Atmos. Chem. Phys. Discuss., 2, S423–S425, 2002
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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The potential of polarization measurements from space at mm and sub-mm wavelengths for determining cirrus cloud parameters" *by* J. Miao et al.

Anonymous Referee #1

Received and published: 20 September 2002

General Comments

In this paper ('The potential of polarization measurements from space at mm and sub-mm wavelengths for determining cirrus cloud parameters'), Miao et al. present radiative transfer modeling results which describe the theoretical effects of various cirrus microphysical parameters on the polarization signal at microwave wavelengths. The authors clearly demonstrate that polarization techniques in the microwave spectrum can provide valuable information on various cirrus microphysical parameters (especially particle size). Cirrus clouds are important components of climate, however, current remote sensing techniques yield large retrieval uncertainties. New techniques such as the one proposed by Miao et al. may result in improved understanding of these complex

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objects. Although I have found several deficiencies in this work which I address in the next section, overall I believe this work is significant and should be published after some revisions.

Specific Comments

1. In the analysis, there seems to be an implicit assumption that the absorption optical depth of the lowest layer (tau_a3) is $>>$ 1. If this is not assumed, then the observed Tb should include a surface emission term. If this is assumed, it should be stated as an assumption. It should also be noted in the paper that the atmospheric transmittance at the lower frequencies considered (89, 150, and 220 GHz) is generally not insignificant (i.e. tau_a3 is not $>>$ 1). Therefore, at these frequencies, an additional polarization signal might develop due to the polarization dependence of surface emissivity.

2. The polarization signal generally should vanish for the nadir viewing geometry (satellite zenith angle of 0) and probably will increase monotonically with increasing viewing angle. This is an important effect which is completely ignored in the paper (all modeling is done for a viewing angle of 54 degrees). I believe the authors need to expand their analysis to study the dependence of the polarization signal with viewing angle.

3. In the second paragraph of the introduction, the authors state that the 'scattering effect' is 'proportional to the volume (or mass) of the ice particles.' This seems to imply that the intensity of the scattered radiation is linearly proportional to the third moment of the ice particle size distribution, which is not generally true. I believe the authors should clarify their statement.

4. The presented results are specifically for the case of single scattering. I believe the authors should address the issue of multiple scattering, at least in a qualitative way. For example, should multiple scattering tend to increase or decrease the polarization signal?

5. I do not understand the concepts described in the last paragraph in section 2. I

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believe this paragraph should be rewritten to more clearly explain the value of measurements of the polarization signal at multiple frequencies.

6. In Section 3.1, the authors should introduce and define all variables appearing in Eq. 10 before presenting the actual equation.

7. In the fourth paragraph of section 3.3.1, I believe the authors should add the word 'approximately' immediately before the phrases 'inversely proportional' and 'directly proportional.'

8. In the first paragraph of the conclusion, I believe the authors should mention the fact that surface emission terms have been ignored.

Technical Corrections

1. In second sentence in the abstract, change 'its' to 'their'.

2. In last sentence in third paragraph of the introduction, change 'presents' to 'present'.

3. In second paragraph of section 3.2 change 'exits' to 'exist'.

4. In fourth paragraph of section 3.3.2, change 'siae' to 'size'.

5. In third paragraph of conclusion, change 'the this' to 'this'.

6. In the caption to Fig. 5, change '6 gm-2' to '60 gm-2'.

Interactive comment on Atmos. Chem. Phys. Discuss., 2, 1403, 2002.