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The variability of the isotopic signal during the last Glacial as seen from the ultra-high resolution NEEM and NorthGRIP ice cores.

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The continuity and high resolution available in polar ice core records constitutes them an excellent tool for the study of the stadial-interstadial transitions, notably through the study of the water isotopic composition of polar precipitation $\left(\delta^{18}\mathrm{O},\ \delta\mathrm{D}\right)$. The quest for the highest resolution possible has resulted in experimental sampling and analysis techniques that have yielded data sets with a potential to change the current picture on the climatic signals of the last Glacial. Specifically, the ultra-high resolution $\delta^{18}\mathrm{O}$ signals from the NorthGRIP and NEEM ice cores, present a variability at multi-annual and decadal time scales, whose interpretation gives rise to further puzzling though interesting questions and an obvious paradox.

By means of simple firn isotope diffusion and densification calculations, we firstly demonstrate that the variability of observed signals is unlikely to be due to post depositional effects that are known to occur on the surface of the Greenland ice cap and alter the $\delta^{18}\mathrm{O}$ composition of the precipitated snow. Assuming specific values for the $\delta^{18}\mathrm{O}$ sensitivity to temperature (commonly referred to as the $\delta^{18}\mathrm{O}$ slope), we estimate that the temperature signal during the stadials has a variability that extents from interstadial to extremely cold levels with peak-to-peak fluctuations of almost 35 K occurring in a few years. Similarly, during interstadial phases the temperature varies rapidly from stadial to Holocene levels while the signal variability shows a maximum during the LGM, with magnitudes of up to $15‰$ that translate to ≈ 50 K when a $\delta^{18}\mathrm{O}$ slope of $0.3‰\mathrm{K}^{-1}$ is used. We assess the validity of these results and comment on the stability of the $\delta^{18}\mathrm{O}$ slope. Driven by a simple logical queue, we conclude that the observed $\delta^{18}\mathrm{O}$ variability reflects a climatic signal although not necessarily attributed 100% to temperature changes. From this we can assume that there occur climatic mechanisms during the previously thought stable stadial phases that allow for swift changes, with magnitudes comparable if not greater to that of the stadial-interstadial transitions. We are thus tempted to propose that rapid climate change is the normal mode of climate during the last Glacial and that some of the mechanisms associated with the stadial-interstadial transitions are possibly in play also during other, phenomenally more stable times of the Glacial climate record.