MODELLING NORTH-ATLANTIC WATER COLUMN RESPIRATORY CO_2 PRODUCTION, VERTICAL CARBON FLUX, NUTRIENT RETENTION EFFICIENCY, AND BENTHIC RESPIRATION

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Abstract: New North Atlantic rates of carbon-flux (F_c), oxygen utilization (OUR), and mineralization, when combined with new oceanographic concepts, can provide new insight into the dynamics of metabolic ocean biogeochemistry. Here, data from helium-tritium dating, advection-diffusion modeling, apparent oxygen utilization, respiratory electron transport activity (ETS), and three different types of sediment traps were used to calculate new metabolic-based rates. First, we used OUR to calculate CO_2 remineralization (J_c) profiles. J_c, at 100m, ranged from 0.4 to 109 millimol CO_2 m^{-3} $yr^{-1}$and from 1000m, it ranged lower, from 0.001 to 4.3 millimol CO_2 m^{-3} yr^{-1}. Secondly, we used J_c to calculate carbon flux (F_c) profiles. These, plus measured F_c, ranged from 1.5 to 17.8 millimol C m^{-2} yr^{-1} at 100m and to 0.03 to 12.1 millimol C m^{-2} yr^{-1} at 1000m. Thirdly, integrating J_c from the bottom of the mixed layer to the seafloor yielded New Production (NP) and Export Production (E). The two are considered equal. We found a North Atlantic NP range of 0.07 to 23.3 mol C m^{-2} yr^{-1}. Fourth, from the ratio, J_c/F_c, we calculated the nutrient retention efficiency (NRE = (J_c/F_c,)*100) that predicts future regenerated production. NRE is inversely related to carbon-flux transfer efficiency (T_{eff}) and both NRE and T_{eff} are related to b, the attenuation exponents of J_c and F_c. For a 50m water column centered at 125m, NRE ranged from 51 to 27% while T_{eff} ranged from 49 to 73%. In a 50m water column at 1025m, NRE ranged, much lower, from 8 to 4 % while T_{eff} ranged, much higher, from 92 to 96%. Fifth, benthic J_c was calculated, using different limits of integration, from F_c. It varied indirectly with water column NRE. For the North Atlantic, we found that benthic J_c ranged from 2.1 to 7040.0 millimol C m^{-2} yr^{-1}.

Key words: OUR, AOU, respiratory ETS, ocean metabolism, ocean particle flux.

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