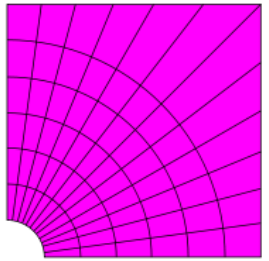
TUTORIAL 02:
CREATE MY CONFIGURATION

Numerical Aspects: Horizontal discretization

➢ **Structured grids**

The grid cells have the same number of sides.



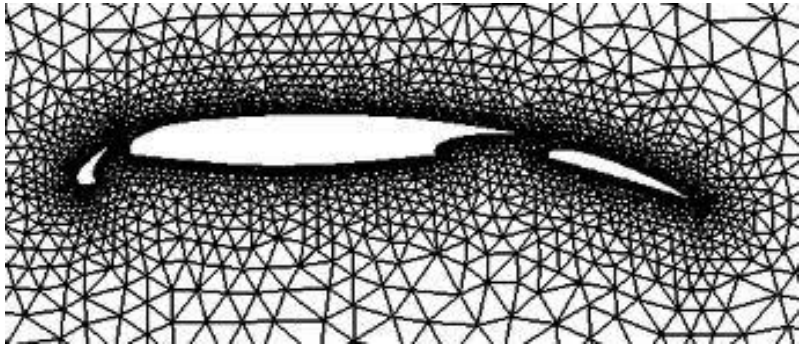
CROCO

➢ **Unstructured grids**

The domain is tiled using more general geometrical shapes (triangles, …) pieced together to optimally fit details of the geometry.

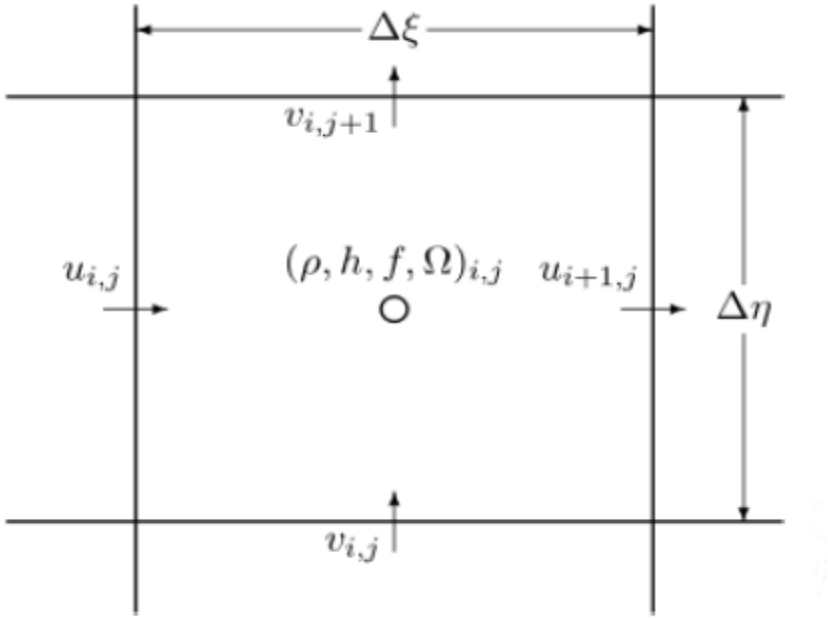
✓Good for tidal modeling, engineering applications.

✓Problems: geostrophic balance accuracy, wave scattering by non-uniform grids, conservation and positivity properties, …



Numerical Aspects: Horizontal discretization

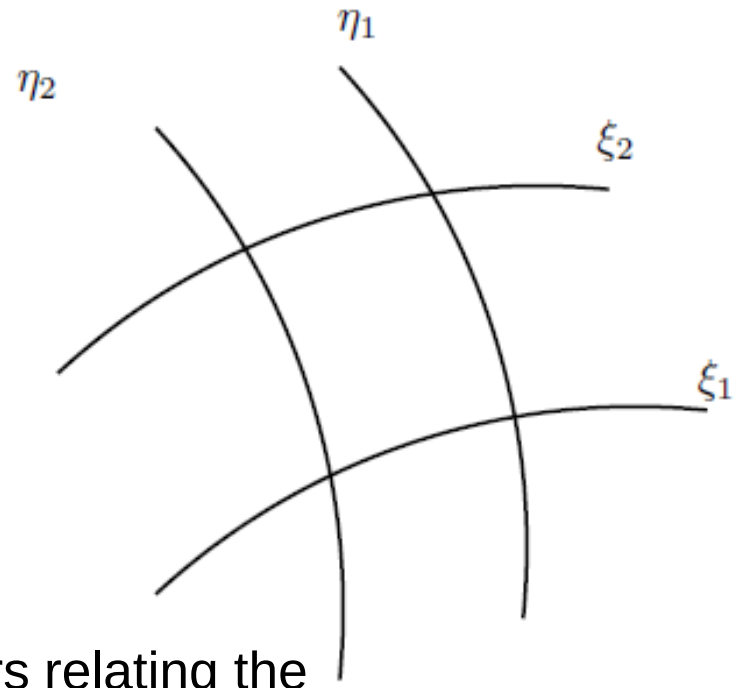
CROCO grid is discretized in **coastline-** and **terrain-following curvilinear coordinates** with **free-surface**, on an **Arakawa-C grid**.



(a) Grille C d'Arakawa

$$(ds)_\xi = \left(\frac{1}{m}\right) d\xi$$

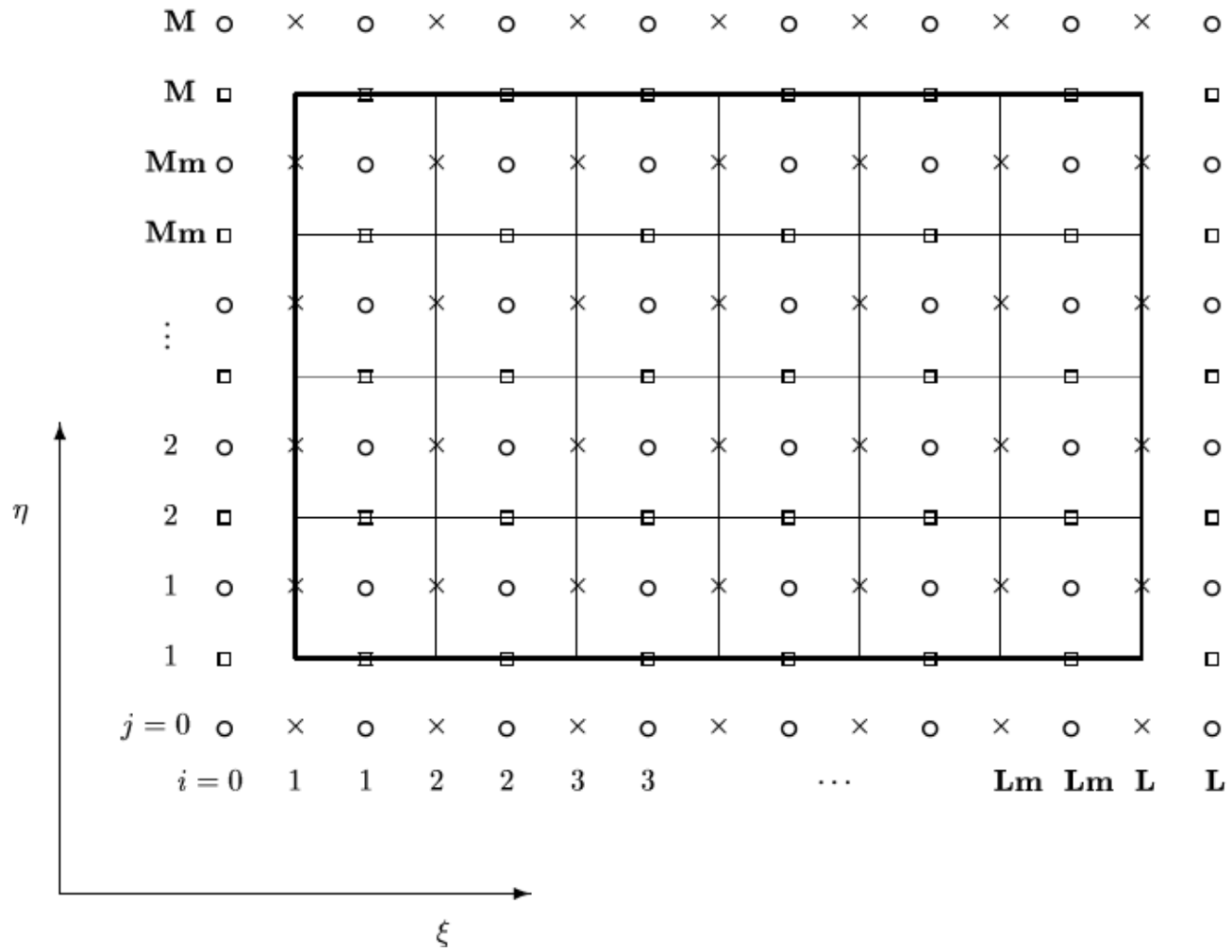
$$(ds)_\eta = \left(\frac{1}{n}\right) d\eta$$



↳ m, n: scale factors relating the differential distances to the physical arc lengths

Numerical Aspects: Horizontal discretization

CROCO horizontal grid



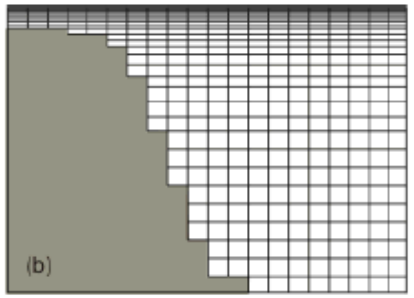
$\times$ – u points

$\square$ – v points

$\circ$ – ρ points

Numerical Aspects: Vertical discretization

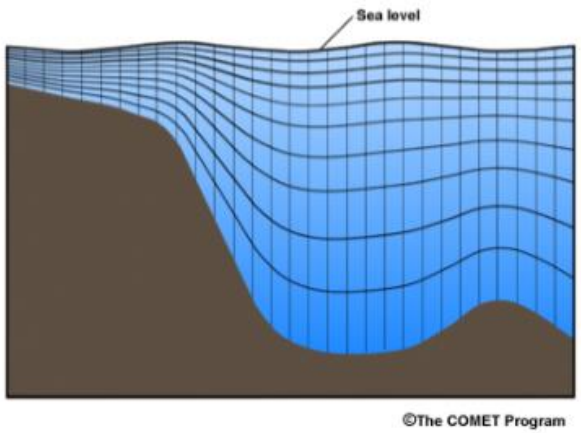
Z-Coordinates



Sigma (and stretched) Coordinates

Terrain-following curvilinear coordinates with free-surface

CROCO



free surface

Vertical sigma coord.

Water column thikness

$$z(x, y, \sigma, t) = \zeta.(1+ \sigma) + hc\ .\sigma + (h - hc\ ).C(\sigma)$$

Parameters controlling the stretching between surface and bottom

Stretching function C=f(θs,θb)

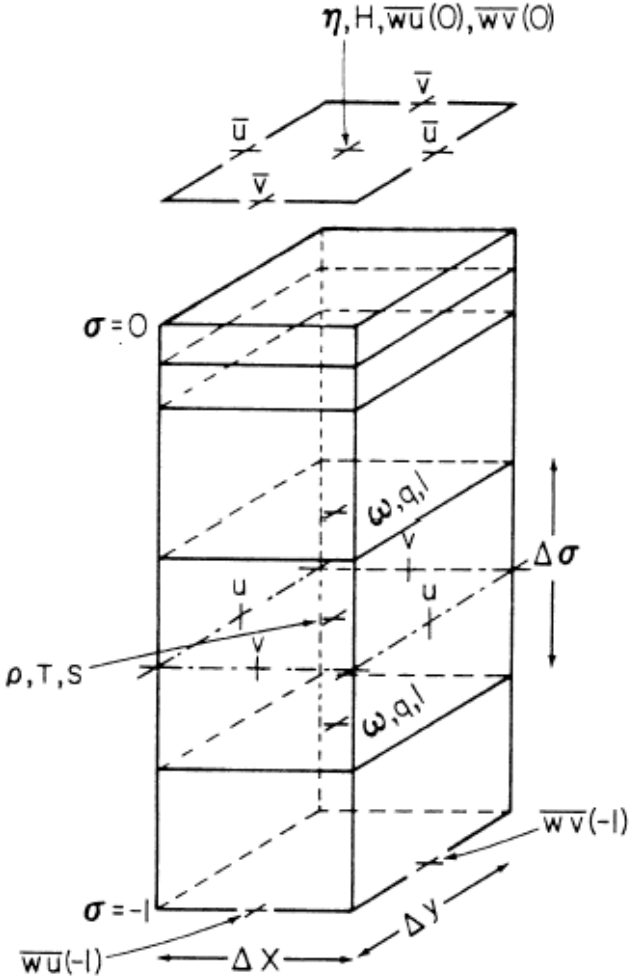


Fig. 1. The locations of the variables on the finite difference grid.

OBJECTIVES

- Get familiar with **CROCO and CROCO_TOOLS directories**.
- Run MATLAB and pre-processing tools for the 1st experiment.
- Modify and run MATLAB scripts.
- Create the horizontal and vertical grids.
- Make your own grid and configuration.

STEP 1: Logging onto the HPC cluster

- From a terminal/konsole:

```
ssh -X login@lengau.chpc.ac.za
```

- Reserve one interactive processor to do this pre-processing step

```
[login@login2 ~]$ qsubi1
[login@cnode0220 ~]$
```

- Go directly into your `lustre` directory:

```
[login@cnode0220 ~]$ cd lustre
[login@cnode0220 lustre]$ ls
croco croco_tools
[login@cnode0220 ~]$
```

STEP 2: Creating the work directory of your first CROCO

- From croco directory, Edit the file `create_config.bash` using the Linux command `vi` or the `nedit` software
  Line 27: replace the string "`Run`" by "Run_BENGUELA_LR"

- Execute the new file `create_config.bash`

```
[login@cnode0220 croco]$ ./create_config_bash
```

- Go to the new directory created: Run_BENGUELA_LR.

STEP 3: Recreating BENGUELA_LR CROCO Grid

- Run the basic pre-processing steps to create the grid:

```
[login@cnode0220 Run_BENGUELA_LR]$ matlab -nodesktop
```

```
                            < M A T L A B (R) >
                  Copyright 1984-2020 The MathWorks, Inc.
                R2020a Update 8 (9.8.0.1873465) 64-bit (glnxa64)
                             February 3, 2022

To get started, type doc.
For product information, visit www.mathworks.com.
>> start
>> edit crocotools_param
```

```
>> make_grid
```

- Take a look at the new files.
- Inspect the vertical grids and play with the parameters and the matlab function:`draw_zonal_section(N,theta_s,theta_b,hc,vtransform,lat_index)`

Vertical grid: Parameters θs,θb

- Formulation Vtransform=1

$$z(x,y,\sigma,t) = z_0(x,y,\sigma) + \zeta(x,y,t)\left[1 + \frac{z_0(x,y,\sigma)}{h(x,y)}\right]$$

$$z_0(x,y,\sigma) = h_c\sigma + [h(x,y) - h_c]Cs(\sigma)$$

$$Cs(\sigma) = (1-\theta_b)\frac{sinh(\theta_s\,\sigma)}{N} + \theta_b\left[\frac{0.5\,tanh\left((\sigma+0.5)\theta_s\right)}{tanh(0.5\,\theta_s)} - 0.5\right]$$

- Formulation Vtransform=2

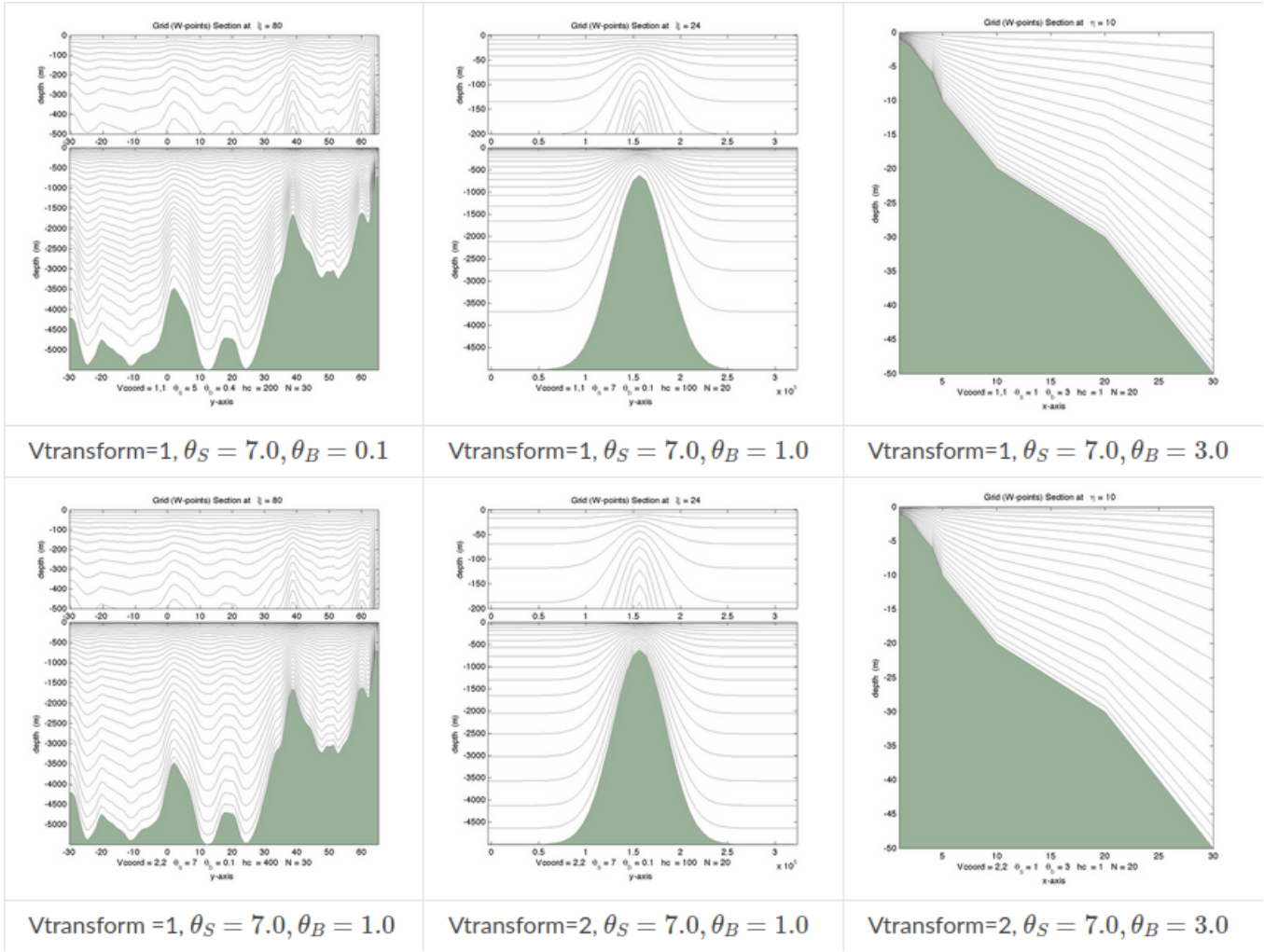
$$z(x,y,\sigma,t) = \zeta(x,y,\sigma) + [\zeta(x,y,t) + h(x,y)]z_0(x,y,\sigma)$$

$$z_0(x,y,\sigma) = \frac{h_c\sigma + h(x,y)Cs(\sigma)}{h_c + h(x,y)}$$

$$sc = \frac{\sigma - N}{N}$$

$$csf = \frac{1. - cosh(\theta_s\,sc)}{cosh(\theta_s) - 1.} \quad \text{if } \theta_b > 0, \quad csf = -sc^2 \quad \text{otherwise}$$

$$Cs(\sigma) = \frac{e^{\theta_b csf} - 1.}{1. - e^{-\theta_b}} \quad \text{if } \theta_s > 0, \quad Cs(\sigma) = csf \quad \text{otherwise}$$



Vtransform=1, $\theta_S = 7.0, \theta_B = 0.1$ | Vtransform=1, $\theta_S = 7.0, \theta_B = 1.0$ | Vtransform=1, $\theta_S = 7.0, \theta_B = 3.0$

Vtransform =1, $\theta_S = 7.0, \theta_B = 1.0$ | Vtransform=2, $\theta_S = 7.0, \theta_B = 1.0$ | Vtransform=2, $\theta_S = 7.0, \theta_B = 3.0$

Coastal and Regional Ocean COmmunity model

STEP 4: Creating your CROCO Grid

➢ Re-do Step 2 & 3 with your own parameters: Edit the file `create_config.bash`

Call your configuration `Run_Clim`. You can play with the grid rotation and the editmask.

Special attention to:

- grid size (LLm, MMm): do not exceed a 100x100 grid
- choose a place where there is a river
- do not overlap the equatorial zone by less than 2°

STEP 6: Exiting

- Exit Matlab:

```
exit
```

- Give back the compute node:

```
exit
```

- Logoff the Lengau cluster:

```
exit
```