

CLIMOS

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Key Documents Related to Ocean Iron Fertilization and Climate Change

Climos Original Docs:

OIF BACKGROUND

- [Frequently Asked Questions](#)
Questions answered on Climos itself, on how OIF works, on how much carbon it could sequester, and on the potential environmental effects.
- [The Climos Code of Conduct](#)
Climos proposal on any commercial OIF operation should be conducted to ensure maximum credibility
- [Ocean Fertilization as an Effective Tool for Climate Change Mitigation](#)
Published by the [International Emissions Trading Association](#) (December 2007). Description of how OIF can be incorporated into a carbon market framework by generating carbon credits. Addresses issues such as additionality, permanence, measurement techniques.
- [Commercial Rationale for OIF](#)
Commercial participation can accelerate the rate of research into OIF as a potentially valuable carbon mitigation technology.
- [Analysis of the Legality of OIF under the London Convention](#)
Discussion on the legal issues being considered by the London Convention.

OIF SCIENCE

- [Response to the Canadian Review of OIF \(May 2008\)](#)
A review of the questions raised by the Canadian submission to the London Convention Scientific Working Group meeting in Guayaquil, Ecuador, May 2008 (original Canadian review [here](#))
- [Response to the Greenpeace Research Labs critique of OIF \(May 2008\)](#)
A review of the questions raised by a technical paper on OIF by Greenpeace Research Laboratories (original Greenpeace doc [here](#)).

OIF ENVIRONMENTAL EFFECTS

- [Conceptual Model Description](#) (May 2008)

The *Conceptual Model* is the first stage of the formal Environmental Impact Assessment on OIF being conducted by [Tetratech](#). It reviews the state of scientific knowledge around OIF, and highlights the questions and concerns that must be addressed in the EIA as well as through future scientific research. The full conceptual model will be released late summer 2008.

CARBON MARKET RELATED

- [Climos Statement on Lieberman-Warner](#) (June 2008)

Comments on the US Federal climate change Bill that reached the Senate floor in June 2008.

International Policy on OIF:

SCIENTIFIC ADVISORY STATEMENTS

- [IOC Ad Hoc Working Group on OIF statement](#) (June 2008)

The [International Oceanographic Commission](#) statement by an internal scientific working group. Suggests a method to allow OIF research to continue while ensuring scientific credibility and environmental protection by creating an international review panel composed of scientists, NGOs, and regulators. This panel would review individual OIF projects on a case-by-case basis before allowing them to proceed. Also critiques the CBD's statement on OIF from May 2008. (Original IOC doc [here](#) - April 2008)

- [SCOR / GESAMP](#) (March 04, 2008)

Joint statement on OIF by the [Scientific Committee on Oceanic Research](#) and the [Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection](#). This statement "commends efforts by some commercial ventures to create codes of conduct and obtain outside reviews".

- [SOLAS](#) (July 2007)

Statement by the [Surface Ocean and Lower Atmosphere Study](#).

LONDON CONVENTION STATEMENTS

- Statement from 2008 Scientific Group meeting (May 2008) (pending)
- [Statement of Concern on OIF](#) from 2007 general meeting

UN COUNCIL ON BIOLOGICAL DIVERSITY STATEMENTS

- Statement from 2008 COP meeting (May 2008) (pending)

SCIENCE POLICY STATEMENTS ON CLIMATE CHANGE

- [G8+ 5 National Academies](#) -- June 2008

[Joint Science Academies' Statement: Climate Change Adaptation and the Transition to a Low Carbon Society](#)

A joint statement by the National Science Academies of thirteen prominent nations. Outlines the steps that need to be taken to transition to a low-carbon society. Recommend increased research into geoengineering techniques in parallel with an aggressive emissions reductions strategy. This recommendation was clarified in a [follow-up news article](#) to refer to ocean iron fertilization.

NEWS MEDIA COVERAGE OF INTERNATIONAL POLICY ON OIF

- [Link to news section](#)

Science Papers on OIF:

SYNTHESIS PAPERS

- Lampitt *et al.* 2008 – Philosophical Transactions of the Royal Society

[Ocean Fertilisation: a potential means of geo-engineering](#)

A review paper on the ocean fertilization techniques, their ability to sequester carbon, and the potential side effects. Calls for continued experiments of larger scale than before, and suggests that commercial participation could be appropriate.

- Buessler *et al.* 2008 -- Science Policy Forum

[Ocean Iron Fertilization—Moving Forward in a Sea of Uncertainty](#)

A policy statement by 14 senior oceanographers that are leaders in the field of ocean iron fertilization. They state that further research into OIF is vital to understanding its potential as a carbon mitigation tool and for understanding the potential for environmental effects. They also suggest that carbon credits cannot be sold from an OIF project until the scientific community has verified their existence as a result of the project.

- Boyd *et al.* 2007 – Science

[Mesoscale Iron Enrichment Experiments 1993–2005: Synthesis and Future Directions](#)

Summarizes the results of all OIF experiments to date. Recommends further research into OIF at a moderate scale.

OIF EXPERIMENTAL STUDIES

- Smetceck *et al.* 2008 – submitted

[Massive carbon flux to the deep sea from an iron-fertilized phytoplankton bloom in the Southern Ocean](#)

Carbon sequestration measurements from the most recent OIF experiment, EIFEX in 2004. It found the highest rates of

sequestration yet measured by an OIF experiment. This is partly due to continually improving experimental design for measuring carbon.

NATURAL OIF EXPERIMENTAL STUDIES

- **Blaine *et al* 2007 – Nature**

[Effect of natural iron fertilization on carbon sequestration in the Southern Ocean](#)

Research into “natural” OIF that occurs above the Kerguelen Island plateau in the Southern Ocean. Seasonal increases in iron supply fertilize a large bloom of phytoplankton. The rates of carbon sequestration via action of the biological pump are the highest ever observed in the ocean.

BIOLOGICAL PUMP STUDIES

- **Buesseler *et al* 2007 – Science**

[Revisiting Carbon Flux Through the Ocean’s Twilight Zone](#)

Recent measurements of the carbon sequestration effectiveness of the biological pump from natural open-ocean phytoplankton blooms. New experimental techniques using neutrally buoyant sediment traps show that significant quantities of carbon can sink into the deep ocean. Up to 50% of exported carbon was observed sinking to 500m depth, which roughly corresponds to a 100 year permanence time period.

MODELING STUDIES

- **Jin *et al* 2008 – Biogeosciences**

[The impact on atmospheric CO₂ of iron fertilization induced changes in the ocean’s biological pump](#) (PDF)

Modeling study that simulates the atmospheric drawdown of moderate and large scale OIF in the Tropical Pacific. The model uses an explicit iron cycle and an ecological response model, coupled with an ocean circulation model. Atmospheric drawdown rates are 75–93% of the measured carbon export, which suggests that OIF can have a significant effect on atmospheric CO₂. The study also did not find “downstream” nutrient depletion effects from continuous OIF.

- **Aumont and Bopp 2006 – Global Biogeochemical Cycles**

[Globalizing results from ocean in situ iron fertilization studies](#)

Modeling study that simulates large scale OIF on a global basis and on a 100 year timescale. Results show that the Southern Ocean is the largest sink for carbon from OIF, which accumulates 90% of the total sequestration. Total carbon sequestration after 100 years is 33 ppm of CO₂ (250 GtCO₂). “Downstream” depletion of nutrients was found in Tropical oceans, but was not found in the Southern Ocean. This suggests that location of an OIF project is critical for both ensuring carbon sequestration effectiveness and for mitigating potential negative ecological effects.

PALEOGRAPHIC OIF STUDIES

- **Cassar *et al* 2007 – Science**

[The Southern Ocean Biological Response to Aeolian Iron Deposition](#)

Synthesis of modeling results and paleo-measurements of carbon export and airborne dust flux in the Southern Ocean. Results suggest that enhanced OIF stimulated by higher iron flux was

responsible for half of the atmospheric drawdown of CO₂ during the glacial cycle (40ppm CO₂).

- **Winckler *et al.* 2008 -- Science**
[Covariant Glacial-Interglacial Dust Fluxes in the Equatorial Pacific and Antarctica](#)
500,000 year record biological productivity and dust flux from deep-ocean sediment cores in the Tropical Pacific. Shows that dust flux increases during glacial cycles compared to present conditions, and that biological carbon export increases in response to increasing iron-containing dust.
- **Lambert et al 2008 – Nature**
[Dust-climate couplings over the past 800,000 years from the EPICA Dome C ice core](#)
800,000 year record of dust and temperature in Antarctic ice cores. Shows statistical correlation between high dust and low temperatures in Antarctica.
- **Petit et al 1999 – Nature**
[Climate and atmospheric history of the past 420,000 years from the Vostok ice core](#)
Often cited paper that shows the graphical relationship between high dust flux and low temperatures and low CO₂ levels.

BIOGENIC GAS STUDIES

- **Jin and Gruber 2003 – Geophysical Research Letters**
[Offsetting the radiative benefit of ocean fertilization by enhancing N₂O emissions](#)
Modeling study that suggests N₂O production would be minimal if OIF is conducted in high-latitude oceans, and would offset less than 10% of the total carbon sequestration value of OIF. However, N₂O production would be greater if OIF is conducted in tropical oceans, and could significantly offset the CO₂ reduction benefit. This points to the critical importance of carefully choosing the location of OIF to avoid significant N₂O production.
- **Walter et al. 2005 -- Geophysical Research Letters**
[Nitrous oxide measurements during EIFEX, the European Iron Fertilization Experiment in the subpolar South Atlantic Ocean.](#)
Measured N₂O production from the EIFEX experiment in the Southern Ocean. Found no significant production of N₂O.
- **Law and Ling 2001 -- Deep-Sea Research II**
[Nitrous oxide flux and response to increased iron availability in the Antarctic Circumpolar Current.](#)
Measured N₂O production from the SOIREE experiment in the Southern Ocean. Found a potential 6-12% offset in CO₂ reduction benefits.

ECOLOGICAL EFFECTS OF OIF

- **Smith 2007 – Science**
[Free-Drifting Icebergs: Hot Spots of Chemical and Biological Enrichment in the Weddell Sea](#)
Melting icebergs produce an iron fertilization effect because of the dust entrained in the ice. This produces a significant enhancement of biological productivity of phytoplankton, which increases biological activity at higher trophic levels, such as fish and birds. This research was [covered in Time Magazine](#).

- [Takeda and Tsuda 2005 – Progress in Oceanography](#)
[An in situ iron-enrichment experiment in the western subarctic Pacific \(SEEDS\): Introduction and summary. Progress in Oceanography](#)

The only OIF study that examined the effects of OIF on higher trophic levels such as fish. The authors write, “*Trawl samplings of salmon and other nekton were performed inside and outside of the iron-enriched patch at the end of the experiment (day 14). Although there was no significant divergence in salmon catch between inside and outside of the patch, catch of juvenile Northern mackerel was obviously high in the iron-enriched patch*”.

IMPACTS OF CO2 EMISSIONS

- [Hansen et al. 2008– ArXiv.org](#)
[Target atmospheric CO2: Where should humanity aim?](#)
Dr. Jim Hansen’s latest paper that analyzes a “safe” level of atmospheric CO2. Hansen et al. write, “If humanity wishes to preserve a planet similar to that on which civilization developed and to which life on Earth is adapted, paleoclimate evidence and ongoing climate change suggest that CO2 will need to be reduced from its current 385 ppm to at most 350 ppm.”

News Media Articles:

INTERNATIONAL POLICY ON OIF

- [Despite opposition, ocean iron fertilization forging ahead](#) – Cleantech.com (June 10, 2008)
Well-balanced analysis of the developing regulatory frameworks around OIF. Explains that UN policy makers are looking to the London Convention process for developing effective regulatory policy. Also explains that there was no actual “moratorium” issued by the Convention on Biological Diversity (CBD).

CLIMOS IN THE NEWS

- [Plankton to the Rescue](#) – Jan 22, 2008
Cleantech.com interview with Dan Whaley, CEO of Climos
- [10 Ideas that are Changing the World](#) – March 24, 2008
Time Magazine mentions Climos in an article about big ideas that have a global effect on the planet. Reference is to geoengineering.
- [Sustainable Industries Journal interviews Dan Whaley](#) – June 30, 2008
- [S.F. Entrepreneur Floats a Bold Idea to ‘Fertilize’ Ocean](#) – March 30, 2008
The Sacramento Bee covers Climos’ Series A funding.
- [Startup Fervor Shifts to Energy in Silicon Valley](#) – March 14, 2007

NY Times mentions Climos as a promising clean tech startup.

Climate Change Mitigation Policy:

POST KYOTO NEGOTIATIONS

- [Breaking the Climate Deadlock](#)

High level overview of the post-Kyoto climate regulation framework. Addresses the key questions on how incorporate all countries and carbon sectors into new binding regulations. Tony Blair, former UK Prime Minister, is the policy leader on this effort. Also see [website](#).

CARBON MITIGATION POTENTIAL SUPPLY

- [US GHG Mitigation Potential – McKinsey 2007](#)

A US-based cost curve for GHG mitigation potential. [This is a seminal view of the cost of climate change mitigation.](#)

- [Global GHG Mitigation Potential – McKinsey 2007](#)

A global cost curve for GHG mitigation potential. This is a seminal view of the cost of climate change mitigation. This particular report was commissioned by the Swedish electric utility, Vattenfall.

CARBON MARKET ANALYSIS

- [IETA Offsets Position Paper](#) – IETA (June 2008)

The International Emissions Trading Association official position on the role of offsets under cap and trade mechanisms. Offsets will reduce the societal cost of achieving GHG reduction targets, while capturing emission reductions from sectors and jurisdictions outside of the cap and trade regime. Climos staff co-wrote this document.

- [2007 Greenhouse Gas Market Report](#) – IETA (Dec 2007)

Multiple articles on the state and trends of the global GHG marketplace.

- [State and Trends of the Carbon Market 2007](#) – The World Bank (May 2007)

Data intensive report on the size of emerging carbon markets worldwide in 2005-6. Focused primarily on the regulatory markets such as EU ETS, CDM, and JI.

- [State of the Voluntary Carbon Market](#) – Ecosystem Marketplace (May 2008)

Data intensive report on the size of emerging voluntary carbon markets. USA focused, and has very good analysis on the motivations of buyers and project developers within the voluntary market.

US REGULATORY FRAMEWORKS

- [California Scoping Plan Draft](#)
California's comprehensive climate mitigation plan. First to regulatory framework to cover the transportation sector with cap and trade. Several more innovative ideas such as the Carbon Trust concept. Will set up a regional cap-and-trade system under the Western Climate Initiative (WCI). Offsets are recommended to meet 10% of the compliance obligation of covered entities.
- [WCI Draft Plan](#) (pending)
Regional climate mitigation framework in Western North America.
- [Lieberman-Warner Climate Security Act of 2008 \(PDF\)](#)
Major climate legislation that made it to the Senate floor in June 2008 but went no further. Would have covered 85% of the US emission under cap-and-trade.

US PRESIDENTIAL CANDIDATES

- [Obama's climate plan](#)
- [McCain's climate plan](#)