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Atmospheric Measurement Techniques Discussions

Interactive comment on "Application of infrared remote sensing to constrain in-situ estimates of ice crystal particle size during SPartICus" *by* S. J. Cooper and T. J. Garrett

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Comments on "Application of infrared remote sensing to constrain in-situ estimates of ice crystal particle size during SPartICus" by Cooper and Garrett

This manuscript presents some case studies, based on satellite remote sensing, on the particle size in thin cirrus clouds. A bi-spectral method was used to infer ice particle size from MODIS infrared cloud observations. Remote sensing results were compared with the in situ measurement from the SPartICus field campaign. It was found that remote sensing results are in general agreement wit in situ observations. Based on these case studies, the authors argue that their remote sensing method is reliable and can therefore be used to retrieve whether and how many small ice particles (with

re<20μm) exist in thin cirrus clouds.

General comments: The existence and abundance of small ice particles in cirrus clouds are currently a controversial issue. This manuscript, along with the authors' previous paper Cooper and Garrett (2010), presents a perspective of this issue from the remote sensing point of view. My major concern on the present study is whether it tells us anything meaningful given the fact both in situ measurement and remote sensing are subject to big uncertainties and they are quite different in terms of sampling volume. I understand this is a philosophical question and difficult to answer. So I listed some more detailed questions/concerns below. Clarification of these questions may help improve the manuscript before it can be accepted for publication.

Detailed questions: 1. Sampling bias: The authors pointed out (Pg. 3064 line5), "Due to the cautious nature of the BTD retrieval scheme, the relatively small number of Aqua overpasses, and the necessity of having the plane located reasonably near to an acceptable BTD cloud field, we found only a handful of good test cases for comparing MODIS and airborne measurements during the SPartICus campaign." This indicates that their remote sensing method is only applicable to a small subset of SPartICus field campaign. Some information, maybe in a table, should be given on this potential sampling bias. For example, how many times MODIS overpassed the SPartICus campaign. How many cases can be selected from the overpasses for comparison between in situ and remote sensing results. What are the reasons (e.g., cloud too thick?, no collocation?) that some cases are not suitable for comparison?

2. How small is "generally small"? Uncertainty analysis is needed for the remote sensing results: The authors used "generally small" or "generally large" throughout the manuscript. But how small is "generally small"? I think the authors can do better than this and present some more quantitative results. Also important is a through uncertainty analysis. As shown in many previous studies, remote sensing of ice cloud microphysics is subject to substantial uncertainties. This is especially true for IR-based retrieval, because IR method is not only subject to uncertainties in cloud properties but

also significantly to the uncertainties in artillery data like atmospheric profile. Therefore a detailed analysis of the uncertainties is needed to convince the reliability of the remote sensing method. Uncertainties that should be analyzed include, ice particle shape, cloud top temperature and in-cloud temperature variation.

3. Consistency of the underlying physics between in situ and remote sensing: The effective radius from the in situ measurement is based on some empirical image-to-mass relationship in Baker et al. Is this image-to-mass relationship consistent with the assumption of cloud physics used in the remote sensing algorithm? If not, what is the impact of the discrepancy on the comparison between in situ and remote sensing results?

4. Bi-modal particle size distribution: It seems from Figure 5, the ice particle size distribution is bi-modal. What is the assumption of ice particle size distribution in the remote sensing algorithm? Single mode or bi-modal? Is it possible to implement bi-modal size distribution in the remote sensing algorithm? What will be the retrieval results based on bi-modal size distribution? If not possible, why?

5. Other cloud properties: The comparison has been focused on effective radius, but how about other cloud properties such as cloud optical thickness and ice water path? One may argue that cloud optical thickness and ice water path are the “first order” cloud parameters to compare, effective radius is kind of “second order” thing because of its definition. Some comparison on optical thickness and ice water path should be presented and discussed for the sake of evaluating the remote sensing accuracy.

Interactive comment on Atmos. Meas. Tech. Discuss., 4, 3055, 2011.