PBL single column model (SCM) demonstration (Spring 2021)

• preliminaries

- Make a directory called SCM in your lab space, and copy into it:
  
  $LAB/SCM/*.

- You should end up with these files: pbl_ysu.ctl, pbl_ysu.dat, pbl_myj.ctl, pbl_myj.dat, pbl_ysu_p.ctl, pbl_ysu_p.dat, pbl_myj_p.ctl, pbl_myj_p.dat, plotsounding.gs, risfc.gs (and SETUP.TAR, used later)

- Files from older version/model of what will be our EXP#2

- Note for idealized runs, time displayed by GrADS is not consistent with namelist.input, so times displayed don’t match start/end times in namelist

• launch GrADS and open pbl_ysu.ctl. GrADS commands follow:

  * look at SWDOWN to get bearings (sunrise~18Z, sunset~5Z, noon~00Z, mid~12Z)

  set display white

  c

  set t 2 49

  set z 1

  d swdown

  *

  look at 2-m temperature (deg. C)

  c

  d t2-273.15

  *

  without clearing, superimpose PBL height. Note there’s a time lag between them

  d pblh

  *

  observe evolution of potential temperature in PBL. When is the PBL least stable?

  c

  set z 1 26

  d theta

  *

  without clearing, superimpose eddy mixing for momentum (Km, in m^2/s)

  * compare to Part II, slide 13

  d dku3d

  *

  look at dkt3d (Kh, eddy mixing for heat and moisture). Pr ≠ 1 so Km ≠ Kh.

  * [see PBL_Part1.pptx, last slide]

  d dkt3d

  *

  which is larger, dku3d or dkt3d?

  c

  d dku3d-dkt3d
* look at vertical structure of Km during daytime. Note height where Km \( \to 0 \)

* observe PBL height reported at this time, compare with Km \( \to 0 \) height

* observe superadiabatic layer develops near surface during day, and the depth of the neutral layer

* plot dry bulb temperature. Note where inversion starts relative to PBLH

* plot wind speed. Note where the shear layer starts

* We will see YSU determines PBLH using a "bulk surface Richardson number". A Richardson number is a stability divided by a shear

* The script risfc.gs computes this, and stores it in variable called “ri”

* compare wind speed to initial time. What time of day are PBL winds around z=0.6 km fastest?

* take a closer look at day vs. night winds, compared to initial wind profile
* the wind near the surface: compare wind at lowest model level to 10-m wind
* (the lowest model level is about 27.5 m above ground level)

* compare model 10-m wind to wind reconstructed using log profile equation (only valid for neutral conditions)

* confirm that neutral log wind profile *overpredicts* 10-m wind when stable
* and underpredicts when unstable
* stable is when tsk-t2 < 0 (TSK is ground temp, T2 is temp at 2-m above ground)

* Now compare KPP/non-local (YSU) with TKE/local (MYJ) simulations

* eddy mixing applied to heat comparison (m^2/s)
* compare eddy mixing during unstable period (plot MYJ profile first)

```
c
set t 49
d exch_h.2
d dkt3d.1
```

* potential temperature evolution comparison

```
c
set t 2 49
d theta.1
d theta.2
```

* potential temperature profile during daytime; compare to Hong and Pan Fig. 3

```
c
set t 49
d theta.1
d theta.2
```

* water vapor mixing ratio during daytime; compare to Hong and Pan Fig. 4

```
c
set vrange 0 5
d 1000*qvapor.1
d 1000*qvapor.2
```

* compare surface sensible heat flux (W/m^2) – pretty similar

```
c
set z 1
set t 2 49
d hfx.1
d hfx.2
```

* note times when hfx is positive and negative, then do this (YSU run only)

```
* (the factor of 10 is to help make temperature difference easier to see)
* tsk < t2 means ground surface colder than at 2 m level
```

```
d (tsk.1-t2.1)*10
```

* when ground heat flux (grdflx) > 0, soil is giving heat to the surface

```
d grdflx.1
```

* how different is MYJ? Is it important?

```
c
d tsk.1
d tsk.2
d t2.1
d t2.2`
* compare surface latent heat fluxes (W/m^2)
c
d lh.1
d lh.2

* compare soundings – open pressure-level files
reinit
open pbl_ysu_p.ctl
open pbl_myj_p.ctl

* plot daytime sounding for YSU. Note CAPE and CIN
set t 49
set display white
plotsounding.gs

* make pbl_myj_p the default file, plot daytime sounding
set dfile 2
plotsounding.gs