Atmos. Chem. Phys. Discuss., 13, C4020–C4022, 2013
www.atmos-chem-phys-discuss.net/13/C4020/2013/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Mid-latitude cirrus classification at Rome Tor Vergata through a multi-channel Raman–Mie–Rayleigh lidar" *by* D. Dionisi et al.

Anonymous Referee #1

Received and published: 21 June 2013

This paper presents a classification of ground-based lidar observations of cirrus according to their macrophysical characteristics. The classification method follows that of a previous publication. The paper presents new and interesting results, but I have a number of comments on the methodology and on the interpretation of the results. The English could be improved in many places, although the meaning can usually be understood. There were 2 or 3 places where I could not understand what is meant.

Major comments:

1) A more a detailed description of the classification method is required. From Figure

3, except for Class IV, it is not clear that there are distinct classes of cirrus but perhaps just a broad continuous distribution within which arbitrary boundaries have been drawn. In clustering algorithms I am familiar with, the number of clusters is supplied to the algorithm a priori. Is that the case with this algorithm? If so, was the algorithm tested with different numbers of a priori classes? Does the data appear more clustered if plotted against other axes? The text says a "discriminant factor analysis" was performed, but doesn't describe the basis of this analysis or when it is applied – before the HCM? After?

2) Are all the statistics derived from 355 and 387 nm data, or were 532 nm profiles also used?

3) Clouds colder than -25C are identified as cirrus. Supercooled water clouds can be found at colder temperatures, however. Apparently the lidar system does not have a depolarization capability, which would help to resolve this ambiguity. This should be mentioned as a source of uncertainty.

4) An error analysis of the lidar ratio estimation is sorely needed. How much of the spread in Figure 4 is due to noise and how much is true variability? Class I, with the lowest optical depth, has the largest spread, implying most of the variability is due to the effect of noise on the retrieval. Since random noise often results in systematic biases in lidar retrievals, this may affect the inferences which can be drawn from the mean value of the lidar ratio.

5) The authors make a strong attempt to interpret the statistical results and draw conclusions. They do not consider the statistical significance of the trends is often rather limited, however, and mean values may be biased by outliers or non-linear effects of signal noise. In general, their interpretations are over-optimistic in my view. Several low values of lidar ratio in the upper left panel of Figure 5 may represent supercooled water clouds. Were any steps taken to screen out water clouds, other than thresholding data by temperature? Several low values of lidar ratio ($\sim$10) in the lower left panel of Figure

5 could be due to the presence of oriented plates. If these outliers were removed, there would be a significant impact on the trend in lidar ratio with temperature.

6) Multiple scattering effects are estimated only approximately, using just a single value for the multiple scattering correction. This should be discussed as another source of uncertainty in the optical depth and lidar ratio results. Multiple scattering has a strong dependence on FOV and wavelength, and weaker dependence on optical depth, altitude, and habit. Because the FOV is different for each of the three lidar channels, the multiple scattering corrections will be different for each of the channels. Unaccounted for variability in the multiple scattering could explain some of the trends seen in lidar ratio, which are quite weak in some cases shown in Figures 5 and 6.

Minor comments: 1) Sassen and Cho (1992) is referenced as classifying cirrus with optical depth greater than 0.3 as opaque. The 1992 paper actually describes cirrus with optical depth greater than 2-3 as opaque, but opaque cirrus is grouped into their category of $0.3 < OD < 3$.

2) Text says “resumed” several times when “summarized” is meant

3) Text says “sensibility” several times when “sensitivity” is meant

---

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 9615, 2013.