Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2018-1035-RC1, 2019

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Common volume satellite studies of polar mesospheric clouds with Odin/OSIRIS tomography and AIM/CIPS nadir imaging" *by* Lina Broman et al.

Anonymous Referee #2

Received and published: 25 February 2019

General Comments

This paper presents a detailed comparison of polar mesospheric cloud (PMC) albedo and ice water content between two different satellite instruments. The instruments are the Optical Spectrograph and InfraRed Imager System (OSIRIS) on the Odin satellite and the Cloud Imaging and Particle Size (CIPS) instrument on the Aeronomy of Ice in the Mesosphere (AIM) satellite. Because OSIRIS typically views PMCs on the limb whereas CIPS typically views PMCs in the nadir, the authors have carefully considered coincidence criteria, scattering conditions, observation geometry, and instrument sensitivity in the uniquely coordinated study between the two instruments. As part

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Discussion paper

of the study, the authors present the first thorough error characterization of OSIRIS tomographic cloud brightness and ice water content.

This is an important paper and establishes a valuable precedent for subsequent comparisons between PMC limb viewing instruments and PMC nadir imagers. The results show good agreement, particularly given the diversity of data included in the study. Most importantly, however, the authors provide an exhaustive error analysis that will be a useful reference in future PMC correlative studies.

The Reviewer recommends the paper for publication provided that the authors address the comments below. The "Specific Comments" are relatively minor but important, particularly in providing context of their results with the existing body of work on this topic.

Specific Comments

1. Abstract. Please indicate latitude range and years used in the analysis. Also, if PMC frequency is not compared between OSIRIS and CIPS within the common volume, the authors should explicitly say so in the abstract.

2. p. 8. Lines 9-11. Did Benze et al. [2011] use the operational CIPS product to compare directly with SBUV? The Reviewer looked at this paper and it appears that the good agreement with SBUV as stated here arises because a separate CIPS retrieval was developed to simulate the SBUV PMC retrieval. This is not a validation of the CIPS or SBUV data, which is what is suggested by this statement. How do operational SBUV and v4.20 CIPS PMC albedos, IWC and frequencies compare for the same volume and the same time at these high latitudes (78-80 N)? If the authors do not have a ready answer or if it is beyond the scope of this work then they should be explicit about what was done previously to find agreement between CIPS and SBUV (i.e. a separate CIPS algorithm). They could also delete these sentences entirely without loss of content to the paper.

3. p. 16, end of section. Please include a paragraph here explicitly indicating what is done with pixels where there are no clouds at all. If the authors have set all pixels less than 2e-6 sr-1 to zero, then they need to explicitly say here whether they have averaged the zeros into their calculations of albedo and IWC or not. This distinction has historically been a source of great confusion in the field of PMCs. It may be that at these high latitudes there is always a cloud within the common volume for their limited dataset and if so they need to say that as well. This does not appear to be the case from looking at Figure 2. However, the authors winnow the dataset to 788 total observations (p. 17, line 9) so it is not clear how Figure 2 evolves with the study.

4. Conclusions. This section is lacking a summary of relevant conditions under which the comparisons are made. This includes (but is not limited to) the years studied, the latitudes used and the local times of the comparisons. This should also emphasize that the authors are comparing albedo and IWC and not PMC frequency. This section is also lacking a summary of previous related work by Bailey et al. [2015] using common volume observations of SOFIE and CIPS on the same AIM satellite. Bailey et al. state that CIPS IWC is a factor of two smaller than SOFIE IWC, differences that are generally larger and go in the opposite direction of the present work with OSIRIS. Although the authors have done a thorough analysis of their two datasets (OSIRIS and CIPS), the reader should be made aware of these differences of CIPS IWC with the limb viewing SOFIE IWC. This is all the more important because IWC is the native measurement quantity for SOFIE. Differences in the method of observation, calibration, coincidence criteria, latitudes of the comparison, the years studied, the solar zenith angles and the local times of the comparison may all play a role in reconciling these differences and could be included to raise awareness with the reader. The above could be done with two paragraphs and if the authors prefer they could rename this section “Discussion and Conclusions”.

Technical Corrections

p. 1, line 17. “ice” should be “ice water content”. Similarly, on line 20 “ice content”

should be “ice water content” to avoid confusion.

p. 2, line 17. “larg” should be “large”

p. 2, line 30. “. . .reason for the increasing visibility of PMCs at mid-latitudes” should be “. . .reason for the increasing visibility of PMCs at mid-latitudes in the modern era.” To the Reviewer’s knowledge, decadal-scale trends of mesospheric clouds observed from the ground since the late 20th century are weak or non-existent.

p. 2, line 36. “advantage” should be “advantages”.

p. 10, Figure 1. This figure has a geographic range that is much larger than the region of interest and could be improved dramatically. On lines 9-10 the authors say that the cloud albedo is variable but the region of interest is drawn over the data so the reader cannot see this. By reducing the latitude and longitude ranges of the image, only the borders of the region of interest can be drawn and the boxed region can remain unfilled so that the reader can see the structure within. If the geographic range is small enough, the red area could also be drawn with borders rather than filled. If the authors prefer, the figure could be drawn with two panels: Panel “a” could be the current figure and panel “b” could be the zoomed in version. Please also include a color bar showing the range of cloud albedo in the figure(s).

p. 11, Figure 2. Please include tick marks on the x and y axes to better guide the reader. Also, please indicate the total number of detections either within the Figure or in the caption. Since this is the first figure quantitative showing CIPS data, it would also be instructive to indicate that this is CIPS data, and include average latitude, local time, year of the data and a CV frequency either within the Figure or in the caption. Thank you.

p. 13, line 15. Please include here the ranges of Cspectral and Cphase used in the analysis so that the reader can appreciate the impact of these adjustments in the context of the data.

p. 14. The offset and uncertainty in line 17 is a bit different than line 26. This is further modified on p. 17 line 15, but is still not quite the same as reported in the abstract and summary. Please check to make sure the numbers self-consistent throughout. Thank you.

p. 15, Figure 4 caption. “error bars is” should be “error bars are” and “error bar denote” should be “error bars denote”.

p. 16 lines 2-4. Do the authors mean the error bars in Figures 4 and 6? Please indicate the figures explicitly. Also, the Reviewer only sees black (not grey) error bars in these figures. Are they referring to these? Please be explicit. Thank you.

p. 20, line 30. A wind of 100 m/s near 85 km seems large. Can the authors provide a reference for this or otherwise justify this wind speed? Is it possible that the cloud could be sublimating and reforming elsewhere? If so the authors should state that as a possibility. To this end, the authors should include the time difference between the two observations in the captions of Figures 8, 9 and 10.

p. 24, lines 25-27. Please explicitly indicate the version of CIPS data used in this study here (in addition to p. 8, line 8).

Figures 4, 6 and 7. Please indicate explicitly whether null detections are included in the indicated average. If null detections are ignored in these comparisons then they should say that instead.

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