Reviewer 2 Summary

The study by Brashear et al. shows how stable water isotope interannual variability on the Greenland ice sheet changes throughout the Last Glacial, being stronger during stadials than interstadials, with peaks preceding D-O events by hundreds of years.

They adjusted minor irregularities in the text and further
· show the robustness of their results towards diffusion correction,
· discuss possible uncertainties of the diffusion estimates related to systematic density changes,
· show in a graphic how accumulation rates coevolve with the high frequency isotope variability.

With this, they address some of the issues we raised in the first review. We therefore think that the paper is in a good state for publishing.

We have just a few comments left to revise:

Two minor comments:

1) Fig. 8A; Thanks for adding this graphic. In the review answer you state: “As expected, declines in variability lead accumulation shifts by hundreds of years for most D-O events. This suggests precipitation intermittency and stratigraphic noise during cold stadial phases cannot account for the early shifts in 7-15 year variability, relative to D-O warming”. As changes in stratigraphic noise and precipitation intermittency with time cannot be quantified, while higher accumulation rate changes might facilitate signal preservation, (which do seems strongly correlated to high frequency variability), noise changes could still be a reason for variability changes, which should still be stated in the text as one (counter?) hypothesis.
    - Its important to note that higher accumulation rates (interstadials) are associated with lower high-frequency variability in this study, which is in contradiction to your comment above
    - The following text has been included at line 385 to consider the effects of stratigraphic noise: “ There are additional explanations of the lead-lag result, though they currently lack strong evidence. The first variable to consider is stratigraphic noise, which is non-climatic variability imparted to the water isotope record due to processes like precipitation intermittency, surface sublimation, and wind-driven snow erosion. Stratigraphic noise hinders the extraction of climate-induced high-frequency signals during low accumulation phases (e.g. LGP stadials), thus raising concerns that local depositional processes may also drive the results presented in this study. Unfortunately, the temporal evolution of stratigraphic noise cannot be quantified directly and currently, there are no LGP signal-to-noise ratio comparisons with nearby Greenland ice cores. Still, contributions of non-climatic noise are likely state dependent (e.g. GI vs GS

phases) and inherently linked to accumulation rate. EGRIP 7-15 year variability also exhibits a centennial lead-lag with accumulation, suggesting the primary driver for this deviation lies elsewhere (Fig. A8)."

2) While we acknowledge that the specifics of the diffusion correction do not alter the results, we insist that the method description must be comprehensive enough to ensure full reproducibility, as this is standard good scientific practice.
   - Currently, it is unclear in which frequency range the fit is performed or how this range is determined (e.g., manually for each depth or using a single range).
     - The following text has been added on line 173 to address this comment: "The EGRIP δD diffused interval ranges between the 2-25 year band, and the Gaussian fit is optimized by manually adjusting this interval for each age window. This ensures the diffusion length is not calculated based on measurement noise, which occurs at an even higher frequencies and can be identified as a sudden bend in the slope of P(f)."
   - Additionally, it is unclear whether the fit is applied to P or ln(P) , as suggested in line 190: "Diffusion length, sigma_a , can also be quantified as the slope, m , of a linear regression, y , fitted to ln[P(f)] versus f^2 of the diffused interval." The references cited use different approaches. If I read it right, Kahle (2021) accounts for the red CFA spectra by fitting two Gaussian distributions, whereas Jones et al. (2018) uses only one Gaussian "fits to the frequency at which there is a distinct slope break in ln(PD) ." Therefore, simply citing these references does not provide the reader with a reproducible method.
     - At line 190, we have clarified that this is an alternative approach to calculate diffusion length, in which the slope of a linear regression fitted to ln[P(f)] vs f^2 represents the diffusion length. The citations associated with this section are (Jones et al. 2017b, 2018): "Diffusion length, σ_a, can be alternatively quantified as the slope, *m*, of a linear regression, *y*, fitted to ln[P(f)] versus f^2 of the diffused interval. Uncertainty bounds are defined as maximum and minimum slopes within one standard deviation of *y* (Jones et al. 2017b, 2018) (Fig. A4)."
     - Kahle (2021), along with several other papers, is cited earlier in the methods section as an example of a study that uses spectral analysis to estimate cumulative mean water isotope diffusion in a water isotope record. Kahle (2021) is not meant to represent the methods outlined. Rather, we cite Jones et al. (2017b, 2018) throughout the description of methods used where only one Gaussian fit is used.