Supplementary File 2. Derivation of fecal pellet carbon flux and fecal pellet decay rate

We assume a simple two-layer system. A population of copepods resides in the upper layer. Let n be the concentration of copepods (individuals m^{-3}) in the upper layer of the ocean. This upper layer has thickness h (m) and is well-mixed; this is essentially the depth to which we think the Continuous Plankton Recorder samples are representative of the plankton community. The copepods are producing sinking fecal pellets at a rate of FPP (fecal pellets time^{-1}); and the pellets contain a constant amount of carbon κ (gC) per fecal pellet volume FPV (10^6 μm^3). These pellets decay at a rate r (gC time^{-1}), and have a sinking rate SR (m time^{-1}) at the base of the surface layer.

Let FPC_{sfc} (gC m^{-3}) be the concentration of copepod fecal pellets in the upper layer. The total number of pellets in the layer is $h \times FPC_{sfc}$. Over a time interval Δt, the entire layer shifts down by $SR \times \Delta t$. The total number of pellets is $FPC_{sfc}(h - SR \times \Delta t) + FPC_{sfc}(SR \times \Delta t)$, where the first term is the number of fecal pellets remaining and the last term is the number of pellets leaving the surface layer. This allows us to write a differential equation for the concentration of copepod fecal pellets in this upper layer:

$$\frac{\mathrm{dFPC_{sfc}}}{dt} = FPP\,\kappa\,FPV\,n - rFPC_{sfc} - \frac{SR}{h}FPC_{sfc} \qquad (1)$$

At steady state,

$$FPC_{sfc} = \frac{FPP\,\kappa\,FPV}{r + SR/h}n \qquad (2)$$

We now consider the layer below the surface well-mixed layer, of arbitrary depth. Within this layer, fecal pellets sink at the rate SR (m time^{-1}) and decay at rate r (gC time^{-1}). These are not necessarily the same as the rates in the upper layer, but we assume that this is the case for this study. The rate of change of concentration is then,

$$\frac{\partial FPC}{\partial t} = -r\,FPC - SR\frac{\partial FPC}{\partial z} \quad (3)$$

At steady state,

$$SR\frac{\partial FPC}{\partial z} = -r\,FPC \quad (4)$$

And, solving for *FPC*,

$$FPC(z) = FPC_{sfc}\, e^{-r/SR\,z} \quad (5)$$

Where FPC_{sfc} is the concentration in the upper layer given by (2),

$$FPC_d = \left(\frac{FPP\ \kappa\ FPV}{r + SR/h}\,n\right) e^{-r/SR\,z} \quad (6)$$

The fecal pellet carbon flux (gC m^{-2} $time^{-1}$) at a particular depth (z) is the concentration times the pellets' sinking rates (*SR*):

$$FPCflux = SR\,\frac{FPP\ \kappa\ FPV}{r + SR/h}\,n\, e^{-r/SR\,z} \quad (7)$$

We determined the fecal pellet decay rate, *r* (gC $time^{-1}$) by setting the proportion of fecal pellet carbon produced near the surface that reaches a given depth ($FPC_d : FPC_{sfc}$) to a range of reasonable retention values (*ret*), based upon the literature,

$$(1\text{-}ret) = FPC_d/FPC_{sfc} \quad (8)$$

We then solved for either one decay rate for the entire dataset to give the estimated fecal pellet carbon retention,

$$(1\text{-}ret) = \left(\frac{FPP\ \kappa\ FPV}{r + SR/h}\,n\right) e^{-r/SR\,z} \Big/ \frac{FPP\ \kappa\ FPV}{r + SR/h}\,n$$

$$r = \ln(1\text{-}ret)\,\frac{SR}{\Delta z}$$