August sea surface temperature (aSST) record based on fossil diatom assemblages and transfer function is generated from a 2800-year-long marine sediment core Rapid 21-COM from the Iceland Basin, in the northern subpolar North Atlantic (Miettinen et al. 2012). The record has a resolution of 2–10 years for interval 800–2004 CE representing the highest-resolution diatom SST reconstruction from the subpolar North Atlantic for this period, and for 40 years for interval 300 BCE–800 CE. The record is compiled with the high-resolution aSST record from core CR004E/2011 from the Voring Plateau, in the Norwegian Sea (Berner et al. 2011), to explore the variability of the aSST gradient between these areas during the late Holocene.

2. Material and methods

The composite marine sediment core Rapid 21-COM consists of the 54.3 cm long box-core Rapid 21-C and the 372.5 cm long eastern core Rapid 21-3K recovered from the Iceland Basin (17°27'SN, 27°19'30'W) in 2004. The age model for the core is based on AMS ¹³C and ¹⁴C dates (Buesseler et al. 2007; Sere et al. 2011). The age model for the composite core CR948/2011 from the Voring Plateau (65°58.18'N, 07°38.36'W) is based on AMS ¹³C and ¹⁴C dates (Berner et al. 2011).

A modern training set consisting of 139 surface samples with 52 marine planktonic diatom species from the Nordic Seas and the North Atlantic (Andersen et al. 2004) was utilized to convert downcore diatom counts to quantitative SST using the weighted averaging partial least squares (WA-PLS) transfer function method (ter Braak and Juggins 1993). Significance of Crossings of the Derivative (Chardhuri and Marron 1999) was used to explore significant features in the reconstructed aSST record at different scales. The Wavelet coherence analysis (Torrence and Compo 1998) was used to examine relationships between the pairs of time series on different timescales, and the wavelet transform based technique was applied for band-pass filtering and visualization of the quasi-periodic behavior of the analyzed records (Torrence and Compo 1998).

3. Results

The reconstructed aSST record for core Rapid 21-COM from the northern subpolar North Atlantic indicates a warming trend of ~1 °C of the surface waters during the last 2800 years. The record shows total aSST range from 11.9 to 14.3 °C and the mean SST of 13.2 °C.

The aSST difference (temperature gradient) dSST between the two cores varies between 0.1 and 3.6 °C demonstrating a pronounced multumillennial variation which is statistically significant in the bands of 200–450 and 640–960 years. The highest gradients (>2.4 °C) occur 300 BCE–0 CE and 600–900 years. The record level of ~3.6 °C attained as late as in the 19 century before the cumulative warming trend of ~1 °C since 1850 CE (Barnola et al. 1979; Schilt et al. 2013) and the LIA (ca. 1500–1850 CE; D’Arrigo and Jacoby 2002). The aSST gradient shows nearly anti-phase variations for reconstructed aSST in the scale of 640–950 years.

In order to isolate statistically significant variations in the bands of 200–450 and 640–960 years detected in the aSST records, the signals were band-pass filtered in the respective frequency ranges. Results show nearly anti-phase variations for reconstructed aSST in the scale of 640–950 years.

The aSST records for core Rapid 21-COM from the subpolar North Atlantic and for core CR948/2011 from the Norwegian Sea show multicentennial and sub-millennial scale variability at the time scales of about 640–960 years, and multumillennial variability at the shorter time-scales from ~200 to 450 years (especially before 150 AD).

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4. Conclusions

- The aSST records from the Iceland Basin and the Voring Plateau show persistent opposite climate trends toward warming in the northern subpolar North Atlantic and cooling in the Norwegian Sea during the late Holocene.
- At the multumillennial scale of aSST variability (600–900 years), the records are nearly in antiphase with warm (colder) periods in the subpolar North Atlantic corresponding to the colder (warmer) periods in the Norwegian Sea.
- At the shorter time scale (200–450 years), the records display a phase-locked behavior with a tendency for the positive aSST anomalies in the Norwegian Sea to lead by ca. 30 years the negative aSST anomalies in the subpolar North Atlantic.
- This apparent tendency to coherent antiphased aSST variations implies an aSST seesaw between the northern subpolar North Atlantic and the Norwegian Sea.
- This aSST seesaw might have had a strong effect on two major climate anomalies (MWP and LIA) in the northwest Europe during the past Millennium.
- Coupled changes in aSST between the subpolar North Atlantic and the Norwegian Sea indicate common driving forces behind the observed variability.
- The observed aSST seesaw could be a surface expression of the variability of the eastern and western branches of the Atlantic meridional overturning circulation (AMOC) and North Atlantic Current (NAC) in the subpolar North Atlantic with a possible amplification through atmospheric feedback.