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Temperature vs ecosystem structure control over remineralisation length scale of sinking particles in the Global Ocean

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Ocean biological processes, principally the surface production, sinking and interior conversion of organic carbon to CO_2 store enough carbon in the ocean interior to keep atmospheric CO_2 concentration substantially lower than it would otherwise be. The size of this effect is linked to the depth at which sinking organic matter is remineralised in the ocean, with a deeper mineralisation causing a greater storage. Two prominent hypotheses regarding the control over the depth at which sinking material is lost are Temperature and Ecosystem Structure, specifically the proportion of diatoms in the surface community. These are both theoretically valid (temperature controls respiration, diatoms control density) and have some support in the literature, however to date have been considered in isolation. In this paper we firstly compute the strength of these effects in isolation from simple theory and show that they produce relationships consistent with existing literature thus suggesting that both factors may play a role. We use these relationships to produce an equation linking mineralisation depth, parameterised as remineralisation length scale, to community structure and temperature, thus uniting the two factors. An analysis of this equation suggests that community structure exerts a stronger control over remineralisation length scale than does temperature.