2D Squall Line demonstration (Part 2)

ATM 419/563 Spring 2023 - Fovell

* Exploring microphysics options

Move into your SQUALL directory.
Edit your namelist.input to set mp_physics to your assigned option (see PPT)
You may also need to change the value for hail_opt

```
mp_physics = ##
```

$srun -p snow ideal.exe
$srun -p snow wrf.exe

Unpack your simulation, using w2g and control_file.ensemble [NOTE THIS!!!]
Name your file mp## where ## is your microphysics option.
If your option is < 10, use leading zero (e.g., mp02, or mp07)
If you are using mp=6 or 16 with hail, call the runs mp66 and mp77, respectively

```
$ w2g control_file.ensemble mp##
```

Copy your mp##.ctl and mp##.dat files to $LAB/SQUALL/

* GrADS ensemble dimension (after all runs are completed/processed)

GrADS has an ensemble dimension that can streamline looking at a set of related experiments. The problem is the files have to have identical ctl files.
In our case, different microphysics schemes output different hydrometeor arrays (as many as 17 [!] mixing ratios for cloud, ice, rain, snow, graupel and hail, and number concentration variables for some or all of those species)

Our ensemble will only consider schemes that produce QCLOUD and QRAIN at a minimum. Some schemes also produce QICE, QSNOW, QGRAUPEL, or QHAIL but we won’t archive that even if they are computed

So control_file.ensemble ONLY outputs those microphysics-related hydrometeor fields even if the scheme produces others
• Move into **my SQUALL directory**, where the microphysics ensemble members are
  
  $ cd$/LAB/SQUALL

• Launch GrADS and open **mp_ensemble.ctl**

• Using uthetap.gs, wthetap.gs: visualize final time U or W and perturbation theta fields
  for some members. Feel free to explore more later!

  set e 1  # 1st ensemble member: Purdue Lin (mp=2) examined in Part 1
  uthetap.gs
  set e 14  # NSSL’s version of Purdue Lin (mp=21)
  uthetap.gs  # note difference
  set e 17  # Thompson with aerosol (mp=28)
  uthetap.gs  # note difference
  set e 2  # Kessler scheme (no ice species, mp=1)
  uthetap.gs  # note difference

  set e 4  # WSM6 [qc,qi,qr,qs,qg, single moment, mp=6]
  wthetap.gs  # W and perturbation potential temperature
  set e 10  # WDM6 [qc,qi,qr,qs,qg, double moment, mp=16]
  wthetap.gs  # this version is producing pre-squall convection
  set e 16  # WDM7 [qc,qi,qr,qs,qg, plus hail, double moment, mp=26]
  wthetap.gs  # pre-squall convection absent again

  set e 1  # back to Purdue Lin (essentially the oldest ice microphysics scheme)
  uthetap.gs
  set e 22  # the incredibly expensive bin microphysics scheme (mp=32)
  uthetap.gs  # did all of that extra computational work really matter?
  set e 21  # the somewhat less expensive version of the bin scheme (mp=30)
  uthetap.gs  # what the heck?

• A Hovmoller diagram for near-surface temperature, except the vertical axis is the
  • *ensemble dimension*. Identify leading edge of cold pool and how it varies among
  • members. On vertical axis, numbers = order, **numbers ≠ mp scheme**

reset
set t last  # sets last available time
set z 1
set e 1 last  # sets range to all ensemble members
set x 1 201
set xaxis 0 400 50
d tc  # near-surface temperature (deg. C)
draw ylab member number not scheme number
draw xlab x (km)
A Hovmoller diagram for ensemble precipitation. This plots \textit{rainnc}, or total precipitation received at the surface accumulated to the time selected, in millimeters. (Despite the name, \textit{rainnc} \textit{also} includes precipitation in the form of snow, graupel, or hail, if any. Also, it \textit{only} includes precipitation from the microphysics scheme, not the cumulus scheme, which is not being used here anyway.)

reset
g set t last
g set z 1
g set e 1 last
g set x 1 201
g set xaxis 0 400 50
g set black 0 0
g

d rainnc            # total precip (including frozen), in mm
g draw ylab member number not scheme number
g draw xlab x (km)

g
Max precip accumulations for each ensemble member. Note substantial variation. (100\% difference from weakest to strongest precip producers. Note also bin schemes tend to produce a lot less precip than most bulk schemes. Are bulk schemes overdoing it?)

c
g set z 1
g set x 1
g set t last
g set e 1 last
g set vrange 0 300
g d max(rainnc,x=1,x=201)
g draw xlab ensemble member

g
A hazard of squall lines is straight-line winds associated with descended rear inflow currents. This plots maximum near-surface U for each ensemble member at final time. I might want to look at the max over a set of times, owing to small-scale temporal variability, but which schemes are indicating the largest and smallest wind hazards?

c
g set z 1
g set x 1
g set e 1 last
g set vrange 0 16
g d max(u,x=1,x=201)
• evolution of total domain precip RAINNC over time, for 22 ensemble members. Which schemes produce the most and the least rain?

reset
set x 1
set z 1
set t 1 last

• ESTEP from e=1 to e=22, vrange 0-3000 == total precip range of 100%!
estep.gs tloop(sum(rainnc,x=1,x=201)) 1 22 0 3000

explore more! (end of Part 2)