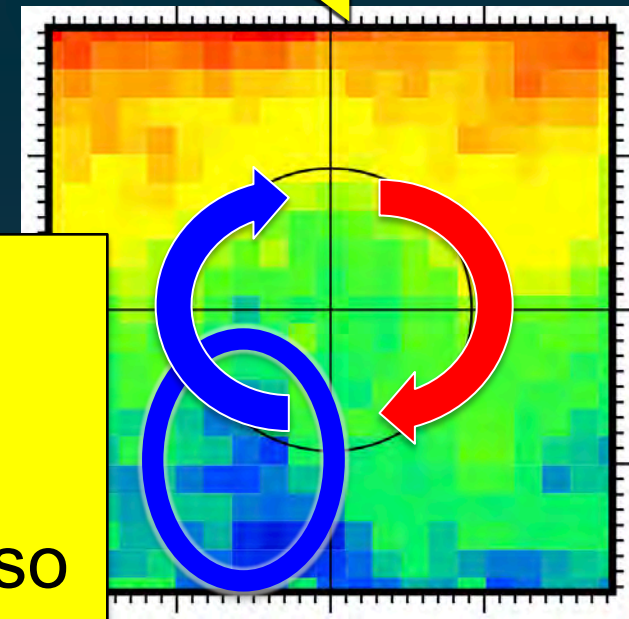
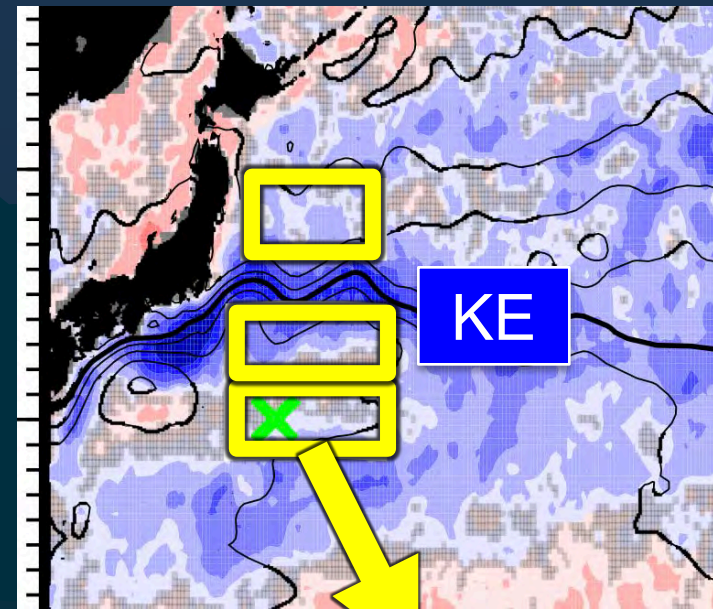
Chl composite around eddies

Anticyclonic eddies in October

The Chl distribution is consistent with eddy stirring.

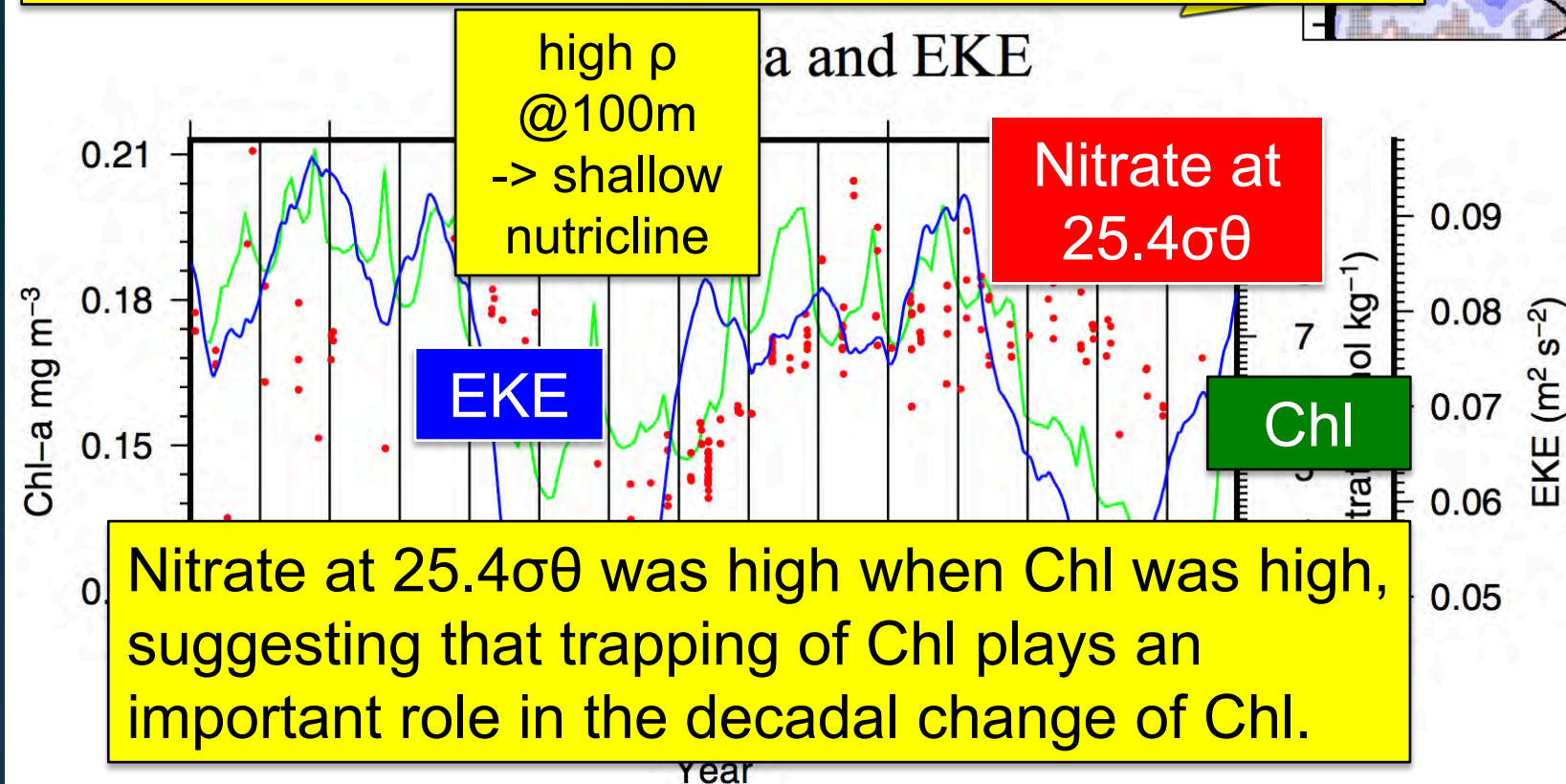
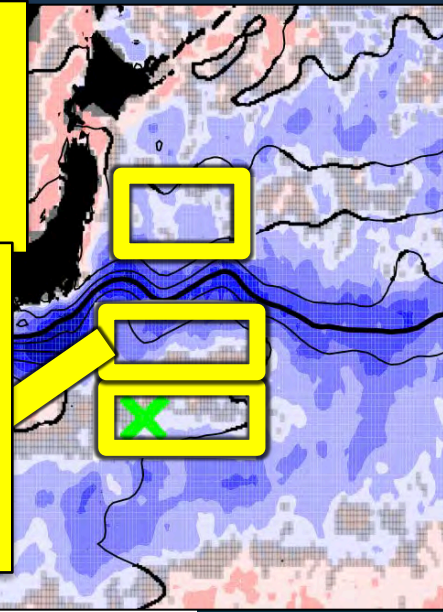
In this area, eddies do not originate from KE, therefore

- Trapping of Chl hardly occurs
- Effect of eddy intensification is also weak because eddies are weak.



EKE and Chl changed almost simultaneously in the decadal timescale, suggesting eddies control decadal variation of Chl.

Large scale Rossby wave can also control Chl by changing depth of nutricline, but our additional analysis of densities denied the mechanism in the area just south of KE.



Nitrate at $25.4\sigma\theta$ was high when Chl was high, suggesting that trapping of Chl plays an important role in the decadal change of Chl.

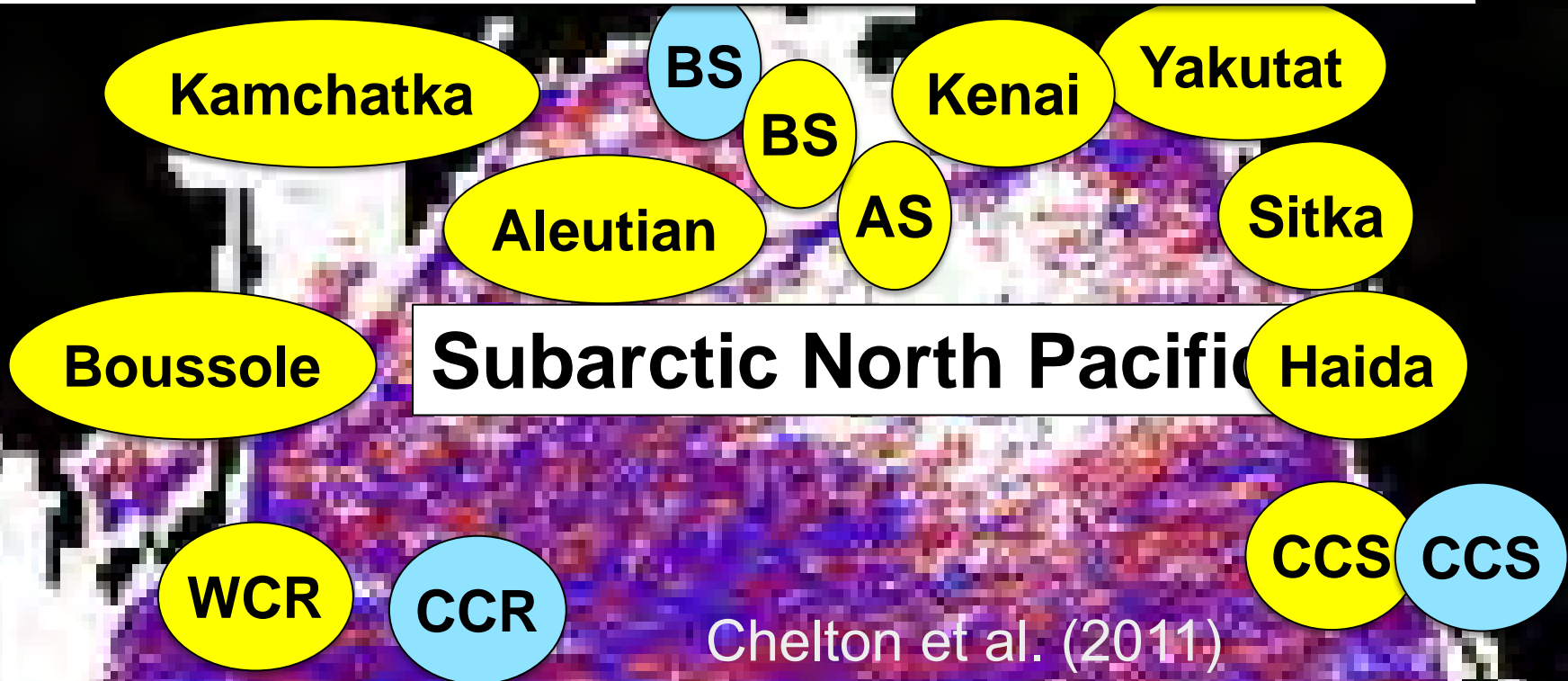
Summary

- | We investigated the relationship between Chl and eddies.
- | Around KE, low (high) Chl was observed in the anticyclonic (cyclonic) eddy core.
- | Far south of KE, such relation was not observed.
- | Decadal-scale changes of Chl around KE were strongly affected by eddy activity.

In the PICES region, many eddies are identified and a lot of information is accumulated.

-> For the better understanding of the impact of eddies on marine ecosystem, it is necessary to perform intercomparison of eddies.

In addition, it is well known that submesoscale processes also have a significant impact on marine ecosystem.



Chelton et al. (2011)

New WG: Mesoscale and submesoscale processes

- | Summarize the detection, observation and modeling methods of meso-/submeso-scale processes.
- | Classify meso-/submeso-scale features, and identify their spatio-temporal variations.
- | Compare the impacts of meso-/submeso-scale processes on heat/material transport and marine ecosystem between areas in the PICES region.

A faint, light-colored world map is visible in the background, centered behind the text. The map shows the outlines of the continents in a light beige or cream color against a dark blue background.

Thank you.