Tutorial 01b LiveCROCO: Domain Change

1. Purpose

In this tutorial we will review basic steps to define simulation of a new domain, different from the classic Benguela domain. We will define a domain for central zone of Chile

2. Creating ChileCentral working directory

First step is to edit **create_run.bash** file with these instructions

```
cd croco
nano create_run.bash
```

Now you have to modify this section to put correct directories

```
#==============================================================================
# BEGIN USER MODIFICATIONS
#
# Get CROCO directory
CROCO_DIR="/home/livecroco/croco"
#
SOURCES_DIR="/home/livecroco/croco"
#
TOOLS_DIR="/home/livecroco/croco_tools"
#
MY_CONFIG_PATH=${SOURCES_DIR}
#
# Name of the configuration directory defined by the user
#
MY_CONFIG_NAME='ChileCentral'
#
#
# END USER MODIFICATIONS
#==============================================================================

```

and then execute de statement

```
./create_run.bash
```

and you will get

```
Your choices :
 - CROCO_DIR        : /home/livecroco/croco
 - TOOLS_DIR        : /home/livecroco/croco_tools
 - CONFIG_HOME_DIR  : /home/livecroco/Desktop
 - CONFIG_WORK_DIR  : /home/livecroco/Desktop
 - CONFIG_NAME      : ChileCentral
 - OPTIONS          : oe-dev
 Do you want to proceed ? [Y/n]
```

and pressing the **Y** key shows

```
Creating configuration ...
```

3. Defining domain - crocotools_param.m

To define input files of new domain, we need to edit **crocotools_param.m** file

```
nano crocotools_param.m
```

If you wish, you can edit **CROCO_title** field. It's a cosmetic change.

```
CROCO_title = 'Chile Central';
```

We first define boundaries of the region using variables

```
%
% Grid dimensions
%
lonmin = -80; Minimum longitude [degree east]
lonmax = -69; Maximum longitude [degree east]
latmin = -33; Minimum latitude [degree north]
latmax = -23; Maximum latitude [degree north]
```

and let's change the size of domain cells

```
%
% Grid resolution [degree]
%
dl = 1/6;
```

As domain cells are smaller, we can change the minimum depth parameter

```
hmin = 55
```

To see graphs of our new domain, activate **makeplot** option

```
makeplot   =  1;
```

Now save file and exit **nano** editor.

3.1. start.m

Check if start.m file has the correct address

```
tools_path='/home/livecroco/croco_tools/';
```

4. Using Octave

To create input files using Octave, we first have to load program using

```
octave-cli
```

First define search paths of tools used by CROCO_TOOLS

```
oct_start
```

Then we write instruction to generate model grid, which is described in **croco_grd.nc** file that will be generated in **CROCO_FILES** directory

```
>> make_grid
mkdir: cannot create directory ‘/home/livecroco/Desktop/ChileCentral/CROCO_FILES/’:
File exists

 Making the grid: /home/livecroco/Desktop/ChileCentral/CROCO_FILES/croco_grd.nc

 Title: Chile Central

 Resolution: 1/6 deg

 Create the grid file...
 LLm = 65
 MMm = 68
....
```

Make a note of these two numbers, as you will need to add them to **param.h** file.
Finally we see following sentences

```
 Filter topography ...
 Apply a filter on the Deep Ocean to reduce isolated seamounts :
   4 pass of a selective filter.
 Apply a selective filter on log(h) to reduce grad(h)/h :
   20 iterations - r_max = 0.36861
   40 iterations - r_max = 0.29979
   60 iterations - r_max = 0.26986
   80 iterations - r_max = 0.25169
   83 iterations - r_max = 0.24962
 Smooth the topography a last time to prevent 2DX noise:
   2 pass of a hanning smoother.

 Write it down...

 Do a plot...
```

The final graph of domain will be, Fig. 1

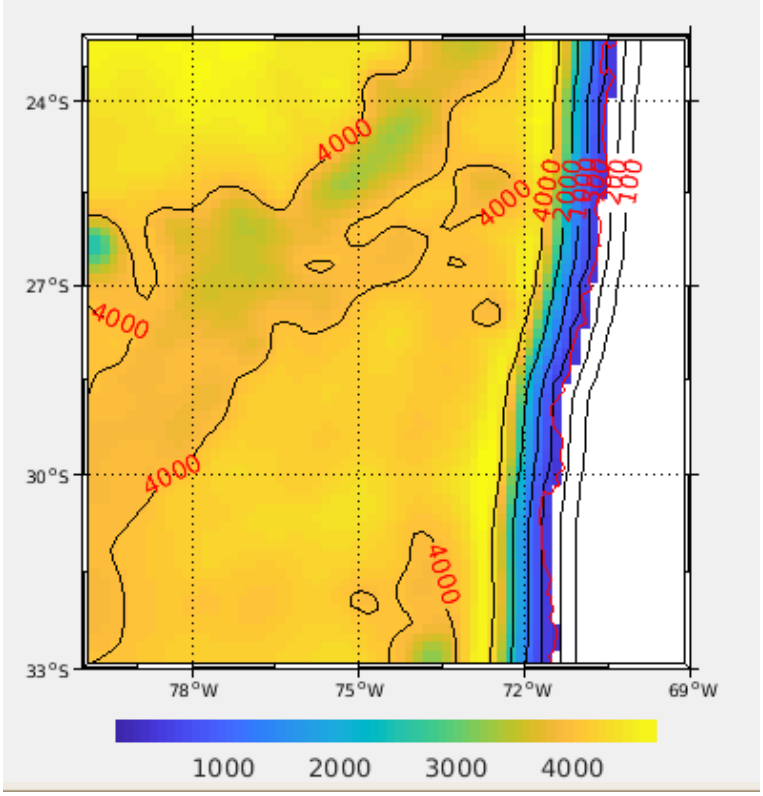

Figura 1: Final map of the Central Chile domain

Note that the domain has the **east** border closed. We will incorporate this information in **cppdefs.n** file. We continue with **make_forcing** instruction to obtain atmospheric forcing.

```
>> make_forcing
```

One of figures shown, Fig. 2

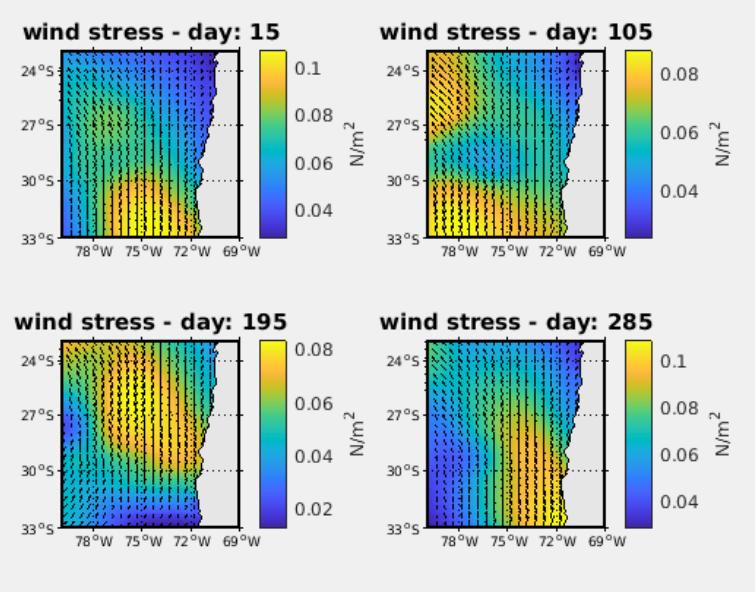

Figura 2: Surface wind stress for Central Chile domain

And finally **make_clim** instruction that creates **croco_clm.nc** file with ocean boundary condition

```
>>make_clim
```

One of figures shown, Fig. 3

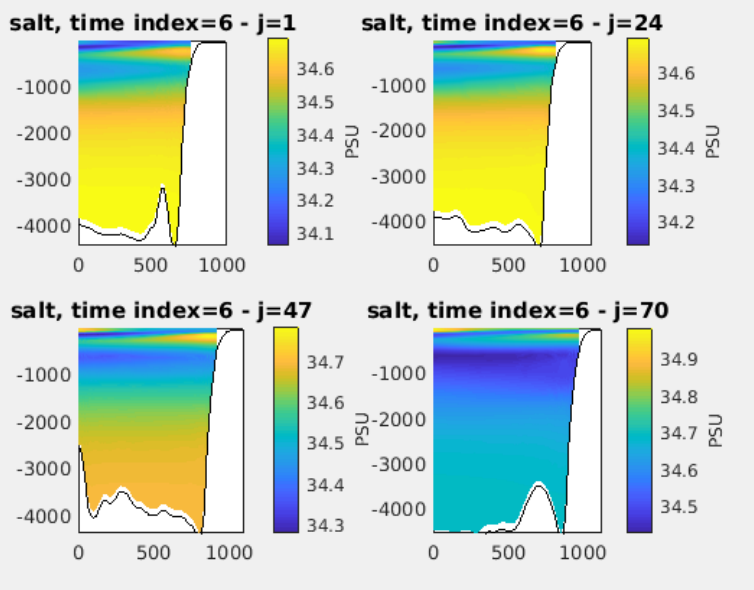

Figura 3: Salinity vertical sections for Central Chile domain

To finish this section, exit Matlab.

5. Domain dimension changes - param.h

We are going to incorporate the changes in the dimensions of the domain

```
LLm = 65
MMm = 68

```

in t**param.h** file. First let's locate the section named **BENGUELA_LR**

```
#  elif defined  BENGUELA\_LR
     parameter (LLm0=41,   MMm0=42,   N=32)   ! BENGUELA_LR
```

y reemplacelo por

```
#  elif defined  CHILECENTRAL
     parameter (LLm0=65,   MMm0=68,   N=32)   ! CHILE CENTRAL
```

In addition to changing dimensions of domain, we add the keyword **CHILECENTRAL** which will connect the files **param.h** and **cppdefs.h**. Save and exit nano editor.

6. Changes to physics - cppdefs.h

One major change in the physics of our domain is that eastern border only has land cells. In those cases we say that it is a closed border. That change must be incorporated in **cppdefs.h** file

```
nano cppdefs.h
```

First we incorporate **CHILECENTRAL** keyword replacing

```
# define BENGUELA_LR
```

with

```
# define CHILECENTRAL
```

Next, the code is told that border is closed by changing

```
# define OBC_EAST
# define OBC_WEST
# define OBC_NORTH
# define OBC_SOUTH
```

to

```
# undef OBC_EAST
# define OBC_WEST
# define OBC_NORTH
# define OBC_SOUTH
```

Save and exit nano editor.

7. Compiling CROCO

Now we are going to compile CROCO executable using

```
./jobcomp
```

8. Previous steps - croco.in

Before launching the simulation, we must consider that size of domain cells decreased by half, according to what we specified in **crocotools_param.m** file. This is part of **CFL** condition (Courant et al. 1928).

```
%
% Grid resolution [degree]
%
dl = 1/6;
```

This change affects **croco.in** file, a file that is read by **croco** executable.
Since resolution was halved, we decreased integration time step (variable **dt[sec]**) by half, modifying

```
time_stepping: NTIMES   dt[sec]  NDTFAST  NINFO
               720       3600       60       1
```

to

```
time_stepping: NTIMES   dt[sec]  NDTFAST  NINFO
            1440        1800        60        1
```

Note that we also double the number of time steps **NTIMES**, so that total time calculated is still 30 days (a climatological month).

Modify recording frequency of **RST**, **HIS**, and **AVG** files according to new time step

```
restart:          NRST, NRPFRST / filename
                 1440   -1
  CROCO_FILES/croco_rst.nc
history: LDEFHIS, NWRT, NRPFHIS / filename
            T     144     0
  CROCO_FILES/croco_his.nc
averages: NTSAVG, NAVG, NRPFAVG / filename
            1     144     0
  CROCO_FILES/croco_avg.nc
```

9. Launching simulation

For this we use

```
./croco croco.in
```

10. Output files

Once simulation finishes successfully, we will find in **CROCO_FILES** directory the following output files

```
croco_avg.nc
croco_his.nc
croco_rst.nc
```

11. Results display

As in the first tutorial, display the results using **ncdump**.

The instruction

```
ncdump -h CROCO_FILES/croco_avg.nc  | less
```

and **ncview**

```
ncview CROCO_FILES/croco_avg.nc
```

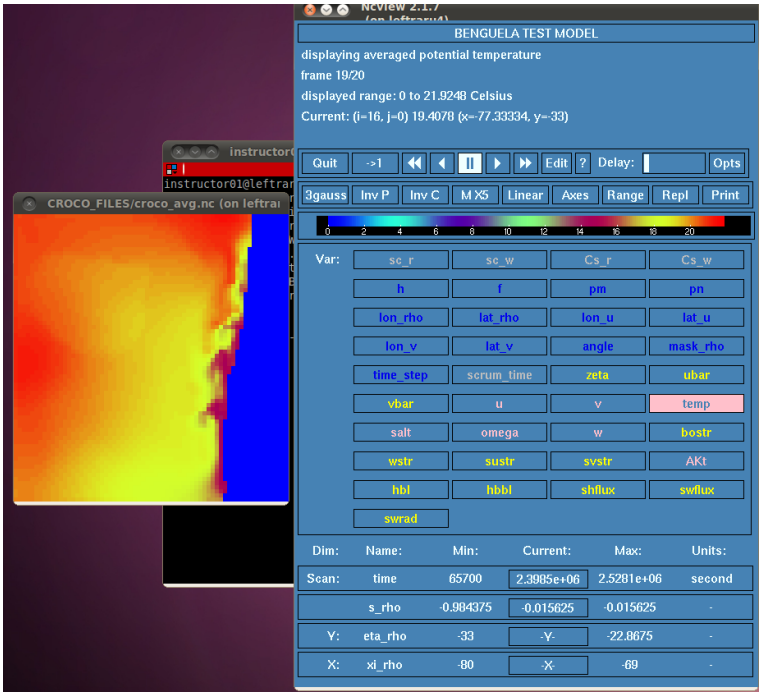

Figura 4: Surface temperature, Central Chile domain

12. Conclusion

In this tutorial you learned how to modify **crocotools_param.m**, **param.h**, **cppdefs.h**, and **croco.in** files to simulate a new domain.

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13. References

Courant, R.; Friedrichs, K.; Lewy, H. (1928), "Über die partiellen Differenzengleichungen der mathematischen Physik", Mathematische Annalen (in German), 100 (1): 32{74,