Marine biophysical interactions and dynamics of upwelling systems: Collaborations with PICES, IMBER

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Tiger team member for this research opportunity
Co-chair: PICES WG for North Pacific climate variability and change
Outline, sorry for busy presentation

• Introduction IMBER & PICES
• A few Highlights of marine biophysical interaction session in the 2\textsuperscript{nd} boundary current symposium
• Summary of upwelling tiger team presentation at CLIVAR SSG, May 2013
• Suggestions
IMBER & PICES
IMBER, a program of IGBP

4 themes
- Interactions between biogeochemical cycles and marine food webs
- Sensitivity to Global Change
- Feedbacks to the Earth System
- Responses of society
6th China-Japan-Korea IMBER Symposium

3-4 October 2013, Tokyo, Japan

IMBER-Japan Programme New Ocean Paradigm on Its Biogeochemistry, Ecosystem and Sustainable Use (NEOPS)

But there is no “Pacific Panel” in IMBER.
PICES: North Pacific Marine Science Organization

• Scope:
  • Physical, chemical, biological, carbon cycle, fisheries
  • From environmental quality to climate change, and interactions with human societies
• PICES is a **fishery** oriented organization (short name stands for Pacific ICES), but PICES is more **multidisciplinary** than ICES.
• 10-year project **FUTURE**: Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Marine Ecosystems
PICES organization & events

• Management: Government council, Science board, permanent 5 committees including physical oceanography and climate

• Science: Section, Study-group, Working Group (3-yr)

• several workshops in a year & annual meeting
  – October annual meeting 2014 China, 2015 Korea.
  – 3rd PICES/ICES/IOC Symposium on “Effects of Climate Change on the World’s Oceans”, Mar 2015, Santos City, Brazil (I will be a member of science stirring committee. )
Highlights of biophysical interaction session in boundary current symposium (9, July 2013)
Summary of session 3, marine biophysical interaction

Common interest: nutrient by the Kuroshio.

Holy grail may be 3D nutrient budget for mean climatology, climate variability on interannual & decadal timescales & climate change.

Upwelling is important component in the budget.
Nitrate flux
- Kuroshio (PN->TK->ASUKA->137E)
- Ryukyu Current (OK)
- Kuroshio recirculation (OK, ASUKA, 137E)

Guo's presentation may appear at the surface in the Kuroshio Extension, dynamical uplift
Phosphate reduction trend found south of Japan in our brand-new dataset
Alternative hypothesis: Circulation-driven oligotrophication

Focus on subtropical gyre

Ocean: Stronger subtropical gyre

Atmos: Stronger wind

Enhanced Kuroshio, → nutrient poor water

Phos & h: corr = -0.55

Phosphate -SSH (r = -0.55)

Minobe’s presentation
**Mathematical Model**
- Physical processes in nutrient supply
- Ecosystem responses to environmental change
- Food-web dynamics & sustainable use of ecosystem services

**Observations**
- Satellite remote sensing of phytoplankton functional category and productivity
- Field observation with novel techniques

**Saito's presentation**
- Multi sensor buoy
- Multi sensor profiler
- Free-falling CTD
- Flow cytometry
- Quantitative-PRC
- Ultra-long path capillary cell spectrophotometry
- Holography imaging system for detritus
- Video plankton recorder
- Drifting sediment tarp/gel trap
- Stable isotope analysis
- Amino-acids stable isotope analysis
Marine biophysical interactions and the dynamics of upwelling systems

CLIVAR: Ken Drinkwater, Peter Brandt, Gokhan Danabasoglu, Jim Hurrell, Matthieu Lengaigne, Mathieu Rouault
IMBER: Ken Drinkwater, Eileen Hofmann, Raleigh Hood,
SPACC: Juergen Alheit, David Checkley, Salvador Lluch-Cota
IOC: Antonio Bode
IOGOOS: Andreas Schmittner
Input: Shoshiro Minobe (join since May 2013)
*SOLAS: Veronique Garcon
Outline of Ken’s talk

• Why Upwelling?

• Types of Upwelling of Interest (all upwellings)
  → **Wind-driven**: Eastern boundary, equatorial, monsoon upwellings
  → **dynamical**: dynamical uplift in WBCs, meso-scale eddies

• Major Themes

• The Way Forward

• Knowledge Exchange, Capacity Building, Communication
1. What is the role of upwelling systems in shaping mean biases in coupled climate models?
2. What controls interannual variability in upwelling systems?
3. What is the interaction between upwelling and large-scale atmospheric climate systems?
4. What is the connection between large-scale climate indices (ENSO, PDO, NAO, AMO/AMV, etc.) and upwelling?

As if mean upwelling is well understood, but not for dynamical upwellings.

Clearer distinction from 3-4? Should “decadal” be added?

Combined?
5. What is the role of upwelling on oxygen and biogeochemistry?

6. How do climate and fisheries affect the ecological dynamics of upwelling ecosystems, including exploited species such as small pelagic fish? Can a better understanding be achieved to inform management and policy?

7. What is the expected physical response in the upwelling areas under climate change?

8. How will these changes affect plankton and fisheries production?
The way forward: Proposed Activities

In an attempt to address the above questions the team will organize and promote the following activities.

- Focused workshops to address one or more of the Major Themes (Main activities)
- Theme sessions at international meetings
- Special issues in primary publications
- Encourage CLIVAR panels to hold meetings on issues related to regional upwelling

Such meetings should, where possible, include climatologists, physical oceanographers, biologists, and fisheries scientists.
The way forward: Initial Focus

• Develop short summary documents on the major issues related to upwelling, with special emphasis on biophysical processes and identify gaps in our knowledge that have a fair success at being filled.

• Organize a workshop and due diligence exercise that will consider links at the international level as well as national level, investigating what activities are already underway, and how a CLIVAR/IMBER collaboration could complement or add value to existing activities, or begin to fill some of the gaps. Such a workshop will be undertaken in 2014 at a location and time to be determined.

• Investigated possibility of proposing SCOR WG on upwelling but have decided not to do so this year—maybe next year.
Suggestion on title

• Present: Marine biophysical interactions and dynamics of upwelling systems
• Tradionaly upwelling systems mean those in the eastern boundary zones, but the scope of this research opportunity is wider including dynamical upwellings. So, I would like sugges
• Suggesion: Marine biophysical interactions and dynamics of upwellings.
My suggestion for major themes

- I would like to suggest a modification of theme 1-5 into new theme 1-4 (original 3-4 are merged into new 3)

1. What is spatio-temporal structure of mean climatological upwellings, and what is their role in shaping mean biases in coupled climate models?

2. What local conditions controls interannual and decadal variability in upwellings?

3. What is the interaction between upwelling and large-scale climate modes (ENSO, PDO, NAO, AMO/AMV, etc.)?

4. ←#7, …expected physical response… climate change.

5. What is the role of upwelling on nutrient, oxygen and biogeochemistry?
Major activities: workshop & papers

- A joint workshop with PICES or a session at a PICES annual meeting or 2015 Brazil symposium?
  - Usually two invited speakers are covered by PICES.
  - Oct. annual meetings (2014 in China, 2015 in Korea)
  - 3rd PICES/ICES/IOC Symposium on “Effects of Climate Change on the World’s Oceans”, Mar 2015, Santos City, Brazil (I will be a member of SSC along with . )

- Any other activities than papers and workshop?
  - Comparison of upwellings, $H(w(100m))$ ($H$ is step function, average of only positive upward velocity), using different eddy resolving model