Author Response to the Comments of Referee #2 to the manuscript "Water vapour isotopes over West Africa as observed from space: which processes control tropospheric H2O/HDO pair distributions?" [EGUSPHERE-2024-1613] submitted to Atmospheric Chemistry and Physics.

We would kindly thank the anonymous referee for providing a review of the manuscript. The individual comments are listed below (shown in red) including our responses (shown in black).

"This manuscript investigates water vapor isotopes (H2O and HDO) over West Africa, focusing on the West African Monsoon (WAM). Using satellite data from IASI, AIRS, and TROPOMI, the study analyzes moisture pathways and isotopic variations during different monsoon phases. Key findings include an anti-correlation between H2O and δD over the Sahel during monsoon convection, driven by dry air intrusions, while the Guinea Coast shows moist, enriched air without significant δD depletion. The study highlights the value of paired isotopic observations in understanding tropical convection and moisture processes in the region. Overall, this manuscript is well written, and no additional observations or model simulations seem necessary. However, a few minor revisions or updates could help clarify the study and improve the understanding of WAM mechanisms."

Thank you for the constructive feedback!

Comments

"1. Monsoon retreat phase. The monsoon consists of rainfall systems moving the convection area north and south. However, this study covers the monsoon onset but lacks analysis of the retreat (withdrawal) phase. There could be asymmetry due to land-sea contrasts and seasonal mean state differences."

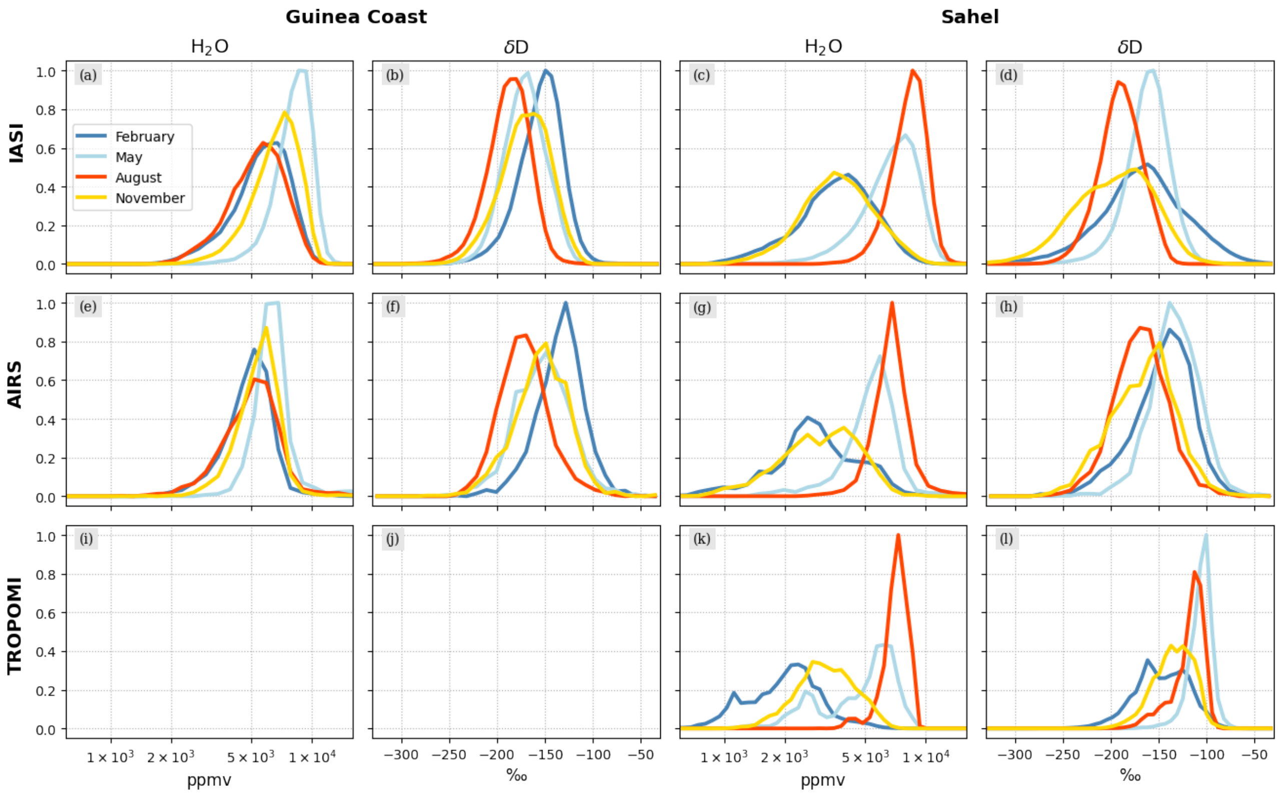
This is indeed an interesting research question. In our study, the clustering method applied to identify non- and post-rain events is targetting the monsoon onset phase, as here we expect a clear and sharp transition from the mixing-dominated pre-onset stage to the convection-dominated post-onset stage. In this way, we aimed to characterize the impact due to convection as opposed to the impact due to air mass mixing, with both being identified as substantial factors for controlling mid-tropospheric {H2O, δD} data (see e.g. Diekmann et al. 2021a).
We agree that a potential asymmetry during the retreat may exist and could point towards further control factors, however, this would exceed the actual scope of this study. We will add it as limitation to this study and mention it as future perspective.

"2. Figures showing contrast. Throughout the figures (e.g., regarding non-rain & post-rain periods, Guinea Coast & Sahel), the differences are not clearly visible (except during the monsoon peak month of August) for readers to capture the changes in H2O and δD pairs. The authors may consider adding additional figures highlighting these differences to better illustrate which processes or regions are associated with enrichment or depletion as moisture changes."

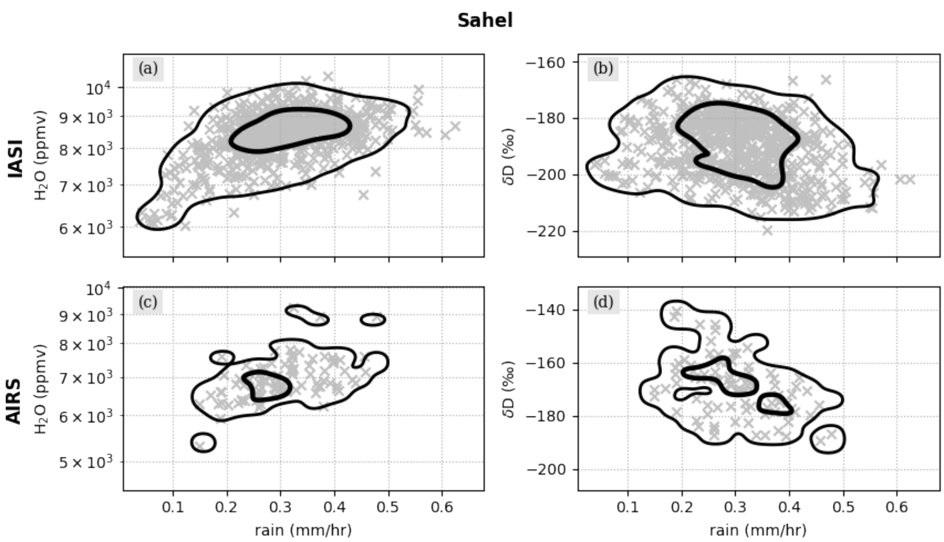
Thank you for the valuable feedback. We understand that some plots throughout our manuscript contain quite a lot of information and that it may become difficult to grasp the relevant differences in H2O and δD. Therefore, we will add the following figures and the corresponding discussions with the aim to further underline the differences between distributions of H2O and δD:

→ The following figure complements the analysis for Fig. 9 that shows the paired {H2O, δD} distributions of IASI, AIRS and TROPOMI for the months February, May, August and November for the respectively available years. To underline the differences in H2O and δD for the different periods and regions, we have visualized the H2O and δD distributions from Fig. 9 separately as probability density functions. It reflects the features described throughout the analysis of Fig. 9, e.g. that for the Sahel

data from IASI and AIRS δD shows a clear drop from winter to summer, while H2O increases. In contrast, over the Guinea Coast we don't observe aconsiderable change in H2O between winter and summer, whereas the summer δD is lower than winter δD.
In this way, this figure further underlines the contrasts between H2O and δD distributions for the different regions and time periods.



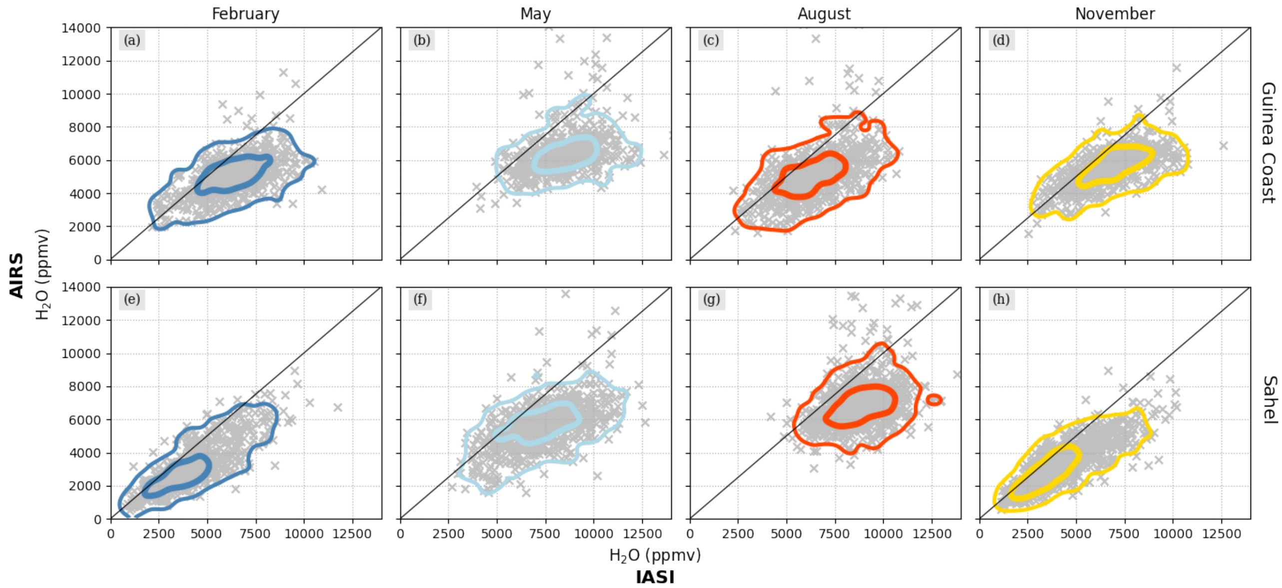
→ In order to emphasize the contrasts between H2O and δD distributions, we would like to mention the following figure, that was created based on a comment from the other reviewer (see other review) and serves to further underline contrasts in distributions of H2O and δD. It shows the correlation between rainfall vs. H2O and δD vs. rainfall for IASI and AIRS monthly averages of the August data for all respectively available years. It underlines the different response of H2O and δD to increased rainfall rates, where in particular δD shows decreasing trends for increasing rainfall rates, while H2O shows opposing features. In this way, this figure clearly emphasizes differences in distributions of H2O and δD as response to rainfall:

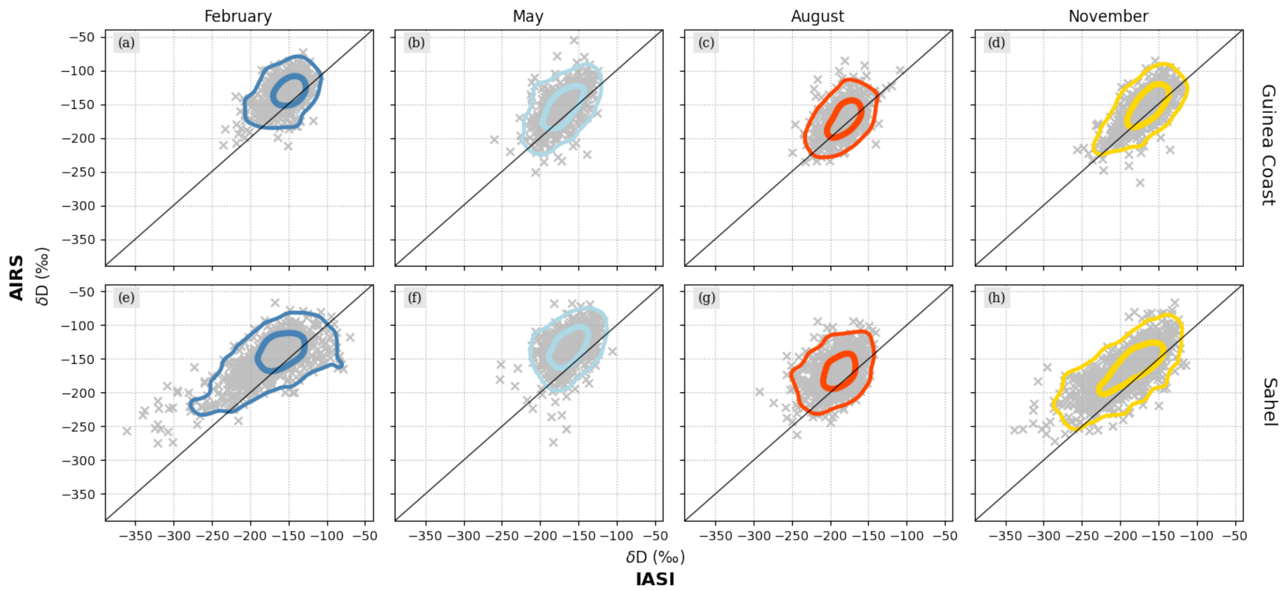


"3. Satellite dataset uncertainty. The authors mention the previously reported uncertainty in the three satellite datasets, but the reliability of using them specifically for the WAM region is not clearly addressed. Please quantify this uncertainty more explicitly, not only through percentage contours or whisker plots for individual datasets but also by considering the spread between the two datasets (IASI and AIRS). Additionally, the authors could emphasize the benefits of using water isotopes, for instance, by showing more distinct anomalies in δD compared to H2O in those datasets."

Thank you for the constructive suggestion. We have decided to add following figures and their discussion to the manuscript:

→ The following figure shows the scatter between IASI and AIRS for the regions and periods shown in Fig. 9 (i.e. Guinea Coast vs. Sahel, during February, May, August and November). It demonstrates the overall good agreement between the data from the instruments and reflects differences that have been discussed in the course of Fig. 9, e.g. deviations in δD for low values, bias in IASI towards higher H2O and towards lower δD values:





→ In addition, the figure containing the PDFs for H_2O and δD from the response to the previous comment serves to further assess the agreement between IASI and AIRS. Despite some differences in their absolute comparison (as shown in the previous figure), the PDFs of H_2O and δD reveal that the overall distribution shapes are well-reflected in both datasets for the considered regions and time periods. Probably the largest difference appears for the δD PDFs during February, which however is a result of the observation that IASI covers a larger range in δD compared to AIRS during February, so that the corresponding IASI δD PDF is wider and more shallow than the AIRS δD PDF.

We will add the figures and the corresponding discussions to the relevant sections.