Supporting information

Influence of North Pacific Decadal Variability on the Western Canadian Arctic over the past 700 years

Text 1
Chronological control

The methods used to count varves rely on both visual examination of thin sections and the use of ~ 7000 microscopic images (1024 X 768 µm) obtained using a scanning electron microscope in backscattered mode. This technique allows for the identification of thin varves (< 0.4 mm), thus decreasing the chances of missing thin varves (Ojala et al., 2012). The chronology of the recent part of the record was also confirmed by radiometric dating (^{137}Cs and ^{210}Pb) (Cuven et al., 2011). Counts were made by two different users and yielded very similar results in the upper part (above 167 cm), in which the first 925 varves are present (1075 CE). The error between the two counts is estimated to be lower than 1.2% (Lapointe et al., 2012), a very good number compared to other similar records (Ojala et al., 2012). Overall, the counts were very consistent since 244 CE implying that the varves from Cape Bounty East Lake are well-defined and unambiguous (Lapointe et al., 2012). Only three coarse layers, dated 1971 (Lapointe et al. 2012), 1446 CE (Fig. S4) and 1300 CE (Fig. S6), are found in the 1766-year long sequence. These are the sole discernible features that have likely caused minor erosion in our sedimentary record from 1300-2000 CE (Figs. S4, S6). Moreover, Ct-Scans of the core did not reveal any hiatus or unconformity. Finally a recent acoustic survey revealed that the coring site was devoid of mass movement deposits (Normandeau et al., 2016b). In brief, all these features are suggesting that our sedimentary record is minimally affected by erosion (Cuven et al., 2011; Lapointe et al., 2012).

For wavelet analysis (Fig.5), we use the interval 244-2000 CE as the lake was fully isolated by glacioisostatic uplift from the ocean after 244 CE (Cuven et al., 2011; Lapointe et al., 2012). We note a weaker correlation between our record and the PDO-reconstruction (Macdonald et al., 2005) prior to ~1300 CE during a period that corresponds broadly with a thick erosive layer dated ~1300 CE in the varve chronology (Lapointe et al., 2012) (Fig. S6). This layer has been suggested to be the consequence of a mass movement deposit in a recent study (Normandeau et al., 2016a). However, this event is also relatively synchronous with an unprecedented negative anomaly in the reconstructed PDO occurring around 1296 CE (Macdonald et al., 2005). Cross-correlation between these two proxy records shows a significant correlation between 993-1299 CE when VT is shifted by 45 years (CBEL lags PDO by 45 years, $r = -0.20$, $p < 0.001$; Fig. S7), suggesting that the large debris flow at ~1300 CE likely eroded 45 varves. It is worth noting that the tree-ring based PDO reconstruction values prior to 1300 CE are almost constantly negative. Moreover, the period encompassing 1000-1300 CE is characterized by periods of massive droughts in the southwestern USA, causing a deficit of soil-water recharge and possibly widespread tree mortality in this region (Williams et al., 2013). In any case, the low distribution of tree-rings prior to 1300 CE impedes a good understanding of the climate in the Northern latitudes (Wilson et al., 2015).

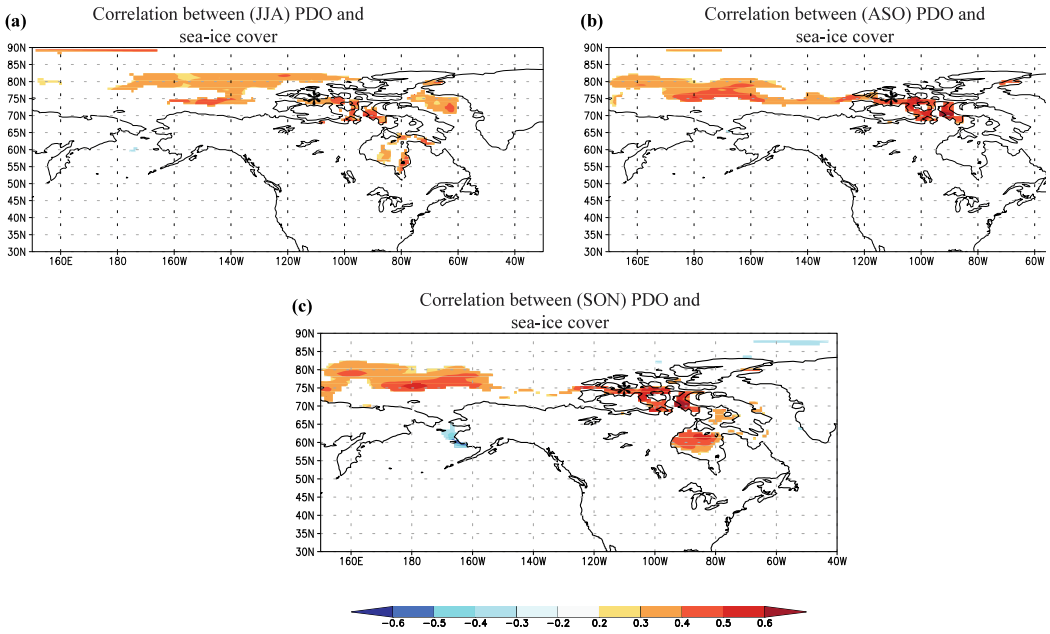

Figure S1. Sea-ice cover anomalies in relation to PDO phases during summer and autumn. Correlation between PDO (Huang et al., 2015) and sea-ice anomalies from ERA-Interim (Dee et al., 2011) for June-August (a), August-October (b), and September-November (c) during 1979-2016. Black asterisk denotes Cape Bounty.

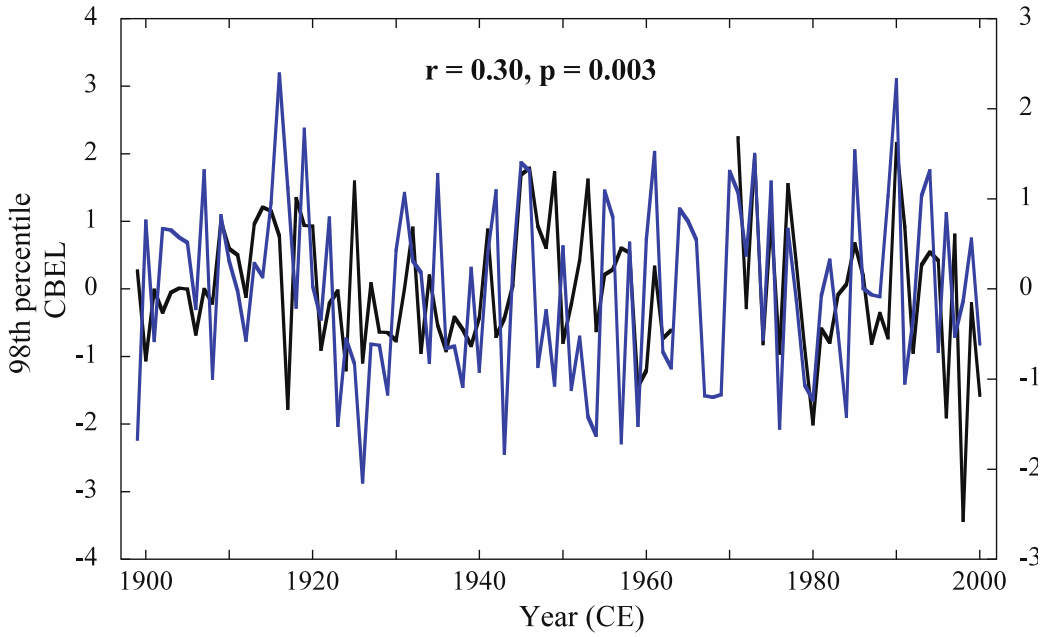

Figure S2. Correlation between the 98th percentile at CBEL (Lapointe et al. 2012) and the NPI during September-November (Trenberth and Hurrell 1994) for the past 100 years.

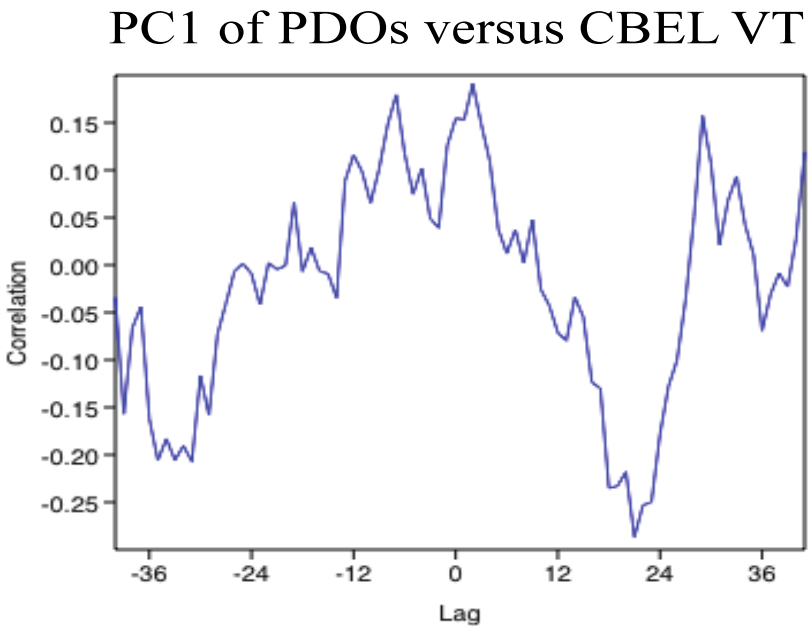

Figure S3. Cross-correlation between annual PC1 of reconstructed PDOs (MacDonald and Case 2005), D'Arrigo et al. 2001, Gedalof and Smith 2001)) versus annual CBEL varve thickness from 1700-1900. Maximum correlation is reached at 18 year lag, that is CBEL leads the PDO reconstructions.

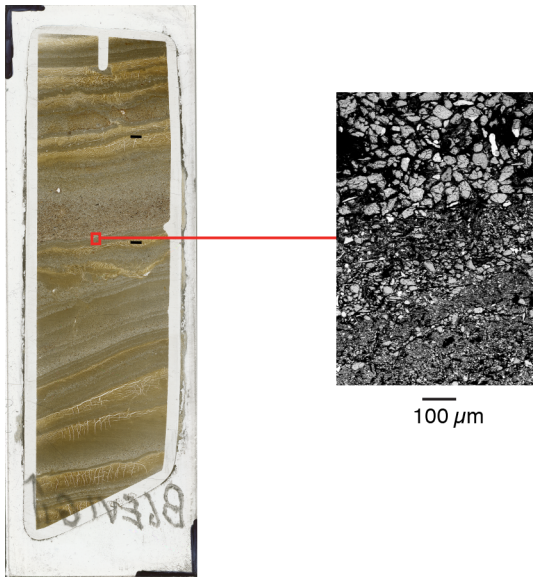

Figure S4. Large turbidite showing erosive features. The black lines indicate the thickness of the layer (1.34 cm) dated to 1446 CE. The backscattered electron image acquired at the scanning electron microscope shows the base of the turbidite (red square). Core # CBEV1, depth from top: 101.88 cm.

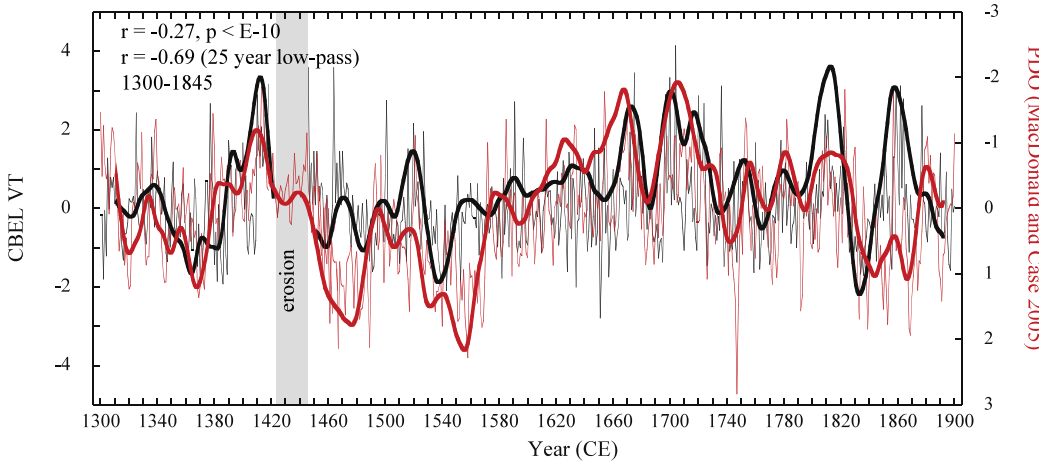

Figure S5. Comparison between CBEL varve thickness and the Pacific Decadal Oscillation (Macdonald et al., 2005) over the last ~700 years. Bold lines are 25-year low-pass filter. Grey shading (b) indicates the 28 years eroded varves at CBEL.

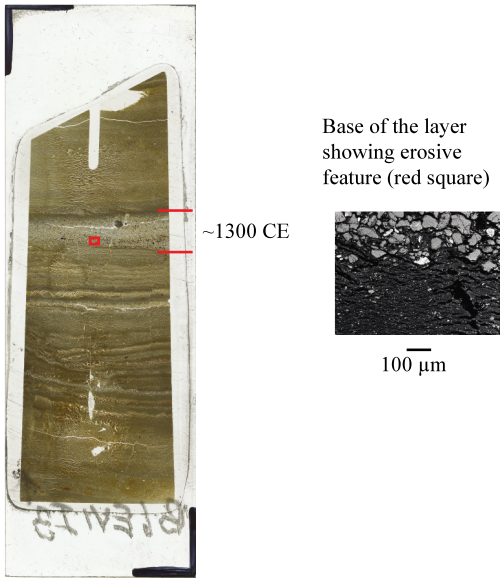

Figure S6. Largest debris flow deposit dated to ~1300 CE. The backscattered electron image acquired at the scanning electron microscope shows the base of the debris flow (red square). Core # CBEV1, depth from top: 130.14 cm.

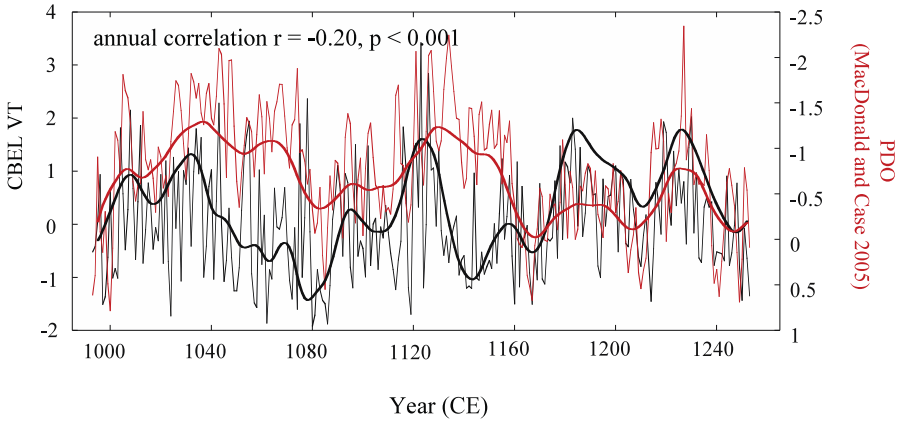

Figure S7. Varve thickness versus reconstructed PDO(Macdonald et al., 2005) during the Medieval Climate Anomaly. Bold lines are 25-year low-pass filter. Varve thickness is shifted 45 years earlier.

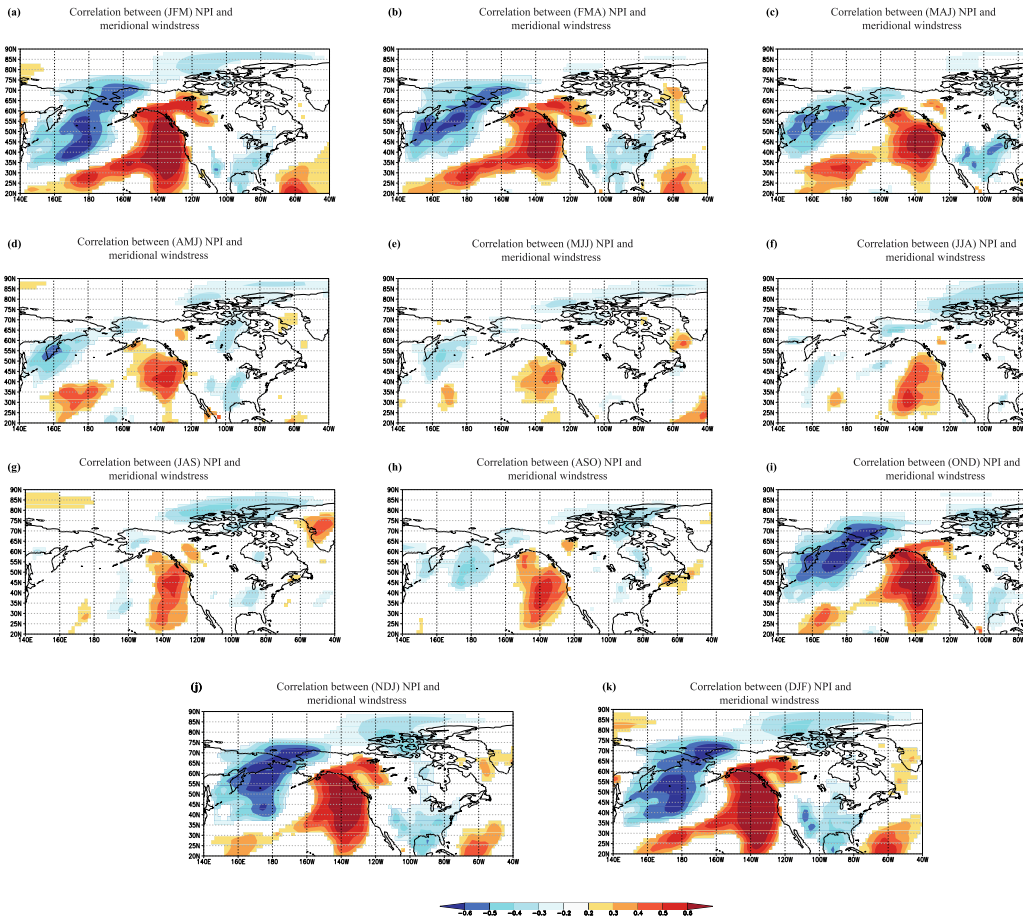

Figure S8. Same as Figure 6a, but for all year-round except SON (as it is in the main text). (a) averaged January-March, (b) February-April, (c) March-May, (d) April-June, (e) May-July, (f) June-August, (g) July-September, (h) August-October, (i) October-December, (j) November-January and (k) December-February.

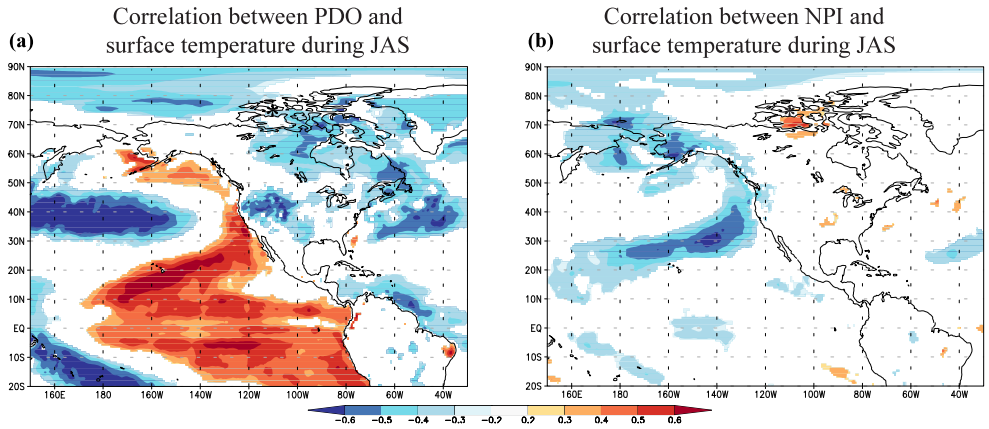

Figure S9. North Pacific influences on temperature anomalies in the western Canadian Arctic. (a), Spatial correlation between July-September PDO index and July-September surface temperature (Dee et al., 2011) for 1979-2016. (b), as in (a), but for the North Pacific Index (Trenberth et al., 1994).

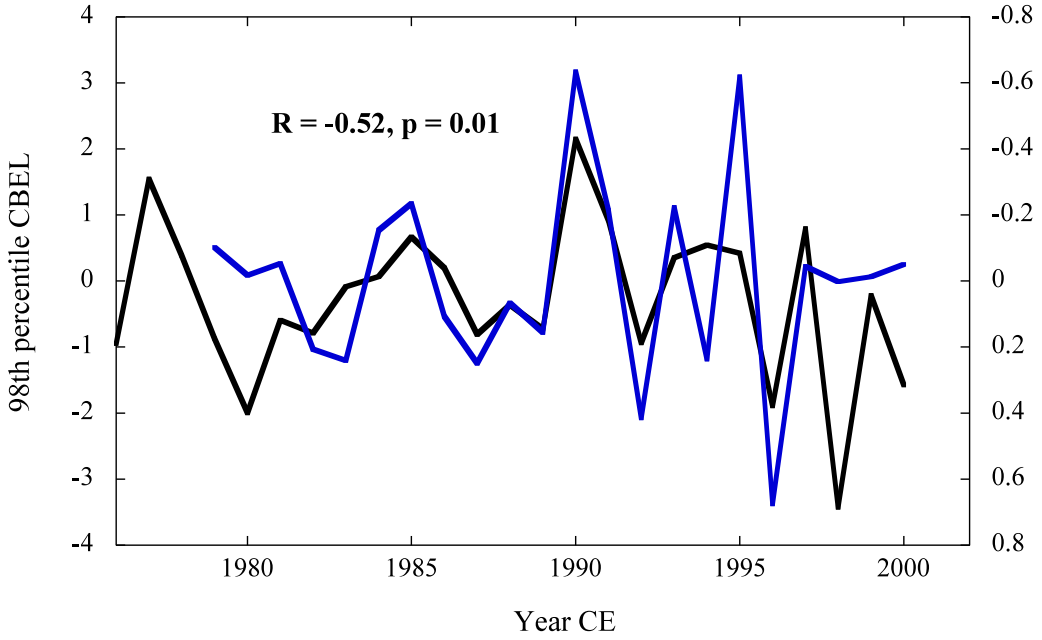

Figure S10. Summer sea ice extent covering 84°- 67°N / 100° W - 170° E compared to the 98th percentile at CBEL.

References

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