Review # 2

Author comment: Thank you for your comments and suggestions. Our responses are shown highlighted in blue below.

A new compact static called birefringent Doppler wind imaging interferometer (BIDWIN) is developed for the purpose of observing upper atmospheric winds using suitably isolated airglow emissions. The data is simulated in the lab using a prototype instrument and the wind is retrieved and compared with wind wheel velocity. The new instrument is validated for use of wind measurements of upper atmosphere. The paper can be accepted considering some questions as follows:

1. In general, this manuscript is too long. The introduction of airglow radiation in section 2.1 can be more concise. It is recommended to incorporate it into the first chapter

Author response: We believe that Section 2.1 is an important and distinct part of the paper. First and foremost, it presents the background regarding the various airglow emissions that can potentially be used to measure upper atmospheric winds. Second, it presents the procedure used to examine the relationship between the optical path difference and the sensitivity to Doppler winds for the various emissions. This information will be important for any researcher attempting to reproduce or build upon the current work.

2. Line 26 describes FPI and DASH, "primarly in the thermosphere region." This description is not rigorous enough, because UARS/FPI has already realized the middle atmosphere wind field detection (can reach below 40km).

Author response: The wording “primarily in the thermosphere region” has been removed.

3.the Birefringent Doppler Windimaging Interferometer (BIDWIN) in 2th line of abstract should be moved to the first line

Author response: We understand the confusion between the two sentences. Therefore, the two first sentences of the abstract have been revised to say:

“”A new compact static wind imaging interferometer, called the Birefringent Doppler Wind imaging Interferometer (BIDWIN) has been developed for the purpose of observing upper atmospheric winds using suitably isolated airglow emissions. The instrument combines…….”

4. The influence of stray light is not been considered in the prototype testing. In fact, this is very important that needs to be considered in the availability evaluation of the measurement result. So it is recommended to add

Author response: A detailed analysis of stray light is outside the scope of this work. However, one of the advantages of using the four quadrant approach is that the same image of the field of interest appears in each quadrant. As a result, any background light or stray light from the field would appear in each image in the same location and not be modulated. Hence this approach is robust to unpolarized scattered light or stray light without spectral signatures.

The interferometer would need to be carefully shielded from any stray light which might be incident from the sides and affect one quadrant but careful construction to prevent this would be the same as would be the case for similar instruments. To ensure this point is clear to the readers we have added the following sentence at the end of section 3.

" While a full analysis of stray light is outside the scope of this work, another important feature of the BIDWIN approach is that each quadrant images the same field. Therefore, the background or scattered light from the field will be unmodulated and appear as a constant offset for the corresponding bins in each quadrant. In this case, the fringe phase will not be affected."

5. In the evaluation of wind velocity measurement accuracy, the light source used by the author is He-Ne laser, but the intensity of the laser is several orders of magnitude larger than the intensity of airglow. Please explain whether the testing results are convincing.

Author response: Thanks for your comments. As is described in section 2.2, the expressions for the uncertainty in the wind measurement for the Michelson were originally developed by Ward (1988) and Rochon (2001) and general expressions for the sensitivity of Doppler wind measurements are presented by Kristoffersen et al. (2021). In the ideal case, where four samples are obtained with 90-degree phase steps the expression for the standard deviation, σ_w, of the wind measurement is

$$\sigma_w = \frac{c\lambda}{2\sqrt{2}\pi(\mathrm{SNR})UVD} \qquad \text{(RC2-5-1)}$$

As is discussed in the section 5 of the manuscript, the wind precision of 5 m/s is achievable with an SNR of ~1000 (laser test results). Although the intensity of the laser is several orders of magnitude larger than the intensity of airglow, we will show here the SNR of ~1000 is achievable when observing airglow and the lab test results are convincing.

In section 2.2, we give the expression for the signal S at the detector:

$$S = \frac{10^6}{4\pi} E_0 A\Omega \tau \eta t \qquad \text{(RC2-5-2)}$$

According to Table 2 and Table 6 in the manuscript, the O^1D red line (630nm) has an expected limb intensity of 30kR. The $A\Omega$ for a field instrument is 0.86 cm^2sr, τ is 0.1 when account for the transmittance of the filter and lens system, η is 0.9. If the spatial resolution is 100*100, we can get an SNR of ~1000 with an integration time of 55 seconds. That is to say, we can get a similar SNR whether observing laser or airglow, so the lab test results are convincing.

6. Figure 13 just shows a result of wind drift with time, how about the result of wind drift with temperature?

Author response: Figure 13 shows the thermal drift of the instrument due to the thermal dependence of the optical path difference. Since the temperature in the enclosure is changing as a function of time, the optical path difference is changing as a function of time. Therefore, the drift is actually a function of the changing temperature.