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Contribution of zooplankton fecal pellets to deep ocean particle flux in the Sargasso Sea using quantitative image analysis

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Zooplankton fecal pellets are an important part of the particle flux because they export carbon and other elements from the surface to deep ocean and serve as a nutrient source to deep ocean ecosystems. The Oceanic Flux Program (OFP), located in the Sargasso Sea 75 kilometers southeast of Bermuda, has continually collected deep ocean particle flux since 1978 and is the longest running deep ocean sediment-trap time series in the world. We analyzed quantitative digital microphotographs of the OFP samples (125-500 um size fraction) to better characterize the zooplankton fecal pellet contribution to mesopelagic particle flux. Using image analysis of the OFP digital microphotographic archives, we assessed the variability of fecal pellet flux and fecal pellet size distributions. Here we present OFP data, in conjunction with physical oceanographic data from the Bermuda Testbed Mooring (BTM) and the Bermuda Atlantic Time-Series Study (BATS) programs, that elucidates the change in fecal pellet flux in response to seasonal and mesoscale physical variability in the upper ocean. Three mesoscale eddies passed the OFP area in 2007: an extremely productive cyclonic eddy, a post-bloom mode water eddy and an anticyclonic eddy. Fecal pellet flux at 1500m depth was enhanced during the cyclonic and mode water eddies, but was not enhanced during the anticyclonic eddy, despite indications of increased surface ocean zooplankton biomass from ADCP backscatter intensity measured by the BTM mooring. The fecal pellet size distribution at 1500m depth showed surprisingly little seasonality and was largely unaffected by passage of any of the eddies. However, the fecal pellet size distribution at 500m depth shifted to smaller size pellets during passage of both the cyclonic and mode-water eddies, indicating stimulation of zooplankton production. Differences in fecal pellet size distributions at the three trap depths (500m, 1500m, 3200m) suggest reprocessing of flux material in the water column by different zooplankton communities. Fecal pellets in the 125-500um size fraction contributed 3-9% of total carbon flux, a minimum estimate as fragile particles likely disintegrate post-collection. Our work demonstrates the potential of quantitative digital image analysis for quantitative studies of marine particle flux composition.