REGULATION OF PRIMARY PRODUCTION IN THE GULF OF CALIFORNIA THROUGH INTERACTION OF LARGE-SCALE AND LOCAL OCEAN PROCESSES

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ABSTRACT

The suppression of primary productivity observed in eastern boundary ecosystems of the Pacific during El Niño episodes does not occur throughout the Gulf of California. On the contrary, analysis of the modern siliceous phytoplankton record from annually layered sediments and compilation of available primary productivity measurements indicate that production is significantly increased in the central Gulf during El Niño years compared to anti-El Niño years. Integrated observations of biological and physical variability during the spring of 1983, under the influence of the strong El Niño, show that very high primary productivity occurred along the eastern margin of the central Gulf. This resulted from the upwelling of a nutrient-rich source provided by the locally formed Gulf Water mass originating in the northern Gulf. Lower productivity and phytoplankton biomass were associated with the anomalous penetration of Tropical Surface Water along the western side of the Gulf.

Upwelling of the nutrient-rich Gulf Water in the central Gulf represents a mesoscale response to local wind forcing which had overridden the effects of large-scale remote forcing reflected in the penetration of the Tropical Surface Water and overall depression of the thermal structure associated with the El Niño. However, formation of the nutrient-rich Gulf Water itself appears to occur through modification of Subtropical Subsurface Water which is also advected from the eastern tropical Pacific and penerates into the northern Gulf between the depths of 200 and 400 m. We postulate that the enhanced phytoplankton production observed in the central Gulf during El Niño years results from nutrient enrichment of the Gulf Water by an intensification of the poleward advection of Subtropical Subsurface Water. The increased fertility of Gulf Water would lead to increase nutrient flux during upwelling of this water. This proposed mechanism is analagous to a large-scale chemostat whereby anomalous poleward advection provides an increased horizontal subsurface flux of nutrients to the site of Gulf Water formation and ultimately to the region of vertical entrainment by coastal upwelling.