Global Distribution and Magnitude of Deep Particulate Organic Carbon Fluxes Estimated by Benthic Flux Measurements

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The deep sea floor is the ultimate sediment trap. Once deposited, the majority of the particulate organic matter (POM) reaching the sea floor is remineralized on time-scales of weeks to decades. Because this is rapid relative to rates of deep sea lateral transport, patterns and magnitudes of seafloor remineralization reasonably represent modern-day deep water column POM fluxes. Benthic fluxes are also linked to pore water gradients in the underlying sediments which can only change on time-scales controlled by molecular diffusion rates. Measurements are, therefore, not subject to short-term fluctuations, greatly facilitating the evaluation of mean fluxes. Additionally, since remineralization is a destructive process, resuspension and other transport processes can not affect the evaluation of total flux rates. Because of these attributes, the measurement of benthic fluxes represents an important strategy for accurately assessing the magnitude and distribution of deep particulate fluxes of organic matter.

Over the last three decades, instrumentation has been developed to accurately assess sea floor fluxes and benthic fluxes have been determined at hundreds of deep sea locations. Additionally, correlations have been developed with other sedimentary characteristics to assist in extrapolating measured fluxes throughout the deep ocean basins. The deep POM flux distribution derived from benthic flux estimates is generally consistent with the distribution derived from inverse model calculations but differs significantly from that derived from remotely-sensed surface chlorophyll, chlorophyll-productivity, and productivity-flux-depth relationships. Sea floor-derived flux distributions exhibit greater fluxes along continental margins and smaller fluxes in the high latitudes, especially in the North Atlantic Ocean relative to those based on surface productivity-flux-depth relationships. Globally, sea floor measurements indicate that continental margins supply approximately 1/2 of the total POM flux to the deep ocean and that approximately 2/3 of the total flux is transferred to the deep ocean between 30ºN and 30ºS. For models to accurately represent the present-day biological pump and to predict how the biological pump will operate in the future, it is critical that they incorporate parameterizations for those ecosystems that control the main flux pathways to the deep ocean. Future studies must, therefore, reconcile the differences that currently exist between flux distributions derived from surface productivity-depth relationships and sea floor measurements.