

Biological carbon pump estimate based on multidecadal hydrographic data

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The transfer of photosynthetically produced organic carbon from surface to mesopelagic waters draws carbon dioxide from the atmosphere¹. However, current observation-based estimates disagree on the strength of this biological carbon pump (BCP)². Earth system models (ESMs) also exhibit a large spread of BCP estimates, indicating limited representations of the known carbon export pathways³. Here we use several decades of hydrographic observations to produce a top-down estimate of the strength of the BCP with an inverse biogeochemical model that implicitly accounts for all known export pathways. Our estimate of total organic carbon (TOC) export at 73.4 m (model euphotic zone depth) is 15.00 ± 1.12 Pg C year⁻¹, with only two-thirds reaching 100 m depth owing to rapid remineralization of organic matter in the upper water column. Partitioned by sequestration time below the euphotic zone, τ , the globally integrated organic carbon production rate with $\tau > 3$ months is 11.09 ± 1.02 Pg C year⁻¹, dropping to 8.25 ± 0.30 Pg C year⁻¹ for $\tau > 1$ year, with 81% contributed by the non-advective-diffusive vertical flux owing to sinking particles and vertically migrating zooplankton. Nevertheless, export of organic carbon by mixing and other fluid transport of dissolved matter and suspended particles remains regionally important for meeting the respiratory carbon demand. Furthermore, the temperature dependence of the sequestration efficiency inferred from our inversion suggests that future global warming may intensify the recycling of organic matter in the upper ocean, potentially weakening the BCP.