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Lateral Carbon Sequestration: Direct Observations of the Biological Carbon Pump in the North Pacific Warm Pool Challenge Satellite Estimates

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Satellite-based assessments of the biological carbon pump (BCP) in remote tropical open-ocean regions generally indicate low activity, primarily due to limited nutrients and chlorophyll. However, direct in situ validations of these satellite-derived estimates remain scarce. To address this gap, we conducted measurements in the western North Pacific Warm Pool (between 4° and 13° latitude) using sediment traps and hydrographic sensors at depths of 150, 500, and 1000 meters. Our data reveal that BCP rates at 150 meters (29 to 42 mg-C m^{-2} day^{-1}) are significantly higher than satellite estimates (12–15 mg-C m^{-2} day^{-1}), suggesting a 2- to 3-fold underestimation. Moreover, BCP values at 500 and 1000 meters (22 to 35 mg-C m^{-2} day^{-1}) challenge the conventional depth-dependent decline, implicating lateral particle transport as a key mechanism enhancing deep-water BCP. e-NNA analyses of trap-collected particles further indicate that terrestrial materials and coastal blue carbon—derived from sources such as seaweeds and seagrass leaves—can be transported over distances exceeding 1000 km. These findings underscore the need for additional in situ surveys to refine satellite and biogeochemical model-based BCP estimates in tropical regions and reconcile the discrepancies between model predictions and direct measurements.