About the study

Overall, I find the study interesting with potential to contribute to deepening our understanding of soil-atmosphere water vapour exchange in semi-arid regions. The study investigates soil–atmosphere water vapor exchange in a semi-arid region of the Loess Plateau, Yan'an, China. Using fiber Bragg grating (FBG) sensors, the authors monitored vertical vapor fluxes across a 7 mm dry soil layer and a 10 mm molecular diffusion layer in the air. They collected field data for an eleven-month period, from August 2022 to June 2023, alongside meteorological observations. Their results showed that solar radiation increased vapor fluxes by raising the vapor pressure deficit (VPD), with soil fluxes responding more slowly than air fluxes, lags reached up to 120 minutes in winter. Rainfall events suppressed fluxes as VPD dropped to near zero, but post-rainfall recovery differed as air fluxes rebounded quickly via surface evaporation, while soil fluxes rose gradually as subsurface moisture dried. They used the Structural equation modeling which showed that air fluxes were strongly influenced by solar radiation, temperature, and VPD, whereas soil fluxes were mainly governed by VPD. Through this study we have an understanding of fine-scale soil–atmosphere coupling under variable climate conditions in semi-arid region which could as well be similar in other semi-arid regions of the world.

Nonetheless, I find a few issues, as itemized below, that I feel if addressed have potential to enhance the overall quality of the paper.

2.1 Site selection

Lines 76 – 87:

While variables like elevation, climate and soil type have been described to a satisfactory level, there is complete lack of information on the vegetation cover and land use. This section, I believe, could benefit from the inclusion of a site description of the vegetation cover and land use, since these factors influence soil-atmosphere exchange. Even if the study focused on bare soil surfaces there is need to describe the vegetation type and land use adjacent the study site and state if the study site was originally covered by a particular vegetation type which was only removed for experimental purposes. I recommend the authors considers including this aspect here.

Furthermore, I think it would help the reader to have the study site **Figure S1 in the supplement** brought into the main document under the study site section.

2.2 Field monitoring and setup

Line 92: While the fiber Bragg grating (FBG) system is described in the supplementary information it would be helpful to the reader to bring that information here, section 2.2, so that the reader is able to follow especially that this is the central approach of the study.

Figure 1 is difficult to follow. I think there is room for improvement here. The figure should be easy to understand.

Lines 95-97: "Previous evaluations have demonstrated that the sensors exhibit a compact form factor, high measurement accuracy, low hysteresis, excellent repeatability, and long-term stability (Guo et al., 2023)."

This sentence is not clear. What is this sentence referring to? If possible, please state the evaluations this statement is referencing?

Lines 100 -101: "Three identical sets of FBG sensors were deployed to investigate spatial variations in vapor flux under different microclimatic

conditions." What is the separating distance between the three identical FBG sensors so as to provide insight in the level of variability and whether this is on the same soil type.

Lines 88 – 132: This is a highly technical section and the authors have attempted to describe the experimental setup. However, in my view, there are some gaps. There is limited discussion of calibration and validation processes used in the study. There is no discussion on the potential sensor biases and how these were handled. Sensor calibration and validation are key aspects of this type of study. I would recommend the authors provide information on how the calibration, validation and biases were handled.

As earlier indicated, this study focused on bare soil; vegetation effects are only briefly mentioned in supplementary figures i.e., **Figure S4.** There is need to provide some level of detail on the vegetation and land use and the potential effect on the results of the study. **In my view, if possible, photographs of the study site would be helpful in providing some insights and clarity on the sites being described.** The descriptions in Figure S4, the description of the set-up of the study regarding bare-soil sites is difficult to **understand.** How does Figure S4 speak to the bare-soil field set up?

Figure 2. The date range for data is from 2022 to 2025 yet in the description of the study the time frame provided is August 2022 to June 2023 (Lines 105 – 107). Why this discrepancy?

Limitations of the study

The authors have not explicitly indicated the limitations of their study. I think they can say a few things on the following aspects:

i) The study was conducted on bare soil surfaces, with only preliminary comparative data under vegetated and shaded conditions mentioned in the supplementary figures. This suggests limited generalization to vegetated landscapes.
ii) The monitoring period (August 2022 – June 2023) covers less than two full years, so long-term climatic variability is not fully captured.
iii) The sensors were embedded at only three vertical positions (1 cm above, at the interface, and 7 mm below), meaning vertical resolution is constrained to very fine but limited depths.
iv) The authors note that traditional eddy covariance methods are ineffective in the millimeter-scale molecular sublayer, which is why they used fiber-optic sensors. This highlights a methodological boundary implying that their results are specific to this novel technique and may not be directly comparable to conventional flux measurements.

Results and Conclusions

I think I will have better appreciation of the results and conclusions after clarity has been provided on the characteristics of the study site in terms of land use, land cover and other associated variables that could influence the results and consequently the conclusions.