

# CLIVAR REPORT

Climate and Ocean: Variability, Predictability,



Report on the Third Session of CLIVAR Eastern  
Boundary Upwelling System Research Foci (EBUS RF)

## Meeting Report

9<sup>th</sup> December 2018, Washington DC, USA

March 2019

CLIVAR Report No. 3

## Table of Contents

Table of Contents.....	i
List of Actions.....	ii
1. Background.....	1
2. Research introductions and ways forward.....	1
3. Deliverables in 2019 and Onward.....	2
3.1 A Perspective-style Article.....	2
3.2 ICTP-CLIVAR Summer School and Workshop.....	3
3.3 Contribution to IPCC SROCC Review.....	3
3.4 Other possible products.....	3
4. Updates on relevant groups' activities.....	4
Appendix A: List of Participants.....	5
Appendix B: Agenda.....	6
Appendix C: Syllabus of ICTP-CLIVAR Summer School (Draft).....	7

## List of Actions

*Action 1: To further explore the opportunity in collaboration with US CLIVAR Working group “Changing Width of the Tropical Belt” (EBUS RF co-chairs with Mike Patterson);*

*Action 2: To form a task team specifically focused on this cross-shore wind stress comparison. (Thomas)*

*Action 3: The initial outline of the manuscript will be shared to EBUS RF right after the meeting, and the draft manuscript is expected by the end of May 2019 (Ryan, Alban and Thomas).*

*Action 4: Planning for the summer school will continue through a series of conference calls in winter and spring.*

*Action 5: EBUS RF members interested in commenting on this draft if IPCC SROCC (specifically the box on upwelling systems) will register and send comments through the IPCC process by the deadline (11 January 2019).*

# 1. Background

The EBUS RF met on 9 December 2018 in the Farragut Square Room of the Hamilton Hotel in Washington DC from 8:45 AM to 5:00 PM. This was the first face-to-face meeting of the EBUS group since reconfiguration of chairmanship and members in spring 2018.

11 out of the 17 EBUS RF members were present in person (see Appendix A for List of participants). Additionally, Jing Li from the International CLIVAR Project Office (ICPO) joined by conference call. Mike Patterson (US CLIVAR) was present and offered some insight to the activities of US CLIVAR, and Jeff Becker (US CLIVAR) provided logistical support.

The agenda drafted before the meeting (See Appendix B) guided the discussions on three main sessions, including research introduction by EBUS members and identification for possible future activities; deliverables in 2019 and onwards as well as other relevant issues to the group.

## 2. Research introductions and ways forward

The brief introductions offered by each participant on his/her research provided a good opportunity for the newly configured group to know each other and also provided sound basis for identifying future activities of the group, though it ran much longer than planned (which was not unanticipated). The new configuration of EBUS RF members covers comprehensive scientific background, including regional and large-scale oceanographic and atmospheric processes, regional and global numerical models and observations, as well as biogeochemistry and ecology.

Following brief research introductions, the discussion turned to “ways forward” to make headway on our understanding of the sensitivity of EBUS to climate processes and their representation in models and data. Suggestion are grouped by themes as below. There was more substantial discussion on many of these points.

### Model comparison

- To develop a set of common metrics of key EBUS processes for comparing models with data and for comparisons across systems. (Paquita & Alban)

### Observation and data

- To highlight the need for continued observations. While we need data for model-data comparison, we are often data-limited. Perhaps even highlighting the need for data (and the spatio-temporal resolution of those data) would be valuable. (Uwe)
- To foster international collaborations around regional ecosystem issues. For example, observations from Angola are rare, and involving those scientists in the discussions would be politically astute. It is sometimes challenging to access the data. (Martin)
  - International collaboration in the analyses are key, as many countries are collecting relevant data that do not make their way into global databases. (Art and Thomas)
- To highlight observational requirements. A manuscript on what biological and biogeochemical observations (where, when, what type, and what frequency) would be necessary to resolve the impact of climate variability and change on upwelling. (Ryan)

- There is also an idea of a paper on comparison and discussion of existing in situ observations (buoys) and satellite, and reanalysis biological and biogeochemical data. (Alban)

### Wind forcing

- To investigate/compare aspects of the wind forcing that are most relevant to the various upwelling systems. Those characteristics might include the zonal structure of the meridional wind, the temporal variability of the wind intensity, and boundary-layer dynamics; (Thomas)
- To consider the role of the position/intensity/seasonality of the anticyclone. How do these characteristics influence the wind stress and wind-stress curl fields? It's perhaps also important to think about the impacts of tropical-belt widening (which might influence the poleward displacement of the anticyclones) on the wind-stress curl fields. How are these characteristics related to larger-scale climate modes? (Jenny and Ryan)
  - There could also be some relevant data from ASCAT or from moorings. (Alban)
  - EBUS RF could form a task team specifically focused on the cross-shore wind stress comparison. (Thomas)

*Action 1: To further explore the opportunity in collaboration with US CLIVAR Working group “Changing Width of the Tropical Belt” (EBUS RF co-chairs with Mike Patterson);*

*Action 2: To form a task team specifically focused on this cross-shore wind stress comparison. (Thomas)*

### Biology and Biogeochemistry

- To let the biology, or the biogeochemistry guide our investigation of important factors. We should also let the phenomena describe the geographic locations of interest rather than set firm latitudinal limits to our investigations. There are two possible approaches: we can either look and see where the data indicate the importance of a process, or we could use theory to explore where a process should be important. (Thomas)
  - The biological and biogeochemical properties are valuable, as they are more closely associated with the resources of societal interest, but data on these characteristics might be even harder to come by than the physical atmosphere or ocean properties. (Ryan)

## **3. Deliverables in 2019 and Onward**

### **3.1 A Perspective-style Article**

As suggested by Annalisa, a short ‘**perspective style**’ **article** on current questions in EBUS was proposed. It is motivated by society’s need to understand biological sensitivity to upwelling; by the availability (or scarcity) of observations relevant to improving this understanding; by discrepancies in reanalysis products; by the sensitivity of these systems to Oxygen minimum zone (OMZ)/acidification that might constrain ecological processes; by the SST (and other) biases in large-scale models present in these systems; and by the influence of these systems on air-sea CO<sub>2</sub> fluxes (sequestration or outgassing). These issues in EBUS are of growing interest due to their nutritional and commercial value to a growing population. It is in these regions where the combination of large-scale forcing and regional forcing have some of the most obvious

impacts on marine ecology. An example might be the Bony et al. (2015) article in Nature Geoscience titled “Clouds, circulation and climate sensitivity.”

Roughly, the three key areas of uncertainty that we felt we have the collective capacity to highlight were: 1) need to understand the wind/atmospheric structure, including uncertainties in our resolution of intensity and frequencies of variability (spatial and temporal) of atmospheric forcing on upwelling processes; 2) need to resolve the relative roles of large-scale/synoptic scale processes and local processes in controlling physical and biological properties of EBUS; and 3) need to understand how the characteristics of variability in EBUS oceanic properties (including advection, poleward flow—both at surface and subsurface, biogeochemical properties, turbulence, waves) potentially alter the ecosystem sensitivity to climate change.

Individuals volunteered to contribute key sections of this manuscript. Participants had envisioned that this article would be relatively short (no more than 2,000 words in total with 50 citations). The first draft of the manuscript is expected by the end of May 2019.

*Action 3: The initial outline of the manuscript will be shared to EBUS RF right after the meeting, and the draft manuscript is expected by the end of May 2019 (Ryan, Alban and Thomas).*

### **3.2 ICTP-CLIVAR Summer School and Workshop**

The format and syllabus of the ICTP/CLIVAR Summer School on EBUS to be held on 15 - 21 July 2019 at Trieste, Italy has been discussed during the meeting. Broadly, participants agreed that a productive format for the summer school would be to have a few lectures (two to three) in the morning (9 am – 1 pm) followed by a substantial break for lunch that might allow students to enjoy the setting (hiking/swimming/relaxing). The afternoon sessions (4 pm – 7 pm) might be dedicated to data analysis or some other analytical or hands-on activity. **An outline of the plan for the summer school is attached as Appendix C.**

*Action 4: Planning for the summer school will continue through a series of conference calls in winter and spring.*

### **3.3 Contribution to IPCC SROCC Review**

The final thing the group talked about was contributions to review of the IPCC Special Report on the Ocean and Cryosphere in a Changing Climate (SROCC). Individuals agreed to provide reviews of the one-page section on upwelling systems, but time ran short to discuss a group review during our face-to-face meeting.

*Action 5: EBUS RF members interested in commenting on this draft of IPCC SROCC (specifically the box on upwelling systems) will register and send comments through the IPCC process by the deadline (11 January 2019).*

### **3.4 Other possible products**

Other possibilities for products that were suggested included: 1) a synthesis or a review paper with the regional characterization of the physical processes at play in shaping the variability of EBUS at seasonal to interannual scales; 2) conducting some new science with comparisons of upwelling processes using

high-resolution products that are coming online; and 3) the planned summer school at ICTP and the associated workshop.

#### **4. Updates on relevant groups' activities**

The activities of the SCOR working group were mentioned briefly. The SCOR working group has had one face-to-face meeting, and that occurred in Washington, DC in June 2018. The group is planning a summer school for the summer of 2020. There is interest in discussing the potential for a joint symposium that would involve the two groups, but the SCOR group feels the need to make some independent progress before planning for a joint meeting.



## Appendix A: List of Participants

Name	Institution	Role	Country
Ryan Rykaczewski	University of South Carolina	Co-chair	USA
Thomas Toniazzo	University of Bergen	Co-chair	Norway
Alban Lazar	LOCEAN-IPSL/Sorbonne Université	Co-chair	France
Annalisa Bracco	Georgia Institute of Technology	Member	USA
Art Miller	Scripps Institution of Oceanography	Member	USA
Paquita Zuidema	University of Miami	Member	USA
Uwe Send	Scripps Institution of Oceanography	Member	USA
Jennifer Veitch	South African Environmental Observation Network (SAEON)	Member	South Africa
Moussa Diakhaté	Université Cheikh Anta Diop (UCAD) de Dakar	Member	Senegal
Marisol García-Reyes	Farallon Institute for Advanced Ecosystem Research	Member	USA
Martin Schmidt	Leibniz Institute for Baltic Sea Research Warnemünde	Member	Germany
Mike Patterson	US CLIVAR	Observer	USA
Jeff Becker	US CLIVAR	Observer/ Logistical support	USA
Jing Li (remote)	International CLIVAR Project Office (ICPO)	ICPO	China



## Appendix B: Agenda

8:45	Welcome
9:00	Brief introductions 5 minutes per participant
10:45	Break
11:00	EBUS Prospectus review Complementarity with the Terms of Reference of SCOR-155 WG on EBUS What is missing from this plan? On which of these questions can real, collaborative progress be made with help of our RF? What deliverables are possible? (Annalisa)
12:00	Lunch
1:30	Summer School planning Speakers; Co-funding opportunities; Computer lab schedule; Daily schedule; Advertising (Poster with descriptive extended abstracts); Application deadlines
2:00	IPCC SROCC review
2:30	Deliverables Main objective of the RF in 2019 Longer-term view: main open research questions of strategic relevance for the RF Perspective on ongoing and future research & relevance for CLIVAR
3:00	Break
3:15	Deliverables
4:00	Updates on other groups' activities
4:30	Discussion of summer workshop
5:00	Adjourn

# Appendix C: Syllabus of ICTP-CLIVAR Summer School (Draft)

## ICTP-CLIVAR Summer School on Oceanic Eastern Boundary Upwelling Systems

15 Jul 2019 - 21 Jul 2019 Trieste, Italy

### General information

*Morning lectures (2 lecturers for four hours; 9 AM – 1 PM)*

*Lunch Break for three hours*

*Afternoon session 4 PM – 7 PM (Afternoon data analysis, perhaps three days, and afternoon lectures the other two days)*

**Tools to be decided:** Python; MatLab or no MatLab?; GrADS; Ferret; R

\* This analytical tool/hands-on activity should likely be using the same platform for the whole week, and perhaps the same instructors.

### Topics

#### 1. Introduction

Why are EBUS important? (with some biology, economics and food security discussion)

Key interactions among different realms (atmosphere/ocean physics; climate; feedbacks; ecology; acidification; OMZs; similarities across systems)

#### 2. Oceanic circulation and the upwelling process

#### 3. Atmospheric circulation

#### 4. Biogeochemistry and fisheries

#### 5. Climate impacts and sensitivities (i.e., sensitivity of processes discussion in points 2-4 to climate change)

### Syllabus

#### Day 1

AM: Introductions of speakers and students

AM: Lectures on topic 1 - Introduction

PM: Lecture on available data and tools; model-data comparisons (e.g., ARGO, atmospheric reanalyses, CMIP5). Data Visualization.

Evening: Welcome reception

### Day 2

AM: Lectures on topic 2 – Ocean Circulation and the Upwelling Process

PM: Computer session focusing on

1. Surface oceanic observations and reanalyses.
2. Compare models and data.
3. Preliminary hands-on analyses by students.

### Day 3

AM: Lecture topic 3 – Atmospheric Circulation

PM: Computer session focusing on:

1. Atmospheric observations and reanalyses.
2. Compare models and data. Consider coupled dynamics;
3. Oceanic responses to atmospheric forcing.

17:00-20:00: Participants' poster session, perhaps with each student having two minutes to introduce the poster and his/her work. Drinks might start at 18:30.

### Day 4

AM: Lecture on topic 4 - Biogeochemistry and fisheries

PM: Computer lab on biogeochemical datasets and earth-system models

### Day 5

AM: Lecture on topic 5 - Climate impacts on upwelling processes; GCM simulations, IPCC projections, and their limitations; working with model anomalies as opposed to their raw simulated fields

PM: Debate/Round table on historical trends in some upwelling property and/or on future projections

## **Lectures**

### Atmospheric Dynamics

1. TBA (Rene Garreaud)
2. Air-sea interactions and observations of the surface heat budget (Mathieu Rouault)
3. Dynamic drivers of upwelling-favourably winds and of their variability (Mathieu Rouault)
4. Dynamic drivers of upwelling-favourably winds and of their variability (Thomas Toniazzo)
5. Processes determining the climatological distributions of cloudiness above the EBUS systems (Paquita Zuidema)
6. TBA (Marisol Garcia-Reyes)

### Ocean Dynamics

1. Observed inter-annual variability in the Benguela EBUS (Mathieu Rouault)
2. How does the ocean respond to along-shore wind forcing? (Thomas Toniazzo)
3. Role of Meso- and submesoscale variability in upwelling systems (Annalisa Bracco)
4. *TBC* (Schmidt/Brandt/Dengler/...)

### Biogeochemistry and Ecology

1. *TBC* (Simon Roux / Andreas Oschlies)
2. Influence of upwelling variability on pelagic ecosystem structure (Ryan Rykaczewski)
3. Biogeochemical characteristics of eastern boundary upwelling systems (Ryan Rykaczewski)

### Connections to Large-Scale Climate

1. TBA (Rene Garreaud)
2. Reanalysis data and remote observations on upwelling regions and trend analysis (Mathieu Rouault)
3. The atmospheric circulation in the EBUSs in the large-scale context (Thomas Toniazzo)
4. The oceanic circulation in the EBUSs and connections to waves (Alban Lazar)

5. Response of upwelling-favorable winds to anthropogenic changes in GCMs (Ryan Rykaczewski)
6. *TBA* (Moussa Diakhaté)

#### Connections with global climate modelling

1. Systematic SST biases in GCM and insights from sensitivity experiments (Thomas Toniazzo)
2. Diagnosis of fast SST error growth causes in the southern hemisphere EBUS systems within low- and high-resolution CCSM4 simulations (Paquita Zuidema).
3. Coupled ocean-atmosphere feedbacks (Art Miller)
4. Model data assimilation (Art Miller)

#### **Lecturers**

Annalisa Bracco	Georgia Inst. of Technology, USA
Moussa Diakhaté	Un. Cheikh Anta Diop (UCAD) de Dakar, Senegal
Marisol Garcia-Reyes	Farallon Institute, CA, USA
Rene Garreaud	Univ. of Chile, Chile
Alban Lazar	L'Ocean & Univ. Pierre and Marie Curie, France
Art Miller	SCRIPPS, UCSD, USA
Mathieu Rouault	Un. of Cape Town, South Africa
Ryan Rykaczewski	Un. South Carolina, USA
Thomas Toniazzo	Un. of Bergen, Norway
Paquita Zuidema	Un. of Miami, USA