Particulate organic matter composition and distribution in the Twilight Zone

CALUM PREECE[1*], KOSTAS KIRIAKOULAKIS[2], SABENA BLACKBIRD[1], GEORGE WOLFF[1]

[1]Earth, Ocean & Ecological Sciences, University of Liverpool, L69 3GP, UK (*correspondence: c.preece@liverpool.ac.uk, s.j.blackbird@liverpool.ac.uk, wolff@liverpool.ac.uk)

[2]Faculty of Science, Liverpool John Moores University, L3 3AF, UK (K.Kiriakoulakis@ljmu.ac.uk)

The efficiency of the biological pump in transferring CO_2 from the atmosphere to the deep ocean strongly depends on the degree of processing of particulate organic matter (POM) in the water column during sinking, particularly in the mesopelagic or "Twilight Zone" (100 - 1000m). However, the processes which control the efficiency of carbon storage in are not well known. Our study presents results from lipid biomarker, bulk nitrogen and carbon stable isotopes, and elemental analyses of sinking and suspended material sampled from South Georgia and the Benguela Upwelling Region. Particles were collected from the surface to 500m water depth using stand-alone pump systems (SAPs) fitted with glass fibre filters, snow catchers, and drifting sediment traps (Pelagras).

POM concentrations decrease rapidly with depth, significantly more so in the Benguela Upwelling region than at South Georgia. The OC/TN ratios of the fine particles decrease with depth from values of ~5 to ~3.5 in South Georgia and ~5.5 to ~4 in the Benguela Upwelling Region, implying that C is remineralized more rapidly than N at both locations.

Total lipid concentrations decrease with depth in both regions being dominated by the labile phytoplankton-derived polyunsaturated fatty acids eicosapentenoic acid (EPA) and docosahexenoic acid (DHA). At South Georgia, compounds specific to zooplankton (unsaturated alcohols) are present throughout the water column and are at very high concentrations in surface waters in some samples. The greatest attenuation of labile lipid concentrations is in the upper 150 m of the water column, concentrations do not decrease significantly below this (to 500 m). This implies that while turnover of POM is rapid in the topmost mesopelagic, there is nonetheless labile material available for respiration at 500 m water depth.

Keywords: biological pump, twilight zone, lipid biomarkers, suspended organic matter, stable isotopes, carbon flux