

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.