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 (<u>see PPT</u>)**
• 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 **<u>control_file.ensemble</u> [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 <u>(after all runs are completed/processed)</u>**

• GrADS has an ensemble dimension that can streamline looking at a set of related
• experiments. <u>The problem is the files have to have **identical ctl files**.</u>
• 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 **<u>my</u> 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 **rainnc**, or total precipitation received at the surface accumulated to the time selected, in millimeters. (Despite the name, rainnc *also* includes precipitation in the form of snow, graupel, or hail, if any. Also, it *only* includes precipitation from the microphysics scheme, not the cumulus scheme, which is not being used here anyway.)

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

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

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

• 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
set z 1
set x 1
set e 1 last
set vrange 0 16
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)