Geophysical Research Abstracts
Vol. 12, EGU2010-10731-1, 2010
EGU General Assembly 2010

Calcifying phytoplankton biomass and CO2: A striking balance

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Calcifying phytoplankton play a fundamental role in marine ecosystems and global biogeochemical cycles. Their cell size and abundance modulate the strength of the biological carbon and carbonate "pumps", which represent important feedbacks in the Earth System. Phytoplankton biomass is thus coupled to climate variability, but the behavior of this coupling on geological time scales remains unknown. We compared fossil time series of coccolithophore relative abundance and cell size to geochemical proxy records of global climate change over much of the Cenozoic ($\sim$45-5 million years ago). We show that the Cenozoic decline in atmospheric carbon dioxide levels ($p\mathrm{CO}_2$) caused a reduction in calcifying phytoplankton biomass. Our results demonstrate that long-term variation in CO_2 availability and concomitant shifts in ocean carbonate chemistry have been important drivers of planktonic ecosystems beyond their association with ocean temperature and stratification. This supports the hypothesis that large-celled coccolithophores lacking a carbon concentrating mechanism were disadvantaged in a low-$p\mathrm{CO}_2$ world (Henderiks & Pagani 2008). In addition, decreasing biomass of calcifying phytoplankton may have represented a negative feedback during global cooling by reducing carbon drawdown and burial fluxes, potentially contributing to the stabilization of atmospheric CO_2 concentrations over the past 24 million years (Pagani et al. 2009).

References

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