2D Squall Line demonstration (Part 2)
ATM 419/563 Spring 2021 - Fovell

* Exploring microphysics options

- Move into your SQUALL directory.
- Edit your namelist.input to set mp_physics to your assigned option (see table at end)
- 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
- 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 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, QRAIN, QICE, QSNOW, and QGRAUP at a minimum. Some schemes also produce QHAIL but we won’t archive that

- So control_file ONLY outputs those microphysics-related hydrometeor fields even if the scheme produces other

- Move into **MY SQUALL directory**, where the microphysics ensemble members are

- $ cd $LAB/SQUALL
• Launch GrADS and open \texttt{mp\_ensemble.ctl}

• Using \texttt{uthetap.gs}: visualize final time U and perturbation theta fields for some members. Feel free to explore more later!

\begin{verbatim}
set e 1  # 1st ensemble member: Purdue Lin, which we examined in Part 1
uthetap.gs
set e 11 # NSSL's version of Purdue Lin
uthetap.gs # note difference
set e 14 # Thompson with aerosol
uthetap.gs # note difference
set e 1  # back to Purdue Lin (essentially the oldest ice microphysics scheme)
uthetap.gs
set e 19  # the incredibly expensive bin microphysics scheme
uthetap.gs # note difference
set e 18  # the somewhat less expensive version of the bin scheme
uthetap.gs # what the heck?
\end{verbatim}

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

\begin{verbatim}
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)
\end{verbatim}

• A Hovmoller diagram for ensemble precipitation. This plots \texttt{rainnc}, or total precipitation received at the surface accumulated to the time selected, in millimeters. (Despite the name, \texttt{rainnc} 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.)

\begin{verbatim}
reset
set t last
set z 1
set e 1 last
set x 1 201
set xaxis 0 400 50
set black 0 0
\end{verbatim}
• 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 e 1 last
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
d max(u,x=1,x=201)

• Evolution of total domain precip RAINNC over time, for 19 ensemble members
reset
set x 1
set z 1
set t 1 last
• ESTEP from e=1 to e=19, vrange 0-3000 == total precip range of 100%!
estep.gs tloop(sum(rainnc,x=1,x=201)) 1 19 0 3000

explore more! (end of Part 2)