Geophysical Research Abstracts
Vol. 14, EGU2012-748-2, 2012
EGU General Assembly 2012

Influence of bottom topography and mean circulation on large-scale decadal basin modes

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To understand the decadal oscillation which appear in GCMs, we investigate the influences of bottom topography and mean circulation on the propagation and spatial patterns of the linear baroclinic modes of an idealized basin through the linear stability analysis of a two-layer shallow-water model.

Various idealized bottom reliefs are analyzed in a rectangular extratropical closed basin mimicking a mid-ocean ridge and/or continental slopes. Only large-scale features are investigated: therefore, eddy effects are parameterized as eddy viscosity and/or thickness diffusion.

The decadal period of the baroclinic modes is weakly sensitive to the bottom topography. At coarse resolution, the damping time scale is set by the dissipation. This dissipation selects the largest-scale lowest-frequency modes as the least damped ones. The low-frequency modes dissipation is rationalized though a detailed energy and vorticity budgets computed over an oscillation period, and decomposed into barotropic and baroclinic terms, in order to characterize the energy routes and conversions.

With bottom topography, the barotropic mode arises through the interaction of the baroclinic motion with the topography. The dissipative transfer to the barotropic mode is more effective within closed f/H contours (bowl-shaped topography vs mid-ocean ridge) but remains weak with respect to viscous processes. We finally discuss how a mean circulation driven by wind-stress and/or heat fluxes impact on these large-scale modes.