The changing Arctic and Subarctic environment: proxy- and model-based reconstructions of Holocene climate variability in the northern North Atlantic : Preface

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Preface

"The changing Arctic and Subarctic environment: proxy- and model-based reconstructions of Holocene climate variability in the northern North Atlantic"

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This special issue originates from the EU FP7-Marie Curie initiative "CASE" (The Changing Arctic and Subarctic Environment), an Initial Training Network (ITN) on marine biotic indicators of recent climate changes in the high latitudes of the North Atlantic (http://caseitn.epoc.u-bordeaux1.fr/).

This four-year project (April 2010–March 2014) implemented multidisciplinary research initiatives aiming at assembling palaeoclimate data from the Holocene through recent field programmes in the Nordic Seas, and at integrating palaeoclimate information with modern biological and climate modelling data. Associated objectives were to recruit and train a new generation of European polar scientists with expertise on the Nordic Seas, and to develop a network of European experts in polar research to build structures focused on long-term collaboration in Arctic science.

Together with the Arctic Ocean, the Nordic Seas and the Barents Sea have shown unprecedented changes in physical and chemical conditions in recent decades, which directly influence the ecosystem structure and processes. The extreme sensitivity of the northern North Atlantic to climate changes is related to the intricate connection, within this oceanic realm, of cryospheric (ice sheets and sea ice), atmospheric (winds related to strong gradients in sea-level pressures), and oceanic processes (through the opposing poleward flow of Atlantic water and southward flow of polar waters). The recent decline in seasonal sea ice extent is of particular concern as it modulates the reflection of incoming solar radiation, and influences the exchanges of heat and moisture between the surface ocean and the atmosphere. Moreover, sea ice also plays a central role in the efficiency of shelf (brines) and deep ocean convection processes, thus influencing the climate on a global scale.

Decadal to millennial scale reconstructions of Holocene climate and environments from archives, such as marine sediment cores, and from palaeoclimate modelling hold keys to a better evaluation of the magnitude and implications of the ongoing warming with regard to the full range natural variability of the climate system.

This special issue addresses some of the key questions raised by the CASE project and related to the present polar amplification of climate change:

- Is the present global warming and its amplification in the Arctic and Subarctic domains a unique event on the scale of the Earth recent history (last 10 000 years)?
- How do past decadal- to centennial-scale natural climate changes, as recorded in marine sediments and ice cores, stand in the context of the present human-induced modulation of climate?
- How did Holocene variability in key physical elements affect the structure and diversity of the planktonic ecosystem in the Arctic and Subarctic domains?

The development of micropalaeontological and/or lithogenic proxies of ocean circulation and/or drift-ice origin and amount are the subject of ongoing efforts in order to get closer to a quantified reconstruction of changes in the nature of water masses and of ice-flow drainage patterns. This

topic is addressed by Milzer et al. (2014) and Müller and Knies (2013) from the investigation of surface sediments in the local settings of a central Norwegian fjord and of the Spitsbergen continental margin, respectively.

Not only *atmospheric processes* exert a strong influence on the dynamics of the surface and sub-surface flows of the eastern and western boundary currents of the Nordic Seas (Norwegian Atlantic Current and East Greenland Current, respectively), but they also explain to a high extent the variability in sea-ice export from the Arctic Ocean through the Fram Strait corridor. Results presented in this special issue suggest that recent (last 2 to 3 kyr) changes in North Atlantic Oscillation patterns might be involved into the reconstructed variability of drift-ice transport across the Denmark Strait (Andrews and Jennings, 2014) and of the poleward flow of Atlantic Water along the eastern Nordic Seas (Dylmer et al., 2013). In addition, palaeo-climate modelling experiments interpret the unexpected combination of decreasing export of Arctic sea ice but increasing sea-ice production over the Siberian shelf during the early Holocene as a result of a weakened polar vortex and an associated decrease of zonality in the Nordic Seas pressure regime (Blaschek and Renssen, 2013).

The *western Barents Sea margin* is an hydrologically complex frontal domain where high frequency changes in open and ice-bearing ocean conditions are related to rapid changes in the regional Holocene climate and ocean circulation. Foraminiferal assemblages, stable isotopes, and biomarkers records from an extended Holocene sedimentary section collected in a relatively deep Barents Sea trough provide a unique history of both the surface/sub-surface (Berben et al., 2014) and deep (Groot et al., 2014) expressions of the poleward flow of Atlantic water since the last deglaciation. Modelling of primary productivity on the western Barents Sea shelf highlights the effect of variable sea-ice coverage as a consequence of Holocene climate change revealed on the overall organic carbon storage capacity of Arctic shelves (Pathirana et al., 2014).

The Greenland Sea is, together with the Labrador Sea, one of the key oceanic domains where *deep ocean convection* takes place. Telesiński et al. (2014) reconstruct centennial to millennial scale changes in the rate of overturning circulation since the late glacial times from central and northern Greenland Sea basin proxy data records. They show a more complex pattern than initially thought, as a response to the complex interplay between the Atlantic and Polar water masses and the rate of sea-ice formation and melting.

All original research papers included in this special issue are co-authored by members of the 6 CASE partner institutions which constitute the ITN Network (EPOC at University Bordeaux/CNRS; Geological Survey of Norway – NGU Trondheim; University of Tromsø; VU University Amsterdam; University of Plymouth; and GEOMAR Helmholtz Centre for Ocean Research) as well as by actively collaborating research groups (INSTAAR and Department of Geological Sciences at University of Colorado; GEOTOP University of Québec at Montréal). Most contributions are first-authored by early stage researchers recruited within the framework of CASE, which is supported by the European Community's 7th Framework Programme FP7 2007/2013, Marie-Curie Actions, under grant agreement no. 238111.

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