

What can we learn about the carbon cycle from ^{234}Th ?

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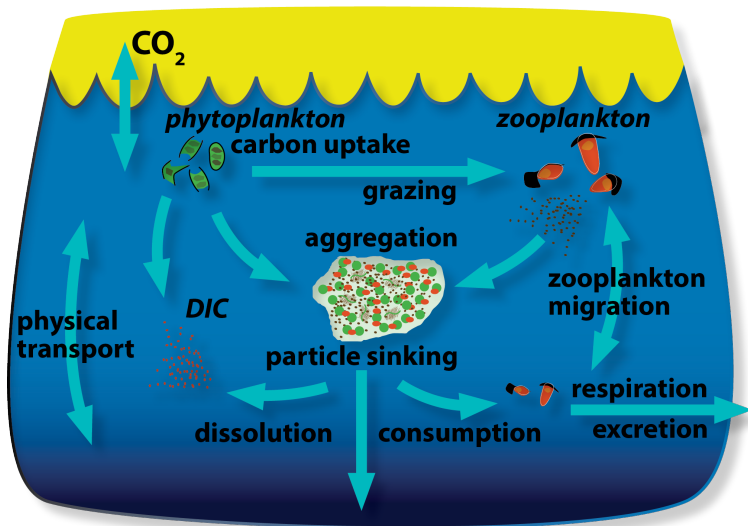
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What's up with ^{234}Th ?

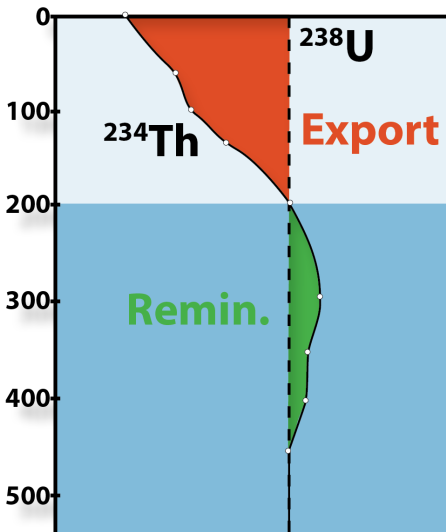
What's up with ^{234}Th ?

The Story: Biological (Carbon) Pump



What's up with ^{234}Th ?

$^{238}\text{U} - ^{234}\text{Th}$ Disequilibria



What's up with ^{234}Th ?

^{234}Th Activity and Flux

We can describe the distribution of ^{234}Th throughout the ocean with an advection-diffusion relationship:

$$\frac{\partial C_{Th}}{\partial t} = \underbrace{\nabla \cdot (\boldsymbol{\kappa} \nabla C_{Th})}_{\text{Diffusion}} - \underbrace{\nabla \cdot (\mathbf{u} C_{Th})}_{\text{Advection}} + \underbrace{\lambda_{Th} (C_U - C_{Th}) - P_{Th}}_{\text{Source \& Sink}}. \quad (1)$$

Assuming steady state (SS, $\partial_t C_{Th} = 0$), we can solve for the flux P_{Th}^z at a depth z to get:

$$P_{Th}^z = \int_{-z}^0 (\lambda_{Th} (C_U - C_{Th}) + \nabla \cdot (\boldsymbol{\kappa} \nabla C_{Th}) - \nabla \cdot (\mathbf{u} C_{Th})) \, dz. \quad (2)$$

What's up with ^{234}Th ?

^{234}Th as a POC Flux Proxy

We then use the ratio of particulate organic carbon (POC) to ^{234}Th to estimate the flux of POC:

$$P_{POC}^z = \frac{[POC]}{C_{Th}} \Big|_z P_{Th}^z. \quad (3)$$

Importantly, we assume that only large size fraction (LSF, $> 51\mu\text{m}$) POC contribute to the downward flux of ^{234}Th .

What's up with ^{234}Th ?

^{234}Th -derived POC Flux Model Inputs

From Eq. (2) and Eq. (3), we see that there are four main inputs to our POC flux model:

- (1) ^{238}U activity: C_U
- (2) ^{234}Th activity: C_{Th}
- (3) POC: ^{234}Th ratio: $[POC]/C_{Th}$
- (4) Integration depth: z

We use in-situ measured values for C_{Th} and $[POC]/C_{Th}$ at a depth z , but assuming that C_U is in continuum within the water column, we estimate C_U with lower error using salinity, S :

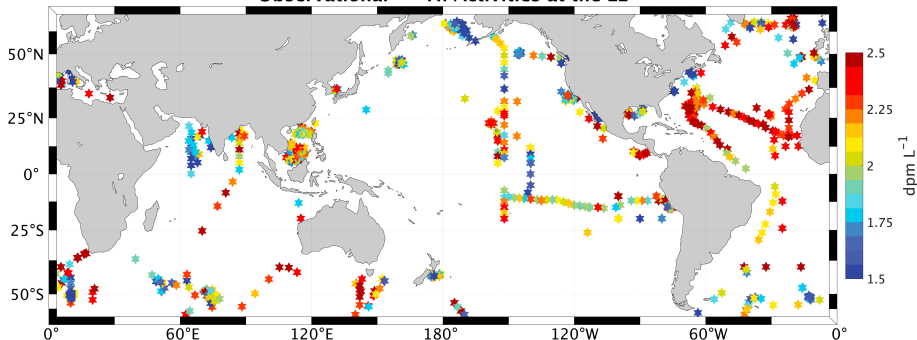
$$C_U (\pm 0.047) = (0.0786 \pm 0.00446) \cdot S - (0.315 \pm 0.158) \quad (4)$$

Global ^{234}Th -Derived Particulate Carbon Flux Model

Global ^{234}Th -Derived Particulate Carbon Flux Model

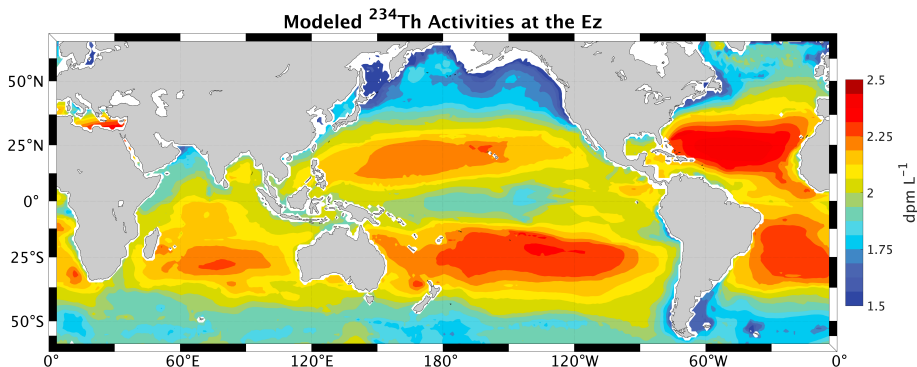
^{234}Th Quality Control

Observational ^{234}Th Activities at the Ez



Global ^{234}Th -Derived Particulate Carbon Flux Model

^{234}Th Global Mapping



Global ^{234}Th -Derived Particulate Carbon Flux Model

POC Flux Estimation

