Activity 2 – Run an idealized ocean basin II

1. Barotropic vorticity equation

- We will diagnose the barotropic vorticity equation from the simulations

See http://jgula.fr/ModNum/HughesDeCuevas01.pdf
and http://jgula.fr/ModNum/diagnostics_croco.pdf

- Rerun the BASIN test case from Activity 1 with additional diagnostics:

1. Add diagnostics in the cppdefs.h :

```
# define  DIAGNOSTICS_VRT
```

2. Modify the croco.in (use the updated version available here: https://www.jgula.fr/ModNum/croco.in.Basin)

3. Re-compile and rerun the simulation (see Activity 1)

- Using your preferred language (python , matlab, julia, etc.) plot together the different terms of the barotropic vorticity budget averaged over the last 5 years of the simulation for the BASIN test case from Activity 1 [available in the basin_diags_vrt_avg.nc file].

- What is the first order balance over the interior of the gyres? What about the western boundary current?

2. Westward intensification of gyres (Stommel, 1948)

-Copy the BASIN test case from Activity 1 and create a new test case: (for example case2)

- Check what happens if you remove the latitudinal variation of the Coriolis parameter (beta-effect), to test the theory of Stommel. To change the value of beta, you need to copy and edit the file ana_grid.F :

```
# if defined BASIN
                      depth=5000.
                      f0=1.E-4
                      beta=0
```

- Plot the different terms of the barotropic vorticity budget averaged over the last 5 years of the simulation. Compare them with the previous one.

2. Viscous boundary layer (Munk, 1950)

- Use a weaker drag and no-slip lateral conditions (in the croco.in)

```
bottom_drag:     RDRG(m/s),      RDRG2, Zob [m],  Cdb_min, Cdb_max
                 3.e-4             0.      0.         0.      0.
gamma2:
                 -1.
```

- Plot the different terms of the barotropic vorticity budget averaged over the last 5 years of the simulation. Compare them with the previous one.

2. Non-linear effects

- Check the impact of the non-linear terms (advection) by removing advection in the cppdefs.h :

```
# undef UV_ADV
```

- Plot the different terms of the barotropic vorticity budget averaged over the last 5 years of the simulation. Compare them with the previous one.

3. Make it more turbulent

- Decrease the explicit dissipation in the croco.in

```
lateral_visc:   VISC2,    VISC4    [m^2/sec for all]
                 100.       0.

tracer_diff2: TNU2(1:NT)           [m^2/sec for all]
               100.       0.
```

- Edit the file param.h and increase the number of points:

```
#if defined BASIN
      parameter (LLm0=120,   MMm0=100,   N=20)
```

- Find the largest possible barotropic and baroclinic time-steps

- plot the different terms of the barotropic vorticity budget averaged over the last 5 years of the simulation.