A)Introduction to DTDM (the code, input control file, how to run)

1)The code for DTDM (Dynamics and Thermodynamics Demonstration Model) was developed in Fortran 77 by Rob Fovell. We have installed the code but we will not be accessing it directly. Instead we will run it via the variables we choose in the "input control files." Link to DTDM http://www.atmos.ucla.edu/~fovell/DTDM/

Go to the directory dtdm

```
>cd dtdm
```

View the file input_seabreeze.txt

```
>gedit  input_seabreeze.txt
```

Each of the sections has an explanation followed with the option to select the parameters.

In the first section we can select the name of the output file.
You can use "c" to comment any line.

```
&experiment
c       casename = 'seabreeze.rotunno.30deg',
        casename = 'seabreeze.rotunno.60deg',
/
```

The comment causes problems in the file naming environment. Delete the line above with the 30 deg. You should be left with

```
&experiment
        casename = 'seabreeze.rotunno.60deg',
/
```

Scroll through the various sections and familiarize yourself with the parameters and options.

Finally the seabreeze control section:

```
c=================================================================
c
c The rotunno_seabreeze namelist implements a lower tropospheric
c  heat source following Rotunno (1983), useful for long-term
c  integrations of the sea-land-breeze circulation
c
c  iseabreeze (1 = turn Rotunno heat source on; default is 0)
c  sb_ampl - amplitude of heat source (K$s; default = 0.000175)
c  sb_x0 - controls heat source shape at coastline (m; default = 1000.)
c  sb_z0 - controls heat source shape at coastline (m; default = 1000.)
```

```
c  sb_period - period of heating, in days (default = 1.0)
c  sb_latitude - latitude for experiment (degrees; default = 60.)
c  sb_linear (1 = linearize model; default = 1)
c
c=====================================================================

 &rotunno_seabreeze
          iseabreeze = 1,
          sb_ampl = 0.000175,
          sb_x0 = 1000.,
          sb_z0 = 1000.,
          sb_period = 1.0,
          sb_latitude = 60.,
          sb_linear = 1,
 /
```

Exit gedit and return to the prompt.

2)To run dtdm, at the prompt **(Notice the direction of the arrows)**

dtdm < input_seabreeze.txt > output_seabreeze.txt

B)Introduction to dtdm outputs and the GrADS visualization package

1) Data and Coordinates

1)The output files with extension *.ctl give a description of the data and the coordinates over which they vary. The actual data is in the *.dat files which are in binary format.

View for example the file seabreeze.rotunno.00deg.ctl

> gedit seabreeze.rotunno.00deg.ctl

After the preamble you find the variables:

xdef 199 linear 1 2

-The horizontal variable starts at 1, with an interval 2, for a total of 199 values (1,3,…,397)

ydef 1 linear 1 1

-One value (there is no variation in and out of the plane)

zdef 43 levels

-The levels are listed

tdef 289 linear 00:00Z01JAN2000 5 mn

-Starts at an arbitrary zero time. There are 289 points in 5 minute intervals

289 x 5min=1445min 1445min x(1hr/60 min)= 24 hr

The experiments occur over one day

-There are 12 variables as described. Each is defined at 43 vertical levels and varying in the x direction and in time. There is no variation in and out of the plane.

2) Using the Grids Analysis and Display System (GrADS) – Variable as a function of time

The main webpage is http://www.iges.org/grads/

The documentation page has the Users Guide, Tutorial and Index
http://www.iges.org/grads/gadoc/

Before we investigate plotting edit seabreeze_input.txt and change the latitude to 00 degrees. Make sure to change the name of the output file to: seabreeze.rotunno.00deg

Repeat for a latitude of 30 degrees

Check that indeed you have generated the data files

Now open GrADS by typing in the linux prompt

```
> grads -l
```

A useful command to keep in mind is the query

```
> q
```

Lists commands with a simple description

We are going to go over plotting the horizontal velocity as a function of time

Open the three data files

```
ga-> open seabreeze.rotunno.00deg.ctl
ga-> open seabreeze.rotunno.30deg.ctl
ga-> open seabreeze.rotunno.60deg.ctl
```

Set off the projection map

```
ga->  set mproj off
```

Set the display to white color

```
ga->  set display color white
```

Set off the display of the GrADS label

```
ga->  set grads off
```

Use the full time span
Choose the level at the surface (the lowest)
Select the horizontal position at the boundary between the land and sea

```
ga->   set t 1 289
ga->   set z 1
ga->   set x 100
```

Set the vertical range (the values of the velocity amplitude)

```
ga-> set vrange -25 25
```

x-axis labels (0 to 24 hours in 3 hour intervals)

```
ga->  set xaxis 0 24 3
```

Plot the three velocities

```
ga-> display u
ga-> display u.2
ga-> display u.3
```

Draw a title for the graph and for the axes

```
ga-  draw title  coastline wind vs latitude
ga->  draw xlab time after sunrise (hours)
ga->  draw  ylab  cross-shore  wind at coastline (m/s)
```

Label the curves

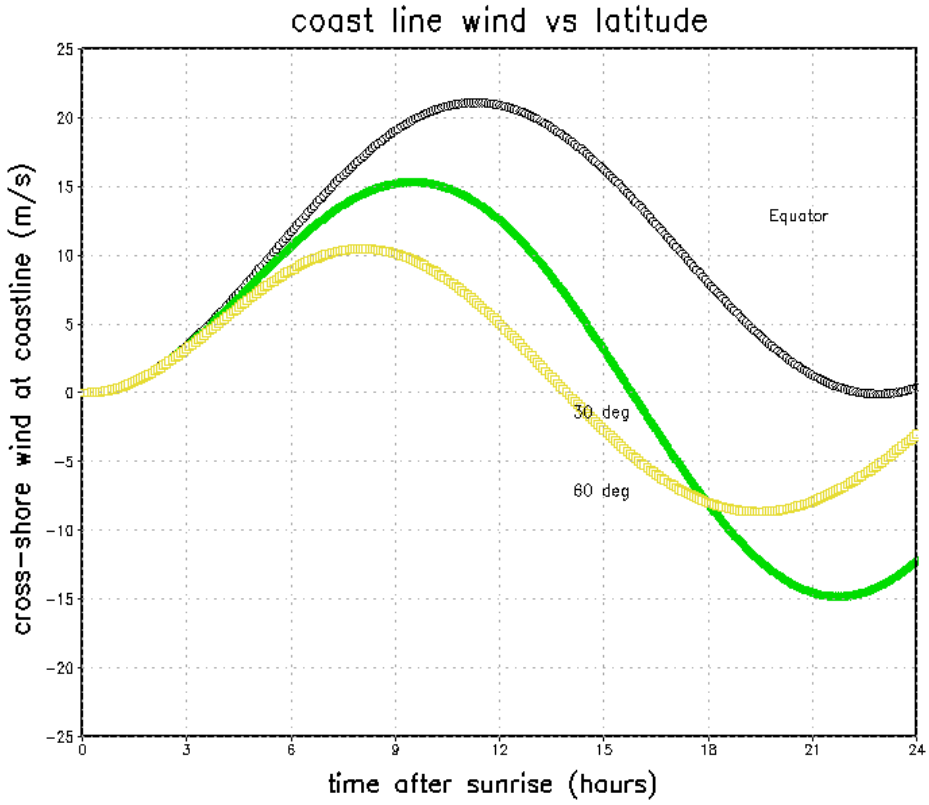
```
ga-> draw string  8.5 6  Equator
ga-> draw string  8  4    30 deg
ga-> draw string  7  3.2  60 deg
```

Get graphics output

ga-> printim uvstime.gif gif

Open another window and view the graph at the linux prompt

> display uvstime.gif



3) Display of the circulation

> clear
> close 3
> close 1

> set t 1 289
> set xaxis 0 24 3
> display sum(u,x=1,x=199)

4) Using GrADS with a script

Scripts offer users the facility to program GrADS operations. Although it is relatively easy for users to produce sophisticated GrADS graphics without ever writing a script, there are occasions where the programming capability makes things even easier.

Here are the commands in seabreeze.gs
You can now recognize some of the commands. Apart from the set up and selection of coordinates this script does two things:

-The command "set gxout shaded" sets up the environment to be able to display the vertical velocity w in shaded format as a function of the horizontal and vertical coordinates. Then it uses the command "set gxout contour" to superpose the perturbed horizontal velocity u' in contour format.

The other commands give specifications for the levels and contours.

The script does not specify the time so it has to be given before.
If the total span is 289 points for 24 hours, noon corresponds to 72, sunset to 144 and mid-night to 217.

Open another window and read the script seabreeze.gs

```
>gedit seabreeze.gs

'set mproj off'
'set display color white'
'set vpage 0.5 11.0 0.5 5'
'clear'
'set grads off'
'set lev 0 3'
'set lon 0 400   '
'run scripts/rgbset.gs'
'set gxout shaded'
'set xaxis 0 400 50'
'set yaxis 0 3 1'
'set clevs -0.05 -0.04 -0.03 -0.02 -0.01 0 0.01 0.02 0.03 0.04 0.05'
'set ccols   49  47  45  43 42 41  0 61 63 65 67 69'
'display w'
'cbarn 1.0 0 6.0'
'set gxout contour'
'set cint 1.5'
'set ccolor 1'
'set black 0 0'
'display  up'
```

To run the program

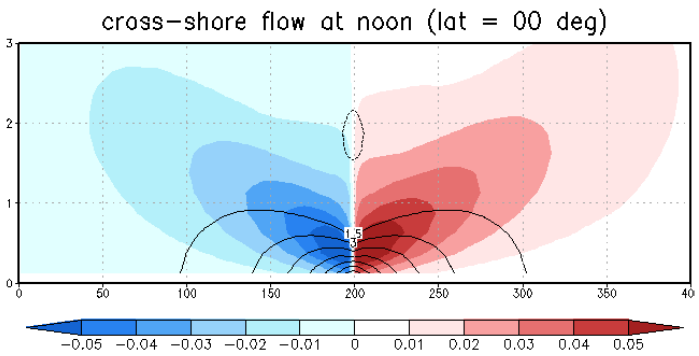
ga-> open seabreeze.rotunno.00deg.ctl
ga-> set t 72
ga-> run seabreeze.gs
ga-> draw title cross-shore at noon (lat = 00 deg)

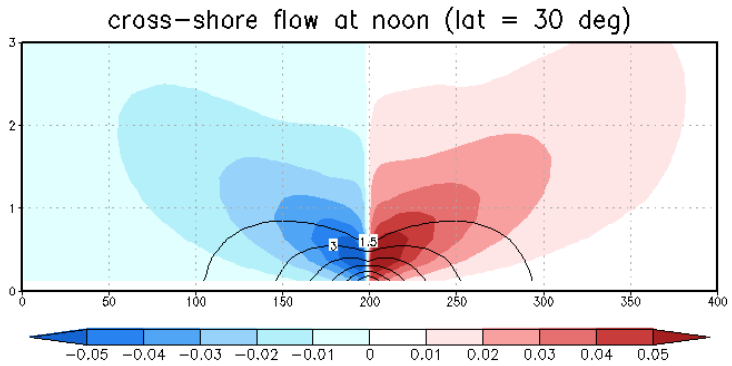
To repeat the exercise for the 30 deg and 60 deg cases first close the 00 deg file

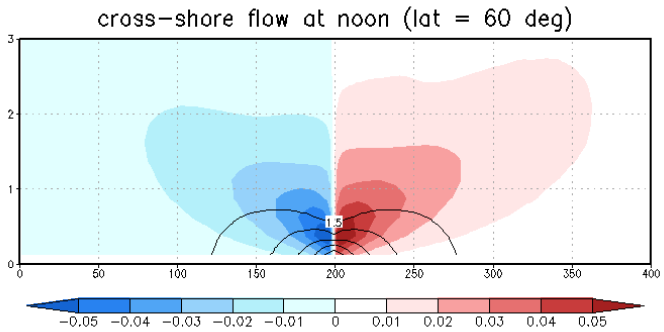
ga-> close 1

Clear the display

ga-> clear







Assignment:

1)Repeat the exercises for the three latitudes (0, 30, 60 degrees) but at sunset and at midnight. Discuss the results by:

a)comparing the output for different latitudes at the same time
b)comparing the output for different latitudes at a given time

2)On the same graph draw the circulation for 0, 30and 60 degrees. Discuss if it fits the theoretical results including the effects of friction.