

Workshop summary - Climate variability in Antarctica and the Southern Hemisphere over the past 2000 years (CLIVASH 2k).

The first CLIVASH 2k workshop was held on Monday 18<sup>th</sup> June, prior to the POLAR2018 open science conference in Davos, Switzerland. The meeting was attended by over thirty participants from fourteen nations, specialising in a range of paleoclimate archives and modelling.

The session was started by Liz Thomas and Barbara Stenni providing an overview of the Antarctica 2k project and outlining the goals of CLIVASH2k. Thomas Bracegirdle provided an update on the AntClim21 workshop and the importance of paleo data for future climate predictions.

Quentin Dalaiden presented some new work on *“Antarctic temperature and surface mass balance in models and observations during the past millennium”* demonstrating how modelling groups are using paleoclimate data collected as part of Antarctica2k. The group then broke for a discussion on *“How can we make paleoclimate data better suited for climate modellers?”* chaired by Thomas Bracegirdle and Hugues Goose.

Summary of discussion points:

- Discussion on the use of low-resolution records
  - Records from the sub-Antarctica are lower resolution and not as clear as ice cores in what they represent. Can the models cope with qualitative data?
  - Sub-Antarctic an important target area for CLIVASH2k, especially wind reconstructions. Records from source of winds, not just north or south of wind belt.
  - Peat records lower resolution but capture important changes at low elevations
- Don't worry about reconstructing SAM index, its winds over a specific region that are important.
  - SAM not always correlated with westerlies.
  - Regional differences in SAM and westerlies
- Suggestions to work with ISO2K group.
  - Comparison between using high and low resolution isotope data from ice cores and corals
- Modellers need:
  - clear targets
  - error estimates
  - description of how your proxy relates to westerly winds / climate parameters
  - difficult to work with qualitative but possible for some models/ modelling groups
  - need larger signal than noise
- Resolution not always a problems, decadal is fine and possible to run centennial and decadal comparisons with 1000 year runs
  - The important issue is accuracy of the dating.
  - Even with dating uncertainty a trend can still be useful
- Important to be clear from the start what data is suitable to avoid disappointment later

- Examples from previous reconstructions where lower resolution records were not used
- Conclusions – if you have an interesting conclusion or finding in your paper then it should be possible to model it.

Bianca Perren continued with the theme of low resolution records in an “*Overview of terrestrial records*”, summarising the available data from the sub-Antarctic region. She highlighted the different proxies and the challenge in their interpretation, concluding that there is little coordination between records. Raphael Neukom presented his experience on “*Multi-proxy integrations*” with some examples of the reconstructions from PAGES. Most methods not designed to incorporate low resolution records but there are hybrid approaches which could prove useful to this group. The second discussion was chaired by Bianca Perren & Raphael Neukom on “How can we combine high and low resolution records?”

Summary of discussion points:

- More records reduce error
  - For example current reconstructions biased towards South America overshadowing Indian Ocean. Thus even low resolution records are important
- Suggestions for dating uncertainty
  - Set more radio carbon dates
  - Criteria (eg 1 date per 500 years)
  - Monte Carlo testing to assess dating uncertainties
- Data assimilation can deal with complex records (not just temperature) but they need to be clear on how they relate to physical variables
  - Add estimates of percentage eg 50% climate, 50% biological
- CLIVASH2K a good platform for coordinating terrestrial records
- Lots of proxies relating to circulations
  - Ice cores, lake, peat, marine
  - Disentangle salt spray from circulation and precipitation
  - Different from other PAGES reconstructions
- PAIS workshop plan to review what proxies can tell us about circulation
  - Invite for people to contribute (Vincent Favier)
- Marine records cover the past 2000 years
  - Adelie Land, Antarctic Peninsula, Ross Sea
  - Models can help guide the marine collections to sensitive regions
- Reminder that we need to be clear on our science questions
  - What are the aims before what data do we have/ need
- Ideas for important regions
  - ASL, sub-Antarctica
  - Location of high resolution marine records to link with ice cores?
- Suggestion to link ice cores and marine records
  - Focus on sea ice/ primary productivity / linkages

We heard from Vincent Favier on “*Antarctic Surface Mass Balance*” who highlighted the process so far and how the changes in SMB are related to temperature, atmospheric circulation and sea ice. Therefore it is important that we incorporate proxies from land and ocean to capture changes and the importance of teleconnections. Johan Etourneau summarized “*Marine records and IODP*”, highlighting the increasing number of marine records that cover the past 2000 years.

The final discussion session was chaired by Vincent Favier & Johan Etourneau “Which region? *Can we identify regions where climate variability signals or responses are better expressed?*”

Summary from Vincent:

Barbara Stenni : Antarctica2k was mainly dedicated to ice cores, and it is clearly crucial to include marine and terrestrial data. IODP has already a distribution system but not necessarily available and in the way people would like to see data for CLIVASH2K.

**Potential other interest:**

Discussion on the interest of studying katabatic winds due to their potential link with polynyas. Katabatic winds cause large impact on ice core signal due to post depositional processes. However, katabatic winds are visible in RCM, but not visible in GCM; and the polynyas located far from the ice cap are not related to these winds.

Snowdrift is observed at the coast is very windy (with katabatic winds) and is not necessarily a great area to study marine information. Sediment cores, marine data are clearly more adapted to study the variability at the ice sheet margin. Deep sea drilling should also be included and PAIS has an interest in supporting that. They would allow getting very good information on the strength of currents.

In Adelie basin there is a sediment core with high resolution data over the Holocene, but the amount of data in the Antarctic margin is very low. Conversely, there exists cores close to the islands in the sub-antarctics and these are thus of interest. A review is necessary to know exactly what is really available. The concerns the type of information, distribution, resolution. It should be necessary to assess which data are consistent with ice core data. There is also an interest in the inclusion of new proxies in the Antarctica2k data base such as d-excess and sodium, or more generally chemistry... However, getting a database only, is not the only product required here. There is a clear interest in expert evaluation of the data.

**Key question: where are the hot-spots? WAIS + Peninsula? Weddell Sea sector? Indian Ocean?**

What is the spatial representativeness of marine sediment cores? Each basin has its own topography, glacier margin?

In order to define different areas of representativeness, something like what Michiel van den Broeke did for temperature on the continent in Pages2K should be done with proxies from marine sediment cores. Areas may be very different according to the proxy, may be different between atmosphere / ocean. One default of the approach here is that the SIE is not a continuously varying proxy (is present or not) and correlation is then not an accurate way to define areas.

These areas will differ according to the timescale we will use for the analysis.

If we want to study teleconnections it is important to keep areas connected with the region where the variability is originating. For instance, in the case of with ENSO, DML should not be disconnected from the Pacific.

The final discussion turned to future planning and activities.

The group were invited to attend the follow-up workshop hosted at the British Antarctic Survey (4<sup>th</sup> – 5<sup>th</sup> September, 2018).

One of the main objectives will be data collection. For this task we need to get people involved and convinced on the attractiveness of the product. PAIS is interested in helping the group with funds to trigger the networking. SCAR grants for scientists.

We propose to write a review (or 2) on different topics. 1. Westerlies (intensity and location), 2. SIE? But the topics are not strictly defined yet.

Several people showed their interest in contributing to this exercise and taking an active role in setting the programme for the September meeting:

Bianca Perren and Zicheng Yu = lead a review on terrestrial records,

Julie Jones = keen to work on regional reconstructions, especially relent to the ASL

Holly Winton = volunteered to help coordinate ice core records

Hugues Goose and Quentin Dalaiden = link to the modelling community

Vincent Favier = regional scale aspects and mid-latitude glaciers aspects

Johan Etourneau = Coordinate marine records and contribute to review of available records