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Fueling phytoplankton production by ageostrophic frontal processes over a steep shelf-slope topography: a case study for the Black Sea

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The buoyancy driven frontal boundary current conformed over the shelf-slope topography around periphery of the Black Sea is marked by enhanced mesoscale variability and relatively high chlorophyll concentrations always exceeding those within the deep interior basin. An eddy-resolving physical-biological model forced with the daily climatological atmospheric forcing over an annual cycle suggests that the presence of ageostrophic cross-frontal secondary circulation accompanying with the along-front quasi-geostrophic rim current is able to provide relatively high phytoplankton biomass ($\sim$ 1.0-1.5 mmol N m-3) within less dense onshore (anticyclonic) side of the coastal front for almost the entire year. It is at least twice higher than that produced intermittently within the cyclonically-dominated interior basin by eddy pumping and buoyancy-induced vertical mixing processes. The frontal-induced plankton production occurs within the entire euphotic zone during winter in response to weaker stratification and more efficient entrainment and upward transport of nutrients whereas development of the strong seasonal stratification shifts the frontogenesis and plankton production to lower part of the euphotic zone during summer months. This mechanism implicates continual bottom-up support to sustain relatively high fish stocks even for their high exploitations, and thus may be a primary factor preventing the collapse of fishery along the southern coastal waters.