Dear Referee #1,

We sincerely thank you for the careful and constructive evaluation of our manuscript entitled "**A Compact Fabry-Perot Interferometer with a Solid Etalon for Measuring Upper Atmospheric Wind and Temperature**." We greatly appreciate your positive assessment of the scientific relevance and instrumental contribution of this work. The comments have helped us improve the clarity, rigor, and presentation of the manuscript.

We have carefully considered all the comments and have revised the manuscript accordingly. In particular, we have clarified the physical basis of the solid-etalon instrument function, provided additional information on the fitting parameters, moderated the interpretation of the temperature intercomparison, clarified the temporal matching procedure, added statistical metrics, and unified several terms and definitions throughout the manuscript. Our detailed responses are provided below. The reviewer's comments are reproduced **in bold**. Our responses and descriptions of the corresponding revisions are in blue. Reversions in the manuscript are marked in purple.

Comment 1: The manuscript states that the conventional FPI instrumental function is modified to account for the solid etalon, but only the final equation is presented. Since the solid etalon is the central methodological novelty of this study, the physical basis of the modified Airy function deserves a more explicit explanation. In particular, the manuscript should clarify how the phase term is modified when the etalon is filled by fused silica. In addition, in the derivation of the instrument function, Equation (1) includes three parameters: I0, I1, and I2. The text only briefly describes these as "constant coefficients". Please clearly specify the specific physical meanings or mathematical fitting roles of these three coefficients within the model to help readers better understand the retrieval algorithm.

Response: We thank the reviewer for this important comment. We agree that the physical basis of the modified Airy function and the roles of the fitting coefficients should be described more explicitly, particularly because the solid etalon is a key component of the SEFPI.

In the revised manuscript, we have expanded the description of the instrumental function and clarified that, for the solid fused-silica etalon, the phase term is determined by the optical path difference inside the solid medium. Specifically, the phase term is expressed as a function of the refractive index (n), the etalon thickness (t), the wavelength (λ), and the internal incidence angle (θ). Thus, compared with an air-spaced etalon, the refractive index of fused silica explicitly contributes to the optical phase and consequently to the transmission profile of the etalon.

We have also clarified the roles of I0, I1, and I2. These coefficients are treated as fitting parameters in the spectral forward model and account for the average intensity level, the linear

falloff of intensity, and the quadratic falloff of intensity, respectively.

The corresponding description and equation have been revised in Section 3 of the manuscript. We believe that these additions make the forward model and the subsequent retrieval procedure clearer and more reproducible.

The second paragraph of Section 3 of the manuscript (Lines 129-145) has been revised as follows:

"Unlike conventional FPIs equipped with air-spaced etalons, the SEFPI employs a solid fused-silica etalon. Therefore, the instrument function commonly used for air-spaced-etalon FPIs cannot be directly applied to the SEFPI. To account for the optical properties of the solid etalon, the forward model is reformulated by explicitly incorporating the refractive index of the solid medium and the corresponding optical path difference (OPD).

For a solid etalon, the OPD between the two transmitted beams after passing through the etalon can be expressed as,

$$OPD = 2nt\sqrt{1 - \left(\frac{sin^2(\theta(r))}{n^2}\right)} \quad (1)$$

Accordingly, the phase term in the instrument function can be written as,

$$\varphi = \frac{2\pi}{\lambda} \cdot OPD \quad (2)$$

Taking into account the actual imperfections of the optical system, the instrument function for the solid etalon is then formulated from the Airy function as,

$$\tilde{A}(r,\lambda) = \int_0^{r_m} b(s,r) \cdot \frac{I_0\left(1+I_1\left(\frac{s}{r_m}\right)+I_2\left(\frac{s}{r_m}\right)^2\right)}{1+\frac{4R}{(1-R)^2}\cdot\sin^2\left(\frac{\varphi}{2}\right)} ds \quad (1)$$

Here, λ denotes the nightglow emission wavelength, r represents the radial distance of the fringes, and s is a dummy variable corresponding to r. R, n, and t refer to the reflectivity, refractive index, and thickness of the solid etalon, respectively. $\theta(r)$ is the angle between the interference fringes and the optical axis, while r_m represents the maximum fringe radius. The parameters I_0, I_1, and I_2 denote the attenuation coefficients corresponding to average intensity, linear falloff and quadratic falloff, respectively. Finally, $b(s,r)$ is the point-spread function characterizing optical defects, as defined in Harding et al. (2014)."

Comment 2: The temperature comparison between the SEFPI at SIZW and the reference FPI at XLO shows a correlation coefficient of 0.86, but also a mean temperature difference of 62.38 K and a standard deviation of 69.89 K. The regression slope is only 0.77, with an intercept of 255.72 K. Although the authors provide a reasonable discussion of possible causes, including differences in spatial sampling and OH contamination, the magnitude

of the systematic temperature difference is relatively large. More importantly, the two FPIs are separated by approximately 502 km. Therefore, this comparison should not be interpreted as a direct validation of the absolute temperature accuracy of the SEFPI, because the two instruments do not observe the same atmospheric volume and may experience different thermospheric conditions. The authors are encouraged to revise the relevant discussion and describe this result more appropriately as a temperature intercomparison, temperature consistency, or preliminary temperature validation. The limitation associated with the spatial separation should also be explicitly acknowledged.

Response: We sincerely thank the reviewer for this insightful and constructive comment. We completely agree that given the ~502 km spatial separation between the SEFPI at SIZW and the reference FPI at XLO, the two instruments do not observe the identical atmospheric volume and are likely subject to different local thermospheric conditions. Unfortunately, the XLO station lacks the necessary infrastructure to support the co-located installation and simultaneous observation of both the SEFPI and the reference FPI. Consequently, we had to rely on observations taken at a distance of 502 km for this initial field campaign. However, given the high correlation (R=0.86) and the generally consistent temporal evolution observed on most nights, we believe this comparison provides a valuable reference for the temperature measurement consistency of the SEFPI. Furthermore, we completely share your perspective on the necessity of spatial colocation. Therefore, we explicitly outlined in the "Conclusion and discussion" section of our manuscript that our future work will focus on conducting co-located simultaneous observations to thoroughly verify the reliability of the temperature measurements.

Following your highly constructive suggestions, we have carefully revised the manuscript to appropriately frame this result:

In Abstract (Lines 16-18): We revised: “Preliminary field validation and intercomparisons were conducted via coincident ground-based measurements with two interferometry techniques.”

In Section 5.2 (Lines 296-300): We added: “It is important to note that due to the ~502 km spatial separation between the SIZW and XLO stations, the two instruments do not observe the identical atmospheric volume and may experience different local thermospheric conditions. Therefore, these results should be interpreted as a temperature intercomparison and preliminary temperature validation demonstrating relative consistency, rather than a direct validation of the SEFPI’s absolute temperature accuracy.”

In Section 6 (Lines 344-345): We added: “Consequently, this spatial separation limits the current comparison to a preliminary temperature consistency check rather than a direct validation of absolute temperature accuracy.”

Comment 3: The field comparison is one of the important validation components of the paper, but the manuscript does not provide sufficient details on how measurements from

different instruments were paired in time. The SEFPI integration time is 300 s, while the DCOI has a temporal resolution of approximately 26 min and the XLO FPI has a complete observation cycle of approximately 31 min. The authors should specify: the temporal matching criterion, whether linear interpolation was used, whether the different integration times were taken into account.

Response: Thank you for your helpful suggestion. We agree that the temporal matching procedure should be described explicitly because the three instruments have substantially different observation and integration times. In particular, the SEFPI and DCOI measurements had an integration time of 5 min and a temporal resolution of approximately 26 min, while the FPI used an integration time of 100 s for each of its three channels and a temporal resolution of approximately 31 min. In the revised manuscript, we have added a detailed description of the temporal matching procedure used for the field comparisons. The comparison was performed based on the observation timestamps of the measurements. We have clarified the temporal matching criterion and specified how the measurements with different integration periods were handled.

We have added the following data process description to the Section 5 (Lines 220-228):

"Before cross comparison, the SEFPI, DCOI, and FPI observations were independently quality controlled by removing measurements affected by clouds, precipitation, or moonlight contamination, as identified from cloud sensor measurements and all-sky airglow images. For the wind measurements, the northward and southward observations were first interpolated to common observation times and then averaged to obtain the representative meridional wind, while the eastward and westward observations were processed similarly to derive the zonal wind. For the SEFPI and FPI temperature measurements, observations from the five viewing directions were interpolated to a common reference time, such as the zenith observation time, and then averaged. Finally, to account for the asynchronous sampling of the three instruments, the DCOI and FPI measurements were linearly interpolated to the corresponding SEFPI observation times and subsequently compared with the SEFPI measurements for the wind and temperature analyses."

Comment 4: In Fig. 7 and 9, the RMSE can also be provided, together with mean bias μ.

Response: We thank the reviewer for this suggestion. Accordingly, we have added the root-mean-square error (RMSE) to the statistical analysis of the field comparisons. For the wind comparison between the SEFPI and DCOI at the SIZW station, the RMSEs of the meridional and zonal wind components are 29.4 m/s and 19.88 m/s, respectively. For the comparison between the SEFPI at SIZW and the FPI at XLO, the corresponding RMSEs are 18.33 m/s and 17.91 m/s for the meridional and zonal wind components, respectively. For the temperature comparison, the RMSE is 96.96 K.

The RMSE provides a quantitative measure of the overall discrepancy between the SEFPI measurements and the reference observations, while the mean difference characterizes the average systematic offset. Together, these metrics provide a more comprehensive assessment of the agreement and measurement differences among the instruments. The corresponding RMSE values have been added to the relevant panels in Figures 7 and 9 of the manuscript.

The Figures 7 and 9 of the manuscript have been revised as follows:

Figure 7:

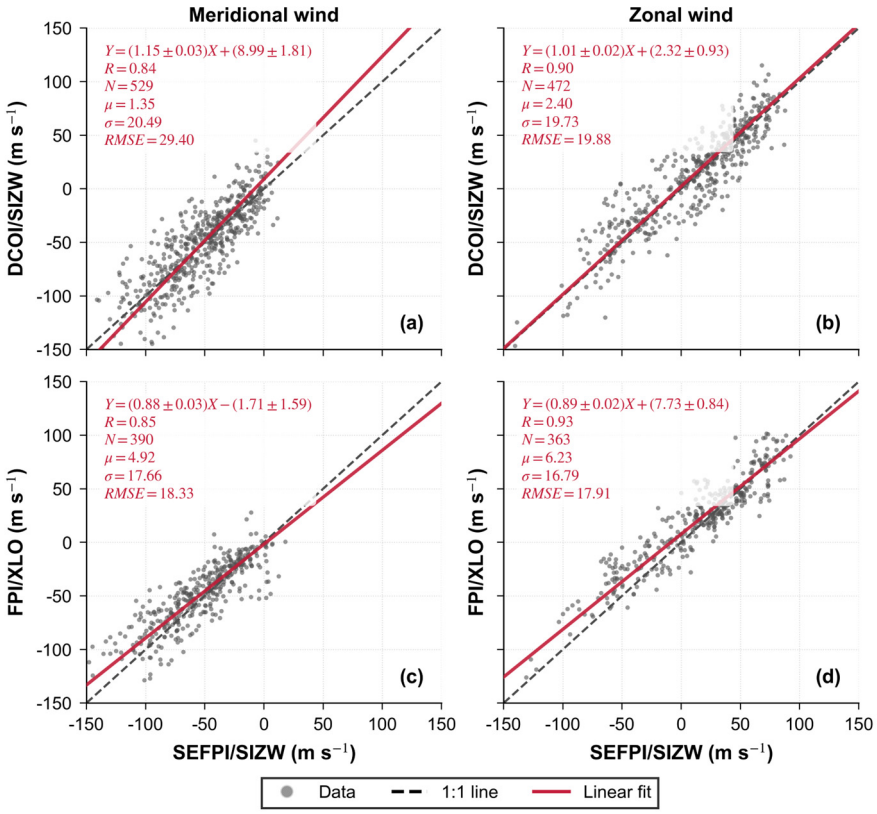
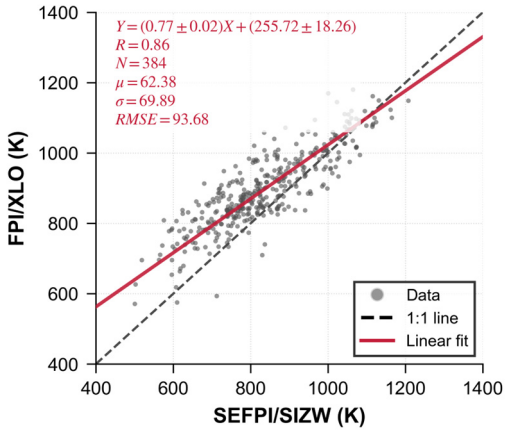


Figure 9:



Comment 5: The abstract states an "overall mean wind difference of 1.88 m/s", whereas the main text describes this quantity as a "mean absolute difference." To avoid ambiguity, I suggest using the same terminology throughout the manuscript and revising the abstract to "an overall mean absolute difference of 1.88 m/s".

Response: We thank the reviewer for identifying this inconsistency. We agree that the terminology should be unified to accurately describe the statistical quantity. We have therefore revised the Abstract and the corresponding descriptions in the main text to consistently use "an overall mean absolute difference of 1.88 m/s".

The relevant sentence in the Abstract (Lines 20-22) and Section 5 (Lines 266-268 and Lines 294-295) have been revised as follows:

Lines 20-22: "Statistical analysis yielded an overall mean absolute wind difference of 1.88 m/s relative to the co-located DCOI instrument and 5.58 m/s relative to the conventional FPI located 502 km away. Temperature comparisons between the two FPIs revealed a correlation coefficient of 0.86 and a mean absolute difference of 62.38 K."

Lines 266-268: "The SEFPI measurements were generally lower than the FPI measurements, with an overall mean absolute difference of 5.58 m/s and a standard deviation of the discrepancies below 17.66 m/s."

Lines 294-295: "The mean absolute temperature difference was 62.38 K, with the SEFPI generally yielding lower temperatures than the FPI."

Comment 6: The abstract refers to an "effective aperture diameter of 70 mm," whereas Table 1 lists the solid etalon diameter as "Φ= 70 mm." It is recommended that the authors clarify whether the reported 70 mm refers to the physical diameter, clear aperture, or effective optical aperture of the solid etalon. Consistent terminology should then be used throughout the manuscript.

Response: Thank you for your insight suggestion. We agree that "effective aperture diameter" and "physical diameter" should not be used interchangeably. In the revised manuscript, we have clarified that the reported 70 mm refers to the physical diameter of the solid fused-silica etalon, rather than an independently determined effective optical aperture. We have therefore removed or revised the term "effective aperture diameter" where appropriate and use "70 mm-diameter solid etalon" consistently throughout the manuscript.

We have revised the first sentence of Abstract (Line 11-12) as follows:

"A compact solid etalon Fabry-Perot interferometer (SEFPI) with a 70 mm-diameter solid fused-silica etalon has been developed for ground-based measurements of upper atmospheric winds and temperatures at an altitude of approximately 250 km."

Dear Referee #2,

We are grateful to the reviewer for the careful assessment of our manuscript entitled **"A Compact Fabry-Perot Interferometer with a Solid Etalon for Measuring Upper Atmospheric Wind and Temperature."** We sincerely appreciate the reviewer's positive evaluation and support for the publication of this work.