

CLIVAR REPORT

Climate and Ocean: Variability, Predictability, and Change



Meeting report

The 4th Session of the CLIVAR Climate Dynamics Panel

4 – 5 June, 2019 Mykonos island, Greek

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ACTION ITEMS

- Noel proposed financial support for a workshop in Bergen in 2020 from WCRP (Noel, Been accepted).
- Shang-Ping, Elisa, Marcelo, Olga and Mat proposed to volunteer to step down. Yohai, Simona and Shoshiro are proposed 1-year extension. Noel is proposed to be co-chair. Will find a member from the Southern Hemisphere (all relevant members).
- The current and proposed co-chairs will make a plan of new members and then share it with panel members (Mat, Shoshiro and Noel).
- Have a joint workshop in Japan in April 2021 between CDP and recently funded Japanese project hotspot2, CDP-5 will be alongside the workshop (Shoshiro).

1. Introduction

The fourth session of CLIVAR Climate Dynamics Panel (CDP-4) was held on 4-5 October 2019 at Saint Jhon Hotel in Mykonos island, Greek. Seven out of 12 CDP members attended this panel meeting. CDP-4 was organized alongside with the Cloud Feedback Model intercomparison Project (CFMIP), which would foster collaboration between the two communities. This CFMIP meeting focused on the theme of the WCRP Grand Challenge on Clouds, Circulation and Climate Sensitivity, fostered collaboration with the CLIVAR CDP program, and addressed all other ongoing CFMIP activities, including CFMIP-sponsored Model Intercomparison Projects (MIPs) and experiments.

The CDP co-chairs, Mat Collins and Shoshiro Minobe made the opening remark, introducing the mission of CDP in CLIVAR, and the achievements it has derived.

2. Reports from the CFMIP representatives

To foster the combination with CFMIP, the CDP co-chairs invited three CFMIP representatives, including Masa Watanabe, the CFMIP co-chair, Paulo Ceppi and Yen-Ting Hwang, the CFMIP Coordinator to give presentations during this panel meeting. Topics of the invited presentation included the overview of CFMIP, and specific scientific reports.

Overview of CFMIP (Masahiro Watanabe)

- Introduced the structure and activities of CFMIP. CFMIP started in 2003 as a WCRP endorsed the project, a part of CMIP. One important activity of CFMIP is to coordinate GCM experiments, now it is in phase 3 engaging CMIP6. Another focus point is about diagnostics of clouds for process understanding. Detailed information on CMIP6/CFMIP3 experiments and status was introduced in the report. Up to the meeting time, 10 of 28 models from 15 model groups have submitted their datasets. In addition to CFMIP3, several CFMIP-affiliated coordinated projects including the MIP projects (RCE-MIP, ETIN-MIP, SPOOKIE II, et al.) and information sharing projects (COSP, CFMIP-OBS datasets, CFMIP Diagnostic Codes Catalogue) are presented.
- Some topics that been discussed in this CFMIP meeting is introduced by Masahiro. One hot topic is about ‘the pattern of SST change can affect climate feedback’. Several published papers proved the major cause of the discrepancy in climate feedbacks between 20th century observations and GCMs.
- Issues that relevant to CDP. Masahiro showed five aspects: i) Hadley cell expansion & ITCZ tightening, ii) Precipitation & hydrological sensitivity, iii) Jet Shift which driven by FAT/cloud radiative effect, iii) Arctic amplification and iv) Tropical-extratropical linkage.

Three-Stage Hadley Circulation Response to Extratropical Thermal Forcing (Yen-Ting Hwang)

- Anthropogenic and natural forcing in extratropics makes the influence on the tropics being important.
- The diagnostics of CESM large ensemble show structural changes of Hadley Circulation: i) Linear trend of meridional mass stream function (MSF) is very different within different time periods. Decomposing MSF into a symmetric and asymmetric component shows a quite different time series: symmetric is related with enhanced warming at the equator, while asymmetric component can be explained by global energetics; ii) CESM also shows a shift of dynamical precipitation centroid.
- Using three-stage hierarchical models to try to understand atmosphere how would Hadley circulation response to extratropical thermal forcing through different time scales and processes. i) Aqua-planet simulations with 60 ensemble members; ii) Slab ocean simulations with continents; and iii) Considering ocean dynamics with fully coupled models.

The roles of SST patterns and the stratosphere for the jet stream response to greenhouse gas forcing (Ceppi, Paulo A)

- In response to CO₂ forcing, poleward shifts of the circulation occur in less than 10 years. This is because of evolving patterns of SST warming. The “fast” warming pattern favors a poleward shift.
- Changes in subtropical precipitation follow the timescales of circulation shifts. This means that drying in Mediterranean-like regions tends to occur on a fast timescale.
- An exception is the Californian region, where the response to CO₂ is dominated by a slow equatorward shift and corresponding wetting.

3. Reports from CDP members

Understanding uncertainties in future projections of mid-latitude climate (Noel Keenlyside)

- Regional climate change exists huge uncertainties. To understand the processes that lead to them and find the way to reduce them is important to regional climate change projections.
- CMIP5 experiments proved a large uncertainty on the change of SLP in mid-latitude in response to global warming.
- AGCM experiments indicate a dominant role of (tropical) SST in driving the uncertainties, while SIC has a secondary impact. The experiments also show differences in the response to SST and SIC. The differences are particularly large over North America and Euro-Asia.
- Future key scientific questions of CDP
 - Finger prints of oceanic change; Connect synoptic scale to large scales; Cause of the signal-

to-noise issue, and implications.

- A to Q: Want to limit the ongoing experiments, use pragmatic force, combine other factors to look at another uncertainty pattern.

Global Mean Surface Temperature Response to Large-Scale Patterns of Variability in Observations and CMIP5 (Mat Collins)

- Adopt a physically-based method of separating internal variability from forced responses to examine how trends in large-scale patterns influence GMST.
- Slightly underestimate IPO trends >10 years, seriously underestimate AMV trends >20 years.
- The greater the IPO and AMV variability, the greater the imprint on the global mean.
- GMST trend distribution seems about right.
- Thoughts on future panel directions and activities:
 - Current panel interests quite diverse.
 - Decadal variability seems an obvious focus given the merging with DCVP and the CDP focus on inter-basin coupling
 - 'Regional' atmospheric variability and changes still seems a big gap personally.
- A to Q1: AMV is kind of true while at sort of 15-20 years, maybe the model variable has a large longer time scale, to take a multi-decal variability that the model suspect.
- A to Q 2: The AMO does have a sub-tropical signal in some models.

Decadal climate variability and predictability: relevance to the Climate Dynamics panel (Rym Msadek)

- DCVP is defined in coordination with the WCRP/WGSIP DCP, sharing membership but different research topic. Handover of the activities to CDP since it's sunset in March 2019.
- DCVP current state
 - AMV: Internal variability and external forcing in diving mechanisms, climate impacts, response to SPG and tropical part.
 - PDV: Complicate to understand and simulate PDV for its complex process.
 - Predictability: ADV can be predicted in some cases, but can't predict well on the onset of AMOC; PDV predictability is not very good as well, especially in the phase transitions
- Remaining challenges and relevance for CDP.
- Recommendations to CDP
 - Analyse existing experiments (CMIP6 externally-forced, Grand Ensembles of historical, CESM, DCP-C, UK Center).
 - Design new coordinated experiments.
 - Improve internal & external communications.

Forced decadal atmospheric variability revealed by a large ensemble AGCM experiment (Shoshiro Minobe)

- The forced decadal SLP mode is dominant over the tropical Pacific and Indian Oceans, characterized by SO like pattern accompanied by weak PNA and strong PSA teleconnections.
- Westerly wind anomalies in the western tropical Pacific and meridional mode in the central Pacific trigger this forced mode.
- Trans Eurasia teleconnection is important in Bidecadal North Pacific Oscillation.
- Q: Difference with the work of Newman (2016)?
- A: This analysis is different with Newman's work. Newman analyzed the SST, when consider SST the forcing which represented by fluxes associated with weather variation should be taken into account in an AR1 model. But if we look at the atmosphere, we don't need the preprocessing so the result can be got more directly.

Enhanced Oceanic Dynamical Control on Atlantic SST with Absence of Pacific mode Variability (Aixue Hu)

- Without Pacific mode variabilities, the AMO variability enhances on decadal timescale, but dramatically weakens on multi-decadal timescale
- This enhanced decadal AMO variability is closely linked to the strengthened decadal variability of Atlantic meridional overturning circulation, suggesting an enhanced oceanic dynamical control on the North Atlantic sea surface temperature variability.
- Further analysis indicates a weaker equatorial heating anomaly due to muted Pacific mode variability and a decoupling of Pacific North American teleconnection pattern and North Atlantic Oscillation, leading to a strengthened local air-sea coupling in the Atlantic and a stronger decadal AMO variability.

Northern hemisphere monsoon response to mid-Holocene orbital forcing and greenhouse gas-induced global warming (Simona Bordoni)

- In the future, land monsoons will be narrow and weaker than in the mid-Holocene.
- The moisture depletion associated to tropical circulation weakening will limit the further monsoonal rainfall increase with global warming
- The weakening of the tropical circulation represents therefore a constraint for future monsoon dynamics.
- The mid-Holocene is not an analogue of the future.
- A to Q: These are regional physical experiments that are available in the CMIP. Those are comprehensive simulation.

Recent Progress in the Framework Linking Energetics and Tropical Rainfall Distribution (Sarah Kang)

- Experiments perturbed by a cyclic thermal forcing with varying frequency (1-y, 5-y, 15-y) show that only multidecadal timescales extratropical forcing is able to shift the ITCZ.

- Recent fully coupled model studies implied that ITCZ is much less sensitive to extratropical forcing. Ekman balance is proposed to be a main oceanic mechanism for damping ITCZ shifts.
- The Ekman damping effect on ITCZ is limited due to its small gross stability. Instead, Oceanic damping effect arises from strengthening of AMOC/SO climatological circumpolar upwelling
- Even though the forcing is zonally uniform, the tropical SST has high spatial structure.
- Ongoing work on spatial pattern of tropical response to regional extratropical thermal forcing.
- Thoughts of how to better understand and predict tropical precipitation: Combine the theoretical pros on using hierarchical models.
- Q to A: In the experiments, the forcing is introduced abruptly. When you put forcing, usually you are introducing atmosphere strengthening at southern ocean on a synoptic scale.

4. Panel business

CDP direction

The frontline problems and techniques described in Collins et al. (2018 NCC) and those of DCVP are now form the scientific topics and techniques of CDP. Among the frontline problems, “Developing predictive theories of climate dynamics” is at a different level from other topics and overlapping with them, may be considered as overarching them. Thus, CDP’s research topics are

1. Response to external forcing of mid-latitude jets, storms and blocking
2. Basin-to-basin and tropical-extratropical teleconnections
3. Decadal variability and predictability

With techniques

1. High-resolution coupled modelling
2. Partial coupling and pacemaker experiments
3. Decadal predictability experiments
4. Complex diagnostics and simplified models

There was an opinion that decadal variability and predictability should not be limited to CDP. This is a reasonable and CDP will not monopolize it. On the other hand, in association with the request from SSG to CDP carrying on DCVP activities, it is important that CDP is positive for it.

Membership

Co-chairs suggested that a current co-chair Mat will step down and Noel will be the next co-chair, with Shoshiro will continue. This suggestion has been accepted.

Co-chairs explained that nine of 12 members term will end this year but for a better staggering of membership, about half of them may extend one year. In 2020, we will not have our panel meeting, and thus one-year extension does not make a big difference. Before the meeting, Shang-Ping, Elisa, Marcelo, Olga proposed to volunteer to step down and Yohai proposed that he is OK to step down or stay. In 2021, new members will gather in the panel meeting and will have face-to-face discussion.

Several names for new member candidates are suggested in the discussion. It is also emphasized that we should have a good gender and geographical balance including member(s) from the Southern Hemisphere.

The application deadline to the CLIVAR web page for new panel members is October 10. After that the current and new co-chairs (Mat, Shoshiro and Noel) will make a plan of new members and then share it with panel members.

Next year funding

In 2020, we do not have our panel meeting, and thus we can use CDP budget something else. Noel proposed that financial help for a workshop in Bergen in 2020 as CDP budget request to SSG and this proposal has been accepted.

Next panel meeting

Shoshiro proposed to have a joint workshop in Japan in April 2021 between CDP and recently funded Japanese project hotspot2 and to that workshop CDP panel meeting will be attached. The hotspot2 project focuses mid-latitude air-sea interaction, the timing is constrained by the fact that Japanese fiscal year starts from April and Hotspot2 is busy for observations in May-July. He also suggested organizing the Science Organizing Committee (SOC) including a few CDP members but this will be decided in future. The joint workshop proposal has been accepted.

Possible pan-WCRP activities, ANDEX, TPE & Greenland

The request from CLIVAR SSG co-chair about CDP involvement about possible WCRP-wide activities, ANDEX, TPE, and Greenland was discussed. It is argued that ANDEX and TPE are generally relevant to CDP. Aixue showed his interest in Greenland. In the email exchanges after the meeting, Aixue showed his second interesting to TPE, and Noel and Shoshiro suggested they can be involved to ANDEX and TPE, respectively.

5. AGENDA

CLIVAR Climate Dynamics Panel

4th Meeting, Mykonos, Greece, Oct. 4- Oct. 5 2019

Pelagos room in [St. John Hotel](http://www.saintjohn.gr/mykonos_conference_hotel/) , Agios Ioannis - 84600 Mykonos, Cyclades Islands Greece

https://www.saintjohn.gr/mykonos_conference_hotel/

October 4 (13:45-17:05): Science presentations and discussion.

13:45 -14:05 Overview of CFMIP (Masahiro Watanabe)

14:05 -14:25 Three-Stage Hadley Circulation Response to Extratropical Thermal Forcing (Yen-Ting Hwang)

14:25 -14:45 The roles of SST patterns and the stratosphere for the jet stream response to greenhouse gas forcing (Ceppi, Paulo A)

14:45 -15:00 Understanding uncertainties in future projections of mid-latitude climate (Noel Keenlyside)

15:00 -15:15 Global Mean Surface Temperature Response to Large-Scale Patterns of Variability in Observations and CMIP5 (Mat Collins)

15:15 -15:30 Decadal climate variability and predictability: relevance to the Climate Dynamics panel (Rym Msadek)

15:50 -16:05 Forced decadal atmospheric variability revealed by a large ensemble AGCM experiment (Shoshiro Minobe)

16:05 -16:20 Enhanced Oceanic Dynamical Control on Atlantic SST with Absence of Pacific mode Variability (Aixue Hu)

16:20 - 16:35 Northern hemisphere monsoon response to mid-Holocene orbital forcing and greenhouse gas-induced global warming (Simona Bordoni)

16:35 - 16:50 Recent Progress in the Framework Linking Energetics and Tropical Rainfall Distribution (Sarah Kang)

16:50 - 17:05 Discussion

October 5 (8:30-11:00): Panel Business

6. PARTICIPANTS

October 4 14:00-18:00:

CDP member

Mat Collins, Shoshiro Minobe, Rym Mdesak, Simona Bordoni, Sarah Kang, Aixue Hu, Noel Keenlyside,

CFMIP guests

Masahiro Watanabe, Yen-Ting Hwang, Paulo Ceppi

October 5: 9:00-11:00

CDP member

Mat Collins, Shoshiro Minobe, Rym Mdesak, Simona Bordoni, Sarah Kang, Aixue Hu, Noel Keenlyside.