Carbon export by vertically migrating zooplankton: Optimal vertical migration and carbon export

Through diel vertical migration (DVM), zooplankton add an active transport to the otherwise passive sinking of detrital material that constitutes the biological pump. This active transport has proven difficult to quantify. We present a model that estimates both the temporal and depth characteristic of optimal DVM behavior based on a trade-off between feeding opportunity and predation risk; factors that vary with latitude, time of year, and the size of the migrating animal. This behavioral component, coupled to a nutrient-phytoplankton-zooplankton (NPZ) productivity model provides estimates of the active transport of carbon by different size fractions of the migrating zooplankton population as function of time and space. The approach is motivated by the difficulty in incorporating behavioral aspects of carbon transport into large scale carbon budgets of the world's oceans. The results show that despite their lower abundance, large zooplankton (length circa 1–2 mm) migrate deeper and transport approximately twice as much carbon as do the smaller zooplankton (length circa 0.2–0.3 mm). In mid-latitudes (∼30°N to ∼45°N), where pronounced spring blooms are observed, up to 20% more carbon is transported than at either equatorial or boreal latitudes. We estimate that the amount of carbon transported below the mixed layer by migrating zooplankton in the North Atlantic Ocean constitutes 27% (16–30%) of the total export flux associated with the biological pump in that region.

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