Oceanic density fronts dynamics

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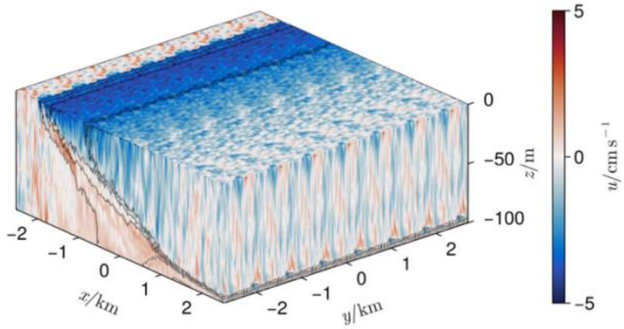
Project description: Oceanic fronts, which populate the ocean's immediate sub-surface, are horizontal boundaries between water masses that differ, e.g., by their density, temperature,



and/or salinity. For about five decades, mathematical models have predicted their formation mechanisms and basic dynamics (Hoskins, 1982). However, these simplified models do not account for turbulence, and therefore, lack the mechanisms that can stop fronts from becoming ever narrower. Currently, Erin Atkinson, a graduate student in my group, has managed to design a numerical setup that captures a full frontogenetic and frontal arrest cycle, by including a large-scale deformation flow, while running simulations that can resolve some level of turbulence (Atkinson et al., 2025; Atkinson & Grisouard, 2025). The result is a front whose width is finite and independent on horizontal resolution. It is the host of intense turbulence, and within which a significant amount of energy is dissipated. This is why oceanic fronts are believed to be candidates to provide "missing dissipation", which oceanographers still cannot account for in the global oceanic energy budget.

Our model does not feature external mechanisms that can generate additional turbulence, such as wind forcing, which excites surface waves and internal waves at or near the local Coriolis frequency through a resonance mechanism. This project aims to adapt Erin's numerical setup to add such wind forcing. You will diagnose how much wave energy is generated by this wind, if it influences the final state of the front, and in particular, its final width and amount of dissipation inside the core of the front.

Requirements: you have notions of vector calculus and partial differential equations, as well as some basic experience in programming. Knowledge about fluid dynamics and the Julia language will be useful but not expected prior to the start of the project.

Bibliography

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