To Reviewer 1

We sincerely appreciate the reviewers' conscientious and meticulous evaluation of our manuscript. Your insightful and crucial suggestions have effectively addressed several oversights in our initial considerations, significantly enhancing the robustness and comprehensiveness of our study. We are truly grateful for your valuable contributions. All the comments from you have been considered in the revised manuscript. I will respond to each of your comments in red font below.

1. How much does the ASHS instrument drift during the Doppler velocity calibration? In the field configuration you have described, a krypton lamp is employed to monitor instrument drift. However, the krypton lamp was used during laboratory calibration to simulate airglow, and no synchronous light source was available to monitor instrument drift. How much does this affect the calibration results?

Reply:

All phase differences and their corresponding Doppler velocities are presented in Fig. 13(a). For the same set of data (at an identical Doppler velocity), the phase shift is predominantly caused by thermal drift, which can lead to substantial retrieval errors. Given the low luminance of the krypton lamp, an exposure time of 30 seconds per frame is necessary, which adequately captures the impact of thermal drift.

Consequently, an algorithm is employed to fit the thermal drift estimation curve through continuous sampling and piecewise fitting. This approach is based on the assumption that the trend of thermal drift remains consistent over a short period. The underlying principle involves quantifying the contribution of thermal drift to the phase shift throughout the experiment by fitting the thermal drift curve. Each data group is partitioned into two segments for fitting purposes, as the drift trend varies across segments. After eliminating the contribution of thermal drift, the results are depicted in Fig. 13(b). It is important to note that the detector operates continuously throughout the experiment, including during the intervals between two groups with different velocities (not illustrated in Fig. 13), as it takes approximately ten seconds for the speed to reach a stable state.

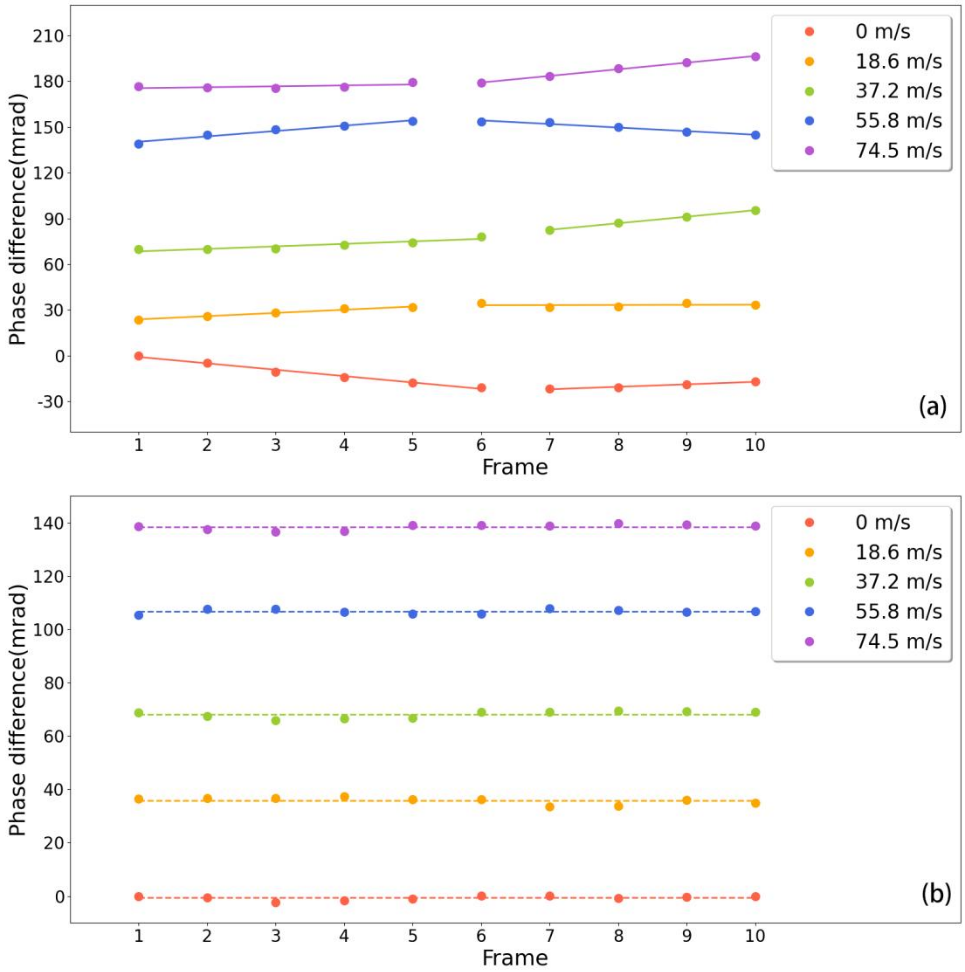

Fig. 13 (a) Continuously sampling and retrieval the phase difference when the Doppler velocity increases from 0 to 74.5 m/s. The solid line is the fitting line of the phase shift contributed to the thermal drift. (b) Phase difference after removing thermal drift contribution. The dash line is the average of the phase difference corresponding to each Doppler velocity.

2. In Fig.11, some of the observed data have very large error bars. This reason must be discussed, as the effective observation sampling rate is also a crucial indicator of an instrument.

Reply:

In the revised version, we have added a discussion on the reason.

Several primary factors contribute to the occurrence of large error bars in the ASHS instrument observations: Firstly, they manifest at the beginning and end of the observation period, primarily due to the degradation of the SNR of the airglow signal caused by the scattering of sunlight in the atmosphere during sunrise and sunset. Secondly, artificial light pollution in the observational environment or detector sampling errors can also lead to such large error bars. Thirdly, meteorological conditions, such as cloudy or rainy weather, play a role. Additionally, inherent variations in the intensity of the airglow signals themselves are another contributing factor.

3. How is the data from LiDAR weighted and averaged?

Reply:

The weighting function is a Gaussian function defined as:

$$y(z) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{(z - z_0)^2}{2\sigma^2}\right)$$

where z_0 is the peak height, σ is the standard deviation, and the Full Width at Half Maximum (FWHM) equals $2\sqrt{2ln2}\sigma$. We referred to Liu et al. (2025)'s results, and chose the peak height of 95 km and the FWHM of 12.5 km.

We have added the description of the weighting function.

4. The manuscript only compares data from different systems for a few days. Perhaps there should be more comparative data since 2024?

Reply:

Operational constraints limited Mohe station's Na lidar data set to five observational days during its commissioning phase in the early period of 2024. Our objective is to present the development of a ground-based ASHS system, with LiDAR being utilized in this context to validate that the new ASHS instrument is capable of measuring neutral winds in the mesopause. Subsequently, we will continue to conduct wind measurement analysis by integrating more long-term data. For the comparative analysis of data between ASHS and LIDAR as well as meteor radar, please refer to Liu et al. (2025).