PICES WG27 Report 2012-2013

NORTH PACIFIC CLIMATE VARIABILITY & CHANGE

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Extending WG27 Terms to 2015

During the WG27 business meeting the group agreed that is would be useful to extend the lifetime of WG27 by 1-year. Below is a summary of the main motivations to request an extension (A,B,C and D).

A. Analyze CMIP5

The output of the IPCC climate models used in the last assessment AR5 has just been released in 2013. WG27 would like to devote some additional time to process the output of these models in the context of TOR # 5

5. *Provide improved metrics to test the mechanisms of climate variability and change in IPCC models, and in coordination with other PICES working groups and FUTURE Advisory Panels, assist in evaluating those models and providing regional climate forecasts over the North Pacific.*

More specifically, we would like to use the CMPI5 to conduct analysis of the biogeochemistry and the changes in ocean circulation. Our efforts are aimed at developing a simple diagnostic of the ocean circulation (e.g. metric that test the realism of the patterns of circulation and of the dynamics that drive them). We will also extract the ocean current information and make it available to the PICES community as one of the ***Science Products*** of WG27

B. Identify gaps between climate and ecosystem science

Although WG27 has made much progress on most TORs and a final report has been drafted, the members discussed the need of devoting more effort on completing TOR #6

6. *Understand and fill the gaps between what physical models can currently produce and what ecosystem scientists suggest are the important physical forcing factors required for predicting species and ecosystem responses to climate variability and change.*

We plan to conduct a conference calls in the Spring of 2014 to further brainstorm on TOR #6. We also plan to link the material of TOR 3 with the CFAME material that has not been published to report on TOR6.

3. *In conjunction with ecosystem scientists, coordinate the development and implementation of process-based models, which include important processes in simple forms, to hindcast the variability of available long-term biological time series.*

Among the discussions that we plan to complete are identifying key oceanic forcing: upwelling strength and timing, stratification and mix later depth, temperature surface and subsurface, strength of the alongshore and cross-shore transport both surface and sub-surface, eddies and submesoscale fronts. Understanding the timing of the physical variability in relation to the timing of ecosystem processes. CFAME produced meta-diagram of the mechanism but without providing actual quantitative measures supporting the physical/biological links. WG27 can revise this for the mechanisms where links can be made and quantified.

C. Organize contributions to 3rd Climate Change Symposium

WG27 will also work on preparing contributions for the 3rd international symposium on The effects of climate change on the world ocean, with the goal of showcasing some of the advances made by WG27 within the FUTURE key research themes.

D. Develop recommendations for new working groups

During the last WG27 meeting there was consensus among the members that more work was needed in completing some of the TORs of WG27 before we could agree on recommendations for new experts groups.

WG27 Science Products (progress update)

Below is a list of updates on the WG27 science products.

A. WG27 Website and peer reviewed publications (78)

The working group maintains an active website (http://wg27.pinces.int) were the scientific material that is produced by the members, which is relevant to the terms of reference of WG27, is posted. From the beginning of the WG27 the members have completed over 78 publications (see picture below). The website also gives access to reports and the outcme of workshops such as the ECOFOR 2012 in Friday Harbour. The WG27 is now in the process to synthesize the material for the WG27 Final Report.

B. Draft of the Final Report

During the business meeting at PICES 2013 the member agree on the format and content of the Final Report. Action items have been developed and assigned to differnet members. A draft of the Final Report is now in place and will be expanded during the year 2013-2014.the scientific material that is produced by the members, which is relevant to the terms of reference of WG27.

C. Synthesis Papers

WG27 members agreed that it would be important to complete two synthesis papers on that outline the progress done on the main terms of reference. After some discussions the group isolated the following:

1. Reduced complexity models to hindcast and forecast North Pacific Climate

(Cummins, Di Lorenzo, Davis, Yeh, Taguchi, Bograd)
Application of Auto-regressive multivariate models of order 1 to hindcast the physical variability of the North Pacific basin scale climate and of coastal environments. Examples for the Gulf of Alaska, CCS and KOE

2. Coherent changes in North Pacific climate and ecosystems

(King, Ito, Minobe, Chiba, Davis, Ustinova, Zuenko, Di Lorenzo)
Synthesis of how climate forcing drives coherent changes between the eastern and western boundaries of the North Pacific (1) climate framework, (2) lower-trophic framework, (3) higher trophic framework.

D. Ocean Currents Database

Form the output of the PICES and ICES sessions and from the discussion within WG27 it is clear that information on how ocean currents are changing is critical to make advances in understanding the mechanism of how ecosystem response to climate forcing. For this reason a set WG27 members (e.g. Dr. Minobe, Dr. Curchister) offered to help in assembling a database with the output of regional scale model hindcast as well as the output of the AR5 models. Were this database will be hosted is still being discussed.

Report on PICES CLIVAR Collaborations

WCRP/CLIVAR 2nd Int. Symposium on Boundary Current Dynamics

(Li Jiang, China July 7-9, 2013).

In this symposium, a joint session between CLIVAR and PICES was held as a one of three sessions. The session is devoted to “biophysical interaction”, with the corresponding convenor, Shoshiro Minobe (Hokkaido University, Japan, WG 27 co-chair) and Hiroaki Saito (Fisheries Research Agency, Japan). The session has five invited and four contributed talks, which cover global paleo ecosystem modeling and ecosystem in the southern Indian Ocean, but majority of the presentations were devoted to the western North Pacific and its marginal seas. A topic commonly discussed in the latter papers is nutrient, and its physical controls including vertical mixing, upwellings, and advections, in association with the Kuroshio (Fig. 1). These studies clarify the large uncertainty of nutrient budget. As a session summary it is suggested that a holy grail may be three-dimensional budget of nutrient for mean climatology, climate variability on interannual and decadal timescales, and climate change. We appreciate travel supports from local organizing committee (especially Prof. Xiaopei Lin, Ocean University of China, China) for the conveners and one invited speaker and from PICES for two invited speakers, and science committee chair, Prof. Lixin Wu (Ocean University of China, China). Profs. Wu and Lin are WG27 members.

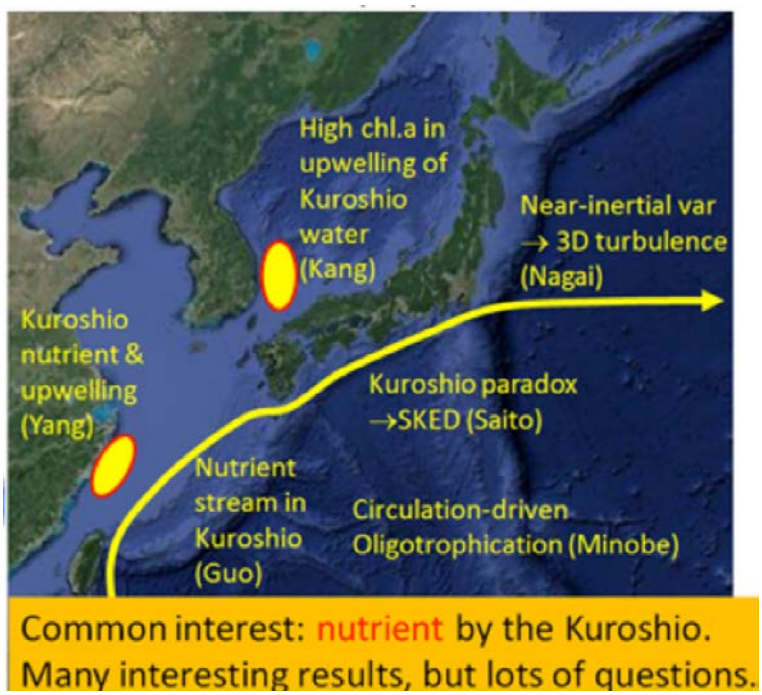


Fig. 1. Summary figure of biophysical interaction session of the symposium.

Biophysical interaction and dynamics of upwelling systems

Shoshiro Minobe (Hokkaido University, Japan, WG27 co-chair) attended CLIVAR SSG meeting held in Kiel, Germany from 6 to 9 May, 2013 as a guest, representing PICES and Japan. This SSG meeting is an important one, because CLIVAR evolves to its second phase from 2014. Thus this SSG meeting is a place where CLIVAR determines its new structure and activities. In new CLIVAR, sciences will be conducted by “core panels” and “focused & integrated research opportunity”. Some research opportunities can be related to PICES, but the most important one should be “biophysical interactions and dynamics of upwelling systems”. In the SSG meeting, the leader of the tiger team for this research opportunity, Prof. Ken Drinkwater (University of Bergen, Norway), present a motivation and expected activities. In the last PICES meeting 2012, POC discussed about this research opportunity, and agreed that the phrase of the title “upwelling systems” is modified. This is because that this phrase sounds as if this research opportunity focuses on just upwellings in the eastern boundary regions, and excludes important upwellings, for example dynamical uplift in the western boundary currents. Following this POC’s suggestion, Minobe proposed in the SSG meeting that the title should be modified, for example the phrase “upwelling systems” may be changed into “upwellings”, but no decision was made about it. Through discussions with Drinkwater and co-chairs of CLIVAR, Minobe joined the tiger team.

As a relating activity, Minobe attended to the CLIVAR’s Pacific panel meeting held in Li Jiang in July. In this meeting, Minobe took care of a short session for this research opportunity, and written a suggestion document based on its discussion for title, major themes, specific activities, etc.

ICES and PICES Joint Sessions in 2013

Following the ECOFOR workshop of 2012 on Forecasting Ecosystem Indicators with process based model, WG27 submitted two session proposals entitled “Identifying mechanisms linking physical climate and ecosystem change”. The proposal were identical and the goal was to collect input on this topic from both the ICES and PICES community. The session descriptions are introduced below along with a report and synthesis of the main findings from the sessions that are relevant to WG27 terms of reference.

Workshop W2 at PICES Annual Meeting 2013 (Canada)

Co-Convenors: Jack Barth (USA), Emanuele Di Lorenzo (USA), Marc Hufnagl (Germany) Jacquelynne King (Canada), Arthur Miller (USA), Shoshiro Minobe (Japan), Ryan Rykaczewski (USA) and Kazuaki Tadokoro (Japan)

Invited Speakers: Jürgen Alheit (Leibniz Institute for Baltic Sea Research, Germany) Bryan Black (University of Texas, USA), Carolina Parada (Instituto de Investigación Pesquera, Chile) Hans-O. Pörtner (Alfred-Wegener-Institute, Germany)

Session description

Climate variability and change in the ocean is now recognized as a significant driver of marine ecosystem response, from primary production to zooplankton composition, and through the trophic chain to fish, marine mammals and other top predators. Past studies have often relied upon existing datasets to draw correlative conclusions (associated with indices and discovered time-lags in the system) regarding the possible mechanisms that may control these linkages. In this workshop, we seek to identify and model key processes that enable us to succinctly and quantifiably explain the mechanisms underlying the correlative relationships in physical-biological datasets, both in the North Pacific and North Atlantic. The description and modeling of these key processes may (a) involve few or several variables (but not full complexity), (b) use dynamical (e.g., eddy-resolving ocean models, NPZ, IBM, etc.) or statistically based methods (e.g., Bayesian, linear inverse models, etc.), (c) explain variability in low or high tropic levels (although we seek to emphasize secondary and higher producers), and (d) include uncertainty estimation. We also solicit ideas and hypotheses concerning new mechanisms of physical-biological linkages that can only be tested by establishing novel long-term observational strategies, where the harvest of understanding will eventually be reaped by future generations of ocean scientists, as well as by developing creative modeling datasets, where ecosystem complexities can be effectively unraveled. The workshop format will be a mixture of talks and group discussions that aim at enriching the exchange of ideas and concepts between physical and biological ocean scientists. The ultimate goal is to deliver: (1) a

set of new hypotheses of the mechanisms of marine ecosystem response to climate forcing, and (2) a description of the observational and modeling datasets required to test these hypotheses using process models.

Theme Session M at ICES Annual Meeting 2013 (Iceland)

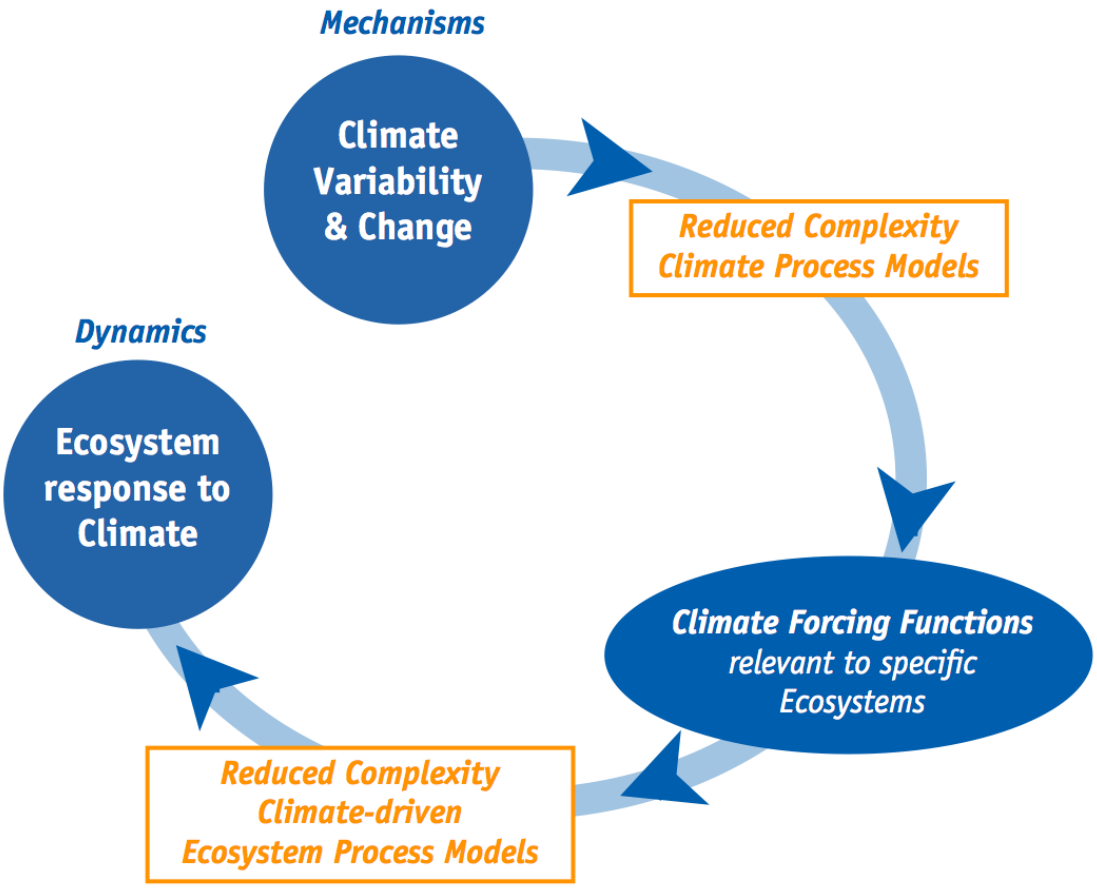
Co-Convenors: Emanuele Di Lorenzo (USA), Marc Hufnagl (Germany), Arthur Miller (USA)

Session description

Climate variability and change in the ocean is now recognized as a significant driver of marine ecosystem response, from primary production to zooplankton composition, and through the trophic chain to fish, marine mammals and other top predators. Past studies have often relied upon existing datasets to draw correlative conclusions (associated with indices and discovered time-lags in the system) regarding the possible mechanisms that may control these linkages. In this workshop, we seek to identify and model key processes that enable us to succinctly and quantifiably explain the mechanisms underlying the correlative relationships in physical-biological datasets, both in the North Pacific and North Atlantic. The description and modeling of these key processes may (a) involve few or several variables (but not full complexity), (b) use dynamical (e.g., eddy-resolving ocean models, NPZ, IBM, etc.) or statistically based methods (e.g., Bayesian, linear inverse models, etc.), (c) explain variability in low or high tropic levels (although we seek to emphasize secondary and higher producers), and (d) include uncertainty estimation. We also solicit ideas and hypotheses concerning new mechanisms of physical-biological linkages that can only be tested by establishing novel long-term observational strategies, where the harvest of understanding will eventually be reaped by future generations of ocean scientists, as well as by developing creative modeling datasets, where ecosystem complexities can be effectively unraveled. The workshop format will be a mixture of talks and group discussions that aim at enriching the exchange of ideas and concepts between physical and biological ocean scientists. The ultimate goal is to deliver: (1) a set of new hypotheses of the mechanisms of marine ecosystem response to climate forcing, and (2) a description of the observational and modeling datasets required to test these hypotheses using process models.

Identifying Mechanisms of physical/biological interactions (report)

The main goal of the PICES/ICES sessions was to (1) identify mechanisms controlling the marine ecosystem response to climate forcing, (2) isolate the climate forcing functions that are relevant to the specific ecosystem that are studied, and (3) link these climate forcing functions to the dynamics of large and regional scale climate variability. Furthermore, in this session we were seeking talks that would allow to synthesize the complex interaction dynamics between climate and marine ecosystem by providing reduced complexity models or understanding of the dynamics. This concept is illustrated in the digram below.



Both the ICES and PICES session were very well attended with about 100-200 participants. Several talks were able to target different aspects of diagram 1 and provided important insight on the nature of the climate forcing to which ecosystem are sensitive too and the dynamics of ecosystem response to environmental perturbations. Below is a synthesis of the main findings.

1. Sensitivity of ecosystem to physical drivers changes with season

During different months of the season different physical drivers become important in driving ecosystem variability. Therefore using regional indices that tracks the seasonal sensitivity of the ecosystem leads to better predictions than using climate indices. In future studies it is critical to examine if IPCC class models can resolve the dynamics of the regional forcing functions.

2. Lower-trophic levels variability tracks regional and local physical forcing

Ecosystem properties of lower trophic level (e.g. nutrient fluxes and primary productivity) are typically sensitive to few environmental driver and often track indices of climate variability that are regional or locally defined. These regionally defined indices allow to capture both the local-scale environmental variability as well as the impacts of large-scale climate variability.

3. Higher-trophic levels integrate multiple forcing and track large-scale climate modes

Ecosystem functions of higher trophic levels (e.g. sardine) are typically sensitive to multiple stressors. Hence higher trophic levels have the ability to integrate multiple sources of environmental variability and exhibit the tendency to align their variability with that of the large-scale climate modes, which capture the shared low-frequency variance among the different environmental forcing.

4. Changes in large-scale and regional scale circulation play a dominant role in driving ecosystem variability

Changes in large-scale and regional scale circulation play a dominant role in driving ecosystem variability both at the lower and higher trophic levels. Resolving the circulation dynamics with regional climate model is key to allow a proper understanding of how coastal ecosystem respond to climate forcing. It will be important in the future to develop adequate data archives of ocean currents and advection pathways that can be used by ecosystem scientists to test hypothesis on the ecosystem response to environmental oceanic forcing. These data archives will likely be assemble using the output of regional scale model hindcast. It was also pointed out the resolving eddies at the regional scale is critical, but it also introduces a random component in the variability associated with the degree of intrinsic nature of the eddy-scale circulation. Future eddy resolving models will need to perform an ensemble hindcast in order to separate the fraction of variance that is deterministically forced vs. the internal variance.

5. Spatial dimension is key for understanding the links between physical variability and ecosystem response

As we develop reduced complexity models of the marine ecosystem response to climate forcing it will be critical to incorporate the spatial dimension (e.g. associated with fish distributions). This topic has already emerged from the section on Climate Change impacts on Marine Ecosystem (S-CCME) and is currently an important topics research/discussion. Although several talks showed example of how the spatial dimension plays an important role, no systematic approach was presented to incorporate the spatial dimension in reduced complexity models. During the discussion a Linear Inverse Model methodology was suggested as one approach to model the spatial dimension of fish distribution in the context of a changing climate.