Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2019-1181-RC2, 2020

Atmospheric Chemistry and Physics Discussions

Interactive comment on "A test of the ability of current bulk optical models to represent the radiative properties of cirrus cloud across the mid-and far-infrared" *by* Richard J. Bantges et al.

Anonymous Referee #1

Received and published: 10 May 2020

The study presents radiative transfer simulations of airborne observations of cirrus clouds across the mid- and far-infrared (IR) wavelength region taken during the CIRC-CREX campaign. A case study is selected, where the following observations are availabe: spectral radiance observations in the mid-IR (ARIES) and in the far-IR (TAFTS), lidar observations, cloud in-situ observations, and radiosonde measurements of the humidity profile. The authors try to simultaneously fit the observations throughout a large IR spectral range (from about 100cm-1 to 1400cm-1) to radiative transfer simulations using state-of-the-art bulk optical properties of cirrus clouds by Baum et al. 2014. They find that it is not possible to find cloud microphysical properties (effective radius and crystal habit) which fit the observations throughout the whole spectrum within the

Printer-friendly version

Discussion paper

measurement uncertainties and conclude that far-IR observations can be used to better constrain retrievals of cirrus optical properties and that there is a need to develop more realistic ice cloud optical models.

The study is well presented with appropriate number of figures and well written. I recommend to publish the paper in ACP after minor revisions following the comments below.

General comments:

1. My first thought about the descrepency of retrieved optical properties in the two spectral ranges was, that the observations might be sensitive to different depths of the cloud. In the discussion, it is mentioned, that this has been investigated by varying the reff-profile within the cloud layer and it was found, that the profile has only a minor impact. I suggest to include this investigation, at least as a short appendix, rather than just mention it in one sentence in the discussion, because this is also an important result.

2. The in-situ observations are mentioned in the "Instrumentation and measurements" section but are not used because "examination of the available in-situ cloud microphysical properties [O'Shea et al., 2016] also indicated a high temporal (and therefore implied spatial) variation in the cloud PSD. These issues, combined with the knowledge that the cloud was decaying over time, suggested that it would be difficult to associate a particular observed PSD with any confidence to the radiation measurements." (p.7 l.194) - I agree that it is often difficult to compare with the in-situ observations. However, I think that you should try to at least compare the results with the in-situ observations. E.g., is the habit distribution observed in-situ similar to the general habit mixture as used by Baum et al. or is it dominated by aggregates of solid columns? The derived PSD from in-situ should also be included for comparison, even though it may not be possible to directly compare it to the results derived from the radiance observations.

Specific comments:

p.5 l.159: Where are the "present day concentrations" of CO2 and minor trace gases obtained from?

p.7 l.206: "a similar overestimate seem relative to the TAFTS measurements in the FIR micro-windows." -> I can not see this in Fig. 5, a difference plot could help.

p.8 l.235: Eq. 1 and 2: Why are absolute differences used in the fit, rather than the more commonly used quadratic differences (Chi-square fit)?

p.8 l.257: The lidar-derived value of optical thickness is smaller than that retrieved from the fit. "The deviation may be a consequence of an inconsistency between the optical properties implicitly assumed when converting the raw lidar measurements to optical depth compared with those used in the simulations here". This is a plausible explanation. Which optical properties are assumed in the lidar observation?

Fig. 7: For consistency, the transmittance should also be included in the upper panel. The transmittance curve should have a different color than "Method 1", it is particular confusing, because "Method 1" is often overplotted and not visible.

Table 4: Results from "Method 4" should be added, even though future observations restricted only to FIR are not anticipated.

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2019-1181, 2020.

Printer-friendly version

Discussion paper