A Field Program to Understand Bio-Physical Drivers of Carbon Sequestration in Western Boundary Current Regions

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Motivation

Goal: develop an interdisciplinary and international research community to facilitate better understanding of the role that WBCs play in climate and carbon sequestration.

Fundamental question:

How do bio-physical interactions, eddies, and mode water formation influence ocean carbon sequestration?
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Kuroshio Extension Jet Variability

Oka et al., 2015 after Qui et al., 2014

* Stable
* Unstable
Mode Water Impacts: March Outcropping

Color = SSH
Thick black contour = KE axis
Magenta = 16-18°C
Bio-Physical Interactions: Eddies

• Lin et al., 2014 found link between annual-average Chla and meandering state.
  • Unstable → 12% higher Chla relative to multiyear mean.
  • Chla in the KE is likely modulated by vertical nutrient supply induced by divergences (convergences) associated with the westward propagation of wind-induced Rossby waves in the central and eastern North Pacific Ocean related to the PDO.
  • Submesoscales are particularly relevant to phytoplankton productivity due to time scales (Mahadevan, 2015).

• Oka et al., 2015 also found link between decadal variability in mode water and biogeochemistry at OK line (routine ship observations south of Japan)
Bio-Physical Interactions: Eddies

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Bio-Physical Interactions: Eddies

March 2008

Longitude

Pressure [dbar]

Latitude

Longitude

Latitude

Pressure [dbar]
Bio-Physical Interactions: Mode Water

\[ v'h' = -\kappa \frac{\partial \bar{h}}{\partial y} \]

Mesoscale stirring along isopycnals and downgradient. Transport of C into interior.

Restratification of mixed layer by submesoscale MLI drives vertical motion and phytoplankton blooms & Suppression of STMW formation.

STMW

Euphotic zone

Net C flux & STMW formation

Thermocline

\[ Q_o \]

\[ F_{CO_2} \]

\[ h_{mix} \]
Bio-Physical Interactions: Mode Water


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Bio-Physical Interactions: KEO-Mode Water

STMW volume data courtesy of Ivana Cerovecki from Cerovecki and Giglio (2016)
Community Feedback Wanted


2. US CLIVAR Process Study and Model Improvement Panel endorsement to submit a proposal for a US CLIVAR Workgroup on biophysical interactions.

Carbon Hot Spot poster
Process Study

Japan

Kuroshio

KEO

Satellite

Glider Path

Glider Path

Research Vessel

Glider

Sail Drone

Float

Mooring

Sediment Trap
Wind & Cooling Counter MLI Restratabification

KEO in Eddy-Rich Location

Eddy Kinetic Energy to Mean Kinetic Energy Ratio

\( \log_{10}(\text{EKE/MKE}) \)

Latitude

Longitude

-1
-0.5
0
0.5
1
1.5
2

KEO

Papa