Mesoscale eddies in the western subarctic North Pacific

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In this W8, we plan to discuss the **Terms of Reference (ToR)** for the new PICES working group on **meso. & submeso. processes**.

Although I will talk about the draft of ToR after coffee break, the main target of the working group at this stage (should be revised) is the **intercomparison of eddies in the PICES region**.

In this presentation, I will talk about a study on eddies around the Kuroshio Ex, which includes intercomparison between eddies.
Mesoscale eddy effects on temporal variability of surface chlorophyll $a$ in the Kuroshio Extension

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Map showing regions:
- North of KE
- Kuroshio Extension (KE)
- South of KE
- Far south of KE (Southern part of the recirculation gyre)
The relation between eddies and Chl has been studied intensively during the last decade. Chelton et al. (2011) indicated that globally dominant mechanism is eddy-induced horizontal advection.
In the strong current region such as KE, the effect of trapping of Chl seems to be dominant (e.g. Sasai et al. 2012).

Kuroshio Extension (KE)

Chl is low INSIDE the anticyclonic eddies detached from the KE.
The purpose of this study

- To clarify the relation between eddy and Chl around the Kuroshio Ex.

- To discuss the impact of eddies on the decadal variation of Chl around the Kuroshio Ex.
Data

- SSHA (AVISO)
- Chl (SeaWiFS/MODIS)
- MLD/Density (MOAA-GPV <- Argo)
- Nitrate (WOD/JODC/JAMSTEC)
Results
Correlation between SSHA and Chl

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

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

Anticyclonic eddies in October

What causes these relations?
Mechanisms by Which Mesoscale Eddies Influence Phytoplankton
Spatial Structure

a) Eddy Stirring
\[ \frac{\partial \langle C H L \rangle}{\partial y} > 0 \]

b) Trapping of CHL
\[ \frac{\partial \langle C H L \rangle}{\partial n} > 0 \]

c) Eddy Intensification

d) Ekman Pumping

Gaube et al. (2014)
Anticyclonic eddy

Sea Surface

Chl can be low.

Isopycnals

Week 1
High Chl

Week 2
Low Chl

Week 3

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)
**Chl composite around eddies**

**Anticyclonic eddies in October**

The Chl distribution is consistent with eddy advection.

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 KE.

Nitrate at 25.4σθ 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, high (low) Chl was observed in the cyclonic (anticyclonic) eddy core.
- Far south of KE, such relation was not observed.
- Decadal-scale changes of Chl around KE were strongly affected by eddy activity.
After the coffee break I will have a brief presentation on the **Terms of Reference (ToR)** for the new PICES working group on meso. and submeso. processes.

The main target of the working group at this stage (should be revised) is the *intercomparison* of eddies in the PICES region.

I’d really like you to come back after the coffee break and discuss the ToR.
Thank you.