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Sea surface temperature development and sea-ice variability in the NW-Pacific and its marginal seas during the past 15.000 years

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1 Objectives

The German-Russian multidisciplinary project KALMAR aims at investigating the climate-affecting system "Kurile Kamchatka-Aleutean arc" with its adjacent marine parts in the NW-Pacific and marginal seas. This study as part of KALMAR, focuses on detailed reconstructions of late Pleistocene to Holocene changes in oceanographic conditions and climate development in the NW-Pacific.

3 Methods

Sediment records from the far NW-Pacific and its marginal seas were used to reconstruct past sea surface temperatures (SST) by alkenone -paleothermometry ($U^{K'}_{37}$; after *Müller et al.,* 1998). Qualitative measurements of the IP_{25} biomarker were applied at selected time intervals (cold stadials: H1 and YD; warm stages: B/A and early Holocene) from all available core-sites to estimate past changes in sea-ice cover in the study area. Additionally, diatom-assemblage studies obtained from high-resolution record SO201-2-12KL were compared to the qualtitative results of sea-ice distribution. The age models from this study are based on AMS ^{14}C ages in combination with inter-core correlation of investigated sediment records via core-logging data derived from high-resolution XRF measurements.

2 Study area

The bathymetric chart (Figure 1) on the right hand shows the the subarctic North Pacific, the Sea of Okhotsk (left) and Bering Sea (top), together with core sites from this study (blue, red and brown spot) and published records (purple and black spot) mentioned in the context. In general, surface currents follows a cyclonic pattern. Warm Pacific surface water is carried by the Alaskan Stream to the study area, which enters the Bering Sea from the south. The Bering Slope Current (BSC) develops, is reflected to the west and leaves the Bering Sea via the East Kamchatka Current (EKC), which connects the Bering Sea with the Sea of Okhotsk.

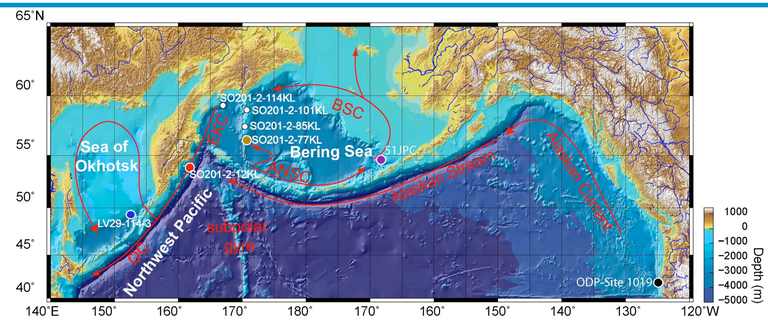

Figure 1: Bathymetric chart of the North Pacific. Core sites are marked by filled spots. Surface circulation is indicated by red arrows (modified after *Stabeno et al.,* 1999).

Results 4

SST reconstructions:

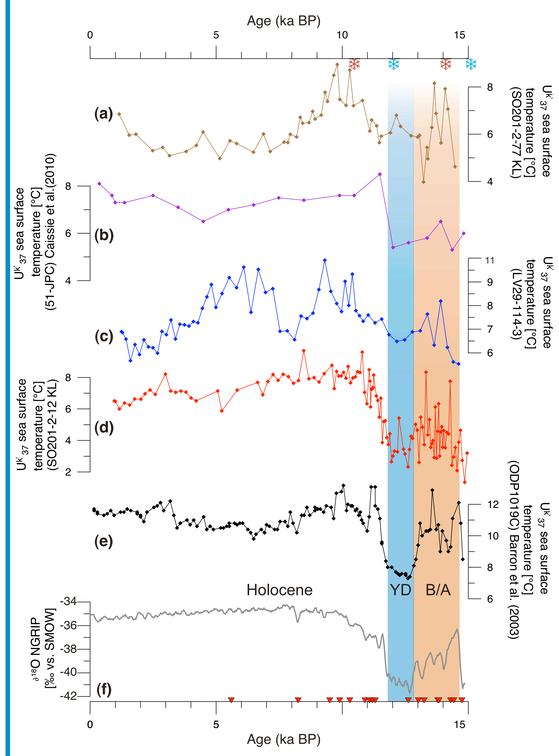

Figure 2: Alkenone-based SST reconstructions from (a) western Bering Sea (this study) (b) eastern Bering Sea (c) Sea of Okhotsk (this study) (d) NW-Pacific (this study) and (e) NE-Pacific compared with the NGRIP isotope record. Red triangles mark age-control points (^{14}C datings), snowflakes on top indicate intervals of IP_{25} measurements (red snowflake = no IP_{25} in the sample; blue snowflake = IP_{25} found in the sample).

Sea-ice variability:

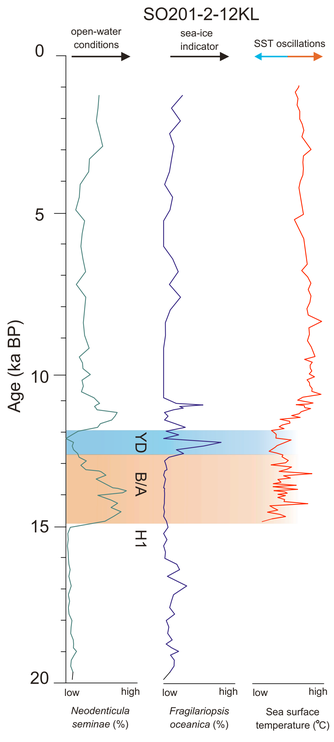

Figure 3: Diatom record from SO201-2-12 KL, Neodenticula seminae (%) given in green and Fragilariopsis oceanica (%) in blue compared with SST reconstructions (in red).

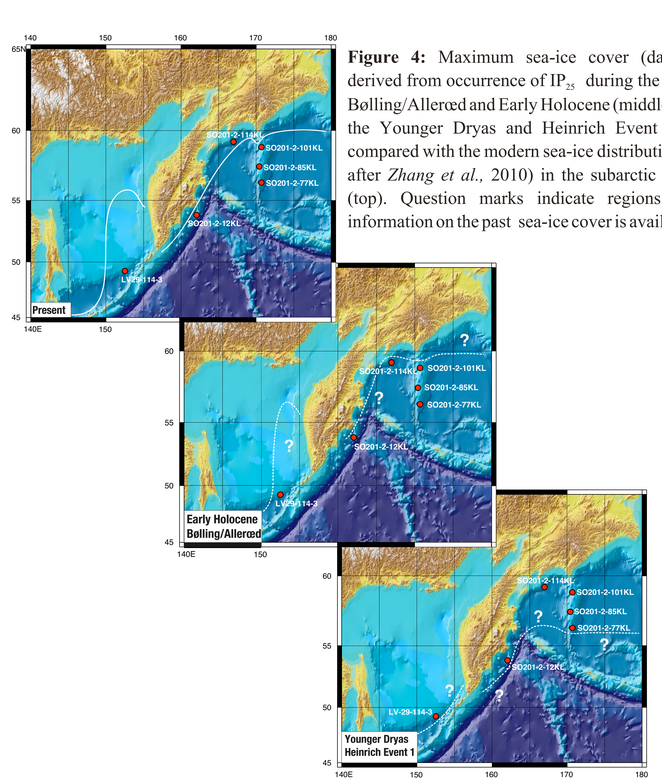

Figure 4: Maximum sea-ice cover (dashed lines) derived from occurrence of IP_{25} during the times of the Bølling/Allerœd and Early Holocene (middle), as well as the Younger Dryas and Heinrich Event 1 (bottom) compared with the modern sea-ice distribution (redrawn after *Zhang et al.,* 2010) in the subarctic NW-Pacific (top). Question marks indicate regions where no information on the past sea-ice cover is available.

5 Conclusions

SST development in the subarctic Pacific:

- **SST development in the subarctic NW-Pacific is characterized by millennial-scale oscillations during the last glacial termination.**
- **Reconstructed temperatures indicate deglacial rise in SST at ca. 14.3 ka BP (B/A), followed by a cold spell at ca. 12.8 ka BP (YD) and peak temperatures at the onset of the Holocene (ca. 10.5 ka BP).**
- **The deglacial SST pattern shows remarable similarities between the subarctic NW-Pacific and its marginal seas the NE-Pacific and even the Greenland temperature record and suggests rapid (atmospheric?) teleconnections between the North Atlantic and North Pacific realm.**

Sea-ice variability during the last deglaciation:

- **Strong variability in sea-ice cover is indicated by qualitative results of the IP_{25} biomarker and further supported by diatom assemblage studies in the subarctic NW-Pacific and its marginal seas.**
- **This results suggests, that the sea-ice boundary strongly oscillated. During H1 and the YD sea-ice reached far more to the South (several hundred miles in the western Bering Sea!) and covered vast areas of the region.**
- **In contrast, warm phases (B/A and early Holocene) are associated with a strongly reduced sea-ice cover. In comparison with warm temperatures indicated by alkenone-paleothermometry during the warm phases in the NW-Pacific, these results further point to a rapid signal propagation of climate fluctuations between the subarctic North Pacific and North Atlantic (atmospheric teleconnections?).**

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