Goldschmidt 2000
September 3rd–8th, 2000
Oxford, UK.

Journal of Conference Abstracts
Volume 5(2), 327

Modelling the Impacts of a Massive Freshwater Discharge in the North Atlantic Ocean on the Global Carbon Cycle

Michel Crucifix (crucifix@astr.ucl.ac.be)[1], **Fortunat Joos**[2] & **Andre Berger**[1]

[1] Institut d'Astronomie et de Geophysique G. Lemaitre, chemin du Cyclotron, 2, B-1348 Louvain-la-Neuve, Belgium
[2] Climate and Environmental Physics, Sidlerstrasse, 5, CH-3012 Bern, Switzerland

An ocean-atmosphere model was coupled to a biogeochemical model of the ocean carbon cycle to study the physical ad biogeochemical effects of a massive freshwater discharge in the North Atlantic Ocean. The following experimental procedure was set up. The freshwater discharge experiment starts from the pre-industrial climate, i.e. the equilibrium response to a 280ppmv CO_2 concentration and modern insolation. Then a total freshwater volume of 6×10^6 km^3 is discharged in the North Atlantic between 45 and 70ºN over 1000 years with a triangular-shape time scenario. The freshwater input reaches 0.38Sv at its maximum. The model is integrated for 4000 years after the freshwater discharge in order to recover equilibrium.

The dynamical response of the model is in agreement with previous studies: the discharge induces a complete shutdown of the thermohaline circulation, a substantial cooling of the North Atlantic and an advance of the sea ice margin in the Northern Hemisphere. These physical effects have in turn consequences on the biological activity. When THC shuts down, ventilation of North Atlantic Deep Waters is drastically reduced and Antarctic Deep Water penetrates further northward. In the Deep Atlantic, increased residence time and enhanced advection of nutrient-rich Antarctic waters induce a local enrichment in DIC and in nutrients. In the equatorial regions, surface DIC concentration increases to compensate the local lowering in pCO_2 induced by the raise of surface alkalinity. In the North Atlantic, Net Primary Production (NPP) drops by 50% in response to the reduction in nutrient supply from the deep ocean and to the surface cooling.

The discharge induces also a gradual decrease in atmospheric CO_2 concentration. CO_2 increases abruptly when THC recovers and finds its initial level after approximately 2000 years. Throughout the experiment, the atmospheric CO_2 concentration is in quasi-equilibrium with the globally averaged CO_2 partial pressure in surface waters (pCO_2,w). A factor analysis was performed to assess the contributions of salinity, temperature, DIC concentration and alkalinity to the pCO_2,w variations. During the first part of the discharge, surface cooling exerts a dominant effect. Then, the CO_2 decrease is rather induced by the net effect of surface DIC and alkalinity changes. The abrupt CO_2 rise at the end of the discharge results from the addition of all terms effects except salinity which has a marginal impact.