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Re: Manuscript Number: AMT-2023-186
Title: Simulation and detection efficiency analysis for polar mesospheric clouds measurements using a spaceborne wide field of view ultraviolet imager
Author: Ke Ren; Haiyang Gao; Shuqi Niu; Shaoyang Sun; Leilei Kou; Yanqing Xie; Liguo Zhang; and Lingbing Bu

Dear Reviewer,

Thank you for your review of the manuscript entitled “Simulation and detection efficiency analysis for polar mesospheric clouds measurements using a spaceborne wide field of view ultraviolet imager” as well as for your valuable suggestions to improve the paper. There may be some procedural mistakes in the reviewing process. I'm pleased to hear that you found the revisions satisfactory.
I'm posting here again the modifications made based on your suggestions. Please note that the reviewer’s comments are shown in bold type and our responses in plain type.

Best regard,
Ke Ren and Haiyang Gao

Summary:

Polar mesospheric clouds (PMCs) are critical for modulating polar and global atmospheric processes. They were previously observed mainly by the CIPS instrument onboard the satellite AIM, which based on the UV imaging technology. However, there is no future plan launching similar instruments into space, causing a gap in monitoring PMCs.

The authors of this paper proposed a new spaceborne wide FOV UV imager (WFUI), and conducted simulation studies to assess the performance of this newly designed imager. Results show that the WFUI performed well in PMCs detection, verified by high detection efficiency. They also found that the detection efficiency varies with seasons due to the seasonal variation of ice water contents in PMCs. Additional sensitivity studies show how to further optimize the WFUI to improve its detection efficiency.

This work by the authors is interesting. Their presentation is thorough and comprehensive. Findings from this work are important. However, there are some places where more clarifications are needed, therefore I suggest a moderate revision for this version of draft.

Major comments:

Questions about methodology:

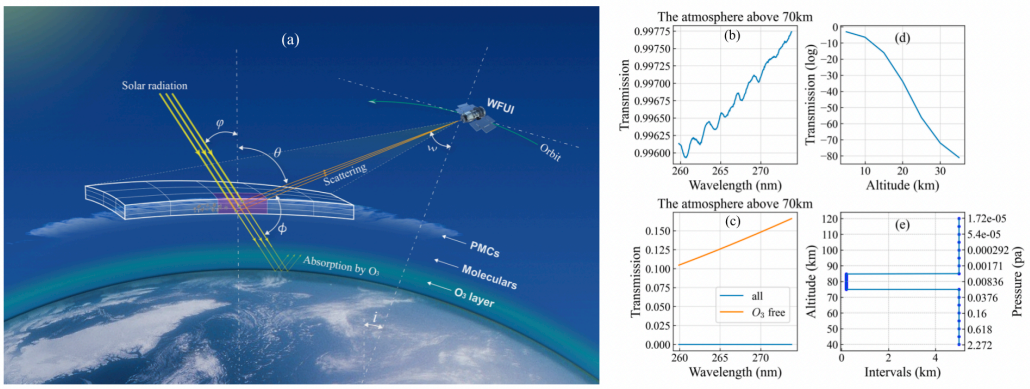
1. L94: "This absorption is primarily from 20 to 25km": it would be more informative to show how the absorption (or transmittance) changes with altitude based on your simulation. Please add the following figure or similar:

X-axis: wavelength, Y-axis: altitude, color: absorption or transmittance.

In this way, you can show readers the whole vertical structure of absorption covering the 265nm band.

Thanks for the reviewer's good comment and instruction.

We utilized the LBLRTM model to compute the transmission at different altitudes for a wavelength of 265 nm, providing readers with a more intuitive representation of the entire vertical absorption structure at 265 nanometers, as illustrated in Figure 1d.



2. Equation for Solar radiation: several symbols are not explained:

(1) \delta_\lambda and its value, (2) t_{\lambda}, (3) c_1, c_2, (4), t_{fmax}, 5, FWHM

Thanks the reviewer for pointing this out.

The symbols mentioned above are explained in Table 2, 'Input parameters for the forward model of the WFUI', in Section 4.1. However, the separation between Table 2 and the current

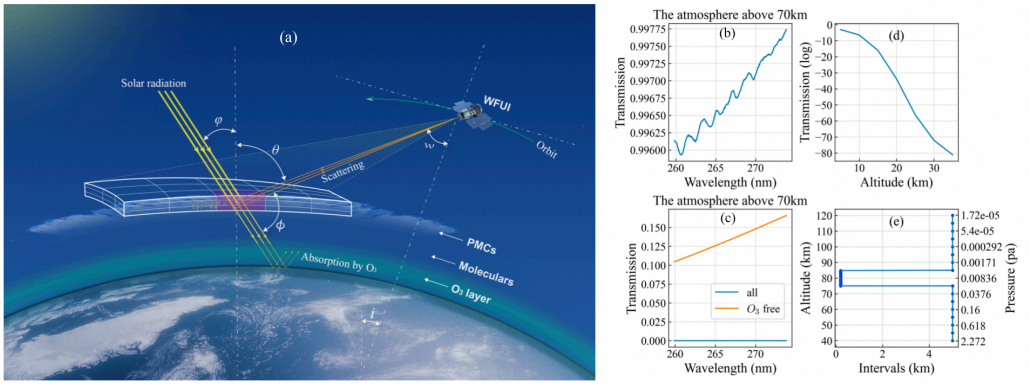
formula may create difficulties in understanding. This was an oversight on our part. To address this, we have supplemented explanations for all symbols after the Equation for Solar radiation.

3. RT calculation: L181-182: "The altitude range….": It would be better if you can add a figure showing the vertical distribution of your atmospheric levels, with corresponding heights and approximated pressures.

Thanks for the reviewer's good comment and instruction.

We have added Figure 1e, illustrating the vertical distribution of atmospheric levels with corresponding heights and approximated pressures. In the text, we provide an explanation for adopting this atmospheric segmentation. The text is revised as follows:

"*… Due to the presence of PMCs within the altitude range of 75 km to 85 km, the altitude range of 75–85 km is meticulously segmented into 50 layers, each with intervals of 0.2 km. The altitude range of 40–75 km was divided into seven layers at 5 km intervals; and 85–120 km was divided into seven layers at 5 km intervals, resulting in a total of 64 layers (Fig. 1e). This approach to altitude layer segmentation not only maintains the accuracy of the calculation results but also effectively improves computational efficiency. …*"



Questions related to results:

L324: "This design allows greater flexibility…meteorological satellites": since now building cubesat constellation is gaining popularity, is it possible to install WFUI on those cubesats? How large/weight will your instrument be? If it is possible, it would be great if the authors can add additional discussion for this part in the Summary section, since I believe this will increase the impact of this paper.

Thanks for the reviewer's suggestion. We add additional discussion for this part in the Summary section.

"*… The WFUI instrument primarily consists of a CCD camera and a lens， which is designed to be compact and allows for greater flexibility in installation on satellites not specifically dedicated to detecting PMCs. According to the estimation of the instrument parameters shown in Table 2, the size of the entire instrument is around 3 L, and it is relatively lightweight. This allows for the possibility of deploying the instrument on a 3-unit CubeSat. …*"

Minor comments:

L14: "such as the Cloud Imaging": "such as" => "adopted by": because the first half of this sentence is the technology, while the second half is about research.

L15. “and development of PMCs”: remove “and developments of”: PMCs are the studying subjects.

Thanks for pointing this out. We have rectified the semantic error in this sentence.

“*… Ultraviolet (UV) imaging technology, adopted by the Cloud Imaging and Particle Size (CIPS) instrument onboard the Aeronomy of Ice in the Mesosphere (AIM) satellite, has significantly advanced the research on PMCs. …*”

L29: “revealed an exponential relationship … of PMCs”: between the IWC and what?

Thanks for pointing this out. We have revised it to 'an exponential relationship between the ice water content (IWC) of PMCs and detection efficiency'.

L40: “and indicator of long-term changes in the Earth’s atmosphere”: long-term changes of what? Please be more specific

Thanks for pointing this out.

The term 'Indicator of long-term changes in the Earth’s atmosphere' specifically denotes long-term changes in temperature and water vapor content. We appreciate your clarification, and the revised information has been incorporated to enhance precision.

“*… Thus, the long-term trend in PMCs variation is considered an indicator of long-term changes of temperature and water vapor content in the Earth’s atmosphere. …*”

L41: “Recently, the frequency”: It would be better to write the approximate time (e.g., year, month, day) here since “Recently” have different meanings for atmospheric researchers studying different phenomenon.

Thanks for the reviewer's suggestion.

We have updated the statement to provide a more specific timeframe. Additionally, for further details and comprehensive information, please refer to [Miao et al., 2022; Kaifler et al., 2018; Tylor et al., 2017].

“*… Prior research has indicated that the frequency and obse*

rved brightness of PMCs in the mid-latitudinal areas have increased over the past half-century. …”

L53: “Himwari-8”: which sensor on Himawari-8 do you refer to?

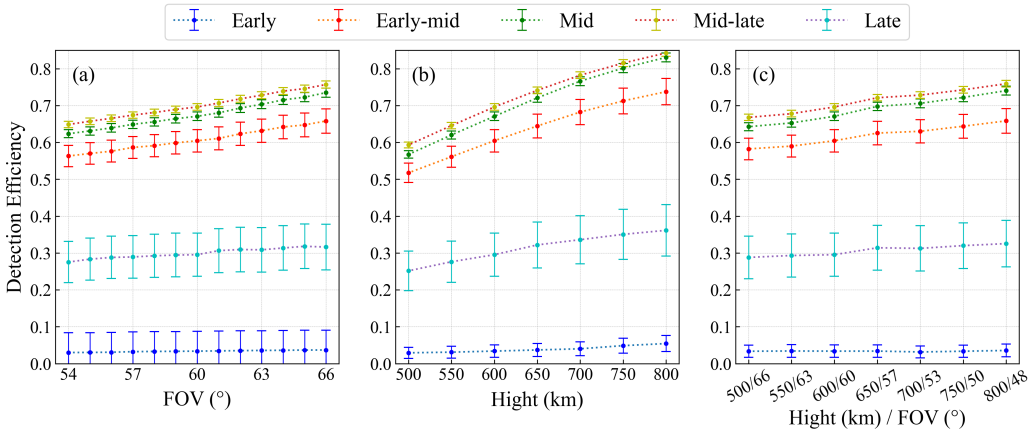
Thanks for the reviewer's good comment and instruction.

'Himawari-8' referred to denotes the Advanced Himawari Imager (AHI) sensor mounted on the Himawari-8 satellite. This information is derived from the study conducted by Tsuda et al. in 2018. Tsuda et al. (2018) provide an initial report on PMCs observations by the satellite Himawari-8. AHI can produce full-disk images including the Earth's limb, which would provide valuable opportunities for PMC observations by continuous limb-viewing from its almost fixed location relative to the Earth.

L445: Figure 10: Should it be “Hight” instead of High

Thanks for pointing this out.

We have replaced 'high' with 'height' in this Figure 10.



Special thanks to the reviewer for his/her good comments.

We have tried our best to revise and improve the manuscript and made a few changes in the manuscript according to the reviewer's good comments. Again, many thanks for your valuable comments and suggestions. We would like to have our paper at your disposal.

We appreciate for reviewer's spending more time on reviewing over paper and offering valuable suggestions and hope that the modification and corrections will meet with approval and hoping that our paper will be published in *Atmospheric Measurement Techniques* as soon as possible.

We look forward to your information about my revised paper.

Yours sincerely,
Ke Ren and Haiyang Gao