**Supplemental Table Captions**

**Table S1.** Geochemical proxies for SST reconstructions, their limitations, and adjustments made to the original datasets for inclusion in this study.

**Supplemental Figure Captions**

**Figure S1**. Example and schematic of regional corrections for δ18Oseawater for sites without constrained δ18Oseawater. This example is from the Bering Sea and shows a) the generalized calcite temperature relationship from Shackleton (1974) with variables color-coded as the plots below. From tie site U1340 b) δ18Ocalcite and Uk’37 temperature records are used to generate a δ18Oseawater curve for U1340. Global ice volume and ice volume corrected δ18Oseawater-ice are shown as an inset to demonstrate the relative influences of sea ice and salinity on δ18Oseawater. Note that this distinction is not made in the following corrections for δ18Oseawater. The δ18Oseawater record can then be used along with δ18Ocalcite at neighboring target sites to solve for temperature (δ18Otemp), as shown for c) HLY02-02-3JPC.

**Figure S2.** Comparison of the δ18Oseawater curves at U1340 (Bering Sea), GGC-15 (Sea of Okhotsk), and MD01-2420 (Western Pacific), after being corrected for global ice volume. Curves are developed based on paired records of δ18O and Uk’37 at U1340 and GGC-15, and paired δ18O and Mg/Ca at MD01-2420.

**Figure S3.** Temperature records from the Bering Sea. Purple shading denotes the Heinrich Stadial 1 Interval, pink the Bølling-Allerød, and blue the Younger Dryas from Greenland records. Data are compiled from Uk’37 (yellow), and δ18Otemp (blue) records.

**Figure S4.** Temperature records from the Sea of Okhotsk. Purple shading denotes the Heinrich Stadial 1 Interval, pink the Bølling-Allerød, and blue the Younger Dryas from Greenland records. Data are compiled from Uk’37 (yellow), and δ18Otemp (blue) records.

**Figure S5.** Temperature records from the Eastern North Pacific. Purple shading denotes the Heinrich Stadial 1 Interval, pink the Bølling-Allerød, and blue the Younger Dryas from Greenland records. Data are compiled from Uk’37 (yellow) and Mg/Ca (red) records.

**Figure S6.** Temperature records from the Western North Pacific. Purple shading denotes the Heinrich Stadial 1 Interval, pink the Bølling-Allerød, and blue the Younger Dryas from Greenland records. Data are compiled from Uk’37 (yellow), δ18Otemp (blue) and Mg/Ca (red) records.

**Supplemental Text**

*Foraminiferal Calcification Environment in the North Pacific*

Previous studies have shown that the global flux of both *G. bulloides* and *N. pachyderma* is weighted towards summer months (Jonkers and Kučera, 2015). In the North Pacific, foraminiferal abundances peak between the late spring and early fall (Eguchi et al., 2003; Reynolds and Thunell, 1985), to the exclusion of winter months (Asahi et al., 2015), with distinct spring and fall blooms in the Sea of Okhotsk (Alderman, 1996). Thus, peak foraminifera production generally overlaps with reported coccolithophore seasonality and is interpreted here as representing a late spring to early fall temperature signal. However, the greater calcification depth of foraminifera relative to coccolithophores needs to be taken into account. Planktic foraminifera have been reported living at depths < 55 m during summer months in the North Pacific (Asahi et al., 2015), or < 130 m specifically for *N. pachyderma* in the Sea of Okhotsk (Bauch et al., 2002). While it is possible that coccolithophores are also not restricted to an exclusively sea surface habitat, Uk’37 is generally calibrated to SST, rather than growth temperature as is done for most foraminifera-based proxies.

*Adjustments for Regional δ18Oseawater*

Regional δ18Oseawater records developed from paired records in the Bering Sea, Sea of Okhotsk, and Western Pacific, account for broad regional changes in δ18Oseawater but we make no distinction between potential sources of δ18Oseawater variability. Records of δ18Oseawater should encompass changes due to global ice volume, as well as the amounts and source of freshwater inputs. Whereas changes in δ18Oseawater due to global ice volume (~ 1 ‰ over the deglaciation (Waelbroeck et al., 2002)) are not expected to show large regional variations, changes in δ18Oseawater due to freshwater could show substantial spatial variability. A dataset of modern open ocean δ18O:salinity demonstrates a range of slopes such that a unit change in salinity would be expected to induce a change in δ18Oseawater in the range of 0.15-0.94 ‰ (LeGrande and Schmidt, 2006). Without further constraint on the source of freshwater, which may itself be subject to spatial and temporal variability, it is extremely speculative to make a more quantitative assessment as to the potential impact of fresh water on regional δ18Oseawater.

*Bering Sea SST Records*

Nine cores were used to reconstruct deglacial temperature within the Bering Sea: HLY02-2-3JPC, SO202-18-6, SO201-2-114KL, SO201-2-85KL, SO201-2-77KL, U1340, HLY02-2-17JPC, HLY02-2-51JPC, and 91-AV-19/4-GC11 (Supplemental Figure 3). The northernmost cores available for temperature reconstruction in the Bering Sea are SO202-18-6, reconstructed with Uk’37, and HLY02-2-3JPC reconstructed with isotopes. Both show a warm Bølling-Allerød and a cool reversal in the Younger Dryas.SO201-2-114KL, along the Kamchatka peninsula, shows very little temperature evolution (<3 °C) through the deglaciation as reconstructed by Uk’37,with relatively cool and stable temperatures through both the Bølling-Allerød and Younger Drays. Further south on the Shirkov Ridge, the record at SO201-2-85KL also relies on Uk’37, indicating a warm and variable Bølling-Allerød, a single cool point within the Younger Dryas and a steady warming trend into the early Holocene (Supplemental Figure 4). Neighboring SO201-2-77KL shows a warm Bølling-Allerød, punctuated by a temperature minimum and a gradual warming into the early Holocene (Supplemental Figure 4).

In the southern Bering Sea, the δ18Otemp record from HLY02-02-51JPC warms into the Heinrich Stadial 1interval, with short-lived cool intervals just prior to the Bølling-Allerød and the onset of the Younger Dryas (Supplemental Figure 3). A lower-resolution Uk’37 record at the site indicates cooler temperatures and warming occurring at the onset of the Holocene. Core HLY2-02-17JPC, relies on regionally corrected δ18O for SST, and shows a warm Bølling-Allerød relative to the Younger Dryas, and then abrupt warming at the onset of the Holocene (Supplemental Figure 3). Regionally corrected δ18O temperatures from nearby site 91-AV-19/4-GC11 show a warming into Heinrich Stadial 1with cooling into the early Holocene (Supplemental Figure 3). In southernmost Bering Sea core U1340, Uk’37 temperatures shows warming into Heinrich Stadial 1, and then variable temperatures throughout the deglaciation.

*Sea of Okhotsk SST Records*

Fourteen cores were identified from the Sea of Okhotsk for temperature reconstruction, eight by Uk’37 and six by δ18Otemp (Supplemental Figure 4). A Uk’37 temperature reconstruction from core MD01-2412, in the southernmost Sea of Okhotsk, indicates a warm Last Glacial Maximum, cooling during Heinrich Stadial 1, and minimal temperature fluctuations in the Bølling-Allerød and Younger Dryas, before a stable warm Holocene. MR06-04-PC04 shows stable temperatures through the Last Glacial Maximum and deglaciation until a cooling in the mid Holocene. Uk’37 temperatures in GGC-15 show a gradual warming trend from the start of the Bølling-Allerød. Records from MR00K3-PC4 shows a warm Last Glacial Maximum and Heinrich Stadial 1, with a cool interval between ~17-18 ka. XP98 PC-4 indicates a cooler Heinrich Stadial 1, and then warming into the Holocene with a single warm point during the Younger Dryas. XP98 PC-2 shows a cooling into Heinrich Stadial 1 continuing into the Bølling-Allerød, and then warming in the Younger Dryas and Holocene. A Uk’37 record from MR06-04-PC07R shows a cooler Last Glacial Maximum, and warming through the deglaciation, although the record is too low resolution to identify sub-millennial deglacial events. At XP07-C9 temperatures inferred from Uk’37 are fairly constant, with a 2**°**C increase in the Holocene as compared to the start of the record in the Bølling-Allerød (Supplemental Figure 4).

V34-90 is the southernmost site with temperature based on δ18Otemp, and shows a warming from the early to mid-Holocene. In V34-98, δ18Otemp shows a minimum in the Younger Dryas, and then gradual warming through the Holocene. Core 936 δ18Otemp, shows a gradual warming through the deglaciation, and stabilizes at ~10**°**C starting in the mid-Holocene (Supplemental Figure 4). Cores LV28-40-4, LV28-42-4, and LV28-41-4 in the north of the Sea of Okhotsk are all based on δ18Otemp. LV28-40-4 indicates that temperatures were cool through the Last Glacial Maximum and Heinrich Stadial 1, with warming in the Younger Dryas and in the mid-Holocene (Supplemental Figure 4). LV28-42-4 records a warm Younger Dryas, and a warming later in the Holocene after 5 ka. Nearby low resolution records from core LV28-41-4 indicate a cool Heinrich Stadial 1and warming after the onset of the Bølling-Allerød (Supplemental Figure 4).

*Eastern North Pacific SST Records*

Twelve cores were used to reconstruct SST along the Eastern Pacific. A high-resolution record from ODP-1019C shows a warm Bølling-Allerød, cool Younger Dryas and then rapid warming at the Holocene boundary. Northern California Current core W8709A-13PC is too low-resolution to show millennial-scale deglacial features but indicate a warming from Heinrich Stadial 1 into the Bølling-Allerød. Along the Canadian Margin, the Uk’37 record at JT96-09 shows a SST maximum during the Bølling-Allerød and a cold reversal in the Younger Dryas. Uk’37 records are also available for four other cores along the Eastern Pacific Margin, these include only one or two data points each, which have been incorporated into our synthesis.

Five cores are also included from the Gulf of Alaska: core EW0408-85JC, located on the northern shelf, EW0408-26TC/JC and EW0408-66JC on the eastern shelf and MD02-2489 and SO202-27-6 in the gyre (Supplemental Figure 1). Low resolution Uk’37 from SO202-27-06 shows a warming from the Last Glacial Maximum into the Holocene. Mg/Ca at MD02-2489 shows a more gradual warming through Heinrich Stadial 1, a warm Bølling-Allerød, and then cooling just prior to the onset of the Younger Dryas. EW0408-26TC/JC, has a cool Heinrich Stadial 1, and abrupt warming at or just prior to the Bølling-Allerød and the beginning of the Holocene. Uk’37 records at EW0408-66JC indicate abrupt warming at the onset of the Holocene, proceeded by a more gradual increase in SST through much of the Younger Dryas. At EW0408-85JC, alkenone derived Uk’37 paleotemperatures indicate a start to deglacial warming during Heinrich Stadial 1, with rapid warming just prior to the onset of the Bølling-Allerød, a cold reversal in the Younger Dryas and then abrupt warming at the start of the Holocene (Supplemental Figure 5).

*Western North Pacific Sea Surface Temperature Records*

Ten cores in the Western North Pacific are used to reconstruct SST, with three located in the Subarctic Gyre, and six located along the Japan margin (Supplemental Figure 6). Along the southern Japan margin, MD01-2420 and MD01-2421 sample along the interface of the modern day Kuroshio and Oyashio currents. At MD01-2421, two Uk’37 records indicate a warm deglaciation, with warming at the onset of the Bølling-Allerød, and then cooling prior to the Younger Dryas, and a gradual warming through the Younger Drays and into the Holocene. Mg/Ca at MD01-2420 shows an increase in SST at the Bølling-Allerød, followed by gradual cooling sustained through the Younger Dryas, and warming through the early Holocene. A low-resolution Uk’37 record at CMC18 also shows a warming through the Holocene. KR02-15-PC6 has a gradual warming through the deglaciation into the Holocene, which accelerates after the Holocene boundary. Another Uk’37 record at GH02-1030 shows a warm Last Glacial Maximum, a temperature minimum during Heinrich Stadial 1, and warming with the beginning of the Bølling-Allerød and a cool point just prior to the onset of the Holocene. δ18Otemp at KT90-9-ST-21 indicates a warm Last Glacial Maximum, a temperature minimum during the Younger Dryas, and a warm Holocene.

Within the gyre are MD01-2416, SO202-07-06, and 4-GC37. In core 4-GC37, δ18Otemp indicates a warm late Bølling-Allerød, followed by a cooling through the Younger Dryas, into a cooler, stable early- to mid-Holocene. A short Uk’37 record at SO202-07-06 indicates Holocene temperatures similar to those observed at the other two sites. At MD01-2416, a multi-proxy approach (Uk’37, δ18O, and Mg/Ca) to temperature assessment was used, and shows a gradual cooling from the onset of the Holocene, stabilizing into a relatively cool Holocene (Supplemental Figure 6).

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