



The ballast hypothesis: not pulling its own weight?

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Introduction: Biological Pump & CO₂





Ballast Hypothesis: CaCO₃ particles have a higher sinking velocity delivering more POC to depth (>1500-2000m)



Introduction: Ballasting





 $POC = \beta_{CaCO3} * CaCO_3 + \beta_{Opal} * Opal + \beta_{Lithogenic} * Lithogenic + \beta_{residual}$

 $POC = 0.089 * CaCO_3 + 0.023 * Opal + 0.027 * Lithogenic + 0.012$

Klaas & Archer (2002), *Global Biogeochemical Cycles* Ragueneau *et al.* (2006), *Global Biogeochemical Cycles* POC = Particulate Organic Carbon CaCO₃ = Calcium Carbonate Opal = Biogenic Silica Lithogenic = non-biogenic minerals



Introduction: Applying regression at regional scales





Challenges of applying regression to subsets of data:

- 1) Smaller subsets of data: larger variance and outliers
- 2) Larger subsets of data: risk of masking spatial variability
- 3) Choice of subsets: level of subjectivity



Methods: Geographically Weighted Regression





Subset of data: defined as *N* nearest neighbours *N* is a global parameter, optimised using an iterative approach

Fotheringham et al. (2002), Geographically Weighted Regression: The Analysis of Spatially Varying Relationships



Methods: Application to Sediment Trap Data





Annual sediment trap fluxes (>1500m): n=156

Subset of data: N = 66 nearest neighbours

Goodness-of-fit statistics improved (R²=0.66 -> 0.82)

Significantly different from global regression model



Results: Spatial variability in CaCO₃ coefficients

60°S







60°S



180°E

Inverse Approaches: Synthetic Fluxes

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Can we estimate 'synthetic fluxes' of POC from tracers?







Khatiwala et al. (2005), Ocean Modelling



- Utilising spatial variability in ballasting relationships
- Explore spatial variability using Geographically Weighted Regression
- Significant spatial variability in the relationship between POC and CaCO₃
 - Strong global regression relationship present in only few regions
 - Variability reminiscent of biogeochemical / ecological regions
 - Global regression model over-estimates POC flux to depth
- Interpretation of spatial relationships limited by size of dataset
- Synthetic POC fluxes
 - Direct inversion of tracers?





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