How to Use the VMIXING Program in HYSPLIT

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Dr. Mark Cohen
NOAA Air Resources Laboratory
College Park MD USA

- There is a program called **`vmixing`** that is present in the exec directory of HYSPLIT
- Its use is somewhat different than most other programs in the exec directory, as will be shown below
- Here, a basic introduction to the use of the **`vmixing`** program is provided, along with some example scripts.
- Previous versions of this tutorial only included Windows DOS Batch scripts, but in the Nov 2019 update, Linux Korn Shell script examples have also been included.
- This tutorial has been carried out with HYSPLIT v5.3.0 (Nov 2021) but should also work with previous versions as well, although the relatively new TKE-output feature may not be present for very old versions, as it was added in 2018.
- There is a related program in HYSPLIT called **`profile`** (see Appendix 1)

- At present, the vmixing program can only be run from the command line (or via a script). There is no option to run the program from the Graphical User Interface (GUI)

- Vmixing allows for six different command line arguments (-p, -s, -t, -a, -m, -w):

```
C:\hysplit4\working>..\exec\vmixing
 Creates a time series of meteorological stability parameters

 USAGE: vmixing (optional arguments)
 -p[process ID]
 -s[KBLS - stability method (1=default)]
 -t[KBLT - PBL mixing scheme (2=default)]
 -a[CAMEO optional variables (0[default]=No, 1=Yes, 2=Yes + Wind Direction]
 -m[TKEMIN - minimum TKE limit for KBLT=3 (0.001=default)]
 -w[an extra file for turbulent velocity variance 0[default]=No,1=Yes)]
```

Note that due to a typo in the vmixing code, the newly added –w option does not work as intended.

- Now, with –w0, a fort.50 output file is written with no header
- And now, with –w1, a header file vmix.process_id.txt is written but does not have the requested data.

The problem is now fixed. A fully functional vmixing program (i.e., with the –w option working) will be included in the next release.

- One crucial argument is "**-p**" (the process id).

- Whatever is given as the process id governs the execution of the program by determining what CONTROL and SETUP file are used

- If the process id is given as "nothing"*, then the program looks in the working directory for CONTROL and if its present, SETUP.CFG

  ..\exec\vmixing **–p**

  ** note that in this case, you still must include the –p*
  if you don't the program will just return the command line options

- If the process id is specified, e.g., "**RUN_01**", then the program looks in the working directory for CONTROL.**RUN_01** and if its present, SETUP.**RUN_01**

  ..\exec\vmixing **–pRUN_01**

- A CONTROL file with the appropriate name (and corresponding SETUP.CFG file with the appropriate name, if desired) must be present, i.e., you have to establish this file (or files) one way or another before you run vmixing

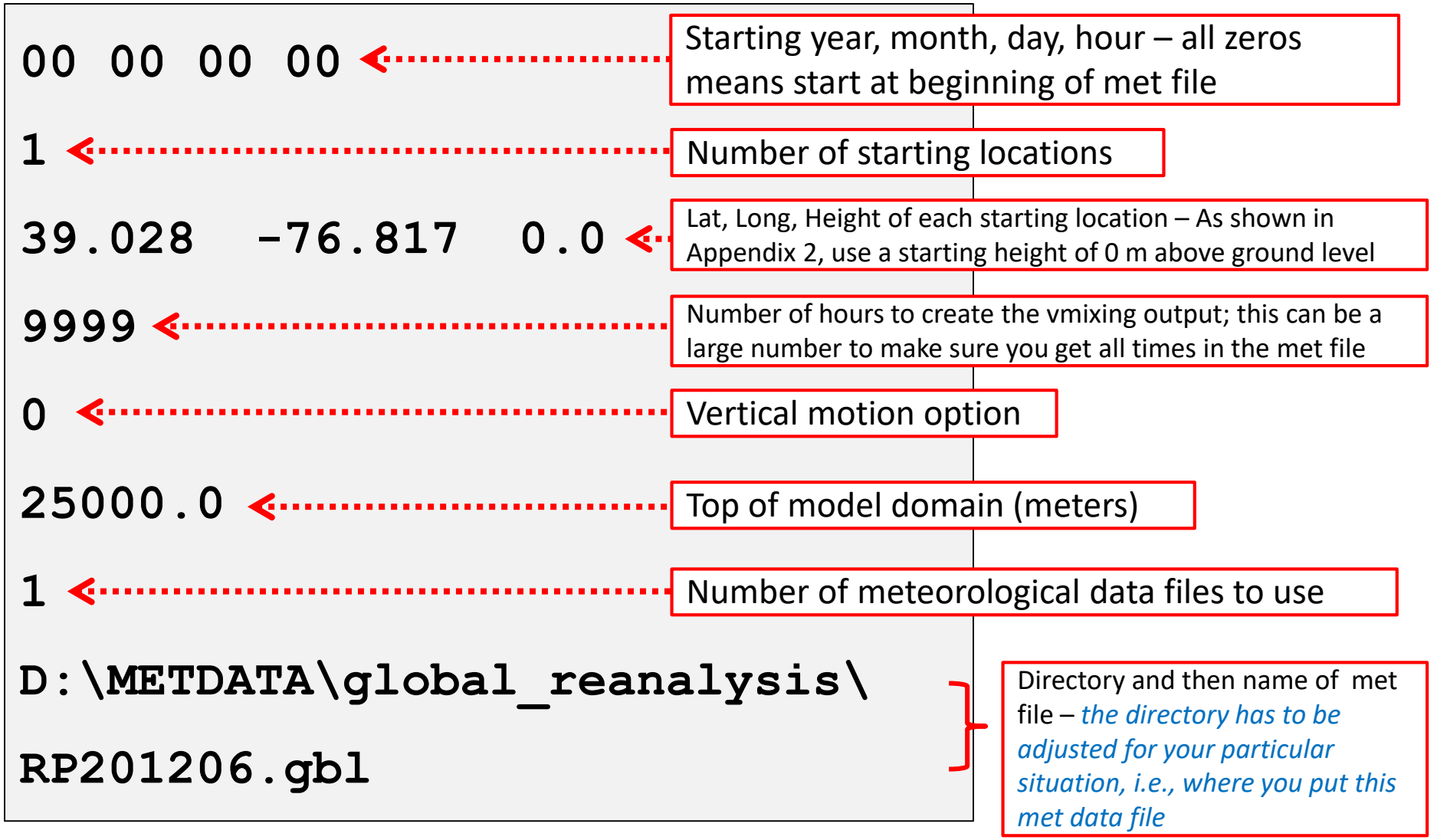
- In the following, we will run the vmixing program to analyze one month of data (June 2012) from the NCEP/NCAR 2.5 degree global reanalysis

- If you want to try to duplicate this analysis, you will have to download the met data file from the ARL archive. Here is a direct URL to the data file (if you click the link, you can save the file to your local computer). You will need to know what directory you saved it in to include in the CONTROL file. This binary file is ~114 MB in size.

  ftp://arlftp.arlhq.noaa.gov/pub/archives/reanalysis/RP201206.gbl

- On the following page is a basic CONTROL file that can be used to run vmixing on this example file. You will need to adjust the 2nd to the last line in the file to match your met file directory

an example CONTROL file to analyze one month of NCEP/NCAR 2.5 degree global reanalysis data (June 2012)



For most "executables" in the hysplit\exec\ directory,

- **if you "run" the program by typing in its name and hitting enter,**
- **with no other "arguments" on the command line,**
- **it will give you a list of the arguments that it either needs or could use!**
- **These are the arguments that can (or must) be specified if running the program from the command line or from a script**

```
C:\hysplit\working_vmixing_tutorial>..\exec\vmixing
 Creates a time series of meteorological stability parameters

 USAGE: vmixing (optional arguments)
 -p[process ID]
 -s[KBLS - stability method (1=default)]
 -t[KBLT - PBL mixing scheme (2=default)]
 -a[CAMEO optional variables (0[default]=No, 1=Yes, 2=Yes + Wind Direction]
 -m[TKEMIN - minimum TKE limit for KBLT=3 (0.001=default)]
 -w[an extra file for turbulent velocity variance (0[default]=No,1=Yes)]

C:\hysplit\working_vmixing_tutorial>
```

```
C:\hysplit\working_vmixing_tutorial>dir CONTROL
 Volume in drive C is OS
 Volume Serial Number is 74EF-A490
 Directory of C:\hysplit\working_vmixing_tutorial
11/19/2019  03:40 PM               106 CONTROL
               1 File(s)            106 bytes
               0 Dir(s)  219,560,742,912 bytes free

C:\hysplit\working_vmixing_tutorial>..\exec\vmixing -p
```

Here's the terminal session in Windows, where we run the vmixing program using the CONTROL file above. **The items typed by the user are in red**

Output while vmixing is running, one line for each time in met file

```
  6   360.0000            9999         9999
 12          6            1            0          0    59124960
 12          6            1            6          0    59125320
 .
 .
 .
 12          6           30            6          0    59167080
 12          6           30           12          0    59167440
```

```
C:\hysplit\working_vmixing_tutorial>dir stability.txt
 Volume in drive C is OS
 Volume Serial Number is 74EF-A490
 Directory of C:\hysplit\working_vmixing_tutorial
11/19/2019  03:40 PM            12,960 STABILITY.txt
               1 File(s)         12,960 bytes
               0 Dir(s)  219,565,789,184 bytes free

C:\hysplit\working_vmixing_tutorial>
```

On the next page is the output created, written to a file called "STABILITY.txt" (if we had specified a process id, it would have gone after the dot. For example, STABILITY.RUN_01.txt.)

You can see that there is a record for each 6 hr time period in the file*, and values are provided for the following variables:

parameter	abbrev	units	notes
Pasquill-Gifford Stability Category	PSQ		
Mixing Height	Z_i	m	
Vertical Mixing Coefficient	K_z	m^2/s	the value written to the output file is 10x the actual Kz value
Friction Velocity	U_*	m/s	
Roughness Length	Z_o	m	
Terrain Height	Z_{terr}	m	
Horizontal Mixing Coefficient	K_h	m^2/s	

* There is not a record for the last time period in the file, June 30, 2012, 18z. This is because when vmixing runs (like HYSPLIT) it needs the next time period to be available to do any calculations for a given time period. So, if you want to get the "last" time period in a given file, you need to include the next file (or at least the next time step).

STABILITY.txt

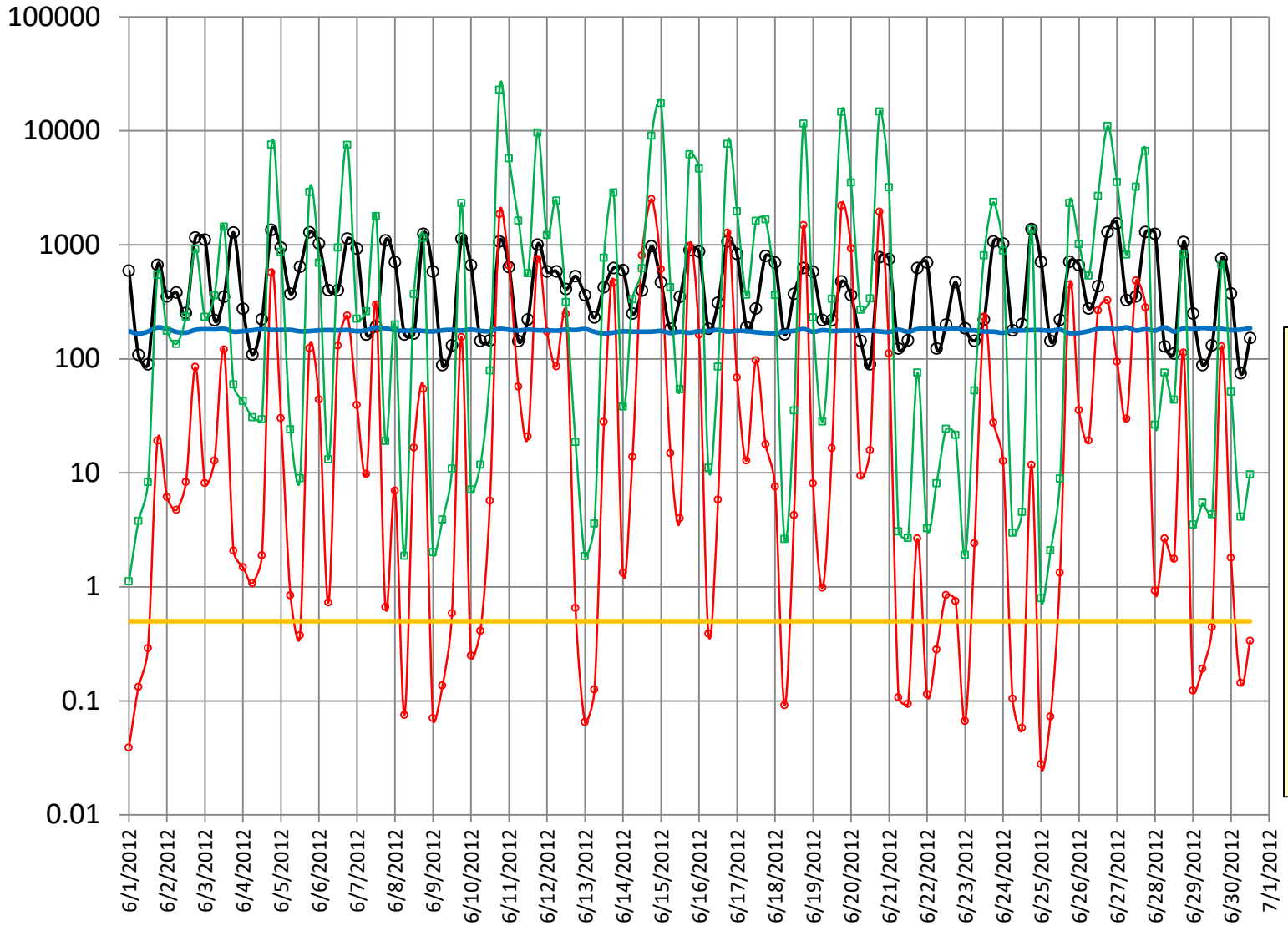
39.03 -76.82 CDC1

JDAY	YR	MO	DA	HR	MN	PSQ	Zi (m)	10xKz (m2/s)	U* (m/s)	Zo (m)	Zterr (m)	Kh (m2/s)
153.000	12	6	1	0	0	G	0.5913E+03	0.3897E-01	0.4026E-02	0.5000E+00	0.1754E+03	0.1114E+01
153.250	12	6	1	6	0	G	0.1084E+03	0.1324E+00	0.8611E-02	0.5000E+00	0.1653E+03	0.3786E+01
153.500	12	6	1	12	0	G	0.8934E+02	0.2898E+00	0.1184E-01	0.5000E+00	0.1739E+03	0.8284E+01
153.750	12	6	1	18	0	F	0.6647E+03	0.1909E+02	0.7841E-01	0.5000E+00	0.1885E+03	0.5458E+03
154.000	12	6	2	0	0	F	0.3514E+03	0.6145E+01	0.4850E-01	0.5000E+00	0.1835E+03	0.1757E+03
154.250	12	6	2	6	0	G	0.3818E+03	0.4727E+01	0.4436E-01	0.5000E+00	0.1722E+03	0.1351E+03
154.500	12	6	2	12	0	F	0.2519E+03	0.8319E+01	0.2687E-01	0.5000E+00	0.1698E+03	0.2336E+03
154.750	12	6	2	18	0	E	0.1158E+04	0.8480E+02	0.1262E+00	0.5000E+00	0.1794E+03	0.9174E+03
155.000	12	6	3	0	0	F	0.1110E+04	0.8139E+01	0.5249E-01	0.5000E+00	0.1819E+03	0.2327E+03
155.250	12	6	3	6	0	F	0.2187E+03	0.1277E+02	0.4007E-01	0.5000E+00	0.1812E+03	0.3594E+03
155.500	12	6	3	12	0	D	0.3497E+03	0.1206E+03	0.5969E-01	0.5000E+00	0.1834E+03	0.1439E+04
155.750	12	6	3	18	0	G	0.1282E+04	0.2079E+01	0.2535E-01	0.5000E+00	0.1730E+03	0.5942E+02
156.000	12	6	4	0	0	G	0.2750E+03	0.1489E+01	0.1808E-01	0.5000E+00	0.1750E+03	0.4256E+02
156.250	12	6	4	6	0	G	0.1090E+03	0.1073E+01	0.1729E-01	0.5000E+00	0.1781E+03	0.3068E+02
156.500	12	6	4	12	0	G	0.2215E+03	0.1888E+01	0.1197E-01	0.5000E+00	0.1822E+03	0.2941E+02
156.750	12	6	4	18	0	C	0.1348E+04	0.5722E+03	0.1920E+00	0.5000E+00	0.1793E+03	0.7533E+04

•
•
•

179.750	12	6	27	18	0	D	0.1291E+04	0.2814E+03	0.2145E+00	0.5000E+00	0.1822E+03	0.6636E+04
180.000	12	6	28	0	0	G	0.1248E+04	0.9243E+00	0.1424E-01	0.5000E+00	0.1769E+03	0.2642E+02
180.250	12	6	28	6	0	G	0.1283E+03	0.2647E+01	0.1913E-01	0.5000E+00	0.1885E+03	0.7567E+02
180.500	12	6	28	12	0	G	0.1113E+03	0.1764E+01	0.1412E-01	0.5000E+00	0.1735E+03	0.4376E+02
180.750	12	6	28	18	0	D	0.1057E+04	0.1129E+03	0.1550E+00	0.5000E+00	0.1849E+03	0.8242E+03
181.000	12	6	29	0	0	G	0.2499E+03	0.1231E+00	0.8299E-02	0.5000E+00	0.1819E+03	0.3519E+01
181.250	12	6	29	6	0	G	0.8790E+02	0.1911E+00	0.1001E-01	0.5000E+00	0.1871E+03	0.5462E+01
181.500	12	6	29	12	0	G	0.1310E+03	0.4428E+00	0.7104E-02	0.5000E+00	0.1839E+03	0.4319E+01
181.750	12	6	29	18	0	D	0.7572E+03	0.1283E+03	0.1789E+00	0.5000E+00	0.1831E+03	0.6717E+03
182.000	12	6	30	0	0	G	0.3731E+03	0.1798E+01	0.1758E-01	0.5000E+00	0.1784E+03	0.5140E+02
182.250	12	6	30	6	0	G	0.7468E+02	0.1438E+00	0.8756E-02	0.5000E+00	0.1803E+03	0.4112E+01
182.500	12	6	30	12	0	G	0.1520E+03	0.3356E+00	0.6206E-02	0.5000E+00	0.1855E+03	0.9664E+01

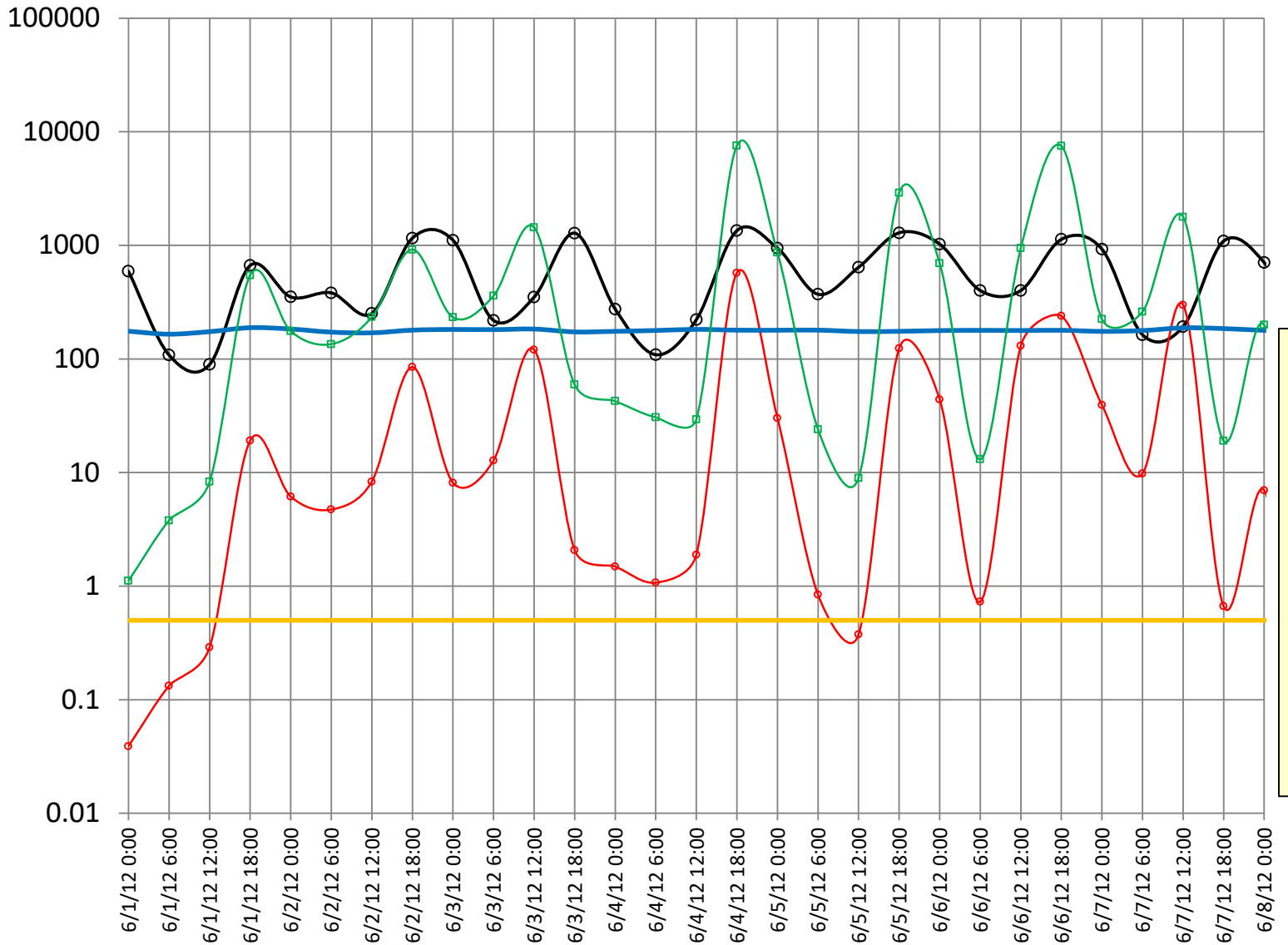
Here's a graph showing the values for the selected site, output from vmixing, for RP201206.gbl



The roughness length (Zo) and terrain height (Zterr) are essentially constant, as would be expected for a given site.

However, you can see a large diurnal (and day to day) variation for the mixing height (Zi) and mixing coefficients (Kz and Kh).

Here's a graph showing the same values for the selected site, output from vmixing, for RP201206.gbl, ***for just one week***



The roughness length (Zo) and terrain height (Zterr) are essentially constant, as would be expected for a given site.

However, you can see a large diurnal (and day to day) variation for the mixing height (Zi) and mixing coefficients (Kz and Kh).

In the above, we were running vmixing from the command line, and creating the CONTROL files with a text editor. However, vmixing can be run with scripts.

A few examples of running vmixing with scripts using a "RUN" and "SET" architecture were created and included in the "working_vmixing_001" files associated with this tutorial.

We have included DOS Batch script examples (.bat files that can be run with Windows), and we have included Korn Shell scripts which can be run on Linux and Mac environments.

As with the command line approach, scripts must be run from the terminal. If you are not familiar with the terminal, a brief introduction is given in Appendix 3.

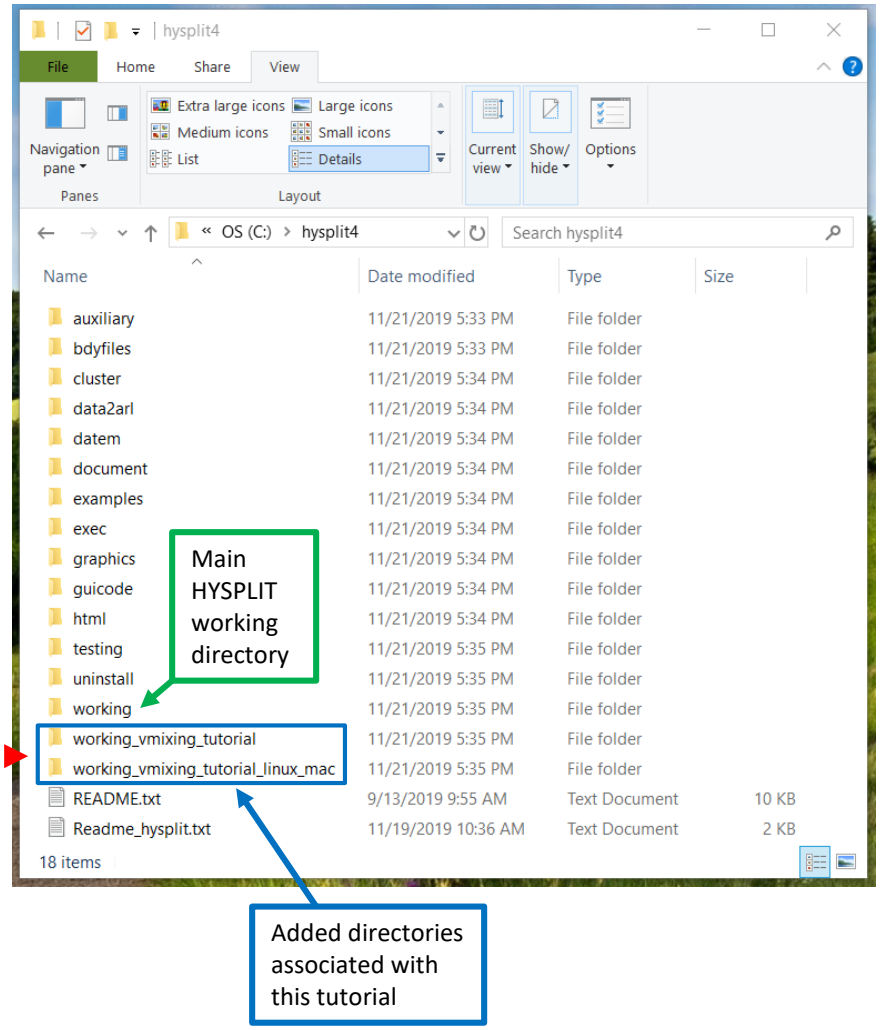
In vmixing_run_001.bat (and .ksh) and vmixing_set_001.bat (and .ksh), a simple structure was used to run vmixing individually on two months of the NCEP/NCAR 2.5 deg global reanalysis dataset for 2012. In this example, each month's data were written to a separate file.

In order to run this script, which specifies all the met files for 2012, you'd have to first download the 12 files for 2012 from:

ftp://arlftp.arlhq.noaa.gov/pub/archives/reanalysis

(i.e., RP201201.gbl, RP201202.gbl, … RP201212.gbl)

- In order to carry out the runs described here, you can place the working directories in the hysplit folder, alongside the existing “main” working directory in the hysplit folder
  - If you are working on a Windows computer, then you just need the “working_vmixing_tutorial” folder
  - If you are working on a Linux or Mac computer, then you just need the “working_vmixing_tutorial_linux_mac” folder
- Note that one can have a number of different working directories
- When one is using the Graphical User Interface, output files are generally placed the main HYSPLIT working directory
- But when is working from the command line or with scripts, it can be helpful to create a new working directory and run HYSPLIT from there
- Having any new working directories on the same “level” as the main working directory is convenient because then all of the relative path references -- e.g., ../exec/ -- will work as intended.



Here's the terminal input (red) and output when vmixing_run_001.bat is run in a Windows terminal

```
C:\Users\Mark.Cohen>cd C:\hysplit4
C:\hysplit>cd working_vmixing_tutorial
C:\hysplit\working_vmixing_tutorial>dir *.bat
 Volume in drive C is OS
 Volume Serial Number is 74EF-A490

 Directory of C:\hysplit\working_vmixing_tutorial

11/20/2019  05:28 PM               808 profile_run_001.bat
11/20/2019  04:07 PM             2,801 profile_set_001.bat
11/21/2019  02:42 PM             2,056 vmixing_run_001.bat
11/20/2019  02:12 PM               960 vmixing_run_002.bat
11/20/2019  09:40 AM            11,667 vmixing_set_001.bat
11/20/2019  02:37 PM            12,215 vmixing_set_002.bat
               6 File(s)         30,507 bytes
               0 Dir(s)  219,566,465,024 bytes free

C:\hysplit\working_vmixing_tutorial>vmixing_run_001
       latitude = 39.028
      longitude = -76.817
         height = 0.0
         metdir = D:\METDATA\global_reanalysis\
        metfile = RP201206.gbl
       run_name = gbl2p5_06_2012_base
           KBLS = 2
           KBLT = 2
extra_variables = 2
     start_year = 00
    start_month = 00
      start_day = 00
     start_hour = 00
        run_hrs = 9999
          KMIXD = 0
          KMIX0 = 50
        1 file(s) copied.
        1 file(s) copied.
 finished creating CONTROL and SETUP.CFG
           6   360.0000            9999        9999
          12          6           1           0           0    59124960
          12          6           1           6           0    59125320
          12          6           1          12           0    59125680
           .
           .
           .
          12          6          30           0           0    59166720
          12          6          30           6           0    59167080
          12          6          30          12           0    59167440
Press any key to continue . . .

C:\hysplit\working_vmixing_tutorial>
```

Navigating to the correct directory once the terminal is open, and making sure that the key scripts are present

Running the vmixing_run_001 DOS Batch Script

Output while the script is running

Output from the vmixing program while it is running in the script

Hit ENTER key to exit from the script, as a "pause" had been inserted at the end of the script

In these example scripts, we have utilized the –a2 option, which tells the vmixing program to output extra variables and include the true wind speed and direction, as opposed to the U and V components of the wind relative to the meteorological data grid.

We caution the user that the u10m and v10m wind vectors output are relative to the given met data grid.

- If the grid is rotated relative to North-South and East-West (as in a lambert conformal or polar stereographic grid, for example), then these are not true cardinal-direction wind vectors.

- For a global lat-long grid like the NCEP/NCAR global reanalysis, the u and v wind vector components may indeed represent true East-West and North-South wind vector components.

- If one includes the –a2 option when running vmixing, one is assured of getting the true wind spend and direction

Here's the first several, and last several lines of the stability output file from vmixing for the RP201206.gbl met data file, when the –a2 extra variables flag is set

You can see all the extra variables that one gets with this flag

39.03 -76.82 CDC1

JDAY	YR	MO	DA	HR	MN	PSQ	MixHgt (m)	10xKz (m2/s)	U* (m/s)	Zo (m)	Zterr (m)	Kh (m2/s)	10mWSPD (m/s)	DSWF (W/m2)	SFCP (HPa)	RH2m (%)	T02m (K)	Density (kg/m3)	Total Cld (%)	u10m (m/s)	v10m (m/s)	WDIR deg
153.000	12	6	1	0	0	G	0.5913E+03	0.3897E-01	0.4026E-02	0.5000E+00	0.1754E+03	0.1114E+01	0.1990E+01	0.6795E+02	0.9906E+03	0.0000E+00	0.2956E+03	0.1158E+01	-0.1000E+03	-0.1407E+01	-0.1407E+01	0.4501E+02
153.250	12	6	1	6	0	G	0.1084E+03	0.1324E+00	0.8611E-02	0.5000E+00	0.1653E+03	0.3786E+01	0.4048E+01	0.0000E+00	0.9920E+03	0.0000E+00	0.2914E+03	0.1176E+01	-0.1000E+03	-0.3626E+01	0.1801E+01	0.1164E+03
153.500	12	6	1	12	0	G	0.8934E+02	0.2898E+00	0.1184E-01	0.5000E+00	0.1739E+03	0.8284E+01	0.4683E+01	0.4210E+03	0.9920E+03	0.0000E+00	0.2916E+03	0.1174E+01	-0.1000E+03	-0.3899E+01	0.2595E+01	0.1236E+03
153.750	12	6	1	18	0	F	0.6647E+03	0.1909E+02	0.7841E-01	0.5000E+00	0.1885E+03	0.5458E+03	0.7673E+01	0.1028E+04	0.9887E+03	0.0000E+00	0.2959E+03	0.1153E+01	-0.1000E+03	-0.5106E+01	0.5728E+01	0.1383E+03

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181.750	12	6	29	18	0	D	0.7572E+03	0.1283E+03	0.1789E+00	0.5000E+00	0.1831E+03	0.6717E+03	0.1556E+01	0.1043E+04	0.9873E+03	0.0000E+00	0.3049E+03	0.1116E+01	-0.1000E+03	0.9757E+00	-0.1212E+01	0.3212E+03
182.000	12	6	30	0	0	G	0.3731E+03	0.1798E+01	0.1758E-01	0.5000E+00	0.1784E+03	0.5140E+02	0.2161E+01	0.1025E+03	0.9859E+03	0.0000E+00	0.3046E+03	0.1116E+01	-0.1000E+03	0.1776E+01	0.1231E+01	0.2353E+03
182.250	12	6	30	6	0	G	0.7468E+02	0.1438E+00	0.8756E-02	0.5000E+00	0.1803E+03	0.4112E+01	0.3078E+01	0.0000E+00	0.9883E+03	0.0000E+00	0.2961E+03	0.1150E+01	-0.1000E+03	0.2867E+01	-0.1119E+01	0.2913E+03
182.500	12	6	30	12	0	G	0.1520E+03	0.3356E+00	0.6206E-02	0.5000E+00	0.1855E+03	0.9664E+01	0.3428E+01	0.4446E+03	0.9902E+03	0.0000E+00	0.2962E+03	0.1153E+01	-0.1000E+03	0.2827E+01	-0.1939E+01	0.3044E+03

These are just simple examples of scripts, with a number of items “hard-wired”. The scripts can be made more general if the user desires. Note that scripts must always be in “plain text”.

The basic structure of these script examples is that the user runs the “RUN” script, and the “RUN” script calls the “SET” script. The user sets the key parameters in the “RUN” script, and the “SET” script takes those parameters and carries out a set of specified actions.

The user can adjust the parameters supplied to the SET script as long as the RUN and SET scripts are coordinated, i.e., the SET script receives a set of parameters and the user has to make sure that it properly uses the parameters it receives, in the exact order that they are received.

In these examples, the following actions are carried out in the SET script, based on the parameters specified in the RUN script:

- The CONTROL file is written
- The SETUP.CFG file is written
- The vmixing program is run

In vmixing_run_002.bat and vmixing_set_002.bat, a very simple example is shown in which we specify 12 different met files in CONTROL, and run vmixing for the entire year 2012 all at once. There are several advantages to doing it this way:

- The "next" data record is always available, so we don't miss out on the last record in each met file (in this case, the last record of each month)

- We have all of the data for year combined for us into one file (eliminating the need to concatenate the data later)

Note that we have not demonstrated the use of other command line arguments here.

For KBLS and KBLT, the options from the HYSPLIT users guide are provided for reference on the following pages.

Note that these and other parameters can also be set via the SETUP namelist file. As noted earlier, if the SETUP.CFG (or SETUP.process_id) file is present, then the vmixing program will read it and use it to guide the calculation.

Vertical Turbulence

KBLT is a flag used to set the vertical turbulence computational method, that is how the turbulent velocity variances are computed from either the heat and momentum fluxes or the model profiles of wind and temperature.

Two different computational approaches (Beljaars/Holtslag and Kanthar/Clayson - see the technical documentation for details) are defined.

Another option is the use the TKE (Turbulent Kinetic Energy) output from the meteorological model provided in the input meteorological data file. Not all model data contain the TKE field.

The last option is a special case where the input meteorological data are assumed to contain the 3-dimensional component velocity variance fields, usually a measured component.

1 - Beljaars/Holtslag and Betchov/Yaglom

2 - Kanthar/Clayson (**DEFAULT**)

3 - TKE field from the input meteorology data file

4 - Measured velocity variances from the input meteorology

Boundary Layer Stability

KBLS defines how the stability is computed. Normally when turbulent fluxes (heat and momentum) are available from the meteorological data file, they are used to compute stability. Sometimes it may be desirable to force the stability to be computed from the wind and temperature profiles, especially if the fluxes represent long-time period averages rather than instantaneous values. If fluxes are not present, the profiles are used for the stability computation.

1 - Heat and momentum fluxes (**DEFAULT**)
2 - Wind and temperature profiles

Appendix 1.
The profile program

HYSPLIT also has a program called **`profile`** that can be run from Graphical User Interface as well as the command line

From the GUI: Meteorology → Display Data → Text Profile

https://www.ready.noaa.gov/hysplitusersguide/S132.htm

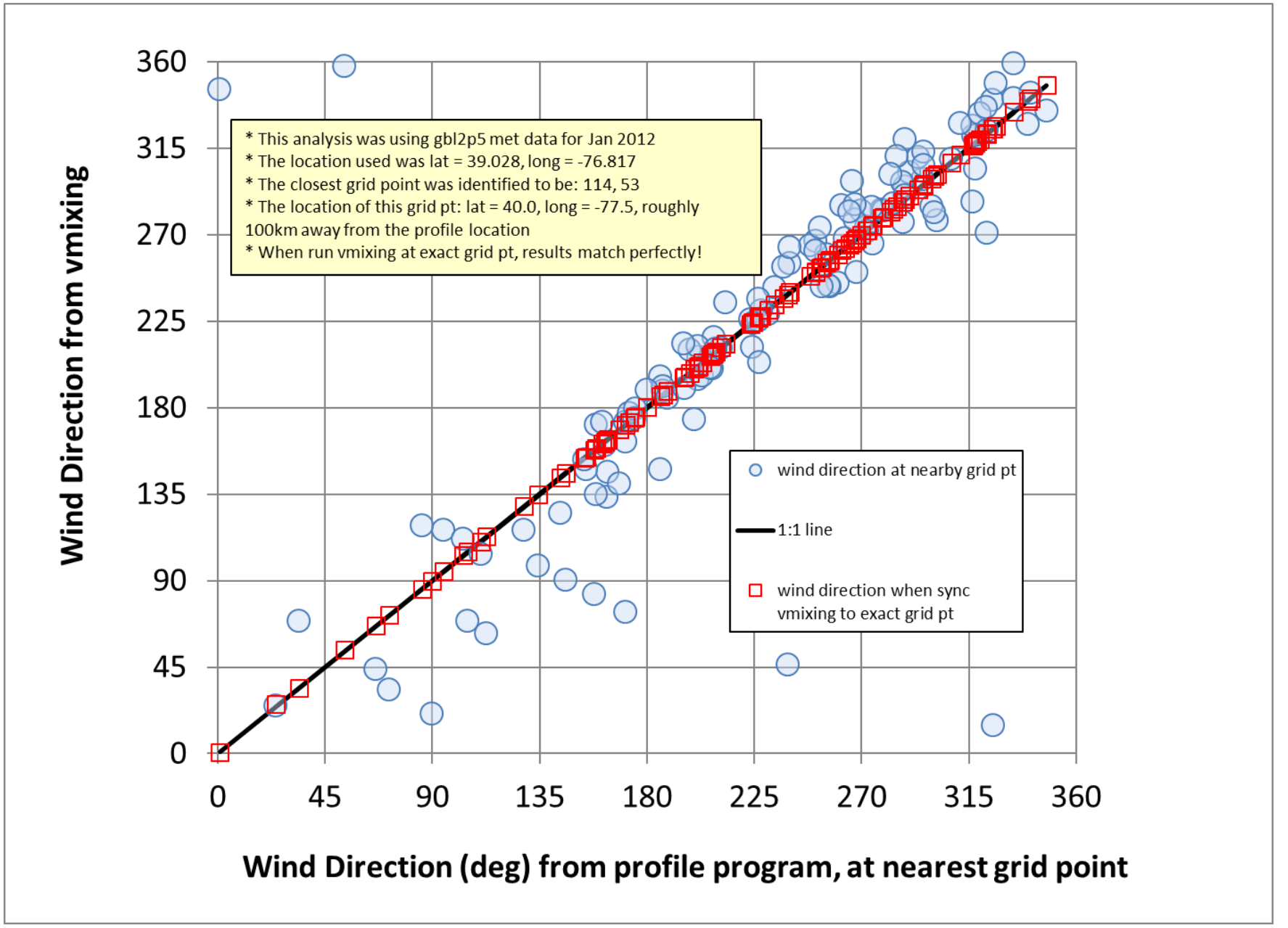
The profile program outputs surface data and meteorological data aloft.

A simple set of scripts (run_profile_001 and set_profile_001) has been included that runs the profile program on the Jun 2012 global reanalysis dataset at the same location as vmixing has been run in the above examples

The profile program does not do any interpolation but simply outputs the meteorological values at the nearest grid point

So, since the location in these examples does not fall on a grid point, the vmixing and profile results for variables common to both outputs (e.g., wind speed and wind direction at the surface) do not match.

However, if vmixing is re-run at the nearest grid point – in this case, for the global reanalysis met data – then the profile and vmixing outputs for common variables do match. This is demonstrated in the plot on the next page (for Jan 2012).


* This analysis was using gbl2p5 met data for Jan 2012
* The location used was lat = 39.028, long = -76.817
* The closest grid point was identified to be: 114, 53
* The location of this grid pt: lat = 40.0, long = -77.5, roughly 100km away from the profile location
* When run vmixing at exact grid pt, results match perfectly!
wind direction at nearby grid pt
1:1 line
wind direction when sync vmixing to exact grid pt
Wind Direction from vmixing
Wind Direction (deg) from profile program, at nearest grid point
0
45
90
135
180
225
270
315
360

Appendix 2.
What starting height to use in vmixing CONTROL file?

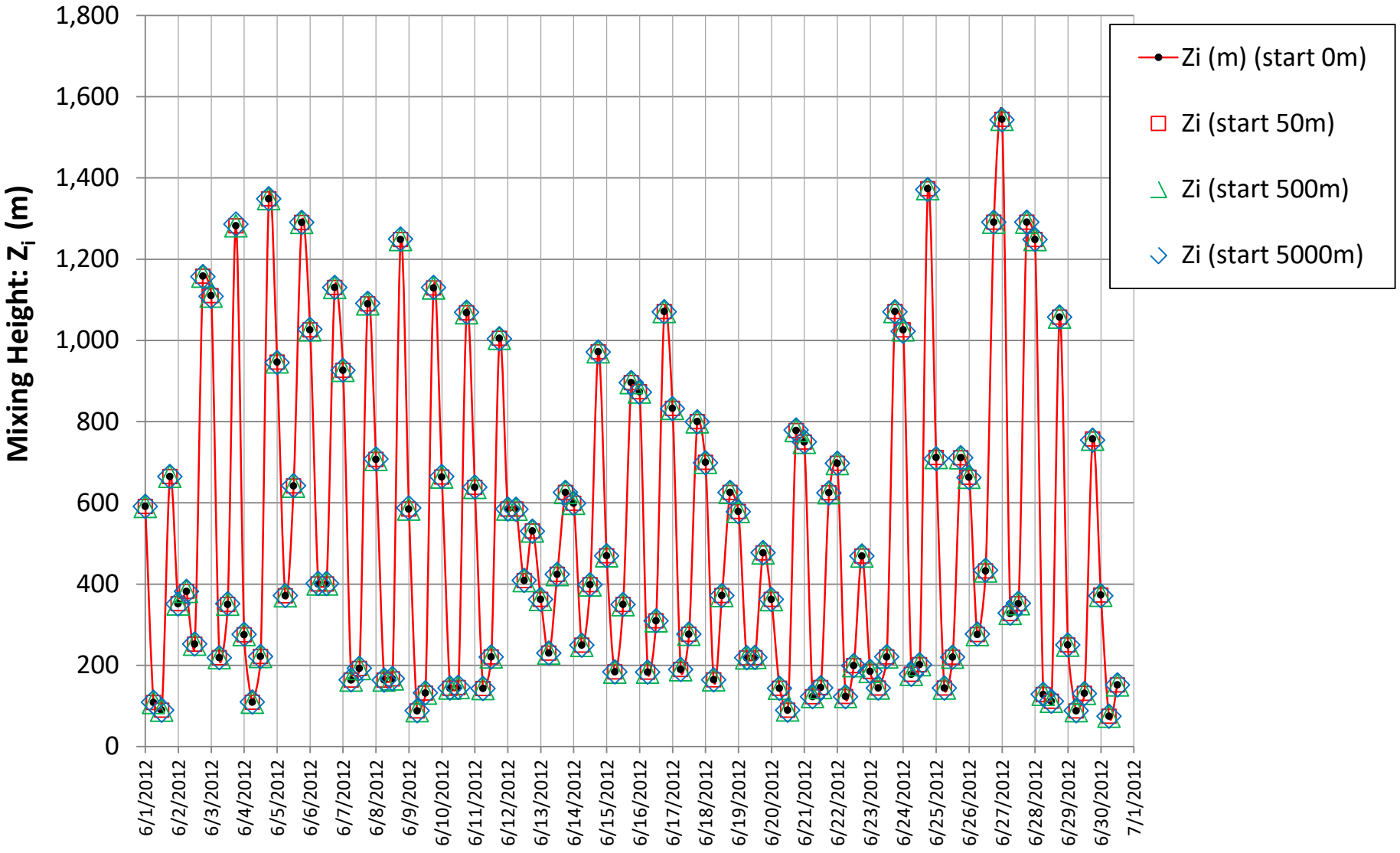
The starting height is a parameter that must be set in the CONTROL file for the vmixing run to be carried out. In all of the above examples, a starting height of "0 m agl" was used.

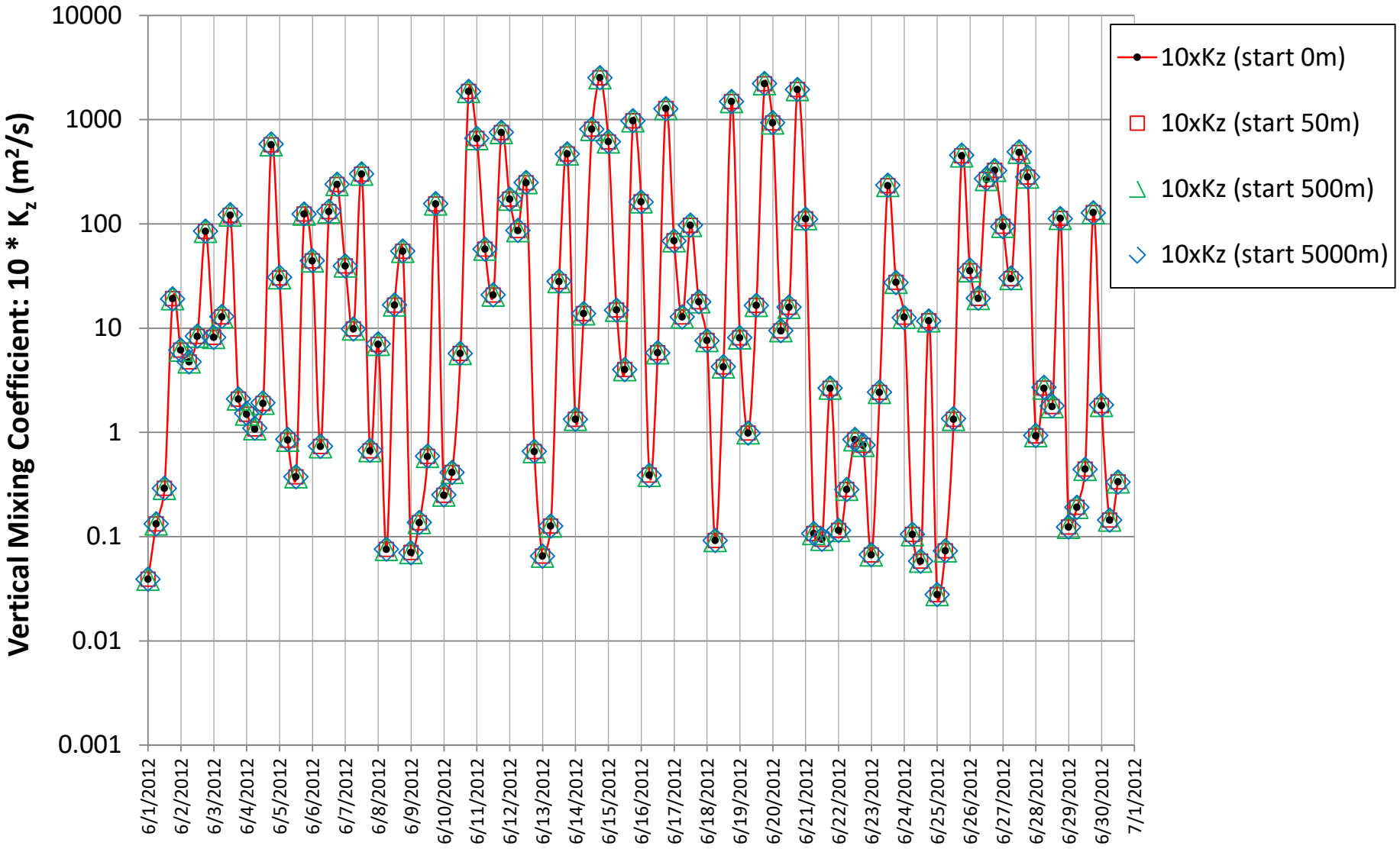
What happens if a non-zero starting height is used?

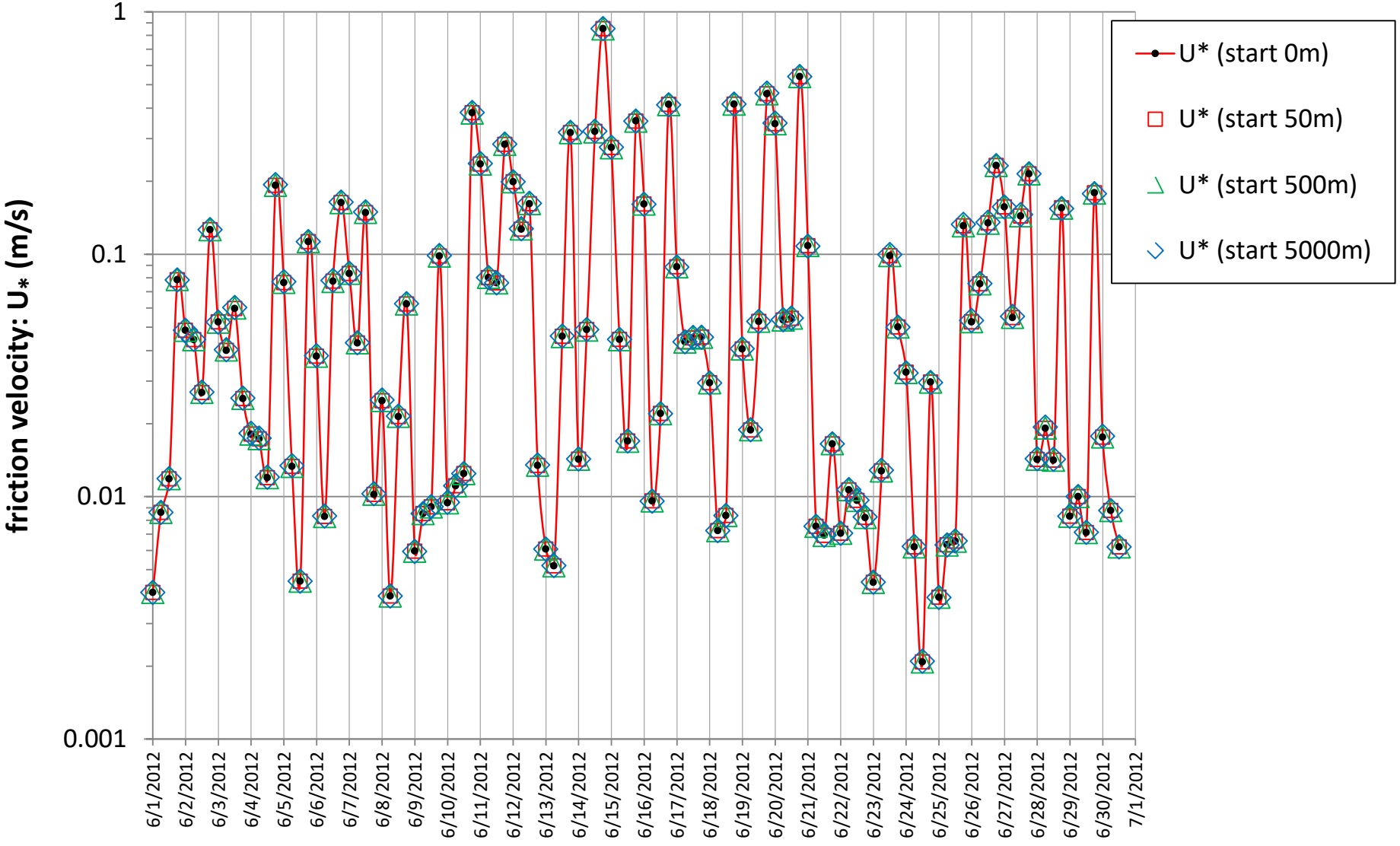
In the following graphs, we show the results for starting heights of 0, 50, 500, and 5000 meters agl. It can be seen that:

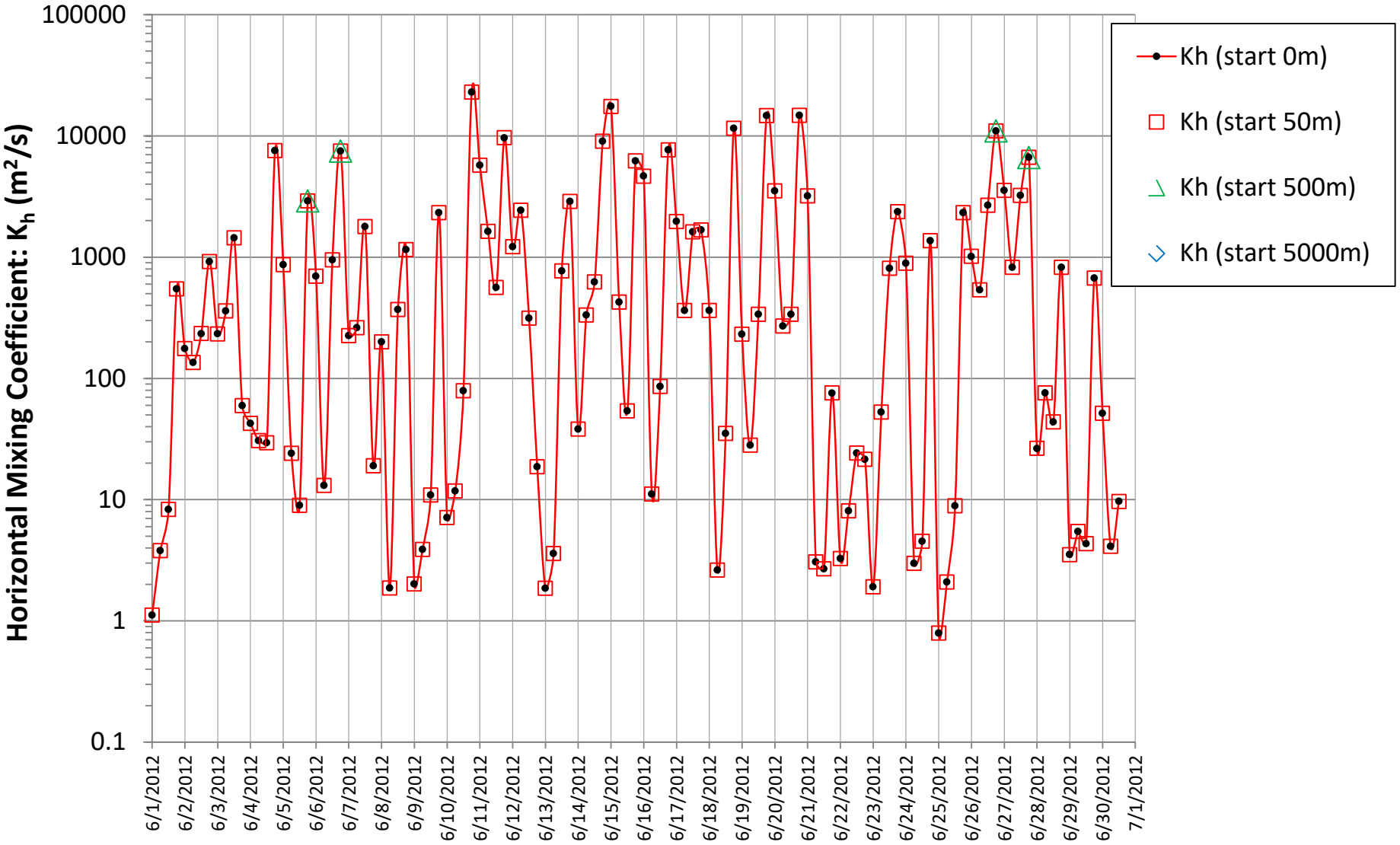
- For mixing height (Zi), the results are identical.
- For the vertical mixing coefficient (Kz), the results are identical
- For the friction velocity (U*), the results are identical
- For the roughness length and terrain height, the results are not shown, but they are identical.
- For the horizontal mixing coefficient (Kh), the results for 0 and 50m are identifical, but aside from a few output values at 500m, the 500m and 5000m Kh values were not output (they are shown as NaN in the output – a Fortran abbreviation for "Not a Number"

It seems that the best way to run vmixing to get boundary layer values is to use a starting height of 0 meters above ground level


Mixing Height: Z_i (m)
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
6/1/2012
6/2/2012
6/3/2012
6/4/2012
6/5/2012
6/6/2012
6/7/2012
6/8/2012
6/9/2012
6/10/2012
6/11/2012
6/12/2012
6/13/2012
6/14/2012
6/15/2012
6/16/2012
6/17/2012
6/18/2012
6/19/2012
6/20/2012
6/21/2012
6/22/2012
6/23/2012
6/24/2012
6/25/2012
6/26/2012
6/27/2012
6/28/2012
6/29/2012
6/30/2012
7/1/2012
Zi (m) (start 0m)
Zi (start 50m)
Zi (start 500m)
Zi (start 5000m)


Vertical Mixing Coefficient: 10 * Kz (m2/s)
10000
1000
100
10
1
0.1
0.01
0.001
6/1/2012
6/2/2012
6/3/2012
6/4/2012
6/5/2012
6/6/2012
6/7/2012
6/8/2012
6/9/2012
6/10/2012
6/11/2012
6/12/2012
6/13/2012
6/14/2012
6/15/2012
6/16/2012
6/17/2012
6/18/2012
6/19/2012
6/20/2012
6/21/2012
6/22/2012
6/23/2012
6/24/2012
6/25/2012
6/26/2012
6/27/2012
6/28/2012
6/29/2012
6/30/2012
7/1/2012
10xKz (start 0m)
10xKz (start 50m)
10xKz (start 500m)
10xKz (start 5000m)


friction velocity: U* (m/s)
1
0.1
0.01
0.001
6/1/2012
6/2/2012
6/3/2012
6/4/2012
6/5/2012
6/6/2012
6/7/2012
6/8/2012
6/9/2012
6/10/2012
6/11/2012
6/12/2012
6/13/2012
6/14/2012
6/15/2012
6/16/2012
6/17/2012
6/18/2012
6/19/2012
6/20/2012
6/21/2012
6/22/2012
6/23/2012
6/24/2012
6/25/2012
6/26/2012
6/27/2012
6/28/2012
6/29/2012
6/30/2012
7/1/2012
U* (start 0m)
U* (start 50m)
U* (start 500m)
U* (start 5000m)

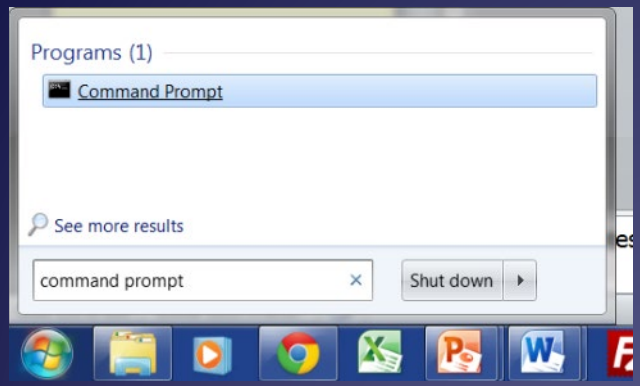

Horizontal Mixing Coefficient: K_h (m^2/s)
100000
10000
1000
100
10
1
0.1
6/1/2012
6/2/2012
6/3/2012
6/4/2012
6/5/2012
6/6/2012
6/7/2012
6/8/2012
6/9/2012
6/10/2012
6/11/2012
6/12/2012
6/13/2012
6/14/2012
6/15/2012
6/16/2012
6/17/2012
6/18/2012
6/19/2012
6/20/2012
6/21/2012
6/22/2012
6/23/2012
6/24/2012
6/25/2012
6/26/2012
6/27/2012
6/28/2012
6/29/2012
6/30/2012
7/1/2012
Kh (start 0m)
Kh (start 50m)
Kh (start 500m)
Kh (start 5000m)

Appendix 3.
Navigating the terminal in Windows, Mac, and Linux operating systems.

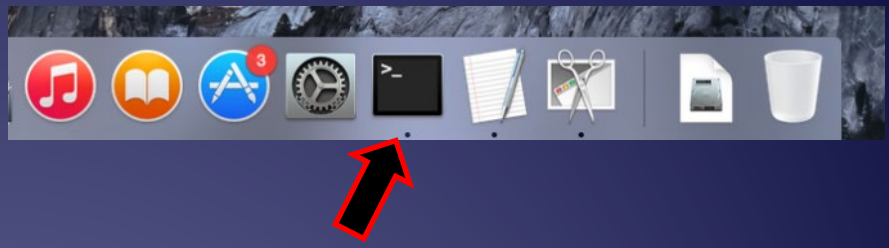
To run HYSPLIT from the Command Line, you must first open up a "terminal window" on your computer – slightly different in Windows, Linux, and Mac

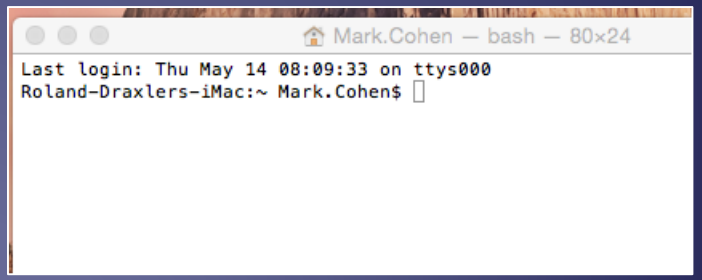
Windows

Start → Search for "Command Prompt"



Linux & Mac





Basic Navigation within Terminal Windows

Windows

Often starts in users directory

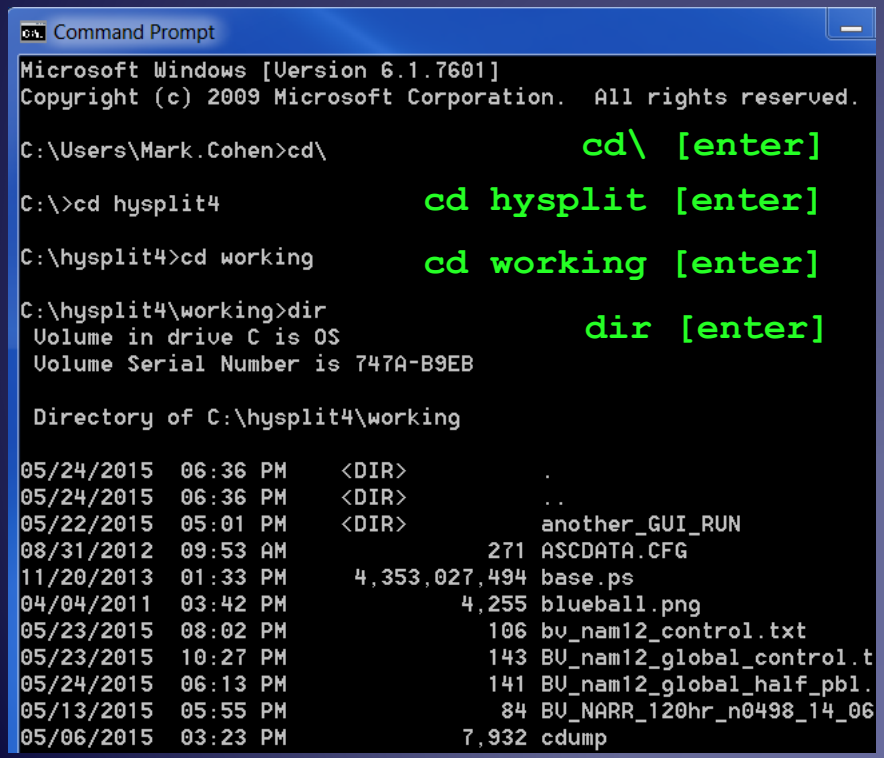
c: → changes to c: drive

cd → changes directory to c:\]

cd hysplit → change dir to hysplit

cd working → change dir to working

dir → lists contents of directory (folder)



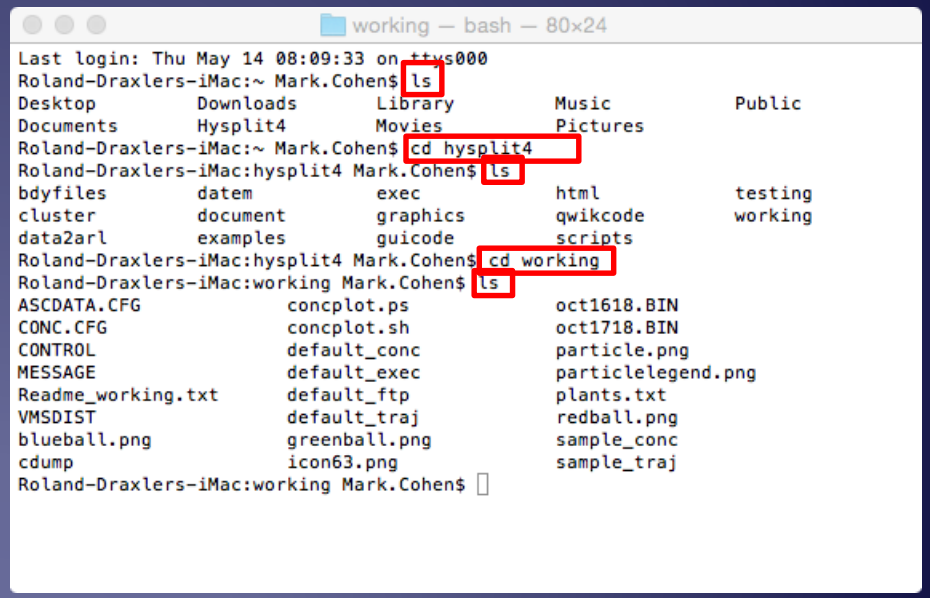
Linux and Mac

Starts in users Home directory

cd hysplit → change dir to hysplit

cd working → change dir to working

ls → lists contents of directory (folder)



Basic Navigation within Terminal Windows

Windows

c: → changes to c: drive
cd → changes directory to c:\]
cd hysplit → change dir to hysplit
cd working → change dir to working
dir → lists contents of directory (folder)

dir/w → wide listing of directory
mkdir → make directory
del → delete a file
copy → copy a file
rename → rename a file

"up arrow" → previous command(s)
"down arrow" → following command(s)

Linux & Mac

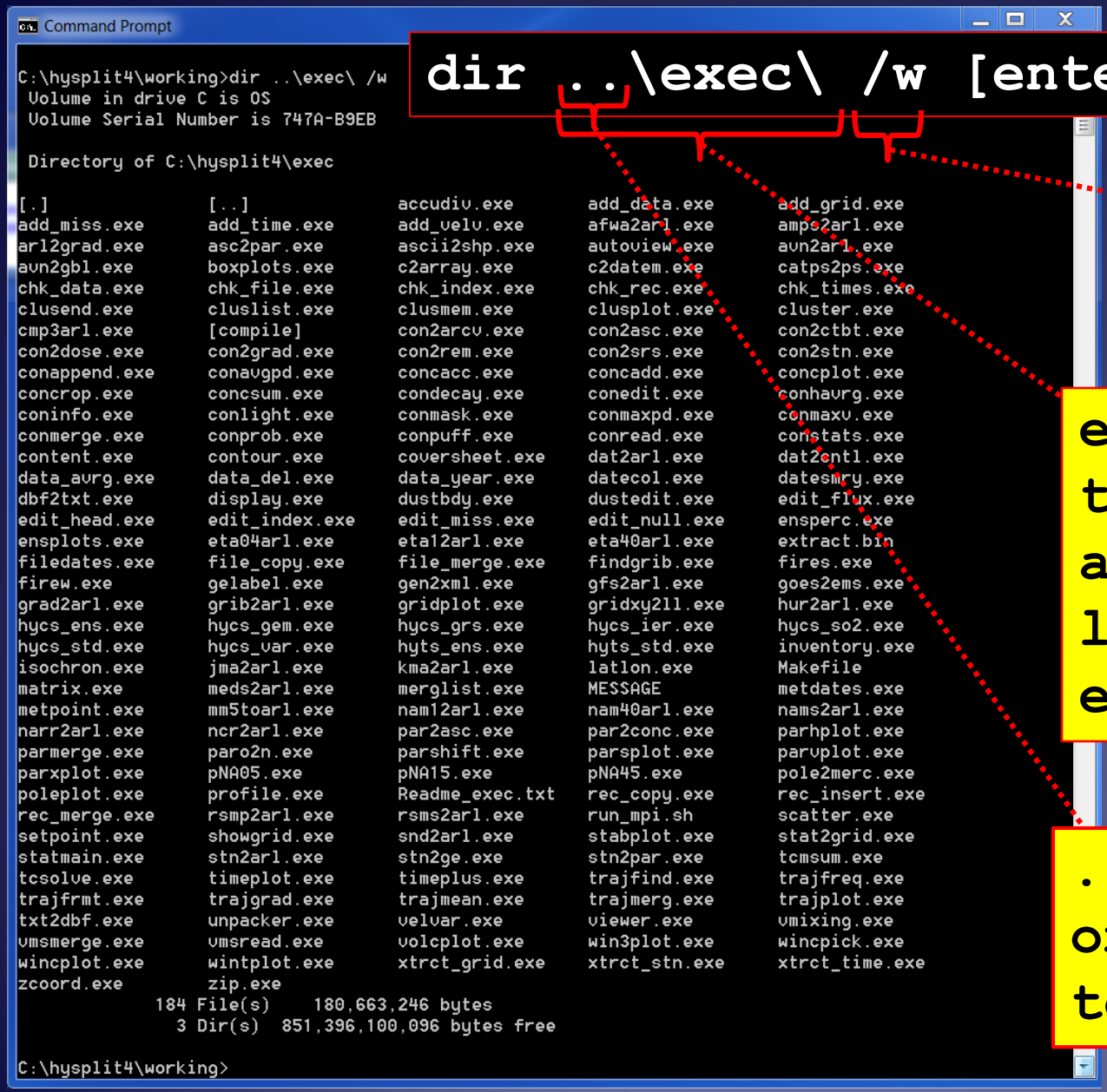
cd ~ → changes to home directory

cd hysplit → change dir to hysplit
cd working → change dir to working
ls → lists contents of directory (folder)

ls -ltr → detailed dir, with new items last
mkdir → make directory
rm → remove (delete) a file
cp → copy file
mv → move file (e.g., to a different name)

"up arrow" → previous command(s)
"down arrow" → following command(s)

For Windows


Command Prompt
C:\hysplit4\working>dir ..\exec\ /w
Volume in drive C is OS
Volume Serial Number is 747A-B9EB
Directory of C:\hysplit4\exec
[.] [..] accudiv.exe add_data.exe add_grid.exe
add_miss.exe add_time.exe add_velv.exe afwa2arl.exe amps2arl.exe
arl2grad.exe asc2par.exe ascii2shp.exe autoview.exe avn2arl.exe
avn2gbl.exe boxplots.exe c2array.exe c2datem.exe catps2ps.exe
chk_data.exe chk_file.exe chk_index.exe chk_rec.exe chk_times.exe
clusend.exe cluslist.exe clusmem.exe clusplot.exe cluster.exe
cmp3arl.exe [compile] con2arcv.exe con2asc.exe con2ctbt.exe
con2dose.exe con2grad.exe con2rem.exe con2srs.exe con2stn.exe
conappend.exe conavgpd.exe concacc.exe concadd.exe concplot.exe
concrop.exe concsum.exe condecay.exe conedit.exe conhavrg.exe
coninfo.exe conlight.exe conmask.exe conmaxpd.exe conmaxv.exe
conmerge.exe conprob.exe conpuff.exe conread.exe constats.exe
content.exe contour.exe coversheet.exe dat2arl.exe dat2cntl.exe
data_avrg.exe data_del.exe data_year.exe datecol.exe datesmry.exe
dbf2txt.exe display.exe dustbdy.exe dustedit.exe edit_flux.exe
edit_head.exe edit_index.exe edit_miss.exe edit_null.exe ensperc.exe
ensplots.exe eta04arl.exe eta12arl.exe eta40arl.exe extract.bin
filedates.exe file_copy.exe file_merge.exe findgrib.exe fires.exe
firew.exe gelabel.exe gen2xml.exe gfs2arl.exe goes2ems.exe
grad2arl.exe grib2arl.exe gridplot.exe gridxy2ll.exe hur2arl.exe
hycs_ens.exe hycs_gem.exe hycs_grs.exe hycs_ier.exe hycs_so2.exe
hycs_std.exe hycs_var.exe hyts_ens.exe hyts_std.exe inventory.exe
isochron.exe jma2arl.exe kma2arl.exe latlon.exe Makefile
matrix.exe meds2arl.exe merglist.exe MESSAGE metdates.exe
metpoint.exe mm5toarl.exe nam12arl.exe nam40arl.exe nams2arl.exe
narr2arl.exe ncr2arl.exe par2asc.exe par2conc.exe parhplot.exe
parmerge.exe paro2n.exe parshift.exe parsplot.exe parvplot.exe
parxplot.exe pNA05.exe pNA15.exe pNA45.exe pole2merc.exe
poleplot.exe profile.exe Readme_exec.txt rec_copy.exe rec_insert.exe
rec_merge.exe rsmp2arl.exe rsms2arl.exe run_mpi.sh scatter.exe
setpoint.exe showgrid.exe snd2arl.exe stabplot.exe stat2grid.exe
statmain.exe stn2arl.exe stn2ge.exe stn2par.exe tcmsum.exe
tcsolve.exe timeplot.exe timeplus.exe trajfind.exe trajfreq.exe
trajfrmt.exe trajgrad.exe trajmean.exe trajmerg.exe trajplot.exe
txt2dbf.exe unpacker.exe velvar.exe viewer.exe vmixing.exe
vmsmerge.exe vmsread.exe volcplot.exe win3plot.exe wincpick.exe
wincplot.exe wintplot.exe xtrct_grid.exe xtrct_stn.exe xtrct_time.exe
zcoord.exe zip.exe
184 File(s) 180,663,246 bytes
3 Dir(s) 851,396,100,096 bytes free
C:\hysplit4\working>
dir ..\exec\ /w [enter]
/w = list in a wide format
exec\ = and then once you are there, look for the exec directory
..\ = go back one directory to hysplit

For Linux & Mac