Laboration 3A: Topography and β-plane

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Aim

The aim of this assignment is to study and understand waves that are generated when $D(y)$ and $f(y)$ are sloping planes of the form $D = D_0 + \alpha y$ and $f = f_0 + \beta y$. For this assignment you should use a model with periodic and open (sponge) boundary conditions. The initial disturbance should be in geostrophic balance to avoid gravity waves.

Experiments and model setup

Model setup

- Use an initial disturbance in geostrophic balance. (Tip: when you define h, you also need to program u and v, so that they are in geostrophic balance.)
- Use periodic boundaries in x (East - West).
- Use open boundaries (Sponge) in y (South - North).
- Program a sloping plane $D = D_0 + \alpha y$ using LOGICAL (or CASE) so that you can chose to have it on or off in the simulation.
- Program a new Coriolis parameter describing $f = f_0 + \beta y$. In the same sense, use LOGICAL (or CASE) so that you can chose to turn it on or off.

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Experiment 1 - β plane

- Consider a rectangular basin with $L = 7 \cdot 10^6$ m and $H = 4000$ m in the mid latitudes (e.g. North Pacific). Run the model for at least 30 days.
- Start by deriving the phase speed and group velocity for Rossby waves in this linear system. (The derivation should not be included in the report, only the final solution).
- Run the model with a β-plane and constant topography (D).
- Describe and explain the evolution of the system.
- Connect the results to theory.
- What kind of waves develop?
- Do they have any distinguishing properties?

Experiment 2 - Phase and group velocities

- Rerun the model as in Experiment 1, but with different wavenumbers. (Tip: To change wavenumber, change disturbance width).
- Compare the obtained phase speed and group velocity to the theoretical values.
- Repeat this exercise but keep f constant and vary the topography using an α plane. Discuss the differences.

Experiment 3 - $\beta - \alpha$ compensation

- Run the model using a varying topography and f-field ($D = D_0 + \alpha y$ and $f = f_0 + \beta y$).
- Calculate the value of α that cancels the β effect. What happens to the initial disturbance under these circumstances?

Good luck!