We’d like to thank the editor for handling our manuscript, as well as anonymous referee #2 for reading our manuscript carefully and providing numerous professional comments and helpful suggestions. We believe they help us to improve the manuscript significantly and provide many useful ideas for our work.

We have carefully read through all the comments and questions and revised the manuscript accordingly. Please find our point-by-point response to referee #2 below. Here, the reviewer’s general and specific questions/comments are formatted in bold font and blue. Our responses are formatted in regular font and black, the manuscript changes are in red.

General comments:

This manuscript presents a sensitivity simulation study to select the optimal frequency bands for middle and upper atmospheric wind measurement using a THz limb sounder. The sensitivity of 0.1-5 THz to wind speed was comprehensively analyzed in a typical profile scenario, and the effects of spectral resolution, bandwidth and system noise were quantitatively analyzed. From my point of view, this sensitivity analysis is meaningful for the specification of future limb sounders and can be suitable for publication in AMT. However, a minor revision is required to clarify the issues that are described below.

(1) The first section introduced the past and planned radiometers for measuring wind, but the relevant frequency bands were not described explicitly later in the manuscript. More discussion or analysis should be provided.

Thanks for your suggestion. We have labelled the instruments which use these bands in Table 1. We also added the statement in the paper when the similar band is selected in our simulation, such as: “the 655 GHz band shows the best performance for stratospheric wind measurement which was already selected for SIW and SMILES-2”.

(2) As stated in referee report #1, the vertical resolution that is a critical parameter for satellite observations, has not been discussed throughout the manuscript, which should be included in the revised manuscript.

Thanks for your suggestion. The sentence has been added to Sect. 5, Line 271: “In addition, the vertical resolution which is not focused in this study is needs to be discussed. The antenna size determines the vertical resolution of the instrument in different frequency bands. The larger the antenna aperture and the higher the frequency, the higher the vertical resolution. For example, the THz atmospheric limb sounder (TALIS) (Wang et al., 2020; Xu et al., 2022) has an antenna diameter of 1.6 m, and it has the vertical resolution of about 1 m at 640 GHz and 5.5 m at 118 GHz. The relationship between the antenna size, scanning parameters and vertical resolution can be found in Eq. 6, Baron et al. (2015). This is also the reason why, as mentioned in Sect. 4.3, 487 GHz may be more suitable for satellite observations, despite the fact that 118 GHz is more sensitive to wind and has smaller errors above 90 km. The vertical resolution is also related to retrieval error. Finer vertical sampling allows the wind retrieval to be performed at a higher vertical resolution than that of the instrument, but this can result in a big loss of precision. For retrievals with sufficient wind signals, the best compromise between retrieval vertical resolution and precision can be obtained if the retrieval vertical resolution matches the vertical resolution of the instrument (Baron et al., 2015). The horizontal resolution depends mainly on the scanning strategy of the instrument. Large integration time (improve the NEDT), as well as the fine vertical sampling discussed above, will increase the scanning time, leading to poor horizontal resolution".

Specific comments:

Sect. 2, Line 64: Why "the variation of brightness temperature (BT) induced by wind is amplified by the spectral line broadening and can be detected"? How the doppler shift can be obtained using a spectral resolution that is larger than the doppler frequency shift?

Thanks for your comment. This is our misrepresentation. What we want to express is that the broadening effect of the spectral lines leads to the specific signatures of the wind which can be detected easier, and that very high spectral resolution is required when the line has very small width. It has been revised as: "can be detected easier". For the doppler shift, we are obtaining it by an indirect method, which is the ΔBT in Fig. 1. The Doppler shift causes the spectral lines to appear to vary antisymmetrically, and this information can be obtained even using a resolution of a few MHz.

Sect. 3.1, Line 105: What are the differences in simulation results between these typical profiles? Do these differences affect the final conclusion?

Different season or latitude profiles show differences in retrieval performance but it will not affect the selection of potential bands. Bands in Table 1 were selected from five AFGL profiles and the sensitive bands were similar for different profiles. The tropical profile used in study is typical and this region is important since the QBO (Quasi-Biennial Oscillation) or SAO (Semi-Annual Oscillation) occurs mainly in the tropical troposphere and mesosphere. There are certain effects of different profiles in retrieval errors, such as molecules with diurnal variation. We have added the statement to the Scet. 5, Line 268: "Another limitation is the diurnal changes of O_3 and OI which will strongly impact the measurement performance (especially O_3 between 60 and 80 km) is not considered here. Baron et al. (2015) presents the retrieval differences between day and night profile and the retrieval performances are degraded in the daytime because of the O_3 diurnal variation in the mesosphere".

Sect. 3.1, Line 103: Where is the BT at tangent heights of 20 km in Fig. 3?

We are sorry for the mistake here, the tangent heights in Fig. 3 are 30, 50, 70, 90 and 110 km, there is no 20 km here.

Sect. 3.1, Line 113: How did you select the spectral lines from Fig. 3? It appears that some of the frequencies in Table 1 are not apparent in Fig. 3.

Thanks for your comment. The ΔBTs in different bands from Fig. 3 is the main reference of selection and the bands with large ΔBTs will be selected. However, this method will miss some groups of lines with moderate intensity which have been proven by Baron et al. (2013, 2015) for good performance of wind measurement. Therefore, we have referred to the conclusions of the previous papers and searched for the groups of O_3 lines with similar density and intensity, this is the reason some of the frequencies in Table 1 are not apparent in Fig. 3. We have added the description to Line 131: "It is important to note that since this selection strategy is based mainly on the intensity of the ΔBTs, the O_3 line groups with moderate intensity will be missed. Therefore, we have referred to the conclusions of the previous studies (Baron et al., 2013a, 2015) such as 359 GHz, 655 GHz, 837 GHz line groups and search for the groups of O_3 lines with the similar density and intensity".

Sect. 3.2: For O3 lines at 1028 GHz the retrieval error seems acceptable, why is this frequency not selected?

It is true that 1028 GHz band also show good retrieval performance. However, it does not show better performance than the 655 GHz, and for the same performance we give preference to the lower bands because the instruments are easier to implement. The sentence to describe the selection strategy has been added in Line 180: "According to the results above, with the retrieval error of 5 m s^{-1} as the limit, the altitude is divided into three parts: ≤ 70 km, 70–100 km and ≥ 100 km. Considering all molecules in each altitude range, the band with small retrieval error is preferred, and the low frequency band is selected under the same conditions".

Sect. 4.1: Why does the 0.5 MHz spectral resolution play such a big role in 118 GHz retrieval, while other bands not?

This is because the Doppler broadening in the upper atmosphere is small and high resolution (< 1 MHz) is needed for wind retrieval. However, the need decreases with increasing frequency due to line width increases with frequency. The lower frequency and lower system noise at 118 GHz compared to other high frequency bands allows for better performance with higher spectral resolution. The sentence has been added to Sect. 5, Line 256: "The results of 118 and 487 GHz in Sect. 4.1 suggest that high spectral resolution (<= 1 MHz) can provide more information in the upper atmosphere but this need decreases with increasing frequency. It could be explained by the fact that the line width increases with frequency due to the Doppler broadening. However, the NEDT increases with increasing frequency and also with increasing spectral resolution, which also strongly affects the retrieval precision. This needs to be traded off".

Sect. 5: As we know, interferometers are mainly used for middle and upper atmospheric wind field measurements. , What would be the advantages and disadvantages of using THz limb soundersthen? Please expland the relevant discussion.

As we discussed in Sect. 1, the THz limb sounder has good performance in measuring middle atmosphere winds, and less affected by diurnal variations. The THz limb sounder, interferometer, and radar/lidar can form a comprehensive measurement program for full-altitude atmospheric wind measurement.