**Abstract**

The influence of bottom topography on the generic properties of the baroclinic basin modes is investigated through linear stability analysis of a two-layer shallow water ocean model. Various idealized bottom profiles mimicking a mid-ocean ridge and continental slopes are implemented in an extratropical f-plane closed basin. The damping rate of the leading baroclinic mode is found to be weakly sensitive to bottom topography while the decadal period is shortened by bottom elevations. The mechanism of modal decay is rationalized through energy and vorticity budgets for the barotropic and baroclinic components, to characterize the energy routes and conversions. For small amplitude topography, the barotropic flow results accurately from the interaction of the flat-bottomed baroclinic motion with the topographic height: it is found to be three times stronger within closed potential vorticity contours than with blocked contours. However, the conversion of energy from the barotropic to the baroclinic mode remains weaker than the frictional processes.

**Model & Method**

The low-frequency ocean circulation is likely a major player, given its large heat capacity and long adjustment. The latter is achieved through the baroclinic planetary waves that cross the Atlantic basin in a few decades at mid-latitude. The baroclinic Rossby waves basin modes have thus been proposed as a possible explanation for the interdecadal oscillation: they are westward-propagating Rossby waves reinitialized at the eastern boundary through random Kelvin wave adjustment (LeCasle 2000) or nonresonant inertia-gravity wave response (Primeau 2002), and owe their existence to mass conservation laws (Cessi and Primeau 2001). However, none of these studies examined the low-frequency large-scale basin modes from a quasi-geostrophic point of view. Moreover, all of them considered a flat bottom or a reduced gravity configuration so that the effect of topography could be ignored. It is then natural to wonder what effect the removal of these simplifications (quasi-geostrophy, flat-bottom) might have on the structure of the baroclinic basin modes, given the well-known tendency of the large-scale topography to couple the vertical modes. This study is motivated by the desire to pursue these investigations by considering the influence of different topographic features on the generic property of the baroclinic basin modes as well as their damping.

**Linbaric vortexy balance**

For each variable, we note $X' \cdot X''$ with $X \equiv X_1 - X_2$, the vertically averaged (barotropic) component and $X' \equiv X_1 - X_2$ its baroclinic counterpart.

- Large-scale SW: $\alpha \cdot \bar{\beta} = f / \eta + (\nu + \sigma) \bar{\nu} + \bar{\psi} = (\nu + \sigma) \bar{\psi} + k \cdot \nabla \times \bar{F}$
- $\bar{P}^c = k \cdot \bar{\psi}' \bar{\nu}' = h_h \cdot (\bar{\psi} \bar{\nu} + k \cdot \nabla \times \bar{F})$

$\Rightarrow$ The barotropic mode is accurately diagnosed through the interaction of the flat-bottomed baroclinic mode with the imposed topography elevation.

**Discussion & Conclusion**

The large-scale basin modes with decadal periods are promoted through eddy viscosity at coarse resolution. The period for the gravest basin mode is slightly shortened suggesting a net acceleration of long Rossby waves by bottom heights as pointed out by Tailleux and McWilliams (2002). Changes in horizontal diffusion do not have a crucial influence on the gravest basin mode of ocean variability. However, varying both amplitudes of viscous dissipation and topography may well act to sustain the decadal mode, thus contributing to the large-scale basin modes. submitted to J. Mar. Res.

**Sensitivity analysis**

1) Dissipation: to $\nu$... $\nu = \frac{5}{10} \times 10^{-4}$.
2) $R_l$ resolution

**Mechanisms of modal decay**

$\frac{\partial u}{\partial t} + \nabla \cdot (\bar{\psi} u) = \frac{v}{\eta} \frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial x^2} (\nu + \sigma) \bar{\psi} + k \cdot \nabla \times \bar{F}$

**References**


This work is part of the project: Ferjani, D. T., Tailleux, and A. Colin de Verdière, 2012: Influence of topography on the large-scale decadal basin modes. submitted to J. Mar. Res.