Atmos. Chem. Phys. Discuss., 4, S851–S853, 2004
www.atmos-chem-phys.org/acpd/4/S851/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Remote sensing of water cloud droplet size distributions using the backscatter glory: a case study" *by* B. Mayer et al.

Anonymous Referee #1

Received and published: 4 June 2004

ŞRemote sensing of water cloud droplet size distributions using the backscatter glory: a case studyŤ by B. Mayer et al.

An algorithm is reported for simultaneous retrieval of cloud optical thickness, particle effective size, and the width of the size distribution of cloud droplets from the backscattering at the 753 nm wavelength. The issue addressed in this paper is interesting. However, the manuscript in its present form needs to be substantially revised before it is formally accepted for publication, because of many major flaws. Furthermore, the retrieval algorithm is not clearly explained. Even with repeated reading, I still could not understand how the retrieved results presented in this paper were obtained. Below are my specific comments for the authorsŠ consideration in the revision process.

(1) The materials contained in the present manuscript need to be substantially re-

organized and expanded. Sec.2 (i.e., ŞMethdosŤ) is the core of this paper. However, the first part of Sec.2 just described how the data were acquired from an air-borne instrument. The second part of Sec.2 essentially describes the forward radiative transfer simulations involved in this study. The retrieval algorithm is not mentioned in Sec. 2! In Sec. 3 (i.e., ŞResultsŤ), the authors vaguely explained the retrieval algorithm, which, I found, is not easy to understand if not at all. Suggestion: The author should include a new subsection, say, Sec. 2.3, in Sec.2 to explicitly explain the retrieval algorithm. Additionally, sensitivity studies should be carried out to understand the sensitivity of the algorithm to various assumptions/parameters in the forward radiative transfer simulation. Without the sensitivity studies, the results reported in this paper are essentially meaningless.

(2) Fig.3 shows that the glory reflectivity is essentially independent of cloud optical thickness. This means that there is no sensitivity of the reflectivity to cloud thickness. From first principles, it is impossible to retrieve the optical thickness if the sensitivity does not exist! In short, the retrieval reported in this paper simply violates basic physical principles.

(3) Are there any in-situ validation for the retrieved showed in Fig. 6? The reported optical thickness seems too low for water clouds.

(4) Eq. (1) and associated discussions: Hansen and Travis (Hansen and Travis, 1974: Light scattering in planetary atmosphere. Space Sci. Rev., 16, 527-610) showed that the bulk optical properties of water clouds depend on the effective size and also on the effective variance. The latter was not discussed in this manuscript. The authors might want to cite Hansen and TravisŠ paper.

(5) The retrieval of the width of the size distribution is quite questionable. The author assumed the gamma size distribution for the forward radiative transfer computation. In realty, the size distribution in cloud is not an idealized gamma function. If the authors assume a different size distribution function, say, the power size distribution, the re-

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trieval result may be different. Thus, sensitivity studies should be carried out to understand the effect of the form (e.g., the gamma distribution or the power law distribution) assumed for the size distributions.

(6) What is the physical basis for introducing the Şglory reflectivityŤ? The quantity defined in Eq. (6) depends on theta (this quantity is not defined in the manuscript though I assume that it indicates the scattering angle). The quantity defined in Eq. (7) is independent of theta. So, why the authors call the difference in Eq. (7) the Şglory reflectivityŤ?

(7) Many variables in the manuscript are not defined. This makes it quite difficult to read the manuscript.

(8) Eqs. (8) and (9) and the associated discussions are not understandable. Are they the key equations for the retrieval algorithm? Why should sigma and c in Eq. (8) be unity?

(9) The manuscript should be carefully edited. There are some missing words in the manuscript. For example, the bottom line in the first page: Şwith give sizeŤ should be Şwith a given sizeŤ.

(10) Two lines below Eq. (1) ŞThe reason for this ĚŤ: Actually, the effective size is the mean path-length of the incident rays inside the particles. Note that when the size parameter is large, geometrical optics is valid and the incident wave can be regarded as a bundle of rays. For a large size parameter, the extinction and absorption properties of the particles are largely determined by the mean path-lengthŮthe physical basis for van de HulstŠ ADT theory.

Interactive comment on Atmos. Chem. Phys. Discuss., 4, 2239, 2004.

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