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Outlining pre-Last Glacial Maximum (∼24 ka) ice configuration over North America: the utility of chronostratigraphic records

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The Laurentide Ice Sheet played a major role in sea level variability, climate and ecosystem dynamics during the Late Pleistocene (∼100 ka to ∼10 ka). Despite the importance of this ice sheet, its evolution and dynamics through much of the pre-Last Glacial Maximum (pre-LGM; ∼24 ka) interval is poorly constrained owing to widespread (but, importantly, incomplete) erosion of the chronostratigraphic record during the LGM advance. Accordingly, we have a relatively poor understanding of the onset of ice sheet growth toward the LGM, along with few insights into the climate system that persisted during times of long-term continental glaciation. To constrain the pre-LGM evolution of the Laurentide Ice Sheet, we focus on information that can be gleaned from portions of the chronostratigraphic record that escaped erosion. We conducted a literature review and identified >800 geochronological determinations from sub-till sites in the glaciated region of Canada. Preservation of these stratigraphic records tends to be clustered in low-lying regions including the Great Lakes, St. Lawrence Lowlands, and Hudson Bay Lowlands. Preserved stratigraphic sequences represent a wide range of pre-LGM environments (e.g. fluvial, peatland, erosional surfaces) and were largely dated to the ∼100 to ∼24 ka interval using radiocarbon dating, U-Th dating, and optically stimulated luminescence. Given that sample collection took place over the span of several decades by a wide variety of stratigraphic workers, these data span a wide range of uncertainties. Thus, a key component of this work is the quantification of uncertainties in the chronostratigraphic dataset. This work yields series of maps showing the most likely ice sheet extents for each Marine Isotope Stage from MIS 5e to MIS 3. Hypothesized ice extents are compared with available geomorphological records (glacial lineations and striations) and records of sea level. We present these maps as “best guesses” of the ice sheet configuration during pre-LGM times and we expect that they will inform key areas in which to focus future chronostratigraphic efforts. Owing to the interconnectedness of ice sheet with many elements of the Quaternary climate system, these ice sheet constraints will be of interest wide scientific audience, notably to numerical modellers who require empirically-derived ice margins for new iterations of ice sheet and sea level models.