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On the role of eddies for coastal productivity and carbon export to the open-ocean

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Several open ocean studies have suggested that eddies tend to enhance biological productivity in the ocean, particularly in low nutrient environments. We demonstrate here on the basis of an eddy-resolving model study of the California Current System (CCS) that meso- and submesoscale processes have the opposite effect in coastal upwelling systems, i.e. they tend to reduce biological productivity and the downward export of carbon. This is caused by a lateral eddy-induced transport that brings warm, nutrient depleted waters toward the shore, thereby suppressing the effect of Ekman-transport induced upwelling. This mechanism could explain the substantially lower productivity of the CCS in comparison to the Canary Current or Benguela current upwelling systems, since the latter two have a substantially lower eddy activity, despite similar upwelling strengths. At the same time, westward propagating eddies represent the main vehicle for transporting organic carbon from the nearshore region to the offshore, thereby enhancing heterotrophic consumption in the open ocean. Therefore, mesoscale and submesoscale processes are of fundamental importance in shaping coastal biogeochemistry and carbon balances.