Dear Reviewer,

Thank you so much for taking care of our manuscript and we appreciate the opportunity to revise it with comprehensive comments. We highly appreciate the detailed valuable comments from the referees on our manuscript of "A Multi-Angle and Polarization-Based Retrieval Algorithm for Aerosol Layer Height of Smoke and Dust". The suggestions are quite helpful and we have incorporated them in the revised version of manuscript. And we hope that the reviewers and the editors will be satisfied with our responses to the 'comments' and the revisions for this manuscript. Please find our detailed responses below to all these comments/suggestions.

Yours sincerely,

Yong Xue

The vertical distribution of aerosols plays significant roles in solar radiation transfer and climate change. The authors use a vector radiative transfer model and information content analysis and evaluate the contributions from key factors, including multiangle and polarimetric information to ALH retrieval. The authors also do some case and sensitivity studies and found that multiangle polarimetric measurements substantially increase the degrees of freedom for signal and improve ALH accuracy. An optimal estimation method is developed. Retrieved ALH values are validated against observations and showed reasonable estimations, such as HARP2 retrievals achieve a root mean square error of 1.03 km. Generally, this manuscript is well organized, written and explained. Some minor comments and suggestions are given.

Response:

We sincerely thank the reviewer for the careful evaluation of our manuscript and for the constructive comments and suggestions. We appreciate the reviewer's positive assessment of our work. Following the reviewer's suggestions, we have revised the manuscript to improve the clarity of the description, strengthen the physical interpretation of the results, and further streamline the presentation. The detailed responses to each comment are provided below.

L143, please explain I, Q, and U.

Response:

Thank you for this suggestion. We have added explanations of the Stokes parameters I, Q, and U at their first appearance in the revised manuscript to improve readability.

Revision:

Lines 199-201: Based on this capability, this study develops a joint retrieval method using multi-angle radiance intensity (I) and linear polarization measurements (Q and U) from HARP2 to improve the sensitivity and accuracy of ALH retrieval.

L145, please rewrite "I represents total radiance intensity ……".

Response:

Thank you for your suggestion. We have moved the sentence to Section 3.1 and

rephrased it to provide a more concise and accurate description of the Stokes parameters.

Revision:

Lines 340-344: UNL-VRTM is based on the VLIDORT model (Spurr, 2006) and computes the Stokes vector $[I, Q, U, V]^T$, where I represents radiance, and Q and U denote the linear polarization components (Wang et al., 2014; Xu and Wang, 2019). Circular polarization (Stokes parameter V) is generally negligible in atmospheric studies (Gassó and Knobelspiesse, 2022).

L149-150, "while Q and U denote the linear polarization components that characterize the polarization state of the scattering field" could be removed to L143.

Response:

We appreciate this suggestion. We have moved this description of Q and U to line 143.

L237, "Conversely" could be improved by using another word.

Response:

Thank you for pointing this out. We have replaced "Conversely" with "In contrast" in the revised manuscript to better describe the relationship between the two statements.

L286-287, "the information content of ALH shows a clear decreasing trend with increasing wavelength, i.e., 441 nm > 549 nm > 669 nm > 873 nm", more explanations about the information content of ALH and the mechanism of this sentence are suggested.

Response:

We thank the reviewer for this valuable suggestion. We have added further explanations regarding the physical mechanism responsible for the wavelength dependence of ALH information content. Specifically, the ALH information content is quantified by the DFS, which represents the amount of independent information on ALH provided by the observations. Shorter wavelengths exhibit stronger Rayleigh scattering, resulting in enhanced sensitivity of the top-of-atmosphere radiance to variations in aerosol vertical distribution. In contrast, Rayleigh scattering decreases rapidly with increasing wavelength, leading to reduced sensitivity to aerosol layer height at longer wavelengths. The corresponding explanations have been added to the

revised manuscript.

Revision:

Lines 412-416: These results indicate that shorter wavelengths have a clear advantage for ALH retrieval. This behavior is primarily attributed to stronger Rayleigh scattering at shorter wavelengths, which enhances the sensitivity of the radiative field to changes in atmospheric vertical structure. In contrast, Rayleigh scattering weakens at longer wavelengths, leading to a significant reduction in sensitivity to layer height.

L465, "This study selects three representative smoke transport events over North America on May 28, May 30, and June 1, 2025" can be removed and combined to L444-445. Please explain why the selected 3 and 6 events is representative.

Response:

Following the reviewer's suggestion, we have moved the introduction of the selected smoke cases to the beginning of the case study section and removed the redundant description. The subsequent text has been revised to focus on the physical characteristics and representativeness of these cases.

Revision:

Lines 695-704: The selection of these cases was based on multiple objective criteria rather than retrieval performance. First, all selected events correspond to well-documented and widely studied biomass burning and dust transport episodes. Second, only cases with simultaneous high-quality observations from HARP2 and TROPOMI on the same day were retained to ensure reliable cross-sensor comparison. Third, strong aerosol loading conditions, characterized by elevated AOD and clearly identifiable aerosol plumes in true-color imagery, were prioritized to guarantee sufficient signal strength for multi-angle polarimetric retrieval. Fourth, scenes with minimal cloud contamination were selected to reduce uncertainties associated with cloud–aerosol mixing. Finally, spatially coherent and continuous aerosol plumes within the study region were required to ensure consistency among different satellite retrieval products.

6 Conclusion, is a little longer and should be shortened. Please report the key conclusions.

Response:

We appreciate the reviewer's suggestion. The conclusion section has been

shortened and revised to focus on the key findings of this study.