Natural Dust Fertilization of Marine Phytoplankton in a High CO_2 World

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Introduction – Marine biological response to increasing anthropogenic CO_2

Anthropogenic inputs of carbon dioxide will affect not only the atmosphere but also the oceans, where increasing sea surface temperatures and ~~a decrease in~~decreasing seawater pH (due to dissolved CO_2) will force a shift in marine microbial productivity. Increasing CO_2 is also expected to increase desertification and subsequent dust inputs to the ocean, which could increase natural fertilization of marine phytoplankton by trace metal nutrients (e.g., Fe). The northern Arabian Sea may be particularly vulnerable to increasing atmospheric CO_2 conditions. Recent anomalous changes in biological productivity have resulted from the expansion of hypoxic, low pH waters in the marine ecosystem.

Experimental – Automated trace metal extraction and preconcentration, analysis by ICP-MS

To ~~test~~ test the ~~effects of~~biological response from increased dust inputs and ~~higher~~ elevated dissolved CO_2 concentrations in the northern Arabian Sea ecosystem, a series of incubations were conducted using a mixotrophic dinoflagellate native to the Arabian Sea, *Cochlodinium polykrikoides*. The marine microbial response was examined following additions ~~to test the marine microbial response to additions~~ of desert dust obtained from Oman under different CO_2 concentrations: ~~150~~ 400 ppm (~~pre-industrial~~current), ~~400~~ 800 ppm (~~current~~projected), and ~~800~~ 1200 ppm (projected). While the marine incubation experiments were conducted at LDEO, the biological uptake of trace nutrients was quantified by measuring dissolved trace metal concentrations in the NHMFL's Geochemistry division.

Aliquots of the incubations were subsampled into quartz tubes and spiked with a mixture of enriched stable isotope standards (Fe, Cd, Cu, Ni, Zn and Pb) and monoisotope standards (Mn and Co). The samples were UV-irradiated to release the metals from organic ligands, ~~then~~ and the metals were extracted from the seawater matrix by passing them over a chelating resin column containing the Nobias Chelate PA-1 resin[1]. The metals were eluted from the column into a small volume of 1.0 M HNO_3 at a preconcentration factor of ~20. Eluted samples were analyzed with calibration standards using the Thermo ELEMENT 2 HR-ICP-MS, housed in the Geochemistry division of the NHMFL. ~~Dissolved trace metal concentrations were plotted against depth to visualize the distributions across the various regimes of the Indian Ocean.~~

Results and Discussion

Preliminary results indicate that while dust may supply phytoplankton with the limiting nutrient Fe, the dust may also carry potentially toxic concentrations of Ni and Cd. ~~:~~ B~~b~~iological growth did not occur in incubations with dust added under low pH (1200 ppm CO_2) and ~~and low pH (high CO_2), but~~ Ni and Cd concentrations were significantly higher than in control incubations. It is possible that Ni and Cd from the Omani dust become more bioavailable – and therefore toxic – under reduced pH conditions.

Conclusions

These analyses were the first ~~of~~ in a series of experiments, which will be completed in Spring 2015.

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References

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