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Quantitative reconstruction of temperature in northern Japan for the last 2000 years and the influential factors to determine climatic fluctuation

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A coastal sedimentary core at St. 5 in Uchiura Bay in northern Japan provided an opportunity to quantitatively estimate terrestrial atmospheric temperatures (AT) using the alkenone proxy because of their strong correlation with summer sea surface temperatures (SSTs) (r2 >0.90). In other words, when we can estimate SST, we can reconstruct AT quantitatively at high time resolution (10-30 years for the last 2K). During the last two millennia, SSTs fluctuated by 4.9 °C before 20 century, reaching two maximum in 1820 AD (22.3°C) and 760 AD (22.0 °C) and two minima around 145 AD (17.4 °C) and 1080 AD (17.4 °C). The SST profile is generally consistent with those obtained from western and central Japan by us (3 sites) and from East Asia by Cook (2013) but shows some differences. Although the MWP (Medieval Warm Period) was not identified in this study because a cold climate prevailed in 990–1100 AD. Particularly low temperatures around 1000–1100 AD can be verified by historical documents from in and around the ancient capital city of Kyoto (Ishii, 2002). The reconstructed SOI (Southern Oscillation Index) data suggest that the equatorial Pacific was predominantly in an El Niño phase in 900–1200 AD. Under modern conditions, during an El Niño episode, the Pacific high is weakened, with reduced atmospheric pressure in the western North Pacific in the vicinity of Japan. This results in an enhanced Okhotsk high, which tends to be accompanied by a cold and cloudy/rainy summer in Japan. A cold climate was definitely observed in 1550–1700 AD, which almost corresponded to the LIA (Little Ice Age). A cold event around 1650 AD can be attributed to big eruptions at Komagatake. This resulted in severe cold type of famine, which is evidenced by historical documents. Because several factors, including external forcing (e.g., solar activity) and internal forcing (e.g., volcanic activity, ENSO, and the Asian monsoon), can affect the climate, we compared SST fluctuations with each of those factors. The fluctuations cannot be explained by a single cause. It is likely that more than one driver, whether external or internal, caused the fluctuations.