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Atmospheric Measurement Techniques Discussions

Interactive comment on "Optical and Geometrical Properties of Cirrus Clouds over the Tibetan Plateau Measured by Lidar and Radiosonde Sounding at the Summertime in 2014" *by* Guangyao Dai et al.

Anonymous Referee #1

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The authors present results from the TIPEX III campaign conducted at Naqu (Tibetan Plateau, China) for two months from a sophisticated lidar system and radiosonde soundings. The purpose of the study is the investigation of cirrus properties and their radiative forcing. The relative small set of data (21 cases only) of course limits the value of the study, especially as more extended climatologies are already existing (for other sites). Consequently, for "compensation" of this shortcoming the description of the methods and the discussion of the findings must be precise and convincing, and a discussion of the uncertainty of the results is mandatory. In the present version of the

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Discussion paper

paper this is however not sufficiently provided. Moreover a clear conclusion ("what do we learn from this study?") and an outlook are missing.

As a result, major revisions are mandatory.

A few detailed comments (without typos, grammar, etc.) in the order of appearance:

1. Throughout the paper: Linear particle depolarization ratio $\longrightarrow$ particle linear depolarization ratio
2. Page 2, line 15: Move IPCC-citation two lines up.
3. 2/20: Ansmann et al. (1992) do not cover polarization lidars. Choose an additional reference.
4. 3/4: "The optical depth of clouds is a key parameter...": What about the single scattering albedo?
5. 3/9: "lidar signals correctly represented the scattering...": What does this mean? I assume that the SNR is larger than a certain threshold so that the Rayleigh signal can be measured.
6. 4/8: What is the reason for four telescopes? Give a short explanation.
7. 4/19: "$\pm$ 5%": absolute or relative?
8. 5/5: "With the help of the WACAL, the optical and geometrical properties of cirrus clouds can be obtained." Be more precise: which parameters were actually determined and what is their accuracy. Is it possible to retrieve the lidar ratio from the 355/387 nm channels? In the following the authors assume a prescribed (constant) lidar ratio.

9. 5/7: How are the ceilometer data used in this study? In contrast to WACAL it seems to me that they provide continuous measurements, so this could be a great opportunity to improve the statistics of the cirrus bottom height, top height, extent – maybe even a rough estimate of the optical depth (after calibration, from integrated backscatter if the lidar ratio is prescribed anyway) can be derived.

10. 5/17: Briefly explain how P_{bg} and P_{noise} are determined.

11. 5/21–23: "the maximum optical depth": what is "maximum" referring to? Explain how "with these thresholds, the dust and volcanic ash layers ... can be filtered out". Was this actually applied, i.e. was volcanic ash present at that site and that time?

12. 6/8: Explain G. It could make sense to repeat the equations from Freudenthaler et al. (2009), but then a discussion on the accuracy of the terms in (2) and (3) should be included. At least the overall accuracy of the derived δ_p and δ_v should be discussed.

13. 6/17: Is it necessary to repeat the equation from Ansmann et al.? Rather discuss why the relatively large lidar ratio of 28 sr was selected (in the literature typically lower values are given), and what the influence of an error in S_{aer} on the retrieved optical depth and δ_p is. By the way: Subscripts "p" and "aer" for "aerosols" or "particles" should be synchronized.

14. 7/1–7: Please rephrase this paragraph: in its present form the purpose of the procedure is hard to understand and it is just copied from the Wu et al. (2015) paper.

15. 7/15: "Moreover, the particle size of cirrus clouds which.." Include 1 or 2 sentences explaining the underlying concept and how it influences the multiple scattering (MS) correction. Later in the paper the MS-issue is more or less ignored,

so what is the reason for the relatively broad discussion of MS? Moreover I am missing a (range of) value(s) of the MS-factor, its accuracy and its influence on the optical depth. It is surprising that an equation for the very well known extinction coefficient (4) is given but no equation how the MS-correction factor is applied.

16. 8/21: How is a "measurement case" defined? A period of n hours with a temporal resolution of m minutes? An average over the night? How can the investigation be extended with the ceilometer measurements (improvement of the "climatology")?

17. 9/5: If only one case is shown it must be explained how representative it is. Is it a "typical" case? Better show a few more examples, or report a summary of all cases.

18. 9/8: The error bars of δ_p are missing. Is it realistic to compare values above and below 7 km in view of the (large?) uncertainty (see also line 13)?

19. 9/15: The authors point out the variability of the ice crystal shape: How does it influence the lidar ratio (assumed to be constant in the paper)?

20. 9/19: "6.02 $\pm$0.60 km": Is this the uncertainty or the temporal variability? Explain and add information on the missing. Is it reasonable to express the average with two decimal places?

21. 9/20: What is "corresponding" referring to? Is the mean extinction coefficient with or without MS-correction?

22. 10/2: Explain the base of the statistics covered in Section 3.2. Is it based on 21 cases only? How is each case treated (as a whole or with a temporal resolution of m minutes)? Why is a very coarse resolution of only 1 km considered? Why are the ceilometer data neglected?

23. 10/5: How long is the period over which the "fluctuations" are determined, i.e. how long was each individual cirrus existing? Same duration for all?

24. Throughout the paper: don't use two decimal places for the percentages!

25. 10/9: Here one would expect information on the vertical extent. So think about moving the corresponding section from below to this place and/or combine Figs. 3–5 to one figure with (a) – (e).

26. 10/24: Better use km^{-1}

27. 11/2: Be sure that for all references the duration and the site of the corresponding study is mentioned. E.g., if Goldfarb et al. (2001) consider 384 nights it is more representative than a 21 night data set.

28. 11/23: Again, this statement implies that the lidar ratio change.

29. 11/23: "According to Fig. 7, it ...": Considering the very large error bars (or ranges of variability?) such a strong statement should be relaxed.

30. 12/5: This statement is valid for other wavelengths as well.

31. 12/10: If Platt is referenced please note that he suggested a cirrus lidar ratio of 18.2 sr.

32. 12/13: "Ext.cf." should be replaced by α in the equation! Please explain why such a fitting curve makes sense: As α is an extensive quantity it is not obvious that it depends on temperature (alone). Surely, particle shape and size are temperature dependent (and thus extinction cross section) but the extinction coefficient is expected to depend on water vapor concentration as well.

33. 12/14: "Due to the stability of the larger cirrus particle radius". What do you mean?

34. 12/19: Define "anomalies". With respect to what?

35. 13/2: "appearance stages, the temperatures were higher...": which temperatures? ("temperature below the cloud"?)? Please be more specific.

36. 13/7: "the Rossby waves can be recognized ...": Is this just a message or a finding from the measurements (or analysis of supplementary data)?

37. 13/14: "the ice particle size by the method described ..." : A 1–2 sentence synopsis would be nice, in particular including information about the inherent assumptions and the sensitivity of the results on these assumptions.

38. 14/6: "with a mean value of 0.44 ± 0.037": 0.037 seem to be the variability. What about the accuracy (see previous comments as well)?

39. 14/9: "The corresponding gradients are also calculated and are presented in Fig. 7 and Fig. 8." This statement is not very useful in the summary. Here results and conclusions should be presented. This is valid for the whole section!

    As ceilometers are mentioned in the paper as one of the measuring systems (and as they recently are becoming more widespread) one would expect a discussion of the benefit of these automated and continuous ceilometer measurements: what are the pros and cons? Consider the corresponding literature (at least some overview papers). A discussion/recommendation can be beneficial for the readership: what kind of information is obtained when ceilometers (networks?) replace the advanced (expensive) lidar.

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