Chapter 2

Getting Started

2.1 Introduction

In this tutorial manual, an introduction is given how to work with COHERENS. We present two COHERENS test cases (river and bohai) and show how to compile the code, run the test case, view the results with various free software visiualisation tools and show how model setup is arranged and can be modified.

The objective of this chapter is to give a first introduction to COHERENS for a beginning user. A more extended description with more technical details about installation and compilation of the code are found in the User Documentation.

2.1.1 General requirements

We will make the following assumptions on your system and the installation of COHERENS.

- You use COHERENS V2.4 or higher. Older versions of COHERENS have a slightly different syntax.

- You have managed to install COHERENS correctly and to set the compiler options correctly in *compilers.cmp* (see below).

- You have a working installation of netCDF on your computer or work station. Note that if you install a compiler, you have to do this before you install netCDF. Otherwise, the netCDF installation will not generate the correct binary files for your compiler.

- You have some software for doing post processing. In this manual, we will use the free software packages NcView, Ferret and Octave. However, it is very well possible to use other (free or commercial) post-processing software such as IDL or Matlab, as long as they can read the netCDF format.

Some other external libraries, which you can use with COHERENS (such as MPI), will not be used in this introduction. The used software and libraries can be found at:

- MPI: `http://www.mcs.anl.gov/research/projects/mpich2/`
- netCDF: `http://www.unidata.ucar.edu/software/netcdf/`
- NcView: `http://meteora.ucsd.edu/~pierce/ncview_home_page.html`
- Ferret: `http://ferret.wrc.noaa.gov/Ferret/`
- Octave: `http://www.gnu.org/software/octave`

2.1.2 Short Linux introduction

This section will make you familiar with working under Linux. If you are already familiar with Linux, you can skip this section without problem.

The first thing to do is to open a terminal in which we can execute the commands we need. Before we continue, there are three important things to know when working on the Linux command line:

1. Linux commands and file names are **case sensitive**. Thus `Run` is not the same as `run`.
2. Linux can help you finish commands (especially file names and directories) when you press on the tab key. Try using this as often as possible.
3. In Linux, files and folders are separated by a forward slash (/) not a backslash (\) that is used in Windows. Using the wrong slash can give very unexpected results!

The following commands are very useful when working with Linux.

2.1.2.1 getting help

If you do not know which command to use, use `apropos`. It will tell you which commands to use. For example, if you want to know how to copy a file, type

```
apropos copy
```

This gives you many results, including the one you need, which is `cp`. In order to understand how to use this command, use `man`. Type

```
man cp
```

2.1.2.2 working with files

To see which files are in a directory use `ls` or `ls -l`[1]. The latter gives more information. Try them both

```
ls
ls -l
```

Aliases for some commands may be defined on your computer. A common alias is `ll` which is the same as `ls -l`. The command for copying a file is

```
cp sourcefile destination
```

The command for moving a file

```
mv sourcefile destination
```

The command for deleting a file is

```
rm filetodelete
```

In case you want to use any of these commands on directories, you must add `-r`

```
rm -r directorytodelete
```

In order to know how much free space there is on the hard disk, type

```
df -h
```

Finally it is important to know that you can use the | symbol to send output from one program to another program. For example, you can use the command `less` to view the output of the previous command

```
df -h | less
```

Exit less by typing the letter `q`.

[1]note that `'l'` is the letter `l` and not the number `'1'`.

2.2 Running a test case

2.2.1 Installing a COHERENS test case

First, you will need to go to the directory where the COHERENS source files are installed. We will assume here that we have them installed on the directory **~/V2.5** where ~ stands for your home directory[2]. When installing a COHERENS test case, such as the ***river*** test, we always start by making a new folder in which the results are placed. In order to do so, type the following commands

```
cd
mkdir river
cd river
```

We follow by making a link to the COHERENS directory, in which the source code and installation scripts are placed. The name of the link **must** be **COHERENS**. We can make the link by typing the following command

```
ln -s ../V2.5/ COHERENS
```

Here, the two arguments are first the location to which the link points and secondly the name of the link. In this command, the two dots (..) are used to refer to the directory that is above the current directory. In case the COHERENS source files are located in another directory, you must adapt the first argument (`../V2.5`) such that it is the location of the directory containing your COHERENS files.

The first test case that we are going to do is called ***river***. It describes the evolution of an estuarine salinity front advected by a tidal current and the corresponding estuarine circulation in an open non-rotating channel (as described in the User Documentation). We run the installation script `install_test` in the **COHERENS** directory, which copies the necessary files to our directory

```
COHERENS/install_test -t river
```

In this command, the argument of the script is the name of the test cases[3]. There are many test cases delivered with COHERENS. Their model setups can be found in the directory **COHERENS/setup**.

In order to examine the files that are generated, we use the command `ls`. Type

[2]The examples below can be run in the same way with other versions of COHERENS as long as they are not older than 2.4.

[3]The -t option is new from COHERENS V2.4 on. In older versions, this option must not be used.

```
ls
```

Now, you should see the following output

```
BCOMPS             deffigs.txt  postparsD    SETUP
BSOURCE            defposts     river.txt    SOURCE
cifruns            defruns      Run          SSOURCE
COHERENS           files.vis    Run_hpd_par  Usrdef_Harmonic_Analysis.f90
coherensflags.cmp  Makefile     Run_hpd_ser  Usrdef_Model.f90
COMPS              postparsA    Run_vic      Usrdef_Output.f90
con_sub_river      postparsB    SCOMPS       Usrdef_Time_Series.f90
DATA               postparsC    SCR
```

The files have different meanings. They are not all necessary for our purposes. We will now examine the most important of these files.

The names in capitals are symbolic links to important locations for COHERENS. For example, the link **SOURCE** points to the FORTRAN source files of the model. The link **COMPS** points to the files needed for the compilation. The model setup is given in the four files whose name starts with *Usrdef_*. For our purposes, the two most important ones are *Usrdef_Model.f90*, which contains the model input and *Usrdef_Time_Series.f90*, which contains information on the data that should be exported as time series. We will discuss this later in the tutorial.

After installing the test case, we are now ready to compile the model. This will be explained in the next section.

2.2.2 Compiling COHERENS

Before we compile the model, we have a look at the files that determine the compilation process. There are three. First there is *Makefile*, which contains instructions about the order in which the model is compiled. Second, there is the file *coherensflags.cmp*. This file contains some statements, which determine which options are used in the compilation of the model. Thus you can make the program a little bit different by changing the options in this file. We will edit this file. An easy to use text editor with a graphical user interface in Linux is called `gedit`. Open the file by typing

```
gedit coherensflags.cmp
```

Note that, if `gedit` is not installed on your system, or if you prefer other text editors, such as `vi`, `nano` or `emacs`, you can of course use these instead of `gedit`.

Now, we are going to add two options. Change the line that starts with CPPDFLAGS = into the following

```
CPPDFLAGS = -DALLOC -DCDF
```

The meaning of these two switches is the following. The first one (-DALLOC) changes the location in the memory that is used in COHERENS (more variables are placed on the heap instead of on the stack). The first advantage of using this option is that there is a much lower risk that the model crashes, because the amount of memory is too low. The reason is that there is much more memory available on the heap than on the stack. The second advantage is that less CPU memory is used by the model. The eventual disadvantage of using this option is that the model might become slightly slower. The second option (-DCDF) enables the netCDF module in COHERENS. Without this option, it is not possible to use netCDF input and output. If you do not set this option and you are trying to generate netCDF output, COHERENS will run normally, but the files are not generated! Another option that can be set in this way and which will not further discussed in this tutorial, is the enabling of parallel computations by setting the switch (-DMPI).

Further, you need to select the paths of the netCDF installation (usually, this is in **/usr/local**). You can do this by removing the comments (indicated by a hash #) in the lines related to netCDF, and changing (if necessary) the location of your netCDF files. The result should look something like this

```
# netCDF directory path
NETCDF_PATH = /usr/local

# netCDF library file
NETCDF_LIB_FILE = netcdf

# netCDF include options
FCIFLAGS_NETCDF = -I$(NETCDF_PATH)/include

# netCDF library options
FLIBS_NETCDF = -L$(NETCDF_PATH)/lib -l$(NETCDF_LIB_FILE)
```

Now save and close the file. The third file that is important for the course is *compilers.cmp* which is located in the folder **COHERENS/code/physics/comps** given by the symbolic link **COMPS**. We will open this file in `gedit` to see its contents

```
gedit COMPS/compilers.cmp
```

In this file, there is a list of “targets”. Each target defines a set of options for different compilers. If one these compilers has been installed on your machine, there is, in principle, no need to change this file. We will use here the Intel Fortran compiler (ifort), or the GNU Fortran compiler (gfortran). We will look up the settings for this compiler in *compilers.cmp*. In this file, you should see the following statements (they may be different because of local settings on your computer)

```
# Linux gfortran (GNU Fortran)
linux-gfort:
$(MAKE) $(EXEFILE) "FC=gfortran" "FCOPTS= -O3" "FCDEFS=" "FCDEBUG=" \
        "CPP=" "CPPF=cpp" "CPPOPTS=-traditional-cpp" "CPPDEFS=$(CPPDFLAGS)"

#Intel fortran compiler v 9 without MPI, dynamically linked
linux-iforts:
$(MAKE) $(EXEFILE) "FC=ifort" "FCOPTS=-cpp1 -i-dynamic" \
        "FCDEFS=$(CPPDFLAGS)" "FCDEBUG=" \
        "FCIFLAGS_COMP=-Wl,-rpath=/usr/local/intel/lib" \
        "CPP=" "CPPF=@cp" "CPPOPTS=" "CPPDEFS="
```

The first word before the colon (e.g. linux-iforts) is the name of the compiler setting, also called the “target”. There are two settings for the Intel compiler in this file. linux-iforts is the normal option for using the Intel Fortran Compiler. This is the recommended setting when performing simulations. In this tutorial, we will make a few changes in this file in order to speed up the compilation process. This is done by disabling the optimization that is performed by the compiler. This optimization takes a lot of time. On our machine, the compilation with optimization takes about 25 minutes. Without optimization, it takes only one minute. However, the optimized version executes much faster (up to 5 times faster). Therefore, for real simulations, one should always use this optimization.

If you are using the gfortran compiler, you can switch of the optimization by setting (take care with the difference between, the capital O and the number 0!)

```
"FCOPTS= -O0"
```

For the Intel Fortran compiler, you can disable the optimization by setting

```
"FCDEBUG= -O0"
```

In order to compile the code, close `gedit` and type (for gfortran)

```
make linux-gfort
```

In order to compile the model using the Intel Compiler, type

```
make linux-iforts
```

This command will print some information on the screen mainly showing, which files were compiled. It may also show some warnings or errors. In case, the compilation was successful, the last output line should be something like

```
make[1]: Leaving directory '/home/coherens/rivertest'
```

The compilation generated many additional files. Use the command `ls` in order to examine the files that are present in the working directory.

We are now ready to run the simulation.

2.2.3 Running COHERENS

In COHERENS, the different runs that are done during a simulation are defined in the file *defruns*, which is located in the working directory. Open this file in `gedit` in order to examine the runs that are being performed

```
gedit defruns
```

In this file, all the runs are defined, with the following syntax

```
Run name,CIF options, CIF file name
```

Note that the last two inputs (CIF option and CIF file name) are optional, which means that you can leave them empty. However, you must **always** put the two commas on this line. Otherwise, COHERENS will generate an error. Comments can be set in the *defruns* file by adding an exclamation mark (!). There are two options for CIF files. In order to read a CIF file, one must add the letter R (note that this option is case sensitive). In order to write a CIF file, one must add the letter W. We will change the *defruns* file. We do so by adding W after the first comma on the first two lines and inserting an exclamation mark at the beginning of the next lines. The result looks like

```
river0A,W,
river1A,W,
!river0B,,
!river1B,,
!river0C,,
!river1C,,
!river0D,,
!river1D,,
```

Note that in the test case ***river***, each run actually exists of two different runs with the numbers 0 and 1. In the run with number zero, a spin up calculation is done without salinity in order to determine the initial conditions for the actual run. In the run with number one, the calculation of the estuarine circulation is performed.

After closing `gedit`, we can run the model with the command:

```
./Run &
```

This command will run the model. The ampersand (&) makes the model run in the background, which means that we can keep working on the command line. We can for example use the command `ls` to see which files are being made by COHERENS. We can check whether COHERENS is still running with the command `top`. Type:

```
top
```

This will show a list of the processes that are occurring on the computer and how much processor time they are using. You can close this program by typing the letter `q` (from quit).

We can also examine how far the run has advanced using the command `grep` which searches a text file for the occurrence of a word given by the user. We apply it here to the *runlog* file, which is a text file COHERENS produces and in which the time step is written. We can search for these time steps in the file, and then send it to another program, called `tail` which returns only the last lines of data. For sending information from one program to the next (this is called a pipe) we use the vertical line (|). Thus in order to find the last occurrence of the string "2003" (the calculations in this file have a start date and end date in 2003) in the *runlog* file, we use the command:

```
grep 2003 river0A.runlogA | tail -1
```

You can also use this command without tail, in order to get all occurrences of the string "2003":

```
grep 2003 river0A.runlogA
```

After the model has finished, something like this will be written to the terminal

```
Main program terminated

real    0m19.678s
user    0m18.490s
sys     0m1.154s
```

Let's have a look at the files that are generated by COHERENS. All these files have a name that is generated from the name of the run (defined in the file *defruns*).

```
ls river*
```

This should give the following result

```
river0A.cifmodA
river0A.inilogA
river0A.runlogA
river0A.timingA
river0A.warlogA
river1A.cifmodA
river1A.inilogA
river1A.runlogA
river1A.timingA
river1A.warlogA
riverA_1.resid3I
riverA_1.resid3N
riverA_1.tsout2I
riverA_1.tsout2N
riverA_1.tsout3I
riverA_1.tsout3N
riverA_2.tsout0A
riverA_2.tsout0I
riverA.2uvobc1U
riverA.modgrdU
riverA.phsicsU
river.txt
```

These files have the following meanings

- Files ending at *.inilogA* are the initialization log files. The name of each subroutine that is called during the initialization is written to this file. It is mainly important for debugging of a model setup and code developers.
- Files with suffix *.runlogA* are log files writing information during the actual run of the model. This files may become quite large for long runs. We have already seen it before when we used this file to examine the progress of the simulations. Otherwise, it is also more important

for code developers than for model users. However, it sometimes occurs that an error is written to a log file, in addition to the *errlog* file discussed below.

- The files ending with *.timingA* contain information on the time it took for the model to run. Open the file *river0A.timingA* in `gedit` and examine the results. This file shows how long the simulation took and it also shows the percentages of the time that different parts of the calculation took (such as 2D calculation, 3D calculation, input and output, . . .).

- Files ending at *.warlogA* are files with warnings about settings that were automatically changed by COHERENS. Before the start of the simulations, COHERENS checks whether some parameters in the model have appropriate values, and if not, COHERENS resets them automatically. When COHERENS changes these values it writes a warning in this file. It may be useful after each simulation to inspect the *.warlogA* files! They can give information on some model settings that were not intended by the user and they may explain unexpected results in the simulations. Open *river0A.warlogA* in `gedit` and examine the warnings. In this case, there are no important changes made to the model.

- A file that should **not** be present is the *.errlogA* file. In this file, error messages are written and the execution of the program stops. Examples of this are incompatible options which can not be automatically reset. At the end of the simulation, COHERENS automatically removes this file. This means that you know for certain that something went wrong with the simulations if this file is present at the end of the simulation. You should then examine this file and fix the problem. Make sure that there is no *errlog* file by typing

  ```
  ls *.errlogA
  ```

  If an error log file exists, but is empty, you must check the *runlog* or *inilog* files to see firstly whether some error message was written to one of these files. If no error message has been written, the program crashed by a type of error not detected by COHERENS.

- The file with suffix *.cifmodA* contains an automatically generated central input file (CIF). Open the file *river1A.cifmodA* in `gedit`. It contains some lists of the different parameters in the model. Each of these lists is separated from the others with a hash sign (#). Comments can be given with an exclamation mark (!). The CIF file while be discussed in more detail in the next chapter.

- There are files with the results of the simulation. Files whose names contain the string *.tsout* and end with the letter N contain time series of some variables. For this simulation, there are three of them, *riverA_1.tsout2N*, *riverA_1.tsout3N* and *riverA_2.tsout0A*. The number after *tsout* indicates the dimension which can be 0, 1 or 2. As an example, *riverA_1.tsout3N* contains three-dimensional data. The last letter of the extension indicates the type of data. The letter N stands for netCDF. Other possibilities are A for ASCII and U for binary. Files ending at I are ASCII files contain information about the output data, but do not contain the data themselves. Files with the string *resid* in their name have been generated for harmonic analysis. Their meaning is similar to the *tsout* files discussed above.

- The file whose names contain the string *2uvobc*, *modgrd* and *phsics* are created by COHERENS for internal use only and are of no interest for the present discussion.

- Finally, the file with the suffix *.txt* is a small ASCII file describing the setups of the different experiments which can be conducted with the test case ***river***.

Because the netCDF output contains binary files, we need a special tool for examining the data. It is called `ncdump`. In order to examine the results, use the following command

```
ncdump riverT_1.tsout2N | less
```

Here, the command `less` is used as a viewer. You can close this program by typing `q`. Using `ncdump`, you can see which variables are in the file and which values they have. However, it is normally more instructive to visualize the data. We will do that in the next sections.

An alternative of the `less` command is to send the ASCII output to another data file. For example, the three dimensional output can be examined by typing

```
ncdump riverT_1.tsout3N >> outdat
gedit outdat
```

Compare the variables that are in this file with those in the two-dimensional file. What are the differences in the dimensions and the variables? Also notice the meaning of the different variables by observing the long_name and units attributes.

2.3 Post-processing the results

2.3.1 Visualising with Ncview

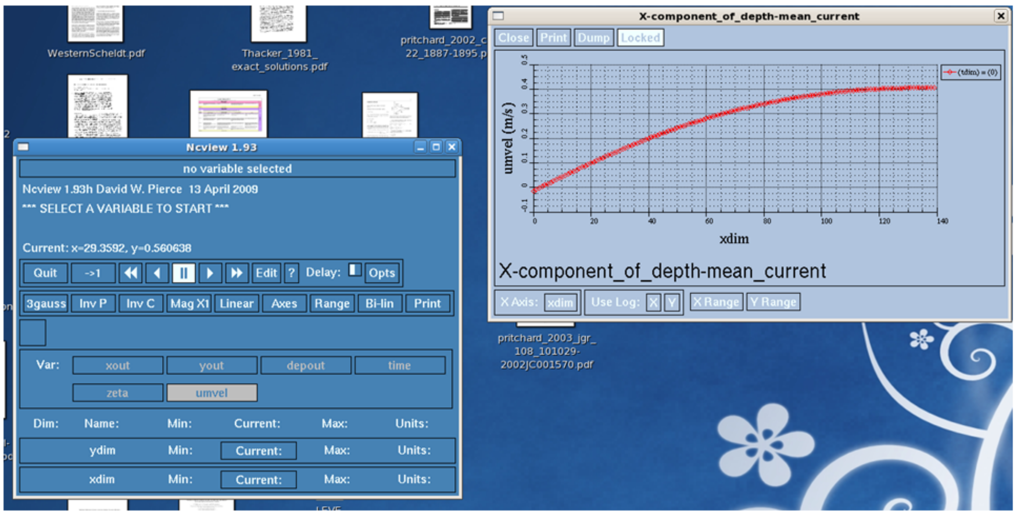
Ncview is a tool for visualizing netCDF data files. It is very easy to use, because of its graphical user interface. However, its possibilities are limited. In order to start this program for a certain data file, type the following command

```
ncview riverA_1.tsout2N
```

When using NcView, you always **must** give the filename of the data that is plotted in the command to start the graphical user interface. An example of the user interface in NcView is given in Figure 2.1. The first thing to do when working with NcView is selecting the variable to plot. This can be done by clicking on the name of the variable you want to select. We start by plotting the sea surface elevation. In order to do so, click on the button with zeta, which is the name used on COHERENS for the sea surface elevation. In order to get more information on a variable, click on the button with the question mark ?.

You should now see a plot of the sea surface elevation, as function of the x location (on the x-axis) and time (on the y-axis). We can change this by clicking on the Axes button. If you do so, a dialog box will appear that lets you select the axes to plot. In this case, there are only two possible options, the time and the x-dimension. Hence, it is not necessary to change the axes. Close the dialog box by clicking on cancel. To make the plot larger, click on the button that says M xn where n is the magnification scale. As you can see, the image is magnified, and the name of this button is changed to the new magnification. Press this button again to make the plot even larger.

When can change the colors in the graph by clicking the leftmost button (its name is one of the color maps, probably 3gauss). Click this button and see how the colors change. Try out the different colormaps, and select one you find useful to work with. A useful selection may be ssec. The ranges of the colorbar are set by the button with Range. Click on it in order to get a dialog box, in which you can set the limits of the colorbar. You can also choose to highlight some special ranges by clicking on the button linear. The name of the button will change in low and the resolution in the color bar will increase for low values of the water level. By clicking it again, it will say Hi and have more resolution for high values of the water level. The button which says Bi-lin will influence the way in which the colors are interpolated (default is bi-linear interpolation). By clicking it, it will say Repl, which gives nearest neighbor interpolation. The latter is less visually appealing, but is



no variable selected
Ncview 1.93h David W. Pierce 13 April 2009
*** SELECT A VARIABLE TO START ***

Current: x=29.3592, y=0.560638

Figure 2.1: Screenshot of using NcView

is sometimes useful near the edges. Finally, we are going to make some files of the data. This can be done by clinking on the button Print. A dialog box will appear. Click on the button File in order to make a file with the data and click on OK. Use nautilus or konqueror (the Linux programs that do the same as windows explorer) to look up the file. Click on it to see it. Now click on umvel to visualize the depth averaged velocities (in the x-direction) and also make an output file with these data. Finally, close NcView by clicking on Quit.

We continue by visualizing the 3-D data. In order to open the 3-D file, type

```
ncview riverA_1.tsout3N
```

In this file, three-dimensional data are stored. In fact, because the river test case is two-dimensional (there is no information in the y-direction), only the data in the x-z direction can be displayed. We will start by visualizing the salinity. Click on sal to visualize the salinity. Now, you will see the initial salinity profile in the x-z plane. We can go to a different moment in time by clicking the arrow to the right. By clicking the two arrows to the right, an animation is shown. You can change the speed of the animation by sliding the slider to the right of the text delay. Watch the animation and observe how the salinity intrusion develops.

Close NcView. We will now continue to make visualizations in Ferret.

2.3.2 visualising with Ferret

Ferret is a more advanced tool for displaying graphics, which has much more possibilities than NcView. However, it is somewhat more difficult to use than NcView, since options are given through the command line. Nevertheless, no real program is necessary to view output, which is different from for example Matlab.

In order to visualize the data, we must first start Ferret by typing

```
ferret
```

Now we are inside Ferret. We can see this, because the command prompt has changed in yes?. The first thing to do is load the data, with the use command. Type

```
use riverA_1.tsout2N
```

This will load the file *riverT_1.tsout2N*, with the two-dimensional data. Now we inspect the variables that are in that file, by typing

```
show data
```

You should now see a list with the variables that were saved in the file *riverA_1.tsout2N*. We can make contour plots of these data (x and time axis) by typing

```
contour zeta
contour umvel
```

We can also make a graph of the velocity at one location or at one moment in time by typing respectively

```
plot umvel[x=50]
plot umvel[t=200]
```

In this command, the part between the square brackets is used to tell Ferret which data has to be plotted.

It is also possible to plot various of these data together by typing

```
plot umvel[x=50], zeta[x=50]
plot umvel[x=50], umvel[x=100]
```

Saving files is somewhat cumbersome in Ferret. The first thing you need to do is tell Ferret to save every graph it makes as a meta file, which is special a text file containing the data of the plot. You can do this by typing

```
set mode metafile
```

Now make the same contour plots as you did before. When you do not want to plot any more files, you can type

```
cancel mode metafile
```

Now close Ferret by typing

```
exit
```

The metafiles that are made by Ferret are text files, with the name *metafile.plt.∼nr∼*, in which *nr* is the number of the file. In order to transform them to graphical files, which you can use in reports, you have to use the command Fprint

```
Fprint -o outputfile00.ps -p portrait metafile*.plt
Fprint -o outputfile01.ps -p portrait metafile*.plt.~01~
```

Note that we used an asterisk (*) in this command, because Fprint changes the filename every time it is invoked. Note that Fprint prints to a file, so in order to use it, a default printer must be selected.

Open Ferret again to visualize the three dimensional data

```
ferret
```

We first load the three dimensional datafile and see which data it contains

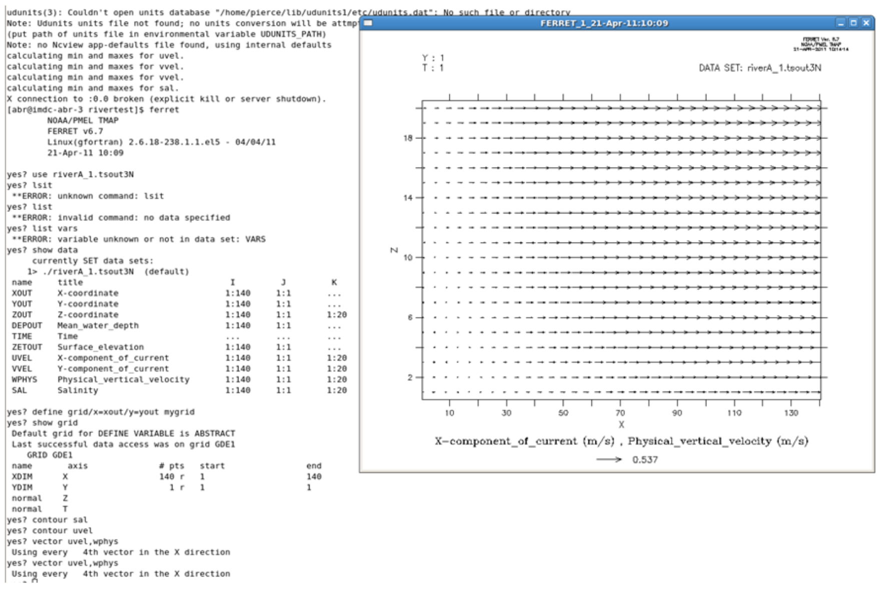
```
use riverA_1.tsout3N
show data
```

In this file, we can make a vector plot of the velocity field at time step 20 using (an example is given in Figure 2.2)

```
vector uvel[t=20],wphys[t=20]
```

We can also make a contour plot of the salinity at this moment in time

```
contour sal[t=20]
```



```
udunits(3): Couldn't open units database "/home/pierce/lib/udunits1/etc/udunits.dat": No such file or directory
Note: Udunits units file not found; no units conversion will be attmp
(put path of units file in environmental variable UDUNITS_PATH)
Note: no Ncview app-defaults file found, using internal defaults
calculating min and maxes for uvel.
calculating min and maxes for vvel.
calculating min and maxes for vvel.
calculating min and maxes for sal.
X connection to :0.0 broken (explicit kill or server shutdown).
[abr@imdc-abr-3 rivertest]$ ferret
        NOAA/PMEL TMAP
        FERRET v6.7
        Linux(gfortran) 2.6.18-238.1.1.el5 - 04/04/11
        21-Apr-11 10:09

yes? use riverA_1.tsout3N
yes? lsit
 **ERROR: unknown command: lsit
yes? list
 **ERROR: invalid command: no data specified
yes? list vars
 **ERROR: variable unknown or not in data set: VARS
yes? show data
     currently SET data sets:
    1> ./riverA_1.tsout3N  (default)
 name     title                             I         J         K
 XOUT     X-coordinate                     1:140     1:1       ...
 YOUT     Y-coordinate                     1:140     1:1       ...
 ZOUT     Z-coordinate                     1:140     1:1       1:20
 DEPOUT   Mean_water_depth                 1:140     1:1       ...
 TIME     Time                             ...       ...       ...
 ZETOUT   Surface_elevation                1:140     1:1       ...
 UVEL     X-component_of_current           1:140     1:1       1:20
 VVEL     Y-component_of_current           1:140     1:1       1:20
 WPHYS    Physical_vertical_velocity       1:140     1:1       1:20
 SAL      Salinity                         1:140     1:1       1:20

yes? define grid/x=xout/y=yout mygrid
yes? show grid
 Default grid for DEFINE VARIABLE is ABSTRACT
 Last successful data access was on grid GDE1
    GRID GDE1
 name       axis              # pts   start                end
 XDIM      X                  140 r   1                    140
 YDIM      Y                    1 r   1                    1
 normal    Z
 normal    T
yes? contour sal
yes? contour uvel
yes? vector uvel,wphys
 Using every   4th vector in the X direction
yes? vector uvel,wphys
 Using every   4th vector in the X direction
```

FERRET_1_21-Apr-11:10:09
Y : 1
T : 1
DATA SET: riverA_1.tsout3N
Z
X
X-component_of_current (m/s) , Physical_vertical_velocity (m/s)
0.537

Figure 2.2: Screenshot of using Ferret

If we want to plot the vectors and contours together, we must add the overlay option

```
vector/overlay uvel[t=20],wphys[t=20]
```

Once again, we can plot time series or profiles, but now we need to provide two axis locations between brackets

```
plot sal[z=1,t=20]
```

Finally, we make an animation using the repeat statement of the first 50 time steps. For the animation of the salinity contours, type

```
repeat/t=1:50/animate/loop=1 (contour sal)
```

For the animation of the flow vectors, type

```
repeat/t=1:50/animate/loop=1 (vector uvel,wphys)
```

2.3.3 visualising with Octave and Matlab

Now we are going to run a second test case, which is called ***bohai***. This test case is a simulation of the tides in the Bohai Sea (northern part of the Yellow Sea, see Figure 2.3). The commands are the same as for the previous ***river*** test. Take care of the following

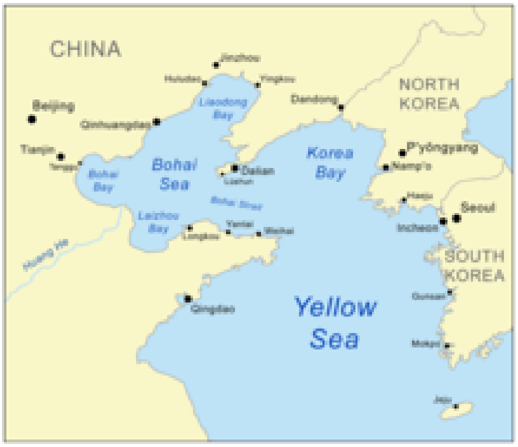


Figure 2.3: Map of the Bohai sea

- Edit the *defruns* file by commenting all lines (i.e. inserting a '!' in the first column) except the first one such that only the first run is made. The name of this run is ***bohaiA***. Note that, contrary to the ***river*** there is no spin up run.
- The date of the simulation, which you need to check the advance of the calculations is in the year 1999 (look this up in the file *Usrdef_Model.f90*). Note that running this test takes about 10–15 minutes depending on the capacity of your machine.
- When visualizing the data with Ferret, you must define the x and y data to make time series. Because this case is two-dimensional, there is only a *tsout2N* file.

We are using the file *bohai_1.1amplt2N* with the harmonically analysed surface M_2-amplitudes as example for making visualisation with Octave or Matlab.

1. Download the octcdf package, for Ubuntu this is rather straightforward using

   ```
   sudo apt-get install octave-octcdf
   ```

   For other platforms such as Windows a useful wiki might be: `http://modb.oce.ulg.ac.be/mediawiki/index.php/NetCDF_toolbox_for_Octave`

2. In this package the ncdump function is included, which provides information about all the contents of the netCDF file. In our example file

we see that there are 3 dimensions and 7 variables. The variable we are interested in is zeta, we are also interested in the dimensions xdim (longitude), ydim (latitude) and time (depth is constant in this example so we disregard it).

3. To load a variable to the Octave environment, firstly check whether the file *ncparsen.m* has been copied from the **scr** to your working directory and type in the qtOctave terminal

   ```
   [locallat] = ncparsen('bohaiA_1.1amplt2N','xout')
   [locallon] = ncparsen('bohaiA_1.1amplt2N','yout')
   [localzeta] = ncparsen('bohaiA_1.1amplt2N','zeta')
   ```

   to load the spatial coordinate arrays xout, yout and the elevation data zeta.

4. In Matlab (R2008a and higher), you can load variables from the netCDF file using the `ncread` function

   ```
   [locallat] = ncread('bohaiA_1.1amplt2N','xout')
   [locallon] = ncread('bohaiA_1.1amplt2N','yout')
   [localzeta] = ncread('bohaiA_1.1amplt2N','zeta')
   ```

5. To let your graphs appear in a workable screen format, set the display to the correct environment (only for Octave)

   ```
   setenv("GNUTERM","wxt")
   ```

6. Now you can make your first graph

   ```
   zetafig = localzeta(1,:,:)
   contourf(localxout,localyout,zetafig)
   ```

7. Add a colorbar by typing

   ```
   colorbar
   ```

8. Put a title and axis legends

   ```
   title("M2-amplitude","fontsize",20,"fontname","Arial_black")
   xlabel("longitude","fontsize",12,"fontname","Arial")
   ylabel("latitude","fontsize",12,"fontname","Arial")
   ```

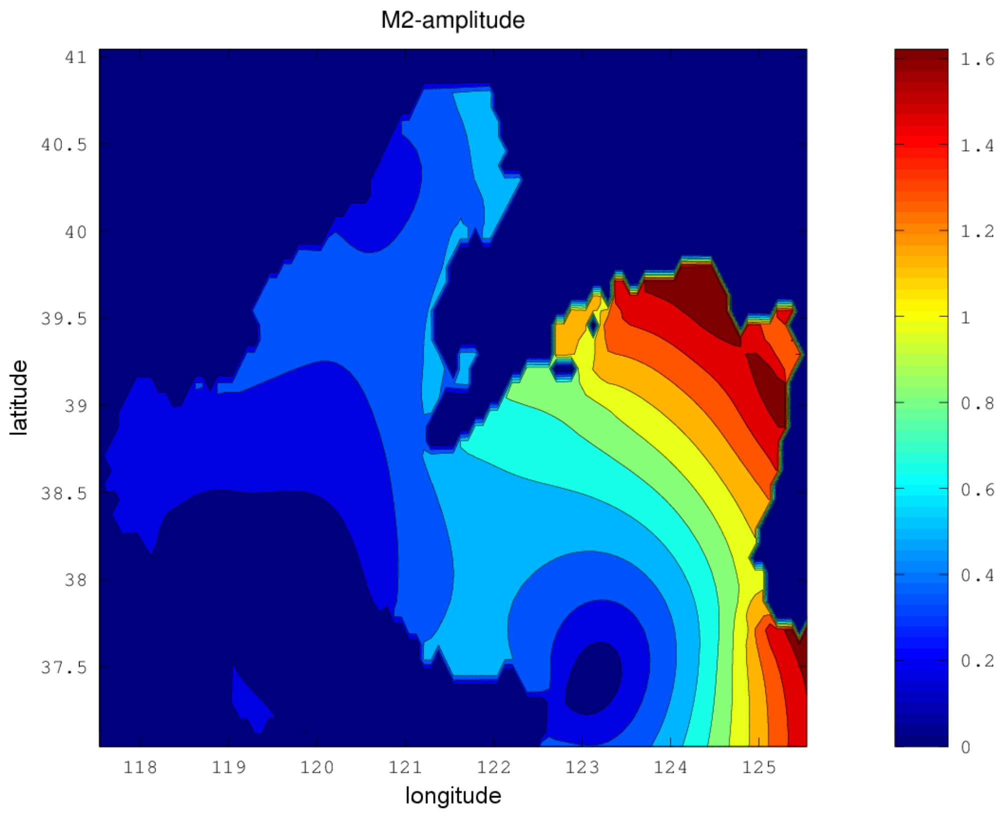


Figure 2.4: Example figure generated with Octave

9. To export the file

```
print -dpng bohai_M2amp.png
```

   The result is shown in Figure 2.4.

10. To improve pixel size

```
print -dpng "-S800,800" "bohai_M2amp.png"
```

11. For more information on a topic type `help topic`, for example `help print`.

2.4 Modifying model setup

Two methods are available to adapt the model settings. In the first one the model parameters are changed in the CIF. The second one consists in editing the *Usrdef_* FORTRAN files. The two methods are described in the subsections below.

2.4.1 Modifying model setup via CIF

2.4.1.1 short CIF introduction

The central input file (CIF) is a functionality introduced in COHERENS V2.1 aimed to define or re-define parameters for model setup without having to do a recompilation. More information on the format of the CIF file can be found in the User Documentation. In addition, all forcing data can be provided in a standard COHERENS format. These formats can be read by the program without the need to change the model setup code (and recompile the program) in the *Usrdef_* files.

2.4.1.2 tutorial ***river*** test case

The following procedure needs to be used to install the tutorial version of the ***river*** test case

1. Select a working directory, e.g.

   ```
   cd /home/coherens/riverCIF
   ```

2. Create a link with the COHERENS root directory (a path name can be defined instead of ~/**V2.5**), e.g.

   ```
   ln -s ../V2.5 COHERENS
   ```

3. Install the tutorial version of the ***river*** test case

   ```
   COHERENS/install_test -t tutorial/river
   ```

4. Adapt your settings by changing *coherensflags.cmp*.

5. Compile (e.g for Intel Fortran)

   ```
   make linux-iforts
   ```

The following procedure is recommended to run the river test case with the CIF functionality

1. Open the file *defruns*

```
river0T,,
river1T,,
```

which shows that no CIF will be read or produced.

2. Run the test case

   ```
   ./Run
   ```

3. The simulation has now created the following input files in standard COHERENS format:

   - *riverT.modgrdN*: model grid arrays
   - *riverT.2uvobc1A*: open boundary conditions
   - *riverT.phsfinN*: initial conditions produced by the initialisation run for the final one

4. Run the test case again now using the CIF functionality

   ```
   cp cifruns defruns
   ```

   Open the file *defruns*

   ```
   river0T,R,river0T.CifModA
   river1T,R,river1T.CifModA
   ```

5. You may open the CIF files to see how information is passed to COHERENS.

2.4.1.3 changing model setup through the CIF

Now, we are going to change the model by adapting the CIF file and the forcing files. We will do the following

1. Change the simulation time.
2. Adjust the time step.
3. Modify settings (e.g. roughness length).
4. Change the form of the output file (e.g. from netCDF to ASCII).
5. Modify the grid resolution (number of rows and columns, grid size).
6. Modify the open boundary conditions.

Changing simulation time The first modification is the modification of the simulation time by editing the CIF file

1. Change the *defruns* file.

   ```
   gedit defruns
   ```

   We will switch off the first of the two simulations for the moment, and only do changes in the second file

   ```
   !river0T,R,river0T.CifModA
   river1T,R,river1T.CifModA
   ```

2. Open and edit the CIF.

   ```
   gedit river1T.CifModA
   ```

   Set the simulation time to 1 day by changing the line

   ```
   CENDDATETIME = 2003/01/06;00:00:00:000
   ```

   into

   ```
   CENDDATETIME = 2003/01/04;00:00:00:000
   ```

   The previous re-setting can also be made by inserting the comment character ! in the first column of the line with the old definition

   ```
   !CENDDATETIME = 2003/01/06;00:00:00:000
   CENDDATETIME = 2003/01/04;00:00:00:000
   ```

3. Run the model with the new simulation time.

   ```
   ./Run
   ```

Note that the time steps for the output data are adapted automatically. This is seen by opening the *warlog* file

```
gedit river1T.warlogA
```

This will show a warning, that the last time step for output is equal to the last time step in the model. However, if you would have increased the calculation time, you would have had to adapt the number of time steps that is outputted manually

```
WARNING: value of integer component %tlims(2) and element 1
of array tsrgpars is set from 8640 to 2880
```

Check in the output data, that you now have indeed only one day of output data. You can do this easily using `ncdump` by typing (use `man ncdump` to look up what `-v` means)

```
ncdump -v time riverT_1.tsout2N | less
```

Modification of the time step This exercise is focused on the modification of the time step by editing the CIF file, the instructions are given below

1. Open and edit the CIF.

   ```
   gedit river1T.CifModA
   ```

2. Set the 2-D time step to 15 seconds. COHERENS also has a 3-D time step for barotropic calculations, which is given as the number of 2-D time steps that pass before a 3-D step is done. This is given by the variable IC3D. In order to leave the 3-D time step unchanged, we modify this value as well by changing

   ```
   DELT2D = 30.
   IC3D = 10
   ```

   into

   ```
   DELT2D = 15.
   IC3D = 20
   ```

3. Run the model with the new time step.

   ```
   ./Run
   ```

Visualize the results.

Checking of errors in the CIF This exercise we will make some errors in the CIF file, such that an error message is generated by COHERENS. In this way, you learn to find the error messages and solve them

1. Open and edit the CIF.

   ```
   gedit river1T.CIF
   ```

2. Create an error in the CIF by re-editing the line

   ```
   IOPT_GRID_NODIM = 3
   ```

   to

   ```
   IOPT_GRID_NODIM
   ```

3. Save the file and run the model

   ```
   ./Run
   ```

An error message will be generated in the *river1T.errlogA* file. Open this file and verify the error message. It will look like this

```
Error occurred on line 29 of CIF file river1T.CifModA
Variable name is not defined
A total of 1 errors occurred in read_cif_params
Error type 7 : Invalid initial values for model parameters or arrays
PROGRAM TERMINATED ABNORMALLY
```

This message tells you that the syntax in the CIF is not correct. Now we try to correct this message, but make another mistake. Edit the CIF and type:

```
IOPT_GRID_NODIM = 4
```

This is obviously an error, because the maximum number of dimensions in COHERENS is 3. When you inspect the file *river1T.errlogA*, you will see the following

```
Invalid value for integer parameter iopt_grid_nodim: 4
Must be between: 1 and 3
A total of 1 errors occurred in check_mod_filepars
Error type 7 : Invalid initial values for model parameters or arrays
PROGRAM TERMINATED ABNORMALLY
```

Here COHERENS tells you that the number of grid dimensions should be between 1 and 3, and thus the value of 4 is not allowed.

Try to perform additional changes in the CIF file to generate some other error messages. Fix the errors and move on to the next exercise.

Form of the output file In this exercise, we modify the format of the output file by editing the CIF. The instructions are given below

1. Open and edit the CIF.

   ```
   gedit river1T.CifModA
   ```

2. Change the format of the output file from netCDF to ASCII. Change the third character of the string

   ```
   TSR2D = 1,T,N,riverT_1.tsout2N,T,,2
   ```

   from N to A:

   ```
   TSR2D = 1,T,A,riverT_1.tsout2N,T,,2
   ```

3. Run the model with the new output format

   ```
   ./Run
   ```

   Now you have a new file, called *riverT_1.tsout2N*, containing ASCII output data. Open the file in `gedit` to inspect the data.

4. Change the current default filename for easy management on the same input line

   ```
   TSR2D = 1,T,A,riverT.txt,T,,2
   ```

5. Run the model with the new output filename.

   ```
   ./Run
   ```

We strongly recommend you to use the netCDF format for your output. Therefore, undo the changes done during this exercise and continue to the next one.

Modification of model settings This exercise is focused on the modification of some settings of the model setup by editing the CIF, in the present exercise we will modify the roughness height, the instructions are given below:

1. Open and edit the CIF

   ```
   gedit river1T.CifModA
   ```

2. Set the roughness to 0.3E-02 [m]

   ```
   ZROUGH_CST = 0.3E-02
   ```

3. Run the model with the new roughness

   ```
           ./Run
   ```

Visualize the results, and see what the effects is of the changed bed roughness. You can modify many things in COHERENS, including the numerical scheme, the turbulence model and many physical parameters. Try to modify some other settings, by looking them up in the user manual and seeing what they do. Interesting settings to change are:

- The numerical scheme for advection, using IOPT_ADV_SCAL, IOPT_ADV_2D and IOPT_ADV_3D
- Horizontal viscosities using IOPT_HDIV_2D, IOPT_HDIV_3D, HDIFMOM_CST and HDIFSCAL_CST
- Vertical turbulence model using IOPT_VDIF_COEF and the various turbulence switches IOPT_TURB_*.

Grid resolution This exercise is focused on the modification of the grid resolution by editing the CIF, as well as the input files. In this way, you get already a first idea how to set up a new model application. The instructions are given below:

1. Adapt the *defruns* file in oder to make sure that both simulations are run (i.e. remove the ! on the first line)

   ```
   river0T,R,river0T.CifModA
   river1T,R,river1T.CifModA
   ```

2. Open and edit both CIFs

```
gedit river0T.CifModA
gedit river1T.CifModA
```

3. We are now resetting the setup so that the test runs with half the current grid size. Firstly, change the number of columns of the computational grid from nc=141 to nc=281[4]

```
NC = 281
NR = 2
```

4. Secondly, change the grid size from 1000 to 500 m. Change the fifth and sixth fields in the line

```
SURFACEGRIDS = 1,1,0,0,1000.,1000.,0.,0.
```

in both CIFs to

```
SURFACEGRIDS = 1,1,0,0,500.,500.,0,0
```

5. Use a new file to called *riverTnew.modgrdN* for the bathymetry. We will generate this file in a moment.

```
MODFILES = modgrd,1,1,N,R,riverTnew.modgrdN,0,0,0,0,F,F,
```

6. Also change the eleventh field for the time series output grid (parameter TSRGPARS, in *river1T.CifModA* only, from 140 to 280

```
TSRGPARS = 1,T,F,F,T,2003/01/03;00:00:00:000,3,0,0,1,280,1,1,1,1,1,20
```

Now save the files. We will continue by making a new bathymetry file.

7. Generate the new bathymetry file. Convert the COHERENS netCDFfile an ASCII text file that can easily be edited, using `ncdump`

```
ncdump riverT.modgrdN > riverTmodgrd.txt
```

[4]The actual number of "active" in the X-direction is given by nc-1. Halving the grid size means then that nc is reset to 2*(nc-1)+1=281.

In this command the > sign is used to send output from one program (in this case `ncdump`) to a file *riverTmodgrd.txt*. Edit the *riverTmodgrd.txt* file generated for a new grid resolution

```
gedit riverTmodgrd.txt
```

The changes that you have to make are

- Change the file name

  ```
  netcdf riverTnew {
  ```

- Change the number of cells

  ```
  X001 = 280 ;
  ```

- Change the bathymetry, by copying all values (20) after depmeanglb, such that are now 280 numbers

  ```
  depmeanglb =
  20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20,
    20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20,
    20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20,
    20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20,
    20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20,
    20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20,
    20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20,
    20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 2
    20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 2
    20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 2
    20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 2
    20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 2
    20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 2
    20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20 ;
  ```

- Change the grid index location of the open boundary, to make it compliant with the new grid

  ```
  iobu = 1, 281 ;
  ```

- Convert the text file back to a netCDF file using `ncgen` (look up how it works using `man ncgen`)

  ```
  ncgen -b riverTmodgrd.txt -o riverTnew.modgrdN
  ```

8. The new grid file can also be created alternatively through the CIF

- Edit the *defruns* file and disable the second run

  ```
  river0T,R,river0T.CifModA
  !river1T,R,river1T.CifModA
  ```

- In *river0T.CifModA* change the line

  ```
  MODFILES = modgrd,1,1,N,R,riverT.modgrdN,0,0,0,0,F,F,
  ```

  into

  ```
  MODFILES = modgrd,1,1,N,W,riverTnew.modgrdN,0,0,0,0,F,F,
  ```

- Run the test case and replace the 'W' again to 'R' on the same line in the *river0T.CifModA*. The new grid file has now been generated automatically.

9. Run the model now with the new grid resolution.

   ```
   ./Run
   ```

Note that for this exercise, it is necessary to run both simulations (***river0T*** and ***river1T***), because the initial conditions that are generated in run ***river0T*** are changed with the new grid resolution and need to be provided for ***river1T***.

Modification of open boundaries This exercise is focused on the modification of the definitions of the open boundaries by editing the open boundary file. The instructions are given below

1. Edit both CIFs files, in order to use a new file with boundary conditions:

   ```
   MODFILES = 2uvobc,1,1,A,R,riverTnew.2uvobc1A,0,0,0,0,F,F,
   ```

2. Open and edit the *riverT.2uvobc1A* file generated previously, which contains the open boundaries in COHERENS ASCII format

   ```
   gedit riverT.2uvobc1A
   ```

3. Modify the type of the upstream open boundary condition from the characteristic method (11) to the method of Flather (8)

   ```
   ityp2dobu
             8          13
   ```

4. Modify the the water level amplitude from 0.8 to 1.0 m

```
ud2obu_amp
    14.00714       0.000000
zetobu_amp
   1.000000        0.000000
```

Note that the amplitude of the depth-integrated velocity is proportional to the water level amplitude in the ***river*** test case and needs therefore be divided by 0.8.

5. Save the file under the new name *riverTnew.2uvobc1A*

6. Run the model with the new boundary definitions

   ```
   ./Run
   ```

2.4.2 Adapting model set up via the *Usrdef_* files

We are now going to repeate the model setup changes by adapting the FORTRAN code in the *Usrdef_* files.

2.4.2.1 installing and running the example test

We re-install, compile and run the tutorial version of ***river*** test again, now without making use of the CIF. The steps are similar to ones shown in the previous section, but repeated here for clarity

1. Select a working directory, e.g.

   ```
   cd /home/coherens/rivertest
   ```

2. Create a link with the COHERENS root directory (a path name can be defined instead of ∼/**V2.5**), e.g.

   ```
   ln -s ../V2.5 COHERENS
   ```

3. Install the tutorial version of the ***river*** test case

   ```
   COHERENS/install_test -t tutorial/river
   ```

4. Adapt your settings by changing *coherensflags.cmp*.

5. Compile (e.g for Intel Fortran)

   ```
   make linux-iforts
   ```

6. Run the test case

   ```
   ./Run
   ```

2.4.2.2 changing model setup through the *Usrdef_* files

The modifications in the model setup, discussed with the CIF method in the previous section, can equally well be performed, by modifying the setups defined in the *Usrdef_* files. Main difference is that you need to recompile the code each time a *Usrdef_* file has been changed. This recompilation only takes a few seconds of time.

Changing model setup parameters As before, switch off the first of the two simulations in *defruns*

```
!river0T,,
river1T,,
```

1. Edit the file *Usrdef_Model.f90*

   ```
   gedit Usrdef_Model.f90
   ```

2. To change the simulation time, modify the following line in routine usrdef_mode_params from

   ```
   CendDateTime = 2003/01/06;00:00:00:000
   ```

   into

   ```
   CEndDateTime = 2003/01/04;00:00:00:000
   ```

3. Note that, lower case characters are used preferentially for variable names contrary to the CIF where all parameter names are given in upper case.

4. Since the comment character '!' has the same meaning in FORTRAN as for the CIF, you may also comment the old definition

   ```
   !CEndDateTime = 2003/01/06;00:00:00:000
   CEndDateTime = 2003/01/04;00:00:00:000
   ```

5. Recompile and run the modified test

   ```
   make linux-iforts
   ./Run
   ```

6. A new time step is taken by changing the following lines in *Usrdef_Model.f90* (routine usrdef_mod_params) from

   ```
   delt2d = 30.0
   ...
   ic3d = 10
   ```

   to

   ```
   delt2d = 15.0
   ...
   ic3d = 20
   ```

7. The roughness length parameter zrough_cst can be changed in the same routine.

8. The switch iopt_grid_nodim is not defined in Usrdef_Model.f90. COHERENS will therefore take the default value which is 3. You can reset this value to the erroneous value of 4 in routine usrdef_mod_params (preferentially in section "Switches") within the file *Usrdef_Model.f90*

   ```
   ...
   SUBROUTINE usrdef_mod_params
   ...
   iopt_grid_nodim = 4
   ...
   END SUBROUTINE usrdef_mod_params
   ```

9. Compile and run. The same error message as in the CIF example is issued.

Form of the output file The instructions for modifying the format of an output file are as follows

1. Edit the file *Usrdef_Time_Series.f90*

   ```
   gedit Usrdef_Time_Series.f90
   ```

2. Change the output format by adding the two lines

```
    ...
    SUBROUTINE usrdef_tsr_params
    ...
    tsr2d(1)%form = 'A'
    tsr2d(2)%filename = 'riverT.txt'
    ...
    END SUBROUTINE usrdef_tsr_params
```

   in routine usrdef_tsr_params. The second line changes the name of the output file as well.

3. Compile and run.

Grid resolution Halving the grid size (in the X-direction) is easily performed by modifying the following lines in *Usrdef_Model.f90*

```
...
SUBROUTINE usrdef_mod_params
...
nc = 281; nr = 2; nz = 20
...
surfacegrids(igrd_model,1)%delxdat = 500.0
surfacegrids(igrd_model,1)%delydat = 500.0
...
END SUBROUTINE usrdef_mod_params
```

Contrary to the CIF case, the output grid, the grid index of the open boundary locations and the bathymetry are automatically adapted by the code to the new grid.

Modification of open boundaries The upstream open boundary condition is reset from the characteristic (11) to the Flather (8) method and the tidal amplitude of the water level is reset from 0.8 to 1.0 m in *Usrdef_Model.f90*

```
...
SUBROUTINE usrdef_2dobc_spec
...
ityp2dobu(1) = 8; ityp2dobu(2) = 13
...
amp = 1.0; phase = -halfpi
...
END SUBROUTINE usrdef_2dobc_spec
```

Note that only the parameter amp needs to be changed. The amplitudes of the water elevation and depth-integrated current are automatically adapted by the code in routine usrdef_2dobc_spec.

2.5 Format and specific syntax of a CIF

Example of a CIF file for the test case River The CIF used in this tutorial is shown here as an example what the CIF looks like

```
!************************************************************
! This is an example CIF file, for running the test case river
! It is the second of two files, which runs the simulation of a
! density current.
! This file uses the tutorial settings
! Written by Alexander Breugem
! April 2012
!************************************************************

! Monitoring parameters
!************************************************************
! In this part, parameters are defined that determine the
! parameters tha are written to the logfiles
!
! Get resonable amount of logdata. Increase the number to obtain more data
LEVPROCS_INI = 7
LEVPROCS_RUN = 3

! Generate a detailed timing file
LEVTIMER = 3

#
!*************************************************************
! Switches and parameters.
! Do not remove the # above
!
! In this part, parameters are set for the run

! Define grid
IOPT_GRID_NODIM = 3
```

```
! Use open boundary conditions
IOPT_OBC_2D = 1

! Switching on simulation of baroclinic currents
IOPT_DENS = 1
IOPT_DENS_GRAD = 1

! Calculate salinity
IOPT_SAL = 2

! Turbulence switch for limiting conditions
IOPT_TURB_IWLIM = 1

! Set up model grid
! Note that you always define an extra dummy cell on the edges
NC = 141
NR = 2
NZ = 20

! Define number of sea boundary conditions
NOSBU = 2
NOSBV = 0
! Define number of river boundary conditions
NRVBU = 0
NRVBV = 0

! Define number of tidal constituents at the boundary
NCONOBC = 1

! Define type of constituent (S2 = 51)
INDEX_OBC = 51

! Set start and endtime amd Time step
CSTARTDATETIME = 2003/01/03;00:00:00:000
CENDDATETIME = 2003/01/06;00:00:00:000
DELT2D = 30.
IC3D = 10

! Select constant water depth
DEPMEAN_CST = 20.
```

```
! Accelaration of gravity
GACC_REF = 9.81

! Bottom friction coefficient
ZROUGH_CST = 0.6E-02

! Define restart files
NORESTARTS = 0

! define runtitle
INTITLE = riverT
OUTTITLE = riverT

! Define number of outputs for time series
NOSETSTSR = 1
NOVARSTSR = 6

! Model files
!************************************************

! The format is: file descriptor,file number,input(1)/output(2),
!                format(A=ascii,N=netcdf,U=binary),
!                status(R=read,W=write,N=usrdef), filename,
!                tlim1,tlim2,tlim3,endfile,info,time_regular,path

! Grid input
MODFILES = modgrd,1,1,N,R,riverT.modgrdN,0,0,0,0,F,F,

! Open boundary conditions input
MODFILES = 2uvobc,1,1,A,R,riverT.2uvobc1A,0,0,0,0,F,F,

! Initial conditions input (restart file from simulation 0)
MODFILES = inicon,1,1,N,N,riverT.phsfinN,0,0,0,0,F,F,

! Horizontal coordinates
SURFACEGRIDS = 1,1,0,0,1000.,1000.,0.,0.

#
!**********************************************
! Do not remove the # above
!
```

```
! Parameters for time series output
!

! Definition of the output variables
! The format is: number (output), key id, dimension (0/2/3),
!                oopt,klev,dep, node,fortran name, long name, unit
! Only the first 3 are required

! Surface elevation (92)
TSRVARS = 1,92,2,,,,,,,,,
! Depth avg U velocity (104)
TSRVARS = 2,107,2,,,,,,,,,

! U velocity
TSRVARS = 3,109,3,,,,,,,,,
! V velocity
TSRVARS = 4,121,3,,,,,,,,,
! Vertical velocity
TSRVARS = 5,123,3,,,,,,,,,
! Salinity
TSRVARS = 6,128,3,,,,,,,,,

! Matching the variables to sets
! Format: iset, ivar1, ivar2,etc.
IVARSTSR = 1,2,3,4,5,6

! Definition of the output files
! Format: set number, defined (T/F), format (A=ascii,N=netCDF, U=binary),
!         filename, info (T/F), path, header_type
TSR2D = 1,T,N,riverT_1.tsout2N,T,,2
TSR3D = 1,T,N,riverT_1.tsout3N,T,,2

! Definition of output grid
! Format: set number,gridded (T/F),gridfile (T/F),land_mask (T/F),
!         timegrid (T/F),ref_date,number dimensions,number stations,
!         start x,end x,stepx,start y,end y,step y, ,start z,end z,
!         step z,start time,end time,timestep
! note that the end time may have to change if you change the time step or
! time interval of the simulation
TSRGPARS = 1,T,F,F,T,2003/01/03;00:00:00:000,3,0,0,1,140,1,1,1,1,1,20,1,0,
           8640,180
```

```
#
!**********************************************
! Do not remove the # above
!
! Parameters for time averaged output

#
!**********************************************
! Do not remove the # above
!
! Parameters for harmonic analysis

#
!**********************************************
! Do not remove the # above
!
! Parameters for harmonic output

#
```