PROXY CALIBRATION AND EVALUATION

ISTAS workshop session :

Paleo-reconstruction and biological archives: decade to millenium

Authors

Kirstin Werner (werner.192@osu.edu)[1], Juliane Müller[2], Anna Pienkowski[3], Christian März[4], Matt O'Regan[5] and Katharine Hendry[5]

Overview

Marine sediment cores from the Arctic Ocean hold essential environmental information beyond the period of historical and observational data acquisition. Climate and oceanographic changes in the past can be elucidated by studying indirect or proxy climate indicators ('proxies'). These proxies include fossilized benthic or planktic organisms, preserved biomarkers, organic matter, or lithic particles transported by either ice or ocean currents, and provide knowledge on environmental conditions in the past Arctic Ocean.

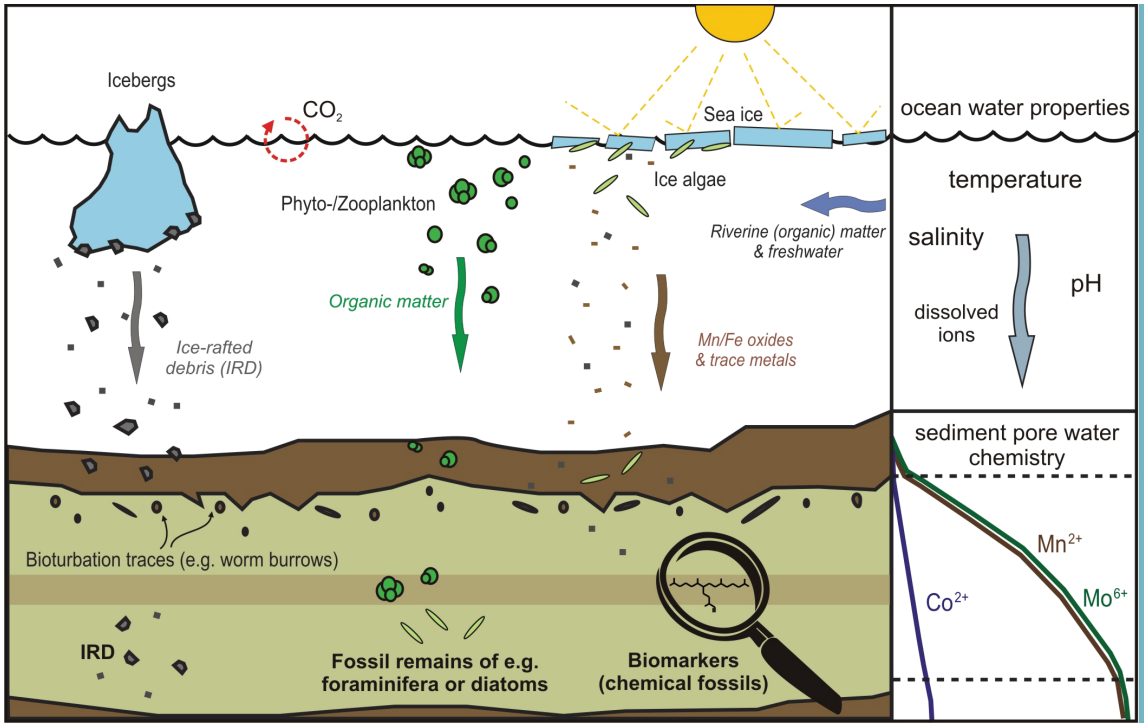

Fig. 1. Scheme for proxies used in geological reconstructions of the Arctic. Ocean (Illustration Christian März, Juliane Müller).

Accurate calibration of modern oceanographic parameters to specific proxies is crucial to apply them to sediment records for environmental conditions (see ART priorities 'Paleoceanographic Time Series'). Uncertainties often arise from imperfect understanding of the detailed response of a proxy to its environment. Novel proxies are not yet sufficiently studied in the (sub-)Arctic seas, and thus suffer from somewhat poor calibrations. Existing proxy calibrations are very useful, but often fragmented and temporally and/or spatially biased.

Improved proxy-to-environment calibrations are needed in the (sub-)Arctic oceans to understand how different aspects of the Arctic changed in the past, and will potentially change in the future. We suggest close collaboration between geoscientists, oceangraphers, biologists and modellers (see also other ART priorities) to focus on key aspects of proxy calibration studies in the Arctic Ocean.

The ISTAS interdisciplinary and international workshop (Integrating spatial and temporal scales in the changing Arctic System: towards future research priorities) was organized in October 2014 by the Arctic in Rapid Transition (ART) network at the IUEM in Plouzané, France. The overarching objective of the workshop was to bring together Arctic scientists of different areas of expertise and experience level in order to discuss future research priorities for the Arctic Ocean and adjacent coasts from an early and mid career researchers' perspective. This set of priority sheets summarizing the workshop's discussions is one of the contributions of the ART network to the 3rd International Conference on Arctic Research Planning (ICARP III) in Japan.

PROXY CALIBRATION AND EVALUATION

RESEARCH PRIORITIES
APPROACHES AND RECOMMENDATIONS

▶ Evaluation and calibration of existing proxy climate indicators

- Quantitatively assess past environmental conditions (temperature, salinity, sea ice, freshwater input, current regime etc.) in the (sub-)Arctic oceans
- Obtain high-quality sample material (from sea surface, water column, and sea floor) more systematically to improve spatial and temporal coverage

▶ Development of new proxies

- Develop reliable proxy methods to track changes in environmental conditions (water mass stratification, ocean acidification, fresh-water budget, bioproductivity etc.)
- Bridge the gap between modern Arctic environmental data and related proxies in sediment records

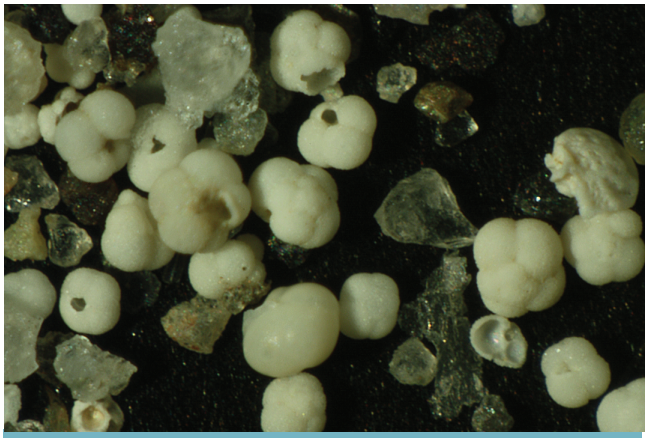

Fig. 2: A marine sediment sample from a sediment core in eastern Fram Strait as viewed under a stereo microscope. Planktic and benthic foraminifera (whitish, round) as well as lithic particles transported by sea ice are visible (Photo Kirstin Werner).

▶ Assessment of seasonal cycles in Arctic Ocean bioproductivity and nutrient cycling

- Focus on seasonal population changes in sediment records (different size fractions of microfossils, different biomarkers etc.)
- Distingiush between annual and seasonal signals in sub-recent sediments by comparing with sediment trap studies

▶ Quantitative assessment of organic and inorganic matter fluxes

- Determine loss and alteration of organic matter during its transport through the water column with sediment trap studies
- Evaluate the impact of sea-ice distribution and current patterns on transport and export fluxes of organic and inorganic matter
- Assess organic and inorganic proxy preservation and diagenetic overprint using pore water analyses and modelling

Summary

- Evaluation and calibration of **existing proxies** for a quantitative assessment of past environmental conditions (temperature, salinity, sea ice etc.);
- Development of **new proxies** (e.g., for stratification, ocean acidification) by adopting reliable methods to track present-day changes in water mass properties;
- Assessment of **seasonal cycles** in Arctic Ocean productivity to distinguish between annual and seasonal signals of microfossil records;
- Quantitative assessment of **particle fluxes** to the sea floor, and potential impact of sea ice or ocean currents on particle transport and accumulation;
- Quantitative **verification** of climate proxies and evaluation of environmental relationships to improve quantitative estimates of past environmental parameters.

Affiliations:
[1] Byrd Polar and Climate Research Center, USA
[2] Alfred Wegener Institute, Germany
[3] School of Ocean Sciences, Bangor University, UK
[4] School of Civil Engineering and Geosciences, Newcastle University, UK
[5] Department of Geological Sciences, Stockholm University, Sweden
[6] School of Earth Sciences, University of Bristol, UK

Contributors:
Natalia Barrientos, Martin Bartels, Dayton Dove, Nikolai Pedentchouk