ONE DIMENSIONAL PHYSICO-CHEMICAL ECOLOGICAL OCEAN MODEL: POTENTIAL APPLICATIONS TO PROTEROZOIC BIOGEOCHEMICAL CYCLING

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The mixed layer and upper thermocline of the ocean represents a complex interaction between biologic, physical, and chemical processes. Primary productivity is not only driven by light and nutrient availability, but also affected by temperature and mixing. In turn, the export of biologically important elements is driven by ecological stoichiometry, test balasting and the physics of coagulation. While it is possible to use records of ocean parameters for the modern ocean, the climatology of the Precambrian was markedly different. Thus, modeling the Archean–Proterozoic ocean involves not only modeling the unique biological and chemical dynamics of an ocean without metazoan export of organic matter, but also markedly different physical and chemical characteristics as well.

Triparate coupling: physical-chemical-biologic union

We combine three established models of ecological interaction, physical processes and aggregate formation. First, a 1D physical model has been set up where air-water interface changes are forced by wind stress and solar heat. The water column profile is maintained by advective-diffusive forces and dynamic instability adjustments. Gas exchange conforms to the Liss and Merlivat model [1]. Two 1D open ocean ecologogical models are driven by physical models of the mixed layer and upper thermocline: 1) a modern ocean and 2) an ocean without metazoans and both oxic and anoxic primary producers. A variation on the Monod nutrient limitation model is employed to account for multiple limiting nutrients. The export of phytoplankton and other detris follows the coagulation models of Jackson [2], where aggregation is a function of differential sedimentation, Brownian motion and shear. Phytoplankton stickiness in the model is calculated from laboratory experiments with prokaryotes. This physico-chemical-ecological model provides insight into the formation of organic matter aggregates under the hypothesized ecological conditions of the Archean–Proterozoic.

References

[1] Liss P.S. and Merlivat, L., (1986) *The Role of Air-Sea Exchange in Geochemical Cycling*, pp. 113–127.
[2] Jackson (2001) *Deep-Sea Research I*, **48** pp. 95-123.