1st review of the paper titled "Exploring commercial GNSS RO products for planetary boundary layer studies in the Arctic region" by Manisha Ganeshan et al.

General comments:

This study explored the use of commercial GNSS RO data, specifically Spire and GeoOptics, for investigating the PBL in the Arctic. It compared NASA-purchased commercial RO data with MetOp observations, highlighting the improved lower tropospheric penetration of the commercial products. However, since the NASA-purchased commercial RO data are processed by the vendors, while the MetOp data are processed by UCAR, and RO penetration probability can be related to many factors, including both hardware design and processing software, such comparison of the penetration probability between commercial and MetOp ROs may not be that scientifically interesting.

The authors also used moisture data obtained from radiosondes to investigate the relationship between moisture and MetOp RO penetration probability. The results indicate a negative correlation, significant only in March and December. During these months, the radiosonde is confined to a very limited latitude and longitude range, and the moisture over Arctic cold season is very low. This raises the question of whether such a relationship exists only in low-moisture situations. What are the authors' opinions on this matter? Does this conclusion hold for RO data processed using different algorithms? Given that the study focuses on commercial RO data, it would be beneficial to redo this investigation using the commercial data.

The last part of this study is the comparison of Arctic winter PBLH between RO and MERRA-2 reanalysis. However how is the PBLH calculate from the reanalysis data? This information is vital for the readers to understand whether the method used is appropriate and the value of the results.

Suggestions for possible revisions include:

1. As shown in Fig. 6, the typical PBLH can be as low as 300 m over the sea ice region. The specific cut-off threshold of 500 m used for selecting RO profiles may introduce biases in the resolved PBLH. Purely visualizing the resolved shallow PBLH from commercial RO as in Fig. 6 doesn't justify the choice of this threshold. A sensitivity test about the cut-off threshold is needed.
2. In addition to the map of the monthly averaged penetration probability in Fig. 5, please include the map of the monthly averaged minimum penetration depth.
3. Explain how the PBL height of MERRA-2 reanalysis was obtained/calculated, and the vertical resolution of the MERRA-2 reanalysis data.

4. Expand the PBLH study to include the Arctic summer season.

In all, I think this paper is not ready to be accepted yet and may be reconsidered after major revisions.

Specific comments:

1. L36-37: “improved predictability over flat surfaces compared to varying slopes”. What’s the meaning of this sentence? Any references support this statement?
2. L45-46: I don’t understand the statement like “RO profiles over the Arctic Ocean dropped sharply …”. Please rephrase it.
3. In L78, the authors mentioned that “Spire data are provided at a similar vertical grid and resolution as other GNSS RO missions”, but later, when the authors tried to explain the observed lesser regional variation of PBLH from Spire compared to GeoOptics, it is mentioned that Spire data have coarser resolution due to smoothing (L250). Are these two statements contradictory to each other? What’s the vertical resolution of Spire data?
4. L82: what is “the amplitude of computed phase match integral”? Any references?
5. L83: What data is considered as “at lower levels”? Below 8 km?
6. L86-89: The part is not clear to me. Has the GeoOptics data below what is called “sharp” layer been discarded by QC check? If so, does it mean the resolved PBLH later would be equal to the minimum penetration depth?
7. L90-94: Are the NOAA Spire and GeoOptics data processed by UCAR? If so, UCAR’s processing starts from which level? Any useful information can we derive from the comparison between NASA and NOAA purchased commercial data?
8. L184-185: Any explanations for “missing seasonal variation in NASA Spire data, but presented in NOAA Spire data”?
9. L194: What is the vertical resolution of radiosonde observations?
10. L200-202: Please provide the results similar to Fig. 3 and 4 at 300 m, 500 m and 700 m?
11. L252-254: Clearly the cut-off height of 500 m is not sufficient to derive the shallow PBL height. I don’t understand the logic of the cut-off threshold used in data analysis being allowed to be mission dependent.
12. I don’t see the value of Fig. 5 e-g. May consider remove them.
13. The observed extremely high GeoOptics PBLH over the 30E to 60E sector is presented in Fig. 6. What’s the explanation for this? Is it physical-related or outlier-effected?