

Report to CLIVAR SSG-20

Panel or Working Group: PAGES/CLIVAR

1. Contributions to developing CLIVAR science and fit, where appropriate, to the CLIVAR imperatives

Ocean 2K Initiative

Following a suggestion from the CLIVAR Scientific Steering Group (SSG) and a meeting of the PAGES 2k network leadership in Bern, July 2011, the PAGES Scientific Steering Committee (SSC) endorsed the formation of a ninth group focusing on the global oceans during the last 2,000 years (2K): Ocean2K.

Motivating this project is an interest in placing observed historical marine conditions into the context of climatic variation over the past 2,000 years.

An Ocean2k paleodata metadatabase (at ocean2k website) comprises paleodata spanning the past 2ka and climate simulations from the fifth Coupled Model Intercomparison Project (CMIP5) and the third Paleoclimate Modelling Intercomparison Project (PMIP3). These records have been gathered from publically accessible and citable sources. It is hoped that the ocean imprint of large-scale variations in processes such as the Atlantic meridional overturning circulation, annular mode activity, monsoon circulations, and El Niño-Southern Oscillation (ENSO) in the data and simulations. This metadatabase is available online at:

<http://www.pages-igbp.org/workinggroups/ocean2k/metadatabase>

A low resolution, first pass synthesis of marine sediment-derived SST records for the past 2 millennia was presented at the fall AGU meeting in 2012. For a full abstract visit <http://fallmeeting.agu.org/2012/scientific-program>. A high-resolution, first pass synthesis of continental-scale temperature reconstructions was also presented at the fall 2012 AGU meeting. For a full abstract visit <http://fallmeeting.agu.org/2012/scientific-program/>. A first pass synthesis of Atlantic SST proxy records during the past 2000 years and its potential links to AMOC variability was presented at the August 2012 AMOC Annual PI Meeting in Boulder Colorado.

At the outset of Ocean 2K a synthesis paper, based on the metadatabase, addressing two key Ocean2K questions:

- a. What are the principal patterns of variation in ocean properties observed in both paleodata and paleomodeling simulations forced with realistic external forcings?
- b. What are the most likely underlying mechanisms?

This is planned for submission in July 2014.

2. Briefly list any specific areas of your panel's activities that you think would contribute to the WCRP Grand Challenges as identified by the JSC at its most recent meeting¹

Provision of skillful future climate information on regional scales

- Development of methodologies relating model skills for paleoclimates to projections.
- Assessment of the magnitude of internal variability with respect to externally forced decadal to multi-decadal temperature variations

Cryospheric response to climate change

- Improving understanding of MOC variability.
- Development of methodologies to combine past and future climate simulations together with syntheses of paleoclimate data in order to constrain climate sensitivity

Improved understanding of the interactions of clouds, aerosols, precipitation, and radiation and their contributions to climate sensitivity

- Analysis of insights on climate sensibility based on past climate, based on model/data comparisons.

Past and future changes in water availability (with connections to water security and hydrological cycle)

- Improving understanding of past changes in water cycles including droughts and floods.

Science underpinning the prediction and attribution of extreme events

- Information from paleoclimate data and long (millennial) simulations on the recurrence of extreme events and relationships with external forcings.

3. Key new science findings in the context of the new ocean-atmosphere CLIVAR (1-3 suggestions)

Observations of a statistically-significant 'global' cooling trend in the marine sediment record over the past 2 millennia. This is qualitatively consistent with the SST cooling observed in realistically-forced AOGCM experiments, in which cooling partly arises from orbitally-induced variations in radiative flux.

Deconvolving AMO and weather regime influences on paleoclimate records (e.g. Greenland ice cores)

Marine sediment and coral proxy records in the Ocean2k metadatabase show SST variability that may reflect AMOC changes.

- High Resolution (annual) sedimentary Mg/Ca, alkenone (Uk37) and faunal assemblage proxy records (from the north and south Atlantic) show strong AMO-like variability during the 20th century. No significant 50-80 year

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1. Provision of skillful future climate information on regional scales (includes decadal and polar predictability)
2. Regional sea-level rise
3. Cryosphere response to climate change (including ice sheets, water resources, permafrost and carbon)
4. Improved understanding of the interactions of clouds, aerosols, precipitation, and radiation and their contributions to climate sensitivity
5. Past and future changes in water availability (with connections to water security and hydrological cycle)
6. Science underpinning the prediction and attribution of extreme events

cycles are apparent earlier in the record but 10-20 year periods appear more persistent.

- Low Resolution (decadal-centennial) coral and sclerosponge Ca/Sr and $\delta^{18}\text{O}$ proxy records from the Atlantic (primarily the Caribbean) show cooling throughout the past 2 millennia and the dipole index can be interpreted as AMOC weakening. These results do not seem sensitive to location of proxy records

4. Key science questions that you anticipate your community would want to tackle in the next 5-10 years within the context of the new ocean-atmosphere CLIVAR (1-3 suggestions)

A number of key scientific issues have been identified by the working group and will be addressed by the intersection over the coming years.

1. Forward modeling of proxy data

Reducing uncertainties in proxy reconstructions (and data synthesis in general) are important for improving climate modeling targets and for understanding the intrinsic variability and forced response of the climate system.

2. Calibration of proxies against variability seen in the instrumental period

Is a pre-requisite for improved synthesis of proxy- and observation-based approaches and requires interaction between paleoclimatologists and climatologists.

3. Regional climate variability

Well-dated, high-resolution proxy reconstructions and model simulations incorporating estimates of natural and anthropogenic forcings for the last 2 ka offer opportunities to assess the natural decadal- to centennial-variability and forced responses in conditions similar to present.

The two relevant emerging activities are PMIP PAST2FUTURE and PMIP 2k. These aim to strengthen the use of past climate simulations and data syntheses to inform projections, and to extend coordinated model inter-comparisons for the last 2 millennia (especially because the first millennium is associated with a distinct conjunction of solar and volcanic forcing compared to the last millennium).

5. North Atlantic circulation changes

Interactions among the ocean, atmosphere, and sea ice are the likely cause of decadal-multi- decadal and centennial variability in the Atlantic meridional overturning circulation (MOC), with attendant impacts on spatial patterns of temperature and precipitation. Thus improved understanding of MOC variability may serve to improve the climate projections in these regions.

6. Cooperation with other WCRP projects, other global change bodies (e.g. IGBP) and links to applications

The CLIVAR-PAGES Working Group is an intersection between WCRP CLIVAR and IGBP PAGES.

7. Activities in the context of scientific capacity building and career support?

Martin Visbeck presented some aspects of CLIVAR science at the PAGES AGM in Goa (Feb 2013). His presentation entitled, 'Selected topics on ocean dynamics in the wider context of climate variability and global sustainability' highlighted the rich spectrum of ocean dynamics needing to be considered when estimating changes in regional ocean heat uptake, CO2 budgets, and possibly even more for estimates of future ocean acidification, freshwater budgets and associated changes in subpolar stratification. He concluded that the complexity of the challenge demands large-scale coordination of ocean observations, research activities, and efforts to inform the public on sustainability issues in the marine realm.

8. Activities in the context of knowledge exchange with societal actors?

Cross interests of historians and archeologists on past climates.

9. New activities being planned, including timeline, request for endorsements, potential for new funding opportunities

Continuation of the Ocean 2K initiative.

PMIP PAST2FUTURE and PMIP2k (see above, point 4) would benefit from CLIVAR endorsement under the umbrella of PAGES CLIVAR as well as enrollment of CLIVAR scientists)

10. Workshops / meetings planned

PMIP2k, October 2014.

Joint workshop between the PAGES 2K network of PAGES and the PAST2K working group of PMIP (Paleoclimate Model Intercomparison Project) November 4-6, 2013 at Universidad Complutense de Madrid, Spain

11. Issues for the SSG

Note that we are in the process of rotating PAGES/CLIVAR chairs.

The PAGES SSC at its February meeting had spared CLIVAR/PAGES a bit from the discussions, recognizing that Gavin Schmidt is fading out as co-chair and Valerie busy with IPCC. From our side it was decided to pick up momentum after September again. This should probably include a panel meeting in order to get action on its way and a new co-chair assigned. Such a meeting could potentially be held alongside one of the workshops or conferences.

Annex A

Proforma for CLIVAR Panel and Working Group requests for SSG approval for meetings

Requests should be made through D/ICPO (rogbar@noc.ac.uk), against the following headings:

- 1. Panel or Working Group:**
- 2. Title of meeting or workshop:**
- 3. Proposed venue:**
- 4. Proposed dates:**
- 5. Proposed attendees, including likely number:**
- 6. Rationale, motivation and justification, including: relevance to CLIVAR themes & JSC cross cutting topics and any cross-panel/working group links and interactions involved:**
- 7. Specific objectives and key agenda items:**
- 8. Anticipated outcomes (deliverables):**
- 9. Format:**
- 10. Science Organising Committee (if relevant)**
- 11. Local Organising Committee (if relevant)**
- 12. Proposed funding sources and anticipated funding requested from WCRP:**