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Atmospheric Measurement Techniques Discussions

Interactive comment on "Determining Cloud Thermodynamic Phase from the Polarized Micro Pulse Lidar" *by* Jasper R. Lewis et al.

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We thank Anonymous Referee 2 for their careful reading of the manuscript and their helpful suggestions to improve this work. Below, we provide responses to specific comments by the reviewer.

I do not see the wavelength of this lidar. I think a table with the instrument specs would be useful.

The wavelength of the lidar (532-nm) is included in the following table which is added to the revised manuscript.

Parameter	
Wavelength	532 nm
Laser pulse energy	6 – 8 μJ
Repetition rate	2500 Hz
Receiver diameter	178 mm
Vertical resolution	75 m
Temporal average	60 s

Line 114 – 116. This sentence makes no sense: The cloud layer observed between 8 – 9 km CTT = -32.1 °C) exhibits NRB near the cloud top in both the co-polar and cross-polar signals compared to the signals nearer the cloud base.

Thanks for catching this mistake. The word "higher" was missing from the original text and has been added in the revised manuscript:

The cloud layer observed between 8 – 9 km (CTT = -32.1 °C) exhibits higher NRB near the cloud top in both the co-polar and cross-polar signals compared to the signals nearer the cloud base.

Lines 120 - 124 Have the authors considered how signal attenuation may affect the depolarization measurement?

To the limit of attenuation, the depolarization measurement is reliable because the cross- and co-polar signals are affected equally. In this regime, multiple scattering effects (discussed in Section 2.2) are more of a concern. Once the signal becomes fully attenuated (also discussed in Section 2.2), depolarization measurements are no longer useful.

Figure 6. I cannot see any unknown phase clouds in this figure. The legend says they are pink, However, Magenta (used for mixed phase) is close to pink, so a different color should be used for unknown.

While admittedly the colors are similar, Figure 6 (as well as Figure 5) has no occurrences of unknown phase clouds. So, using a different color would not affect the images in these cases.

Figure 9. You show the CALIOP spatial distribution of SLF for the -20 C isotherm. It shows only a slight latitudinal dependence. Is that true for other temperatures? The area used for the comparison may be too large despite the spatially uniform data. When comparing a satellite measurement to a ground based measurement, you should not exceed 2x2 degree. What happens to the comparison if you cut down considerably on the area used? Also it would be nice to have state boundaries on that map. It is a little hard to get one's bearings as it is.

The slight latitudinal dependence at other temperatures is similar to that of the -20 °C isotherm. For example, refer to Figures 2a, 3a, and 4a of Tan et al. 2014, which shows the global SLF at -10 °C, -20 °C, and -30 °C, respectively.

Tan, I., T. Storelvmo, and Y.-S. Choi (2014), Spaceborne lidar observations of the ice-nucleating potential of dust, polluted dust and smoke aerosols in mixed-phase clouds, J. Geophys. Res. Atmos., 119, 6653–6665,doi:10.1002/2013JD021333.

The size of the grid box was selected in order to maximize sampling from the satellite observations. A smaller grid box would not provide sufficient statistics for the CALIOP supercooled liquid-water fractions. Furthermore, what we present here is not intended as a coincident, direct cloud-to-cloud comparison. Instead, it is a comparison of independent measurements of the same phenomenon within the same region. As such, the size of the grid box is less important. We attempt to clarify our intent in the revised manuscript as follows:

A comparison of SLFs derived from each instrument (CALIOP and MPLNET) averaged from 2015 – 2019 is shown in Fig. 9. Instead of direct comparisons using coincident overpass times of the GSFC site by the satellite, the comparison uses a statistical approach to investigate the representativeness of the two independent datasets.

Finally, the state boundaries have been added to Figure 9.

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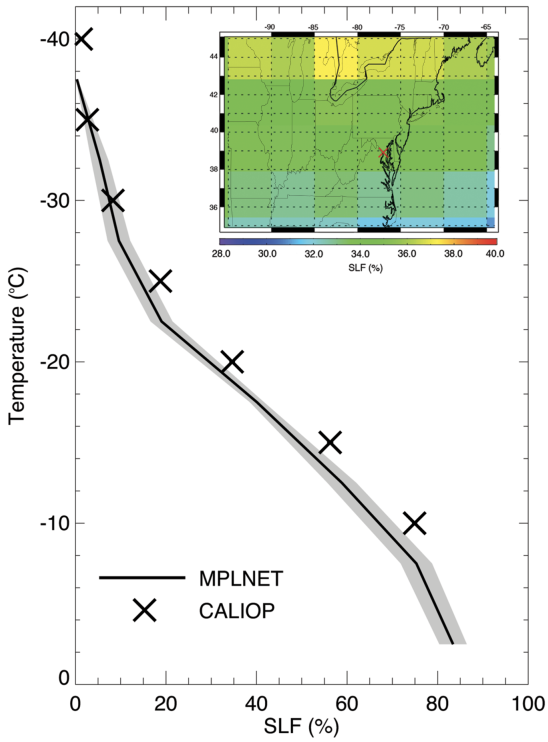
-40
-30
-20
-10
0
Temperature (°C)
0
20
40
60
80
100
SLF (%)
MPLNET
CALIOP
-90
-85
-80
-75
-70
-65
44
42
40
38
36
28.0
30.0
32.0
34.0
36.0
38.0
40.0
SLF (%)

Fig. 1.