A note on ‘The albedo of broken cloud fields’ by A. J. Kite
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Kite described the development of a Monte Carlo model for calculating the albedo of broken clouds in an attempt to explain aircraft measurements, which showed a markedly nonlinear variation of albedo with cloud cover. A broken cloud field was simulated by a regular array of identical hemi-ellipsoidal clouds with homogeneous optical properties. It was found that modelled values of albedo were much higher than measured, and were approximately proportional to cloud cover. The introduction of a Gaussian variation in horizontal cloud dimension greatly reduced this discrepancy, the improvement being ascribed to a reduction in cloud-to-cloud interactions.

During the course of further studies with the same model (Rawlins 1988) it became clear that the simulations involving Gaussian variations were incorrect owing to a software error. The fault was only present in these cases—all other simulations reported in Kite’s paper are unaffected and remain valid. The calculations have been repeated for an amended version of the model and Fig. 1(a) is the corrected form of Kite’s Fig. 6 (reproduced here in Fig. 1(b)). This shows the albedo to be approximately proportional to cloud cover, giving similar results to those from an array of identical clouds. Hence the aircraft observations are not explained and it is necessary to continue to explore alternative reasons for the relatively small albedo of broken cloud fields.

![Monte-Carlo (corrected) Gaussian](image1)

![Monte-Carlo (uncorrected) Gaussian](image2)

Figure 1. \( N_e/N \) versus \( N \) for a Gaussian distribution of cloud sizes, calculated from the Monte Carlo model. \( N \) is the cloud cover and \( N_e \) is the ratio of the simulated albedo of the cloud field to that of a uniform plane-parallel cloud of the same optical thickness (=32 here), weighted according to cloud cover. Two solar zenith angles are shown, \( \theta_0 = 0^\circ \) and \( 60^\circ \). Figure 1(a) is the corrected form. Figure 1(b) is Kite’s Fig. 6.
Kite also suggested that the reduced albedo could be due to a systematic decrease in cloud optical depth with cloud cover. My more recent studies with similar models (Rawlins 1988) indicate that agreement with observations of albedo can be obtained by this assumption but that it then becomes difficult to reconcile the assumed cloud optical depths with observations of the size and liquid water content of finite clouds. Currently, the Monte Carlo approach to simulating broken cloud fields is severely limited by the lack of knowledge of the distributions of liquid water content and cloud size over extended areas. It is hoped that more progress will be made by the use of further aircraft measurements co-ordinated with high resolution satellite observations.

REFERENCES