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# Architectural wood remains and climatic variations in early 2nd millennium CE, northwest Alaska: reflections on the possibilities and limits of Dendroarchaeology

*Vestiges architecturaux en bois et variations climatiques au début du II<sup>e</sup> millénaire de notre ère, nord-ouest de l'Alaska : réflexions sur les possibilités et les limites de la dendroarchéologie*

*Vestigios de arquitectura en madera y variaciones climáticas a principios del segundo milenio e.c., noroeste de Alaska: reflexiones sobre los alcances y limitaciones de la dendroarqueología*

**Juliette Taïeb**

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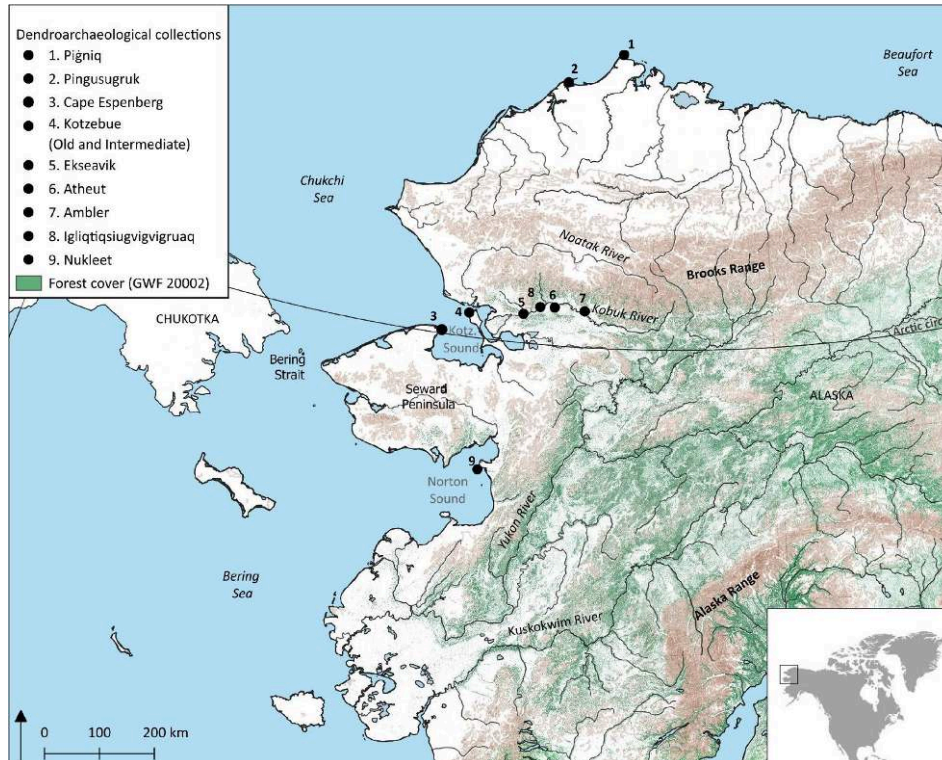
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## **Introduction**

- <sup>1</sup> In the tundra coasts of northwest Alaska, humans collected timbers from driftwood. This coastal driftwood originated in the interior Alaska boreal forest and was carried by major rivers, such as the Yukon and the Kuskokwim in the Interior, and the Noatak and Kobuk rivers in Northwest Alaska, to coastal beaches (Fig. 1; Giddings J. L., 1943, 1952a; Alix C. and K. Brewster, 2004; Alix C., 2005). Therefore, archaeological timbers found in coastal sites may come from various regions of Alaska, and potentially from other areas, carrying climatic information of their geographic region of origin. The

development of chronologies in these driftwood source regions could also be used to trace the provenance of the archaeological wood remains, providing environmental information on past sea currents (Giddings J. L. 1943, 1952a).

**Figure 1.** Map of Alaska showing a non-exhaustive list of Iñupiat archaeological sites of the 2nd millennium CE where tree-ring samples from architectural wood remains were collected



Giddings J. L., 1948, 1952b, 1964; Rye O., 1950; Sheehan G. W., 1997; Griggs C. *et al.*, 2019; Taïeb J. *et al.*, 2022, 2023, 2024). Credits: J. Taïeb; GIS data: Global Forest Watch 2000, Alaska Geospatial Office.

- 2 The chronometric and climatic potential of these architectural wood remains was assessed in 1940s by archaeologist and Alaska dendrochronology pioneer James Louis Giddings (Nash S., 2000). He built a 1000-year-old chronology (978-1948 CE) in the Kobuk Valley, Northwest Alaska, from standing white spruce trees, driftwood, historic cabins, and archaeological sites (Figure 1; Giddings J. L., 1948, 1952b). This chronology enabled absolute dating of arctic archaeological sites for the first time. However, dendroarchaeology was mostly abandoned in Alaska in the 1950s, with the arise of radiocarbon dating (Nash S., 2000; Taïeb J. *et al.*, 2022). Today, this legacy chronology remains the yardstick for dendrochronology, archaeology and paleoclimatic inferences in Northwest Alaska (Murray M. S. *et al.*, 2003; D'Arrigo R. *et al.*, 2005; Griggs C. *et al.*, 2019; Taïeb J. *et al.*, 2022). However, while the chronology was revised by dendroclimatologists in the 1990s and 2000s (Graumlich L. and K. King, 1997; D'Arrigo R. *et al.*, 2005), the replication of the early part of the chronology remains low before the 12th century, limiting dendroclimatic analyses for the early 2nd millennium CE.
- 3 Along the coasts of western Alaska, wooden architectural remains are well preserved in archaeological sites of the last two millennia (Alix C., 2016). At the intersection of archaeology, palaeoclimatology, and ecology, these organic remains offer an annual and local resolution rarely accessible to archaeologists and make the region especially

suitable for dendrochronology (Giddings J. L., 1940, 1943a, 1952b; Griggs C. *et al.*, 2019; Taïeb J. *et al.*, 2022). This archaeological wood provides invaluable information about past climatic variations at various temporal (annual to multi-centennial) and geographical (local to regional, even sometimes hemispheric) scales.

- 4 In a context where past and present Iñupiat cultural variations are often interpreted as responses to climatic and environmental changes, this paper provides an overview of current knowledge of the dendroclimatic possibilities and limits of archaeological architectural wood remains, with a view to exploring their contribution to the broader understanding of the climatic framework of the early 2<sup>nd</sup> millennium CE and socio-ecological dynamics of the early Iñupiat in Northwest Alaska (Liu J. *et al.*, 2007; Lagadeuc Y. and R. Chenorkian, 2009). Dendroclimatology examines climate variations and reconstructs them statistically from tree parameters (Fritts H. C., 1976; Speer J. H., 2012). The main climatic parameters controlling tree growth are known as limiting factors, mainly air temperature and nowadays precipitation in the subarctic environment of Alaska, which controls where a species grows. Building upon recent knowledge since the 2000s, we first introduce the climatic data recorded in white spruces in Interior and Northwest Alaska and then consider the study of past climate based on Alaskan architectural wood remains is considered. Finally, we focus on the Medieval Climate Anomaly frame [MCA] (9<sup>th</sup>-13<sup>th</sup> centuries) in Northwest Alaska and the question of past socio-environmental dynamics in archaeology.

## Exploring the climate records of white spruce in Alaska for Dendroarchaeology

- 5 In Alaska, dendroclimatology, while rooted in dendroarchaeology, progressed significantly in the latter half of the 20<sup>th</sup> century due to methodological—statistical and numerical—advancements. Studies predominantly focus on white spruces (*Picea glauca* [Moench] Voss) in the Alaskan interior boreal forest and along the northern tree line, i.e. the latitudinal limit of the boreal forest, in northwest Alaska and the Brooks Range. White spruce is the dominant species of the Interior Alaskan boreal forest, growing in valley bottoms, floodplains, and along riverbanks (Viereck L. A. and E. L. Little, 2007), and therefore makes up a large proportion of driftwood along Alaska's coastlines and in archaeological sites (Alix C., 2005, 2009).
- 6 The growth of white spruces trees (max. ages 200/400 years) is influenced by various environmental, physiological, health and above all climate parameters (Fritts H.C., 1976; Speer J. H., 2012). Because of the legacy of research on white spruce trees located at altitudinal and latitudinal tree line, there is a widespread perception that most of these trees in Alaska are limited by cold temperatures. However, recent studies have shown drought to be a major limiting factor in interior Alaska (Barber V. A. *et al.*, 2000; Juday G. P. and C. Alix, 2012). This suggests that architectural white spruce remains may reflect a broad range of environmental influences, depending on where they come from. Understanding the origin-specific environmental signals within white spruce samples is essential for accurate interpretation. In Alaska, variations in white spruce ring widths are primarily associated with summer temperatures and, to a lesser degree, with spring precipitations (Giddings J. L., 1941, 1943b; Wilmking M. R. *et al.*, 2004, 2005; Juday G. P. and C. Alix, 2012; D'Arrigo R. *et al.*, 2014; Juday G. P. *et al.*, 2015). White spruce trees demonstrate sensitivity to mean monthly temperatures in June and July of the

current season of growth and two previous seasons, highlighting the need to examine climate conditions over the preceding 36 months to understand what controls the growth.

- 7 Historically, dendroclimatic studies in Alaska focused on ring widths, wood anatomy, and wood density (maximum latewood cells density). Tree growth variations occurred at three climate frequencies: a high frequency corresponding to interannual-scale variations, a medium frequency that corresponds to decadal-scale variations and a low frequency corresponding to multi-decadal-scale variations (Lebourgeois F. and P. Merian, 2012). Ring-widths variations indicate short- and long-term trends that can correspond to favorable or unfavorable climate for white spruce growth. Tree-ring chronologies can also document extreme climate events that influenced tree growth, such as volcanic eruptions, floods, and severe droughts. Wood anatomy and maximum latewood density can be of particular interest for analyzing intra-annual variations and climate extreme events at a seasonal scale (Barber V. A. *et al.*, 2000; Lange J. *et al.*, 2019; Edwards J. *et al.*, 2021; Leland C. *et al.*, 2023).
- 8 Recent decades have seen an expansion of dendroclimatic studies based on stable isotopes compositions and Blue Intensity in Alaska (among others: Sullivan P. F. *et al.*, 2017; Muldoon L. A., 2019; Wilson R. *et al.* 2019). Stable isotopes can be used to reconstruct past climatic variations and the ecological conditions under which trees grow (Daux V., 2013). Stable isotopes represent the result of internal physiological controls of the growth process and help unravel the tree's ecophysiological mechanisms and its interactions with the environment. Studies on carbon  $\delta^{13}\text{C}$  and oxygen  $\delta^{18}\text{O}$  compositions of white spruce trees in interior Alaska and northwest Canada have demonstrated their relationship to spring and summer temperatures, precipitation, moisture indices and water vapor deficit (Barber V. A. *et al.*, 2004; Porter T. J. *et al.*, 2014; Churakova O. V. *et al.*, 2022). To date, moisture and drought indices have only been established in regions further south than Alaska. Therefore, these reconstructions may not reflect a complete picture of past moisture variations in Alaska (Bhuyan U. *et al.*, 2017; Walston J. M. *et al.*, 2023).
- 9 In connection with global warming that began in the 20th century, three different white spruce tree growth responses to increasing temperatures have been observed in Alaska: positive, negative or no response. Trees with a positive response increase in growth with increasing temperatures, while trees with a negative response decrease in growth with increasing temperatures. The positive responders are found primarily in cool moist environments in northern and western Alaska and the negative responders in warm dry interior portions of Alaska (Barber V. A. *et al.*, 2000; Wilmking M. R. and G. P. Juday, 2005; Juday G. P. *et al.*, 2015). It is therefore very important for ring-widths studies of past climatic variations to identify growth response types in the analyzed population in order to not bias the dendroclimatic reconstruction. It has also been shown that some white spruces which had a positive response to temperatures, crossed a threshold in the 20th century and now have a negative response (or vice versa). This phenomenon is known as the "divergence phenomenon" (D'Arrigo R. *et al.*, 2008 : 289-305).
- 10 Analyzing dendroclimatic data involves standardizing tree series (to remove non-climatic trends), assessing climatic signals, and correlating tree variables with meteorological data, over the period for which instrument data exist. In Alaska, the first weather stations to provide reliable instrument data back to the early 20<sup>th</sup> century,

and initially recorded monthly temperatures and precipitations (Shulski M. and G. Wendler, 2007). Calibration and validation periods then ensure the reliability of climatic reconstructions. Trees can either provide a quantitative reconstruction—numerical and metric information—or a qualitative reconstruction—warmer or colder period, wetter or drier—, (Degroot D. *et al.*, 2022).

- 11 Methodological choices influence the reconstruction of climatic variations, at high, medium, and low frequencies (Sheppard P. R., 2010; Cook E. R. and N. Pederson, 2011; Büntgen U. *et al.*, 2021). For example, reconstruction linear models tend to reduce amplitudes in reconstructed variations compared to instrument data and therefore to minimize extremes. It is also important to note that trees are not direct records of past climate variations. Dendroclimatic reconstructions generally achieve 40% of climatic variance of the reconstructed parameter (Guiot J. and A. Nicault, 2010). Because of the organic nature of wood, there is a percentage of variability and unknowns specific to each tree, each context, and each case study.
- 12 In archaeological context in Alaska, the multiple geographic regions of origin of architectural wood add an uncertainty to dendroclimatic studies (Giddings J. L., 1943a, 1943b; Taïeb J. *et al.*, 2022, 2023, 2024). When conducting a contemporary dendroclimatic field study, researchers can select which trees to sample based on their apparent climate sensitivity (Cook E. R. and L. A. Kairiukstis 1990). But, in archaeology, only a limited amount of selectivity is possible. It is important that the chronologies are well replicated over time and space, based on numerous trees that show a consistent and coherent signal from several site chronologies over a region.
- 13 In Alaska, well-replicated chronologies allow documentation of climatic variations of the Little Ice Age [LIA] (14<sup>th</sup>-19<sup>th</sup> centuries), such as variations linked to volcanic eruptions or cooling of the atmosphere (e.g. Edwards J. *et al.*, 2021; Leland C. *et al.*, 2023), as well as climatic oscillations such as the Pacific Decadal Oscillation (D'arrigo R. *et al.*, 2005). As the spatial and temporal replication of white spruces chronologies decreases backward in time, dendroclimatic analyses of prior periods, such as the Medieval Climate Anomaly, become less certain. The availability of the millennial length master chronology first built by J.-L. Giddings, pioneer of dendrochronology in Alaska, can allow the successful cross-dating of trees that grew in Northwest Alaska. However, if the tree originated in interior Alaska, cross-dating is generally limited by the length of available chronologies (maximum 350-450 years), limiting climate reconstructions to this period.

## Insights on climate dynamics and human interactions in Northwest Alaska: a multidisciplinary perspective

- 14 At the onset of the 2nd millennium CE, the Bering Strait and northwest of Alaska witnessed major cultural variations during which the Inuit culture arises in North American Arctic and the Iñupiaq culture in Northwest Alaska. During the Medieval Climate Anomaly and the transition to the Little Ice Age, the Thule/Iñupiaq culture (13<sup>th</sup>-18<sup>th</sup> centuries) emerged in continuity from the Birnirk (8<sup>th</sup>-13<sup>th</sup> centuries) and Punuk (9<sup>th</sup>-13<sup>th</sup> centuries) cultures in the Bering Strait region and/or along the coasts of northwest Alaska (Mason O. K., 2020). During the 13<sup>th</sup> century, coastal Thule/Iñupiat groups settled in the inland portion of the Kobuk and Noatak rivers region (Giddings J. L., 1952b; Mason O. K. and P. M. Bowers, 2009), while others began their migration

eastward to Greenland, inhabiting most of the North American Arctic (Friesen T. M., 2016; Mason O. K., 2020). Until the late 1990s, these cultural changes were theorized in part as responses to the climate and environmental variations of the MCA and LIA, as well as subsequent changes in distribution and abundance of resources (Mason O. K. and S. C. Gerlach, 1995; Dixon J. C., 2003; Mason O. K. and Barber V.A., 2003; Mason O. K., 2020). This includes the Thule eastward migrations in the 13th century and the Thule/Iñupiat cultural dynamics in northwest Alaska, between the coasts and the interior (among others: Bockstoce J., 1973; McGhee R., 1984; Ackerman R. E., 1988; Minc L. D. and K. P. Smith, 1989). A major question remains as to what degree changes in climate conditions contributed to cultural changes besides other multiple factors.

## Documenting major climate variations in Alaska over the last millennium

- 15 The Medieval Climate Anomaly and the Little Ice Age are globally perceived temperature anomalies spanning a few centuries, the first one as warm and the second one as cold (Hughes M. K. and H. F. Diaz, 1994). The amplitude, frequency, and timing of these anomalies vary from region to region and to some extent according to internal climate variability (Nicolle M. *et al.*, 2018; Degroot D. *et al.*, 2021, 2022). For example, the LIA exhibits several alternating episodes of cold and warm temperatures, with various amplitude and persistent effects. Severe volcanic eruptions resulted in cooling episodes during the MCA and the LIA, as well as 1783 during the Laki eruption in Iceland and in 1815 when the Tambora erupted in Indonesia (among others: Oswalt W. H., 1957; Jacoby G. C. *et al.*, 1999; Stoffel M. *et al.*, 2015; Edwards J. *et al.*, 2021).
- 16 The major outlines of the MCA and LIA are documented in northwest Alaska based on climatic and environmental data from natural and, in some cases, archaeological contexts, such as tree rings and dune and lake sediments in northwest Alaska (Mann *et al.*, 2002; D'Arrigo R. *et al.*, 2005), beach ridges along the Bering Strait coastlines (Mason O. K. *et al.*, 2020), moraines and cores of glacial, marine and lacustrine sediments in central, southern and southeast Alaska (Calkin W. and Barclay D. J., 2001; Anderson L. *et al.*, 2007; Wiles G. C. *et al.*, 2008, 2010; Bird B. W. *et al.*, 2009; Barclay D. J. *et al.*, 2009; Jaeger J. M. and B. Kramer, 2014; Vachula R. S., 2015). Zooarchaeological data are available for some archaeological sites, with varying degrees of confidence depending on the excavation and analysis period (Moss M. and P. Bowers, 2007; Crockford S. J., 2008; Jordan J. W., 2009; Norman L. E. Y. *et al.*, 2017, 2018; Mayeux C. *et al.*, 2022).
- 17 While the LIA is well-documented in the region, drawing from several climate indicators at local and regional scales and presenting consistent climatic outcomes, the same cannot be said for the MCA. Both the lack and inconsistency of climatic indicators characterizing MCA variations complicate efforts to fully understand how the MCA affected ecosystems and people in northwest Alaska. These climatic indicators are associated with many diverse ecosystems, from Arctic to Subarctic, from tundra to forest, from marine to terrestrial. Available climate indicators have different temporal resolutions, ranging from annual to decadal, or even multi-centennial. The climate information derived from these indicators also documents different seasons in terms of climate and environmental variability, such as tree rings sensitive to spring and summer conditions and beach ridges documenting fall storms activities. It is clear that these major changes in climate affected the resources (distribution, abundance,

productivity) used by human groups (Mason O.K. and S. C. Gerlach, 1995; Mason O. K. and V. A. Barber, 2003). However, the daily life strategies that humans adopted in relation to their local conditions and to these climatic changes remain only generally understood, partly because of the spatio-temporal resolution of the archaeological data. We can question which indicators derived from archaeological wood would contribute to understanding past variations in this complex system of human and environmental interactions.

- 18 Today, there are not enough reliable indicators in Alaska and northwestern Alaska to propose an annual reconstruction of temperatures for the Medieval Climatic Anomaly. Two of the most promising perspectives to achieve spring and summer resolutions are varve and tree-ring chronologies (D'Arrigo R. *et al.*, 2005; Bird B. W. *et al.*, 2009). A plausible combination of the millennial annual varve chronology of Blue Lake in the Central Brooks Range and the millennial tree-ring chronology of northwest Alaska may eventually provide insights into past annual summer temperature variations. In the case of tree ring dendrochronology in northwest Alaska, early MCA growth remain insufficiently reproduced and are related to a complex summer temperature signal that does not yet allow for a quantitative temperature reconstruction. In the future, it might also be possible to harmonize the isotopic records at the regional scale between white spruce stable isotope and lake sediment oxygen isotope sequences from Marcella Lake in the southwest Yukon Territory, hundreds of kilometers away (Anderson L. *et al.*, 2007; Bird B. W. *et al.*, 2009; Taïeb J., 2023).

### **Socio-ecological dynamics and climate perception in archaeological research: a multi- and interdisciplinary approach**

- 19 For a long time, the relationships between humans and their environment have been perceived in archaeology through the lens of a somewhat environmental determinism (Contreras D., 2016; Magny M., 2017; Arponen V. P. J. *et al.*, 2019; Ion A., 2019; Kristiansen K., 2019). In archaeological research, establishing correlations and causal relationships between climatic, environmental, and cultural variations tended to rely on an oversimplified understanding of climatic and environmental mechanisms, as well as on archaeological data with low spatiotemporal resolution, leading to simplistic hypotheses (Ion A., 2019; Degroot D. *et al.*, 2021), sometimes only based on the contemporaneity of climatic and cultural variations (Kuzucuoğlu C. and Z. Tsirtsoni, 2016; Arponen V. P. J. *et al.*, 2019).
- 20 Many researchers emphasize the importance of multi- and interdisciplinary approaches to understand the articulation and mechanisms between humans, the environment, and climate (Arponen V. P. J. *et al.*, 2019; Kristiansen K., 2019; Jones J. and K. Britton, 2019; Britton K. *et al.*, 2020). Establishing more complex and comprehensive models from an environmental and ecological perspective, with numerous well-dated climatic, ecological, and archaeological data, would allow for better insights into the complexity of climatic variations, ecosystem functioning, and human societies (Contreras D., 2016; Ion A., 2019; Crabtree S. A. and J. A. Dunne, 2022). To avoid incorrect determinism resulting from the use of data from one discipline by another, it is necessary to assess how data sets, whether climatic or archaeological, were produced and what uncertainties remain (Kristiansen K., 2019; Degroot D. *et al.*, 2021). Finally, the



question of what natural indicators and ecofacts represent in terms of their possible impacts on people and their environment must be resolved.

- 21 As environmental archaeology studies continue to assemble data sets, perform analyses, and develop interpretations, it will be particularly important to focus on local evidence when examining the question of past socio-environmental dynamics in Northwest Alaska. Local resolution may allow for discerning human intentionality and possible local responses to climate variations (Kuzucuoğlu C. and Z. Tsirtsoni, 2016; Ion A., 2019). On a human scale, climate change and variability are experienced daily through meteorology, representing short-term conditions.
- 22 In the North American Arctic, traditional ecological knowledge (TEK) and oral traditions offer insights into climate, meteorology, changing landscapes, and how people interacted in their daily life with these environmental factors over recent centuries. TEK also provides a localized human perspective on how climatic and environmental variations can be perceived, enhancing the understanding of the diversity of possible responses to these climate variations (Armstrong C. G. *et al.*, 2017; Lavrillier A. and S. Gabyshev, 2018; Crabtree S. A. and J. A. Dunne 2022; Degroot D. *et al.*, 2022). Early archaeology on environmental and cultural dynamics in the Bering Strait region sometimes associated the notions of favorable and unfavorable climate to the development of human societies. For many, a warm climate in the Arctic was seen as favorable to human societies. In the early 2000s, archaeologist O. K. Mason alternatively proposed that a cold climate may have been more favorable to human coastal settlements, whose diet was based mainly on marine resources—the productivity of which improves with cold conditions (Mason O. K. and V. A. Barber, 2003). This stresses the importance of indigenous perspectives on climate, meteorology, and ecosystems, which are inseparable from the understanding of socio-environmental dynamics that often result in western research as a dichotomized view of nature and humans. However, in Arctic and subarctic regions, TEK are scarce for periods prior to the 18<sup>th</sup> century.
- 23 Aligning the spatio-temporal resolution of climatic data with archaeological data often poses challenges (Nash D. J. *et al.*, 2021). In Northwestern and Northern Alaska, it was pointed out in the 1990s that numerous archaeological data from early 20<sup>th</sup>-century excavations either present an uncertain archaeological context with poor chronometric information or come from collections that are yet to be fully studied and published. While climatic variations may have affected the availability and distribution of animal and plant resources used by humans, the connection between climatic and environmental variations relies on indirect relationships that are difficult to determine for the early 2<sup>nd</sup> millennium CE. This is without considering human factors, such as demography, social, and political interactions, that are as difficult to reconstruct for the region during this period. Since the 1990s, some archaeologists pointed out that the proposed correlations proposed between humans, environment, and climatic variations are rarely at appropriate temporal and spatial scales to confidently grasp the socio-environmental dynamics of this key period in the development of Iñupiaq culture (Mason O. K. and S. C. Gerlach, 1995; McGhee R., 1994 *in* S. J. Langdon, 1996).
- 24 To better perceive the potential role of climate in human-environment interactions and cultural variations, rather than asking whether a hypothesis is plausible, it seems more relevant to assess whether the available climatic, environmental, and archaeological evidence allows for the development of acceptable hypotheses.

Historian D. Degroot recently proposed a model of questions to guide researchers in this direction, entitled "A process for undertaking research into past climate-society" (Degroot D. *et al.*, 2021, see Figure 3, p. 543). He suggests answering binary questions related to data quality, confidence and uncertainties, spatio-temporal scales, and the articulation of causality (Degroot D. *et al.*, 2021).

## Concluding thoughts on the challenges and perspectives of architectural wood remains for climatic research

- 25 Despite challenges such as low replication and reliability of climate indicators across time and location, recent methodological and technological advancements enhance the accuracy of chronologies derived from climatic ecofacts in archaeological contexts (Jones J. and K. Britton, 2019). Cross-dating tree-ring chronologies from coastal archaeological wood to reference chronologies and determining their provenance requires careful attention to methodological questions, given the diverse origins of wood in Thule/Iñupiat sites. If today conventional dendrochronology methods may not be feasible due to the absence of contemporary tree-ring chronologies for the early 2<sup>nd</sup> millennium CE in most of the presumed driftwood sources regions, architectural wood may help develop this network of chronologies over time. New techniques offer promise in resolving uncertainties about the origin of archaeological wood, such as wood anatomy, cell density (e.g., Blue Intensity and Latewood Density), and more recent methods like organic chemical components and molecular biology. For example, DNA mapping of wood, combined with long-term reference chronologies, could resolve questions about the origin of archaeological wood samples (Lowe A. J. and H. B. Cross 2011; Bridge M. C., 2012; Wilson R. *et al.*, 2017; Drake B. L., 2018; Traoré M., 2018; Akhmetzyanov L. *et al.*, 2019; Domínguez-Delmás M. *et al.*, 2020). Architectural wood remains offer the dual advantage of refining both archaeological and paleoclimatic frameworks. As observed in many other archaeological contexts, these remains have significant potential for extending tree-ring chronologies and their spatial networks into the early 2<sup>nd</sup> millennium CE, shedding new light on socio-environmental dynamics in the region.
- 26 By addressing methodological constraints and enhancing contextual understanding through an interdisciplinary approach, future research can unlock further insights into the climatic and ecological history of northwestern Alaska's inhabitants. Collecting numerous wood timbers from archaeological sites is essential for developing extensive datasets and understanding past climatic conditions comprehensively. Over time, this approach will expand chronological information and enable reliable interpretation of climatic and environmental data based on the regions of origin of the wood. Eventually, long chronologies based on architectural wood may provide valuable local insights into summer temperatures and hydroclimatic variations that influence the ecosystems of Northwest Alaska. These improved chronologies will offer new insights at a fine temporal scale, enhancing our understanding of the environment inhabited by people of the Iñupiat homeland (e.g. Edwards J. *et al.*, 2021; Leland C. *et al.*, 2023; Taïeb J., 2023) and their daily interactions with their surroundings.

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## ABSTRACTS

Architectural wood elements are well-preserved in cold soils and archaeological Thule/Iñupiat sites of the early 2<sup>nd</sup> millennium CE in northwestern Alaska. These organic remains, at the intersection of archaeology, palaeoclimatology, and ecology, offer an annual and local resolution rarely accessible to archaeologists, providing insights on past climate variations. In a context where cultural variations of past arctic people are often interpreted as responses to climatic and environmental changes, this paper is a state-of-the-art examination of the dendroclimatic potential of Iñupiat architectural wood remains based on current knowledge. The focus is especially on current possibilities and limits of early Iñupiat architectural wood remains and the need to build a finer sequence for the period of the Medieval Climate Anomaly [MCA] (9th-13th century) to contribute to a broader understanding of the climatic framework of the early 2nd millennium and of early Iñupiat socio-ecological dynamics in Northwest Alaska for future research.

Les vestiges d'architecture en bois préservés dans les sols gelés des sites archéologiques Thulé/Iñupiat du début du II<sup>e</sup> millénaire de notre ère dans le nord-ouest de l'Alaska représentent une ressource précieuse à la croisée de l'archéologie, de la paléoclimatologie et de l'écologie. Ces vestiges archéologiques offrent une résolution annuelle et locale, rarement accessible aux archéologues, et permettent une compréhension plus fine des variations climatiques passées. Dans un contexte où les variations culturelles des Thulé/Iñupiat ont souvent été interprétées comme des réponses aux changements climatiques et environnementaux, cet article examine le potentiel dendroclimatique des bois d'architecture Iñupiat en se fondant sur les connaissances actuelles. Il s'attache plus particulièrement aux possibilités et aux limites actuelles de ces vestiges à haute résolution et à la nécessité de mieux comprendre l'Anomalie Climatique Médiévale (IX<sup>e</sup>-XIII<sup>e</sup> siècles) afin d'éclairer le cadre climatique du début du II<sup>e</sup> millénaire et les dynamiques socio-écologiques des Thulé/Iñupiat dans le nord-ouest de l'Alaska.

Los vestigios de arquitectura en madera conservados en los suelos congelados de los sitios arqueológicos Thule/Iñupiat de principios del segundo milenio d.C., en el noroeste de Alaska, representan un valioso recurso tanto para la arqueología, la paleoclimatología y la ecología. Estos vestigios arqueológicos ofrecen una resolución anual y local de datos cronométricos y climáticos de los que raramente disponen los arqueólogos, y proporcionan una comprensión más detallada de las variaciones climáticas del pasado. En un contexto en el que las variaciones culturales Thule/Iñupiat se han interpretado a menudo como respuestas al cambio climático y medioambiental, este artículo examina el potencial dendroclimático de las maderas arquitectónicas Iñupiat basándose en los conocimientos actuales. Se centra en particular en la evaluación de los alcances y limitaciones actuales de estos restos de alta resolución y en la necesidad de comprender mejor la Anomalía Climática Medieval (siglos IX-XIII) para aportar nuevos datos en torno al marco climático de principios del segundo milenio y las dinámicas socioecológicas de los Thule/Iñupiat en el noroeste de Alaska.

## INDEX

**Keywords:** Dendroarchaeology, Dendroclimatology, Architectural wood, Medieval Climate Anomaly, Northwest Alaska

**Palabras claves:** Dendroarqueología, Dendroclimatología, Madera arquitectónica, Anomalía Climática Medieval, Noroeste de Alaska

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