J.Cardwell, & T.W.Choularton

School of Earth, Atmospheric & Environmental Sciences
The University of Manchester

The University of Manchester

Modelling of an isolated thunderstorm during COPS 15/7/2007

Large eddy simulations of the isolated thunderstorm case observed on the 15th July 2007 at around 14:45 during COPS using the Met Office LEM are shown. These simulations will act as a basis for more detailed microphysical modelling: trajectory analysis will allow the use of a parcel model and we also hope to apply the Explicit Microphysics Model (EMM).

All the soundings from this day were very dry with ground temperatures in the 30's Celsius and as expected the simulations failed to produce cloud, even with extreme initial heat/vapour bubbles. It was clear that orographic lifting had occurred and therefore we lifted the soundings adiabatically. Various profiles were used to initiate the LEM as lifting would obviously taper with height. The simulations produced an isolated cloud when lifted by between 1300 and 1800m with the stronger lifting probably being more realistic. Any further lifting would produce a thin layer cloud which was not observed. With the height of mountains in the area being of very similar height to the range suggested our assumption of orographic lifting is likely to be correct. However the vertical extent of the cloud produced was several Km's less than in reality, suggesting another process is occurring as well..

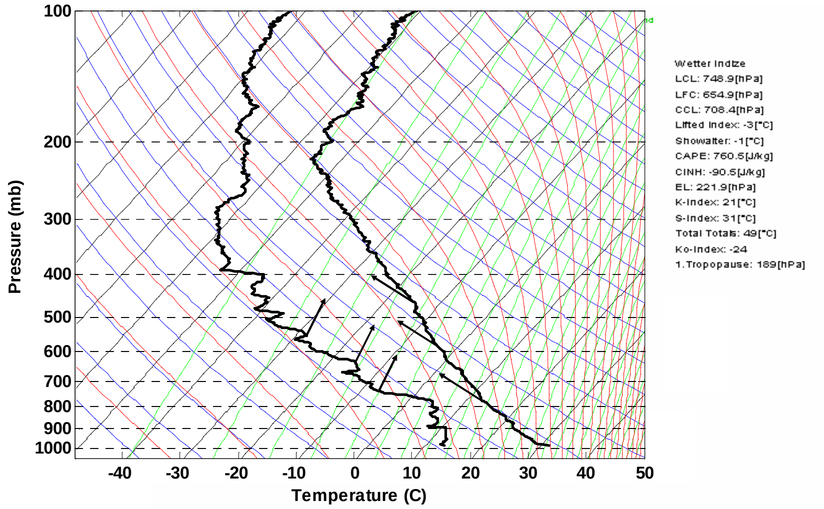

Figure 1: 2pm sounding at Burnhaupt

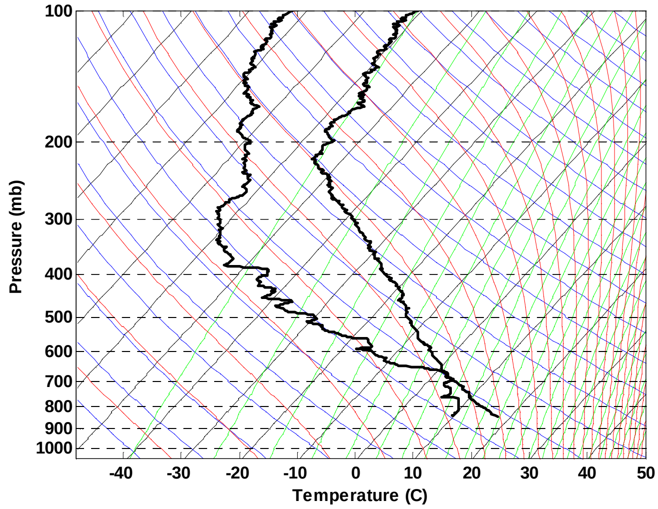

Figure 2: Example lifted sounding (base 831mb)

Figure 1 shows the 2pm sounding at Burnhaupt, it is obvious that sounding would produce no cloud and so the sounding was lifted adiabatically, the direction of the arrows indicate the effect of this lifting (To do this in the LEM you just change the base pressure while keeping the θ profile the same and retain the original mixing ratios). An example of a lifted profile is shown in figure 2, with the upper half of the profile slowly smoothed back to that of the original profile. It can be seen that there is likely to be a very thin layer cloud produced by this new sounding, but often the presence of a strong thermal could remove the expected layer cloud as in this case.

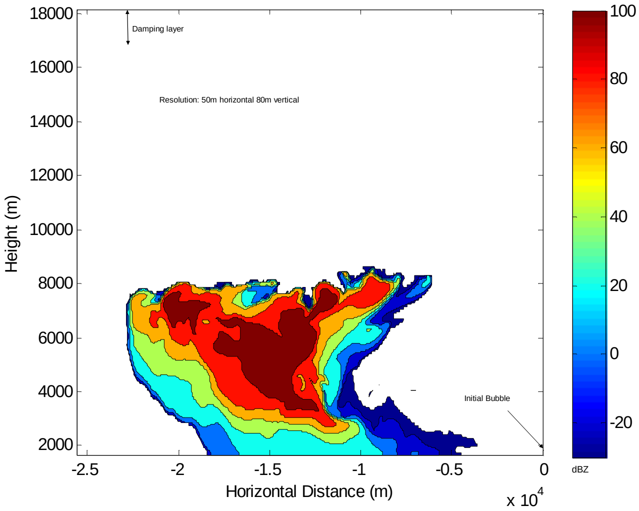

Figure 3: Simulated RADAR image after 50mins

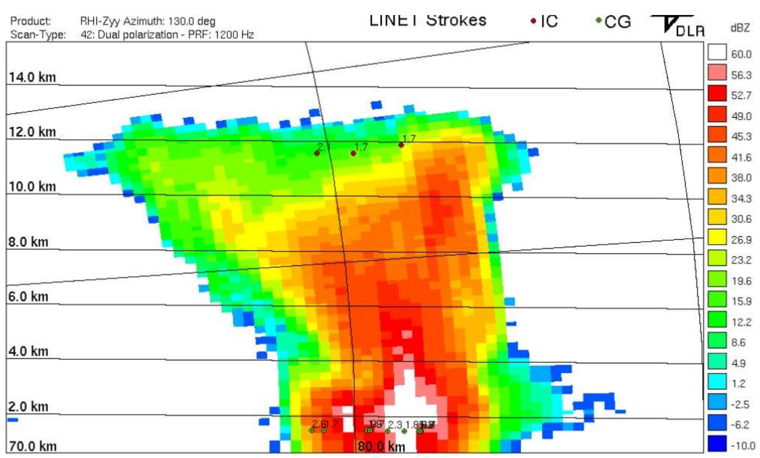

Figure 4: Actual RADAR image at 2.30pm,

There are major differences between the simulated cloud (Figure3) and the observed cloud (Figure 4). Despite showing much stronger dBZ the cloud top height is some 4km less than observed, indicating there is something wrong with the upper air profile, the cloud is of about the same width. The major problem is that the lower boundary of the model is about 1km above the ground (the RADAR shows precipitation down to the ground) and modelling this in some way is probably essential, but unlikely to help the cloud obtain a greater height. The initial bubble near the lower boundary required to spin up the model is somewhat stronger than I have seen before, a large bubble (400m x 560m) with increased temperature (~1ºC) and updraft velocity (2m/s) is required and/or a large increase in water vapour (probably the remains of a previous cloud, which is quite possible during the lifting process, but lifting is not modelled here and can't be properly simulated by the LEM).

Email:- John.cardwell@manchester.ac.uk