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Post-depositional processes visible in the integration of EGRIP high-resolution water isotope record and visual stratigraphy

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With recent advances in analytical techniques, water stable isotope ratios can be measured in astounding detail in ice core records (~mm scale or equivalent to subannual resolution). While this has enabled the study of past climates across a vast range of timescales, the full set of processes driving the highest frequency variability in these water isotope records remains poorly understood. In the EastGRIP ice core, we observe a strong relationship between high-frequency water isotope anomalies (sharp transitions on the scale of cms) and variability in the visual stratigraphy of the ice. The water isotope timeseries reveals these anomalies that would otherwise be missed using traditional lower resolution discrete sampling methods (5-50 cm scale). A comparison with the dark-field imaging of stratigraphic layers (high-resolution line-scanning system; 50µm/pix) from the EGRIP ice core indicates a correlation between bubble-free ice layers and the sharp transitions observed in the isotope record. Prior to this comparison, such anomalies in high-resolution isotope records were often dismissed as analytical artifacts. The striking correspondence to the bubble-free ice layers, which is a parameter measured independently from the isotopes, suggests the isotope variability is real. We are investigating a range of depositional and post-depositional processes that may may be able to explain the origin of this variability and its relationship to the physical properties of the ice. This study has implications for frequency analysis of the isotope data, and the related analysis of isotope diffusion and its effects on the recorded climate signal. Understanding these anomalies opens new doors to the interpretation of climate signals in ice cores.

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