Climos Response to the ETAAC Draft Report

November 27, 2007

Climos would like to thank the ETAAC Committee for mentioning ocean iron fertilization as a "proposal of interest" for carbon dioxide mitigation. Ocean iron fertilization is a process that merits strong consideration from California's ETAAC report for the following reasons:

- Recent scientific research has proven the process to be highly effective at sequestering carbon from both natural sources[1] and artificially created blooms[2, 3].
- California based oceanographers discovered the process in 1990 and have become leading researchers in the fields of iron fertilization and global ocean biogeochemistry as it relates to carbon storage in the ocean.
- Some California based companies are clearly the world's leaders in developing ocean fertilization as a viable carbon sequestration technology eligible for entry in the emerging carbon mitigation markets.
- Ocean fertilization is an emerging technology that has a clearly defined path for research and development in the next decade. The majority of oceanographers involved in this field think that experiments should continue at an expanded scale and that it is appropriate for the carbon market to fund this research in partnership with academia[4].

The above bullets satisfy many of specific areas of focus mentioned on page 1-3 of the Draft Report. Furthermore, the ETAAC Committee defined an area focus to "identify advanced technologies with the greatest GHG emission reduction potential". Ocean iron fertilization is very promising in this regard. The total technical potential of permanent GHG reductions is estimated to be several gigatons of CO_2e/yr by 2020. The cost for these reductions is estimated to be less than $5/ton by 2020.

Unfortunately, the ETAAC draft report suggests that ocean fertilization is a technology that has too many unknowns and potential "irreversible consequences" and thus should not be considered for implementation in California. The weight of scientific evidence would suggest otherwise. A great deal of science has been conducted in the fifteen years since the first iron fertilization experiment, with a total of twelve oceanographic research cruises to study the biological, chemical and carbon storage effects of iron fertilization. In addition, there have been many more related research experiments, cruises, and modeling efforts to understand the role of phytoplankton, which is one of the most fundamental biological processes in the ocean. To date, there is no evidence that iron fertilization would cause irreversible consequences. Oceans are adapted to significant changes iron delivery, as the geologic record shows that the ocean has seen several order of magnitude changes in the amount of iron delivery to the ocean through the last several Ice Age cycles[5]. The biologic response of phytoplankton to iron is more than one billion years old.

However, there is a good deal of evidence in the geologic record that paleo-increases of iron supply to the ocean have caused a significant increase in both biological productivity and carbon sequestration. Figure 1 shows that biologic productivity has mirrored increases in iron supply over the past million years[6]. Furthermore, there is reason to believe that natural iron fertilization contributed substantially to the reduction of ice age atmospheric CO2 levels. It has been known for some time that iron dust flux to the ocean has at least quadrupled during glacial stages of the past one million years [5]. Now, a recent synthesis of measurements and modeling by Cassar et al. shows that "airborne Fe increases production of sub-Antarctic waters, strengthening the link between enhanced Fe delivery and lower CO2 during the ice ages." Their research shows that observed increases in iron flux would have resulted in a 40ppm reduction of atmospheric CO2, which is equal to half of the total CO2 difference between warm and glacial conditions[1].

Many other environmental criticisms have been made regarding ocean iron fertilization. While these criticisms are important to consider, they can be effectively addressed through careful project design and implementation. Climos has released a Code of Conduct which is designed to address these concerns[7]. Most of these concerns are addressed by limiting commercial fertilization activities to the deep ocean and by measuring the biological production of non-CO2 greenhouse gases (e.g. N2O) that are expected be less than 10% of the total carbon sequestration[8, 9]. Climos also recommends that any future iron fertilization experiments should prove their benign effect by conducting an environmental impact assessment and by obtaining a permit for operation. Finally, it is important to recognize that the oceans are already under significant environmental threat from increased atmospheric CO2 levels which cause acidification, and that ocean fertilization reduces surface ocean acidification in addition to removing CO2 from the atmosphere.

Climos recommends the following changes to the ETAAC report:

1. The ETAAC should recognize the substantial amount of scientific research that has been conducted over the past fifteen years. Ocean iron fertilization is not a new idea dreamed up by a few private companies – it is a process that has been studied in scientific detail comparable to any other carbon mitigation technology that exists today.

2. The reference to potential irreversible consequences should be removed. Furthermore, the ETAAC should recognize that iron fertilization can be conducted in a manner that is safe for the environment.

3. The ETAAC should consider a recommendation that AB32 support further research into ocean iron fertilization in parallel with other research efforts into carbon sequestration.

4. The ETAAC should recognize that there is positive role for commercial entities in developing the technology of ocean fertilization. There have been many fruitful advances made through commercial-academic partnerships in biotechnology. The oceanographic community has clearly expressed interest in using the emerging carbon markets as a potential funding source to continue further research[4].

Climos would be willing to provide the ETAAC Committee with any additional supporting information or presentations on ocean fertilization and the issues raised in this letter.

Thank you for your consideration of these comments.

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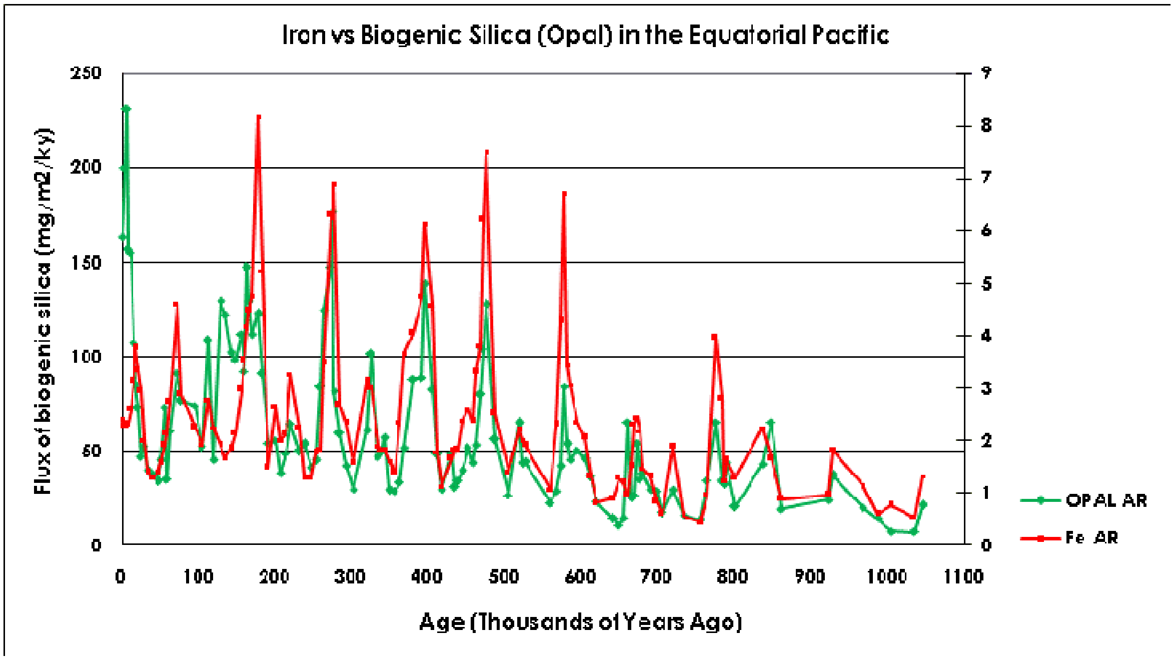

Figure 1: Biological productivity ("Opal AR") mirrors changes in iron dust flux ("Fe AR") over the last 1 million years. (Source: Knowlton and Leinen, 2007, Pre-publication)

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2. Buesseler, K.O., et al., *Revisiting Carbon Flux Through the Ocean's Twilight Zone.* Science, 2007. **316**(5824): p. 567-570.
3. Smetacek, V., et al., *Massive carbon flux to the deep sea from an iron-fertilized phytoplankton bloom in the Southern Ocean.* In Press, 2007.
4. Buesseler, K. *Closing Summary of Woods Hole Symposium on Ocean Iron Fertilization*. 2007 [cited; Available from: http://wbc.whoi.edu:8060/http/WHOI_CMS/Events/OIFC/OIFC9_27_7.mov.
5. Petit, J.R., et al., *Climate and atmospheric history of the past 420,000 years from the Vostok ice core, Antarctica.* Nature, 1999. **399**(June 3): p. 429-436.
6. Knowlton, C. and M. Leinen, *The influence of iron biogenic silica accumulation in the central equatorial Pacific during the last 800,000 years*, in *In Press*. 2007.
7. Climos. *The Climos Code of Conduct*. 2007 [cited; Available from: http://www.climos.com/standards/codeofconduct.pdf.
8. Law, C.S. and R.D. Ling, *Nitrous oxide flux and response to increased iron availability in the Antarctic Circumpolar Current.* Deep-Sea Research II, 2001. **48**: p. 2509-2527.
9. Walter, S., et al., *Nitrous oxide measurements during EIFEX, the European Iron Fertilization Experiment in the subpolar South Atlantic Ocean.* GEOPHYSICAL RESEARCH LETTERS, 2005. **32**(L23613).