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A Unified Model of Geostrophic Adjustment and Frontogenesis

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— Fronts, or regions with strong horizontal density gradients, are ubiquitous and dynamically important features of the ocean and atmosphere. In the ocean, fronts are associated with enhanced air-sea fluxes, turbulence, and biological productivity, while atmospheric fronts are associated with some of the most extreme weather events. Here, we describe a new mathematical framework for describing the formation of fronts, or frontogenesis. This framework unifies two classical problems in geophysical fluid dynamics, geostrophic adjustment and strain-driven frontogenesis, and provides a number of important extensions beyond previous efforts. The model solutions closely match numerical simulations during the early stages of frontogenesis, and provide a means to describe the development of turbulence at mature fronts.

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