

CLIVAR EBUS Research Focus' response to concerns of redundancy with newly approved SCOR WG group on Eastern Boundary Upwelling Ecosystems

The approval of the SCOR working group (WG) on Eastern Boundary Upwelling Ecosystems (EBUE) and the similarity in action items and deliverables with the CLIVAR EBUS Research Focus has raised some concern about potential redundancy of the two groups. While some common goals are evident, members of the CLIVAR EBUS RF feel they maintain a distinct emphasis on large-scale modeling of the coupled ocean-atmosphere system that aligns with the scientific mandate of CLIVAR. They see strong complementarity as well as an opportunity for fruitful collaboration between EBUS and EBUE that can allow more rapid progress on themes of common interest.

Below, we reevaluate the strategy of EBUS RF with emphasis on aspects that are of particular relevance for the CLIVAR community and that leverage the specific expertise and research of CLIVAR scientists. We describe the general research plan that continues the work initiated within EBUS, together with a strategy for the exploitation of the potential for collaboration between EBUS and EBUE working group. We propose a work plan for the immediate period of 2018 and deliverables expected to emerge from those efforts.

In addition, we are planning revision in RF membership and leadership to populate the group with individuals that are committed to scientific participation and to contributing to the deliverables with individual research outcomes. This revision will be based on the past track record of individual members of the EBUS RF and their explicit expression of interest. Some of the current RF members may therefore be removed from the group (in a few cases this has already been done following the indication of the individuals concerned). We also propose to widen participation to EBUS by interested scientists with a suitable research profile, and we particularly welcome members who will act as liaisons between the CLIVAR RF and SCOR WG to facilitate communication and collaboration. Additionally, changes to the chairmanship of the RF are in order.

We agree that there is opportunity for collaboration between the CLIVAR RF and the SCOR WG that can be beneficial for both parties, but also that the two groups will have distinct and complementary strengths.

I. Reevaluation of the EBUS Prospectus

We refer here to the EBUS prospectus, without reproducing it in full. The EBUS prospectus was created well before the formation of the SCOR EBUE WG proposal, and it provided some motivation for the formation of the SCOR EBUE plan. We highlight here three key points that are emphasized in the prospectus (bold parts as in the original document):

- A. **Of particular importance to determine the nature and intensity of coastal upwelling and the associated meridional currents is the offshore distance of the maximum along-shore wind-stress.** More generally the wind structure near the coast is key and is a source of significant uncertainty in all EBUSs that we want to address.

- B. The four tropical wind-driven upwelling areas have basically similar spatio-temporal patterns of wind-stress, except for the Canary system. These patterns exert a similar forcing on the current systems and the SST. Specific characteristics of the individual EBUSs generally stem from significant hydrographic and bathymetric differences. **Such similarity appears to call for a common first order theory for the regional atmospheric circulation in the EBUS, the air-sea interactions, and the role of EBUS in the global climate**

- C. We suggest that focusing on large-scale relationships between physical properties and ecosystem structure should be prioritized. **We hypothesize that observed decadal scale changes in ecosystem structure are forced by large-scale, physical changes in ocean processes resolved by the current generation of global ocean models.**

It is important to recognize that these are ideas that fall within the area of scientific expertise of EBUS members and CLIVAR community in general. It is also clear that they address fundamental questions about the large-scale circulation and its long-term variability, which fall within the remit of CLIVAR. The EBUS RF group therefore will continue to make these the core of its research agenda.

Specifically, the EBUS Prospectus proposes to address the following questions:

- A. On the physics of eastern boundary upwelling systems and linkages to large scale climate:
 - i. What is the structure of atmospheric circulation in EBUS and how is it represented in current global and regional models?
 - ii. What are the dynamical mechanisms linking the upwelling regions with the large-scale climate patterns?

- iii. What are the effects of upwelling on the regional and global air temperatures, precipitation and wind patterns?
- iv. How does a more accurate representation of coastal upwelling in climate simulations improve existing regional and global biases such as in SST and precipitation?
- v. What are the sources, transformations, and destinations of upwelled waters?
- vi. How can the temporal and spatial variability of upwelled waters be described?
- vii. What are the current biases in GCM representation of undercurrents in EBUS?

B. On the role of coastal eastern boundary upwelling systems in regulating biogeochemical processes:

- i. What are key physical and biological processes controlling air-sea CO₂ flux and carbon export in the eastern boundary upwelling systems?
- ii. What are the relative contributions of regional biological productivity and basin-wide circulation to the extent and intensity of oxygen minimum zones in these systems?
- iii. How will the natural and anthropogenic factors change the carbon cycle and ocean acidity in the eastern boundary upwelling regions?
- iv. What is the sensitivity of the oxygen minimum zones in EBUSs to climate variability and to future global warming scenarios?

C. On the climate and fisheries connection leading to fluctuations of fish populations:

- i. What is the source of upwelled waters and nutrients?
- ii. How do mixing and stratification influence the size structure and composition of the plankton community?
- iii. What physical processes affect the survival of fish larvae?

Preliminary discussion among active EBUS RF members, taking into consideration complementary activities within SCOR EBUE, the specific overall mission of EBUS RF, and its contribution to CLIVAR goals, has led to a general consensus that part A of this action plan should be maintained. Within part B, EBUS sees B-i and B-iv also as specific goals relevant to the coupled large-scale circulation and climate change and variability, and thus within its remit. On themes Bii-iii and Ci-iii, it is agreed that cooperation with EBUE will be sought in order to mutually aid progress on the respective objectives of each group.

II. Proposed working plan for 2018

As a result of discussions stimulated during the meeting in Qingdao in October 2016, EBUS RF agreed to undertake an exploration of the representation of coastal upwelling and associated air-sea fluxes in current GCMs. The long-term goal is to understand how upwelling systems will respond to anthropogenic change. However, improved understanding of model representation of the processes and their variability in a historical perspective was considered a preliminary requirement. The current activities of OMDP concerning an inter-model comparison of ocean models forced with the new JRA-55 reanalysis is viewed as an opportunity for cooperation, and the first step in our working plan is an examination of the JRA-55 forcings as well as the forced ocean simulations. To facilitate continued leveraging of the OMDP effort, the EBUS group is interested in understanding how representation of upwelling by the JRA-55-forced models differ from its representation in CORE-II forced models. Additionally, we seek to describe how this representation differs across ocean models. This information will ultimately allow us to better understand the role of large-scale climate phenomena in driving upwelling variability (addressing questions in listed in point A above).

The group developed the following activity plan for 2018:

1. Assessment of the JRA-55 forcing dataset in comparison to existing in-situ data in the EBUSs (addressing Ai-ii);
2. In collaboration with the CLIVAR Ocean Model Development Panel (OMDP), analysis of JRA-55 forced high-resolution ($\sim 1/10^\circ$) ocean runs simulations in the EBUS (addressing Ai, Aii, and Aiv);
3. Development of EBUS specific diagnostics and metrics for model analysis. This includes comparisons to existing observational datasets (addressing Ai-vii);
4. Quantify relative contributions of local forcings and remote ocean wave forcing in the intra-seasonal to interannual variability of EBUS and consider the implications of such forcings on the predictability of upwelling at monthly to annual scales (addressing Aii-iii);
5. Identify dominant or recurrent air-sea interactions within EBUS, at intra-seasonal to seasonal scales, using satellite and in-situ observations and simulations (addressing Ai and Aiii with pertinence to Bi);
6. The 2nd Session of EBUS RF Meeting: jointly with SCOR WG members in summer 2018 [in association with the June 2018 4th Climate Change Symposium (ECCWO) in Washington, DC meeting] to discuss progress and begin discussions concerning joint activities, including hosting an international symposium of climate change and upwelling and a summer school on upwelling

systems.

The group wishes to continue progress on these six planned items in the coming year. Each of the action items noted above are associated with specific commitments from a subset of current RF members. **Point 1 is envisaged as a specific deliverable by EBUS RF for 2018, to result in a report shared with OMDP.**

III. Explicit efforts of collaboration with the SCOR WG

Communication and collaboration between the SCOR EBUE WG and the CLIVAR EBUS RF are essential. We see at least three mechanisms for such interaction:

1. Individuals with joint membership in both the CLIVAR and SCOR groups with the mandate to keep each group informed regarding the activities of the other.

Current members with affiliation in both groups are noted below. In SCOR, “full members” will be funded to participate in meetings, while “associate members” are invited to attend.

Ruben Escribano (SCOR full member)
Enrique Curchitser (SCOR full member)
Ryan Rykaczewski (SCOR associate member)

Other sources of funding may be available to facilitate participation by associate members. PICES (the North Pacific Marine Science Organization) has agreed to support Rykaczewski’s participation in SCOR at USD 1.5k per year in association with his co-chairmanship of a PICES working group on climate and ecosystem predictability.

2. Joint organization of sessions and workshops at international conferences and symposia to facilitate the exchange of information between groups.

To date, at least two joint CLIVAR-SCOR sessions focusing on the upwelling process and are planned, one at the 2018 Ocean Sciences Meeting in Portland, OR, USA and a second at the ECCWO symposium in Washington, DC, USA.

At the ECCWO symposium: Session 7 – “Eastern Boundary upwelling systems: diversity, coupled dynamics and sensitivity to climate change” (Co-chairs Ivonne Montes and Ryan Rykaczewski)

At the 2018 Ocean Sciences Meeting: Session EP34B – “Biophysical Dynamics of Eastern Boundary Upwelling Ecosystems in a Changing Ocean: Closing the Gap Between Wind Stress and Ecosystem Productivity” (Co-chairs Ryan Rykaczewski, Enrique Curchitser, Ruben Escribano, and Michael Jacox)

3. Organization of a jointly sponsored symposium focused on atmosphere-ocean-ecosystem interactions in EBUE. We would seek joint financial support from interested groups. A model for such a symposium is that held in 2008: http://www2.ulpgc.es/hege/almacen/download/7060/7060038/hechoflyer_ebus1.pdf.

In summary, the CLIVAR EBUS RF is excited by the formation of a complementary SCOR WG. The CLIVAR group will continue effort to address questions outlined above and in the EBUS Prospectus, with emphasis on the application of GCMs and basin-scale models, global reanalyses, and coupling within the ocean-atmosphere system; issues for which the CLIVAR community has particular expertise. We look forward to collaborating with the SCOR EBUE group on issues of joint interest, namely biogeochemical processes in upwelling system and the implications of large-scale climate changes on the ecological productivity of these systems.

Annex A

Proforma for CLIVAR Research Focus requests for SSG approval for meetings

1. Panel or Working Group:

Eastern Boundary Upwelling Systems Research Focus

2. Title of meeting or workshop:

The 2nd Session of CLIVAR Eastern Boundary Upwelling Research Focus Meeting (focusing on the representation of upwelling processes in basin and global models and reanalyses)

3. Proposed venue:

Washington, USA (during ECCWO 2018 4th Climate Change Symposium)

4. Proposed dates:

June 9-10, 2018 (2 days)

5. Proposed attendees, including likely number:

We anticipate participation of 10 funded participants, though we hope that the number will be larger given the interest and attendance at ECCWO. A subset of this group will continue to discuss a list of invitees. Preliminarily, we include current RF members and others who we know have interest and will be attending the ECCWO meeting:

Michael Alexander, Jack Barth, Anonio Bode, Steven Bograd, Annalisa Bracco, Enrique Curchitser, Gokhan Danabasoglu, Emanuele Di Lorenzo, Ruben Escribano, Veronique Garcon, Mike Jacox, Isaac Kaplan, Alban Lazar, Art Miller, Ivonne Montes, Marek Ostrowski, Kenneth Rose, Ryan Rykaczewski, Franklin Schwing, Desiree Tommasi, Thomas Toniazzo, Paquita Zuidema

6. Rationale, motivation and justification, including: relevance to CLIVAR science & WCRP Grand Challenges, and any cross-panel/research foci links and interactions involved:

This meeting would be the second meeting of the CLIVAR EBUS Research Focus Group since the inaugural meeting in Ankara in 2015 and the first meeting in Qingdao during CLIVAR Open Science Meeting in Qingdao in 2016. This group is focused on understanding the relationship between large-scale climate variability

and climate change on the dynamics of the ocean's eastern boundary upwelling systems. These systems are of interest for several reasons, namely their role in stimulating large and consistent biases in the accuracy of GCMs, their feedback to the global carbon cycle through air-sea fluxes of CO₂, and their impact on resources of critical importance to coastal populations (food, transportation, and recreation).

Understanding the relationship between anomalies in tropical atmospheric circulation and their teleconnections to upwelling processes along the eastern boundaries is one of the first steps in the EBUS RF action plan. The current predictability of atmosphere-ocean phenomena impart predictive skill in the upwelling process at time scales of 6-12 months in the future. This predictability is most skillful during extreme events. Given this key action item, this step is relevant to WCRP Grand challenges "Clouds, Circulation and Climate Sensitivity," "Near-Term Climate Prediction," and "Weather and Climate Extremes."

Another critical element of EBUS RF is collaboration with the recently established SCOR Working Group on Eastern Boundary Upwelling Ecosystems. At the ECCWO, CLIVAR (Ryan Rykaczewski) and SCOR (Ivonne Montes) members are organizing a joint session focused on the diversity, coupled dynamics, and sensitivity to climate change in Eastern Boundary Upwelling Systems. As such, we anticipate that a large number of scientists with interests in upwelling will be present. This could also act to be the first meeting between of CLIVAR EBUS and SCOR members.

7. Specific objectives and key agenda items:

Describing the representation of upwelling systems in global models and reanalysis datasets is proposed as the key objective of this meeting.

Participants will be asked do come prepared to share assessments of the atmospheric and oceanic processes associated with upwelling as represented by global and/or basin-scale numerical models. Common questions will be posed to each participant and his/her analysis. For example: 1) How does representation of this process compare across upwelling systems around the globe? 2) How does the behavior of the process in numerical models compare with that in observations, and what are the major biases? 3) What will be the utility of the OMDP JRA-55 comparison for improving understanding of the process?

Draft Agenda:

- A. Review of CLIVAR RF and SCOR WG terms of reference.
- B. Update from SCOR WG members regarding their current action items and progress.
- C. Review of current state of JRA-55 reanalysis and JRA-55-forced ocean simulations.
- D. Short presentations by participants with discussion

E. Initial discussion of a joint CLIVAR-SCOR-IMBER symposium on upwelling ecosystems and climate change.

8. Anticipated outcomes (deliverables):

- A. Outline of potential issue of “CLIVAR Exchanges.”
- B. Plan for review article on upwelling systems in global models and reanalyses.
- C. Initial draft of a plan for a joint symposium.

9. Format:

Day 1: Short, 15-minute presentations by participants with discussion focused on model representation, atmosphere-ocean coupling, potential impacts on society, and utility of JRA-55-forced simulations.

Day 2: Discussion and drafting of deliverables.

10. Science Organizing Committee (if relevant)

11. Local Organizing Committee (if relevant)

12. Proposed funding sources and anticipated funding requested from WCRP:

We anticipate requesting 10,120 USD to facilitate participation of 10 participants. This request is meant to cover an additional two days of meals and lodging at the US State Department per diem rate of 253 USD. Participants will be expected to arrange their own transportation (and we expect this additional travel cost to be minimal given the participation of many in the ECCWO symposium).

We also seek the help of WCRP in reserving a venue for this workshop.