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.

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, often geochemical proxies are not yet sufficiently studied in the (sub-)Arctic seas, and thus suffer from partly poor calibrations. Existing proxy calibrations are very useful, but often fragmentary and temporally/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. We suggest close collaboration between geoscientists, oceanographers, biologists, and modellers to focus on key aspects of proxy calibration studies in the Arctic Ocean.
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 current changes in environmental conditions (water mass stratification, ocean acidification, freshwater budget, bioproductivity etc.)
- Bridge the gap between modern Arctic environmental data and related proxies in sediment records

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.)
- Distinguish 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

Keywords
- 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 current 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

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