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Deduction of Z-M relationships in warm clouds through simulations of radar observations

Ol. Pujol, J-F. Georgis, H. Sauvageot

Université Paul Sabatier, Laboratoire d'aérologie, Toulouse, France

(pujo@aero.obs-mip.fr / Phone +330561332747)

Clouds – the non precipitating part of condensed atmospheric water – play a major role in atmosphere (radiative balance, telecommunication, aircraft icing, ...); Linking cloud microphysical characteristics, like liquid water content M_c, to cloud radar reflectivity Z_c is thus of considerable interest in cloud investigations by radar. Associated to in-situ measurements, simulation is a powerful tool to investigate such links in detail. By the way of simulated radar observations of cumulus and stratocumulus, the following relation is proposed: Z_c = 0.034 $M_c^{1.63}$. This synthetic relation not only matches very well previous empirical relationships, but also, it extrapolates them towards high water content (from 1 g m^{-3} to 3 g m^{-3}). Drizzle influence is also simulated. It is shown that, accordingly previous empirical studies, it causes a non correlation between reflectivity and liquid water content. In order to identify warm drizzle clouds, a threshold relative to the cloud liquid water content above which drizzle can be expected is tentatively proposed. This threshold is contingent on the normalized cloud altitude: $M_{c,t}$ = 1.204 $\phi^{0.867}$ where ϕ = (z – z_{CB})/(z_{CT} - z_{CB}) with z the vertical coordinate, z_{CB}, and z_{CT} the cloud base and top altitude respectively.