Coccolithophores and the Biological Carbon Pump

The biological carbon pump explains the movement of dissolved atmospheric carbon in the surface ocean to the ocean’s interior by way of phytoplankton. Coccolithophores, a type of calcifying phytoplankton, are crucial in the export of carbon due to their calcium carbonate plates that act as balancing materials and move particles to the ocean interior faster than individual particles.

Coccolithophores integrated by depth CESM-cocco

Krumhardt’s modified version of the Community Earth System Model (CESM) was used to assess the change in CaCO3 Flux with 280ppm, 400ppm, and 900ppm atmospheric CO2 simulations to represent the preindustrial, present day, and end of century atmospheric CO2 predictions.

CESM-cocco was used in this study due to creation of an explicit phytoplankton functional group for coccolithophores to represent calcifying plankton.

FIGURE 3. The Organic Carbon Average was multiplied by an averaged rain ratio for each Sediment trap data point. The PIC from BATS is shown here in orange as the CESM-cocco measurement is shown in blue.

Ineffective Calcification

Under acidiﬁed conditions, the biological carbon pump is expected to weaken due to decreased rates of calcification and therefore a weakening of the biological carbon pump.

CESM-cocco and Sediment Trap Verification

In order to further verify calcium carbonate flux at depth, BATS PIC average Particulate Organic Carbon sediment trap data was used. These data were then converted to PIC using three different rain ratios corresponding to the BATS region.

FIGURE 2b. The percent difference between the 280ppm-400ppm simulation is shown on the left with an increase in CaCO3 export. The percent difference on the right alternately shows the much larger decrease in CaCO3 export.

Conclusions

Coccolithophore calcium carbonate export is affected by increasing atmospheric CO2:

Carbon limitation in of photosynthesis cause an initial increase in calcium carbonate flux from 280-400ppm

With increased atmospheric CO2, calcium carbonate flux will decrease and the biological carbon pump will weaken.

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