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Submesoscale Currents Modulate the Seasonal Cycle of Nutrients and Productivity in the California Current System

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ABSTRACT

In the California Current, subduction by mesoscale eddies removes nutrients from the coastal surface layer, counteracting upwelling and quenching productivity. Submesoscale eddies are also ubiquitous in the California Current, but their biogeochemical role has not been quantified yet in the region. Here, we present results from a physical-biogeochemical model of the California Current run at a resolution of 1 km, sufficient to represent submesoscale dynamics. By comparing it with a coarser simulation run at 4 km resolution, we demonstrate the importance of submesoscale currents for the seasonal cycles of nutrients and organic matter and highlight the existence of different regimes along a cross-shore gradient. In the productive coastal region, submesoscale currents intensify quenching and reduce productivity, further counteracting wind-driven upwelling. In the offshore oligotrophic region, submesoscale currents enhance the upward transport of nutrients, fueling a dramatic increase in new production. These effects are modulated by seasonality, strengthening near the coast during upwelling and offshore in wintertime. The intensification of the transport by submesoscale eddies drives an adjustment of the planktonic ecosystem, with a reduction of plankton biomass, productivity, and size near the coast and an increase offshore. In contrast, organic matter export by sinking particles and subduction of detritus and living cells are enhanced nearly everywhere. Similar processes are likely important in other regions characterized by seasonal upwelling, for example, other eastern boundary upwelling systems.