In this exercise, the student will demonstrate the relationship between the scale of the forcing (here, a "warm bubble"), the updraft core, the downdraft core, and then the outflow depth. This will be achieved through experimental simulations using the idealized model CM1.

Suggested experiments

By default, the horizontal radius of the warm bubble is 10000 m. At t =1800 sec, what is the approximate updraft core diameter? At t = 2700 sec, what is the approximate downdraft core diameter? At t = 2700 sec, what is the approximate outflow depth?

Now, change the value of the radius of the warm bubble to 20000 m, and estimate updraft, downdraft, and outflow diameter or depth at the same two times.

Finally, repeat with a bubble radius of 5000 m.

Model setup and other instructions

Installation, setup, and execution of this CM1 is fairly straightforward (see: http://www.mmm.ucar.edu/people/bryan/cm1/). A typical Linux workstation will be sufficient to execute this numerical model.

The preceding experiments assume a computational domain defined by:

nx = ny = 60; nz = 40

dx = dy = 1000.; dz = 500.

The "Weisman-Klemp" analytic sounding is used; the environmental winds are assumed to be calm ("zero winds"). These and other parameters are defined in *namelist.input* file (as can be obtained from http://web.ics.purdue.edu/~jtrapp/namelist.input).

This namelist file also takes advantage of the CM1 option to introduce additional parameters. Here:

var3 = height of center of bubble above ground (m) (model variable **zc**)

var4 = horizontal radius of bubble (m) (model variable **bhrad**)

var5 = vertical radius of bubble (m) (model variable **bvrad**)

var6 = max potential temp perturbation (K) (model variable **bptpert**)

which define the "warm bubble" that initiates convection.

These parameters will need to be set in the source file *init3d.F* (in directory src), beginning line ~ 426 (see http://web.ics.purdue.edu/~jtrapp/init3d.F for an example)

One software application that can be used to display the model output is NCL (see http://www.ncl.ucar.edu). An example script can be obtained from http://web.ics.purdue.edu/~jtrapp/cmplotxz.ncl)

The output (as a pdf file, by default) shows vertical cross-sections, through the domain center, of: perturbation potential temperature and winds, and cloud water mixing ratio and winds.