REGIONAL CONTRIBUTIONS OF OCEAN IRON FERTILIZATION TO ATMOSPHERIC CO_2 CHANGES DURING THE LAST GLACIAL TERMINATION

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INTRODUCTION

Oceans are the largest source of carbon storage. Their internal processes directly affect the concentrations of atmospheric pCO_2. In the last 2 million years the climate of the Earth has alternated between glacial and interglacial periods, with low and high atmospheric concentrations of CO_2. Iron fertilization of the oceans is though to have contributed a pproximately 20 p.p.m.v. to the 80-100 p.p.m.v. Holocene-LGM difference in atmospheric CO_2 concentrations

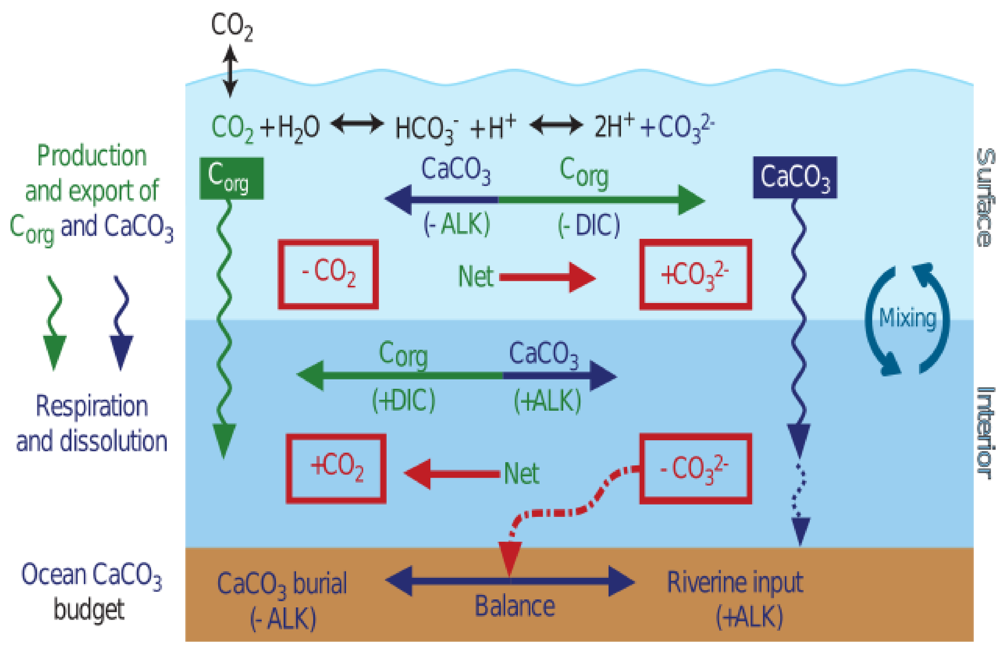

Figure 1: A schematic of the ocean's "biological pump", the sequestration of carbon and alkalinity from the surface ocean (light blue) into the ocean interior (dark blue), and their effects on the ocean's carbon chemistry. Source [1].

In this study, we explore the effect of iron fertilization through mineral dust flux to the ocean surface for Holocene and LGM climatic conditions, but also for idealized intermediate dust values. In this way, we can calculate the theoretical relationship between dust fluxes and atmospheric pCO2 through the modulation of the biological pump in the ocean (**Figure 1**).

MATERIALS AND METHODS

We use the cGENIE carbon cycle-focused Earth System Model of Intermediate Complexity to simulate the effect of various dust fields on atmospheric CO2 through the termination. For five different published Holocene and LGM dust flux estimates [2, 3, 4, 5, 6].

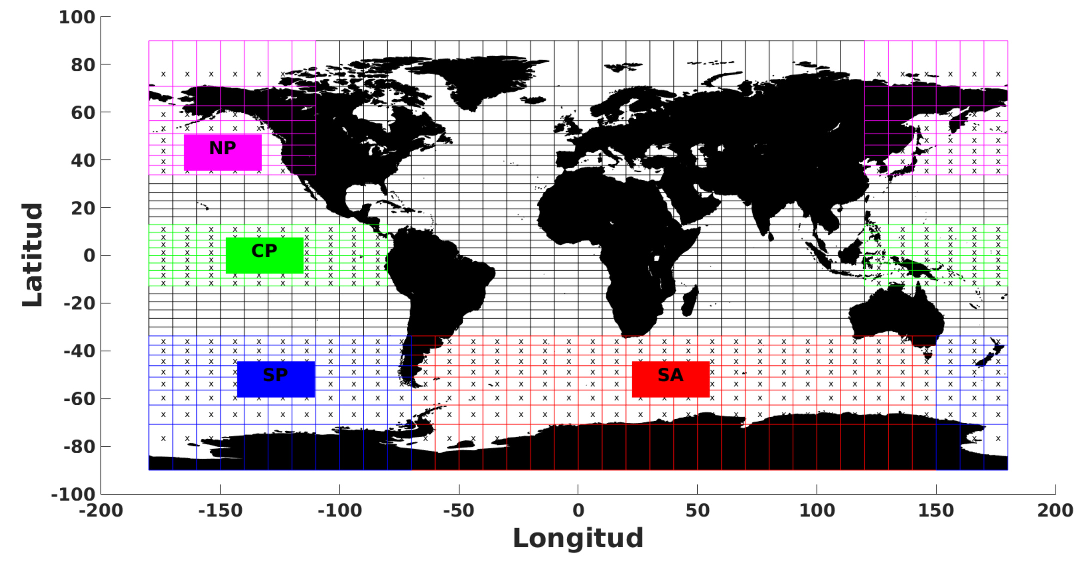

Figure 2: Grid with the specification of oceanic regions run with cGENIE

We produced 8 linearly-spaced intermediate dust flux values at each grid point, thus resulting in 10 incremental global dust flux fields from low Holocene to high LGM values. We simulate the response of atmospheric CO2 through the termination for global dust fluxes, but also isolate specific High-Nutrient Low Chlorophyll (HNLC) regions of the world's ocean (Figure 2) to quantify their individual contribution to the total CO2 changes.

pCO_2 REDUCTION OBTAINED BY CGENIE SIMULATION FOR DUST FIELDS VARYING FROM HOLOCENE TO LGM

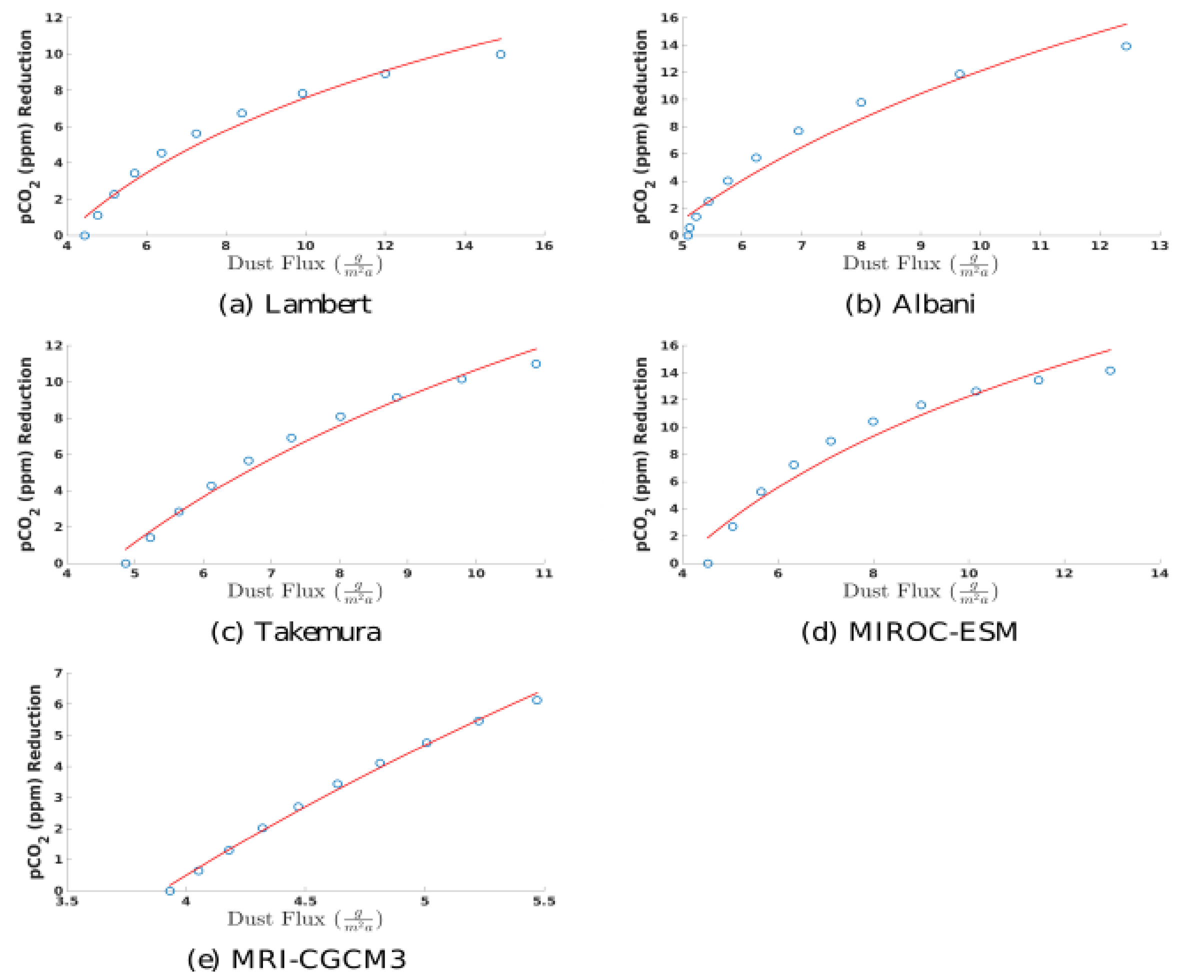

Figure 3: Global fluxes.

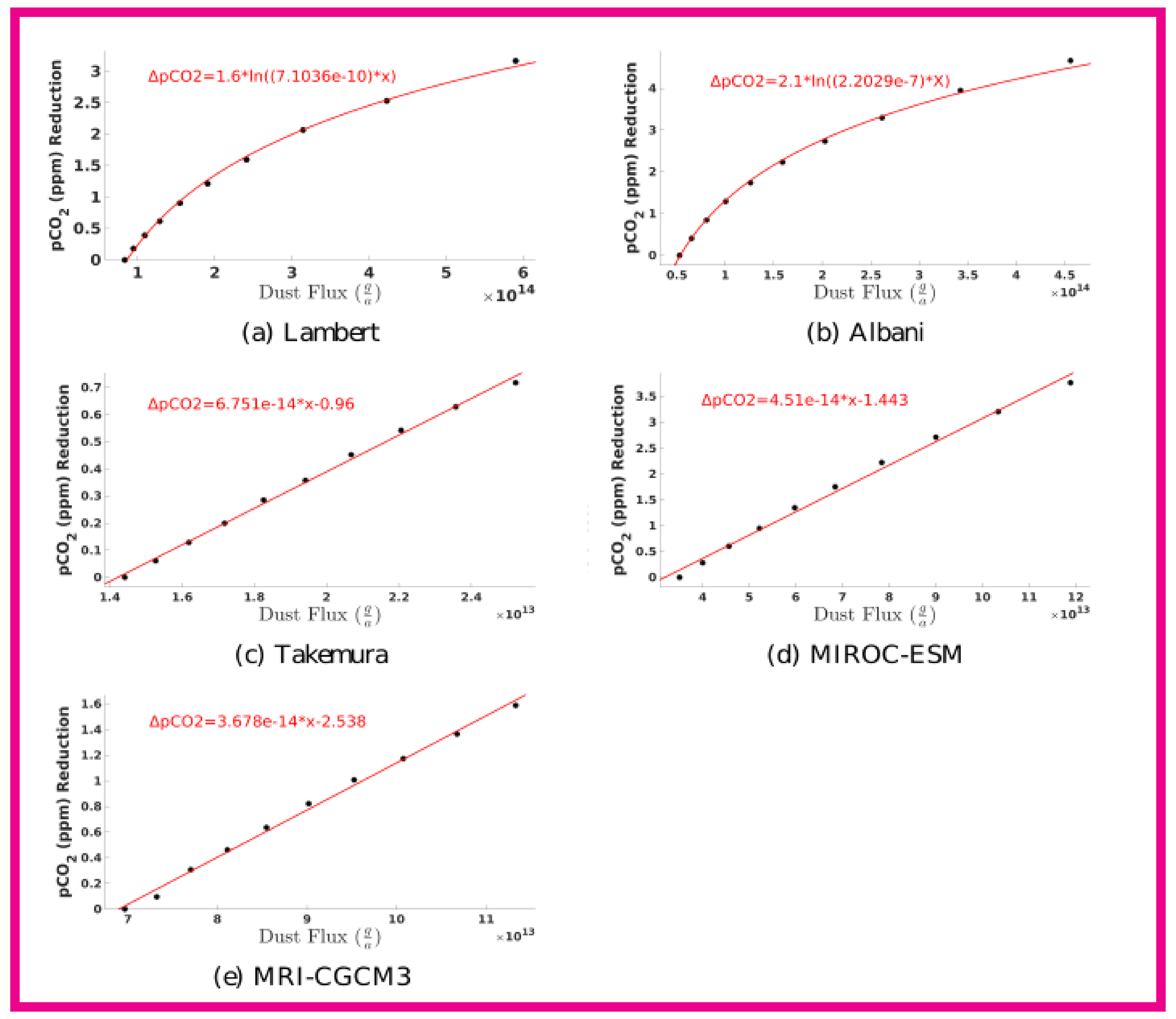

Figure 4: North Pacific regional zone.

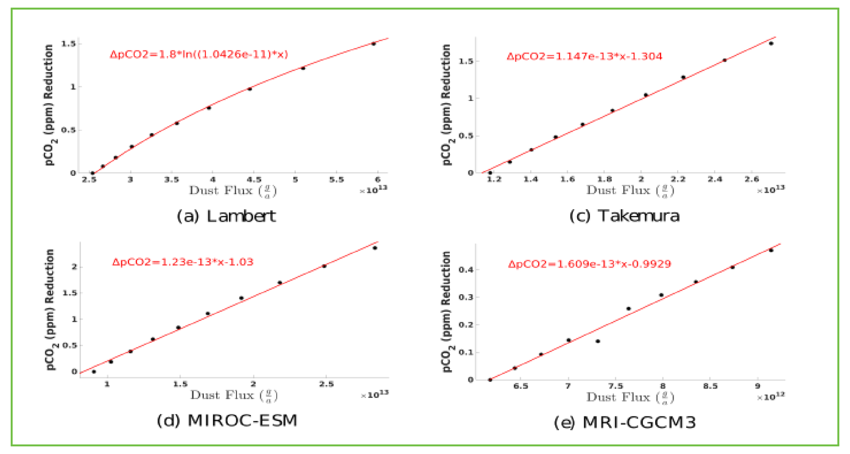

Figure 5: Central Pacific regional zone.

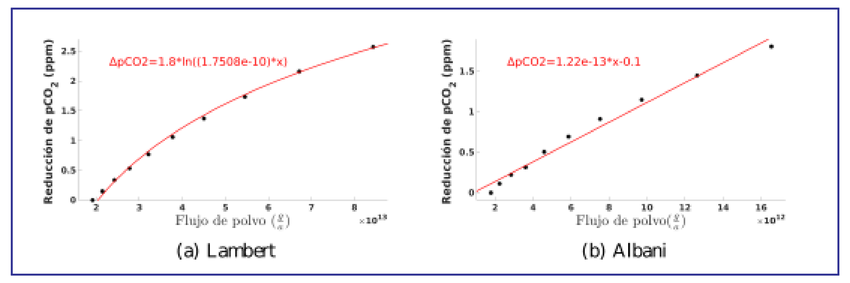

Figure 6: South Pacific regional zone.

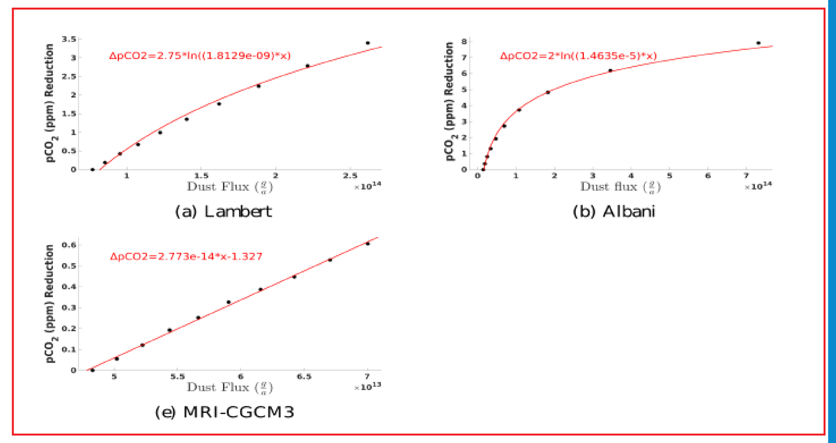

Figure 7: South Atlantic regional zone.

RESULTS

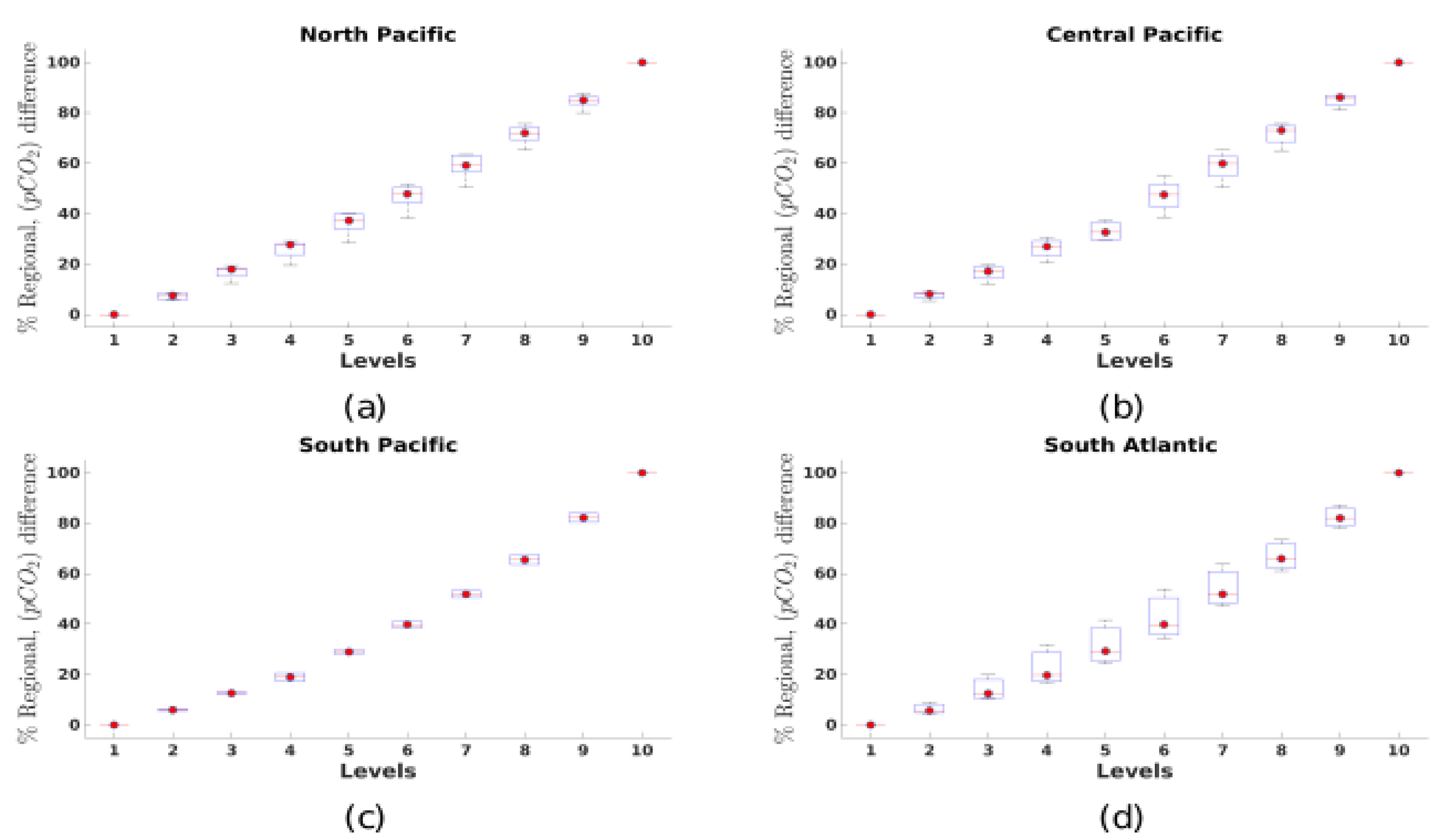

Figure 8: Range percentage of pCO_2 reduction of models: Lambert, Albani, Takemura, MIROC-ESM, MRI-CGCM3.

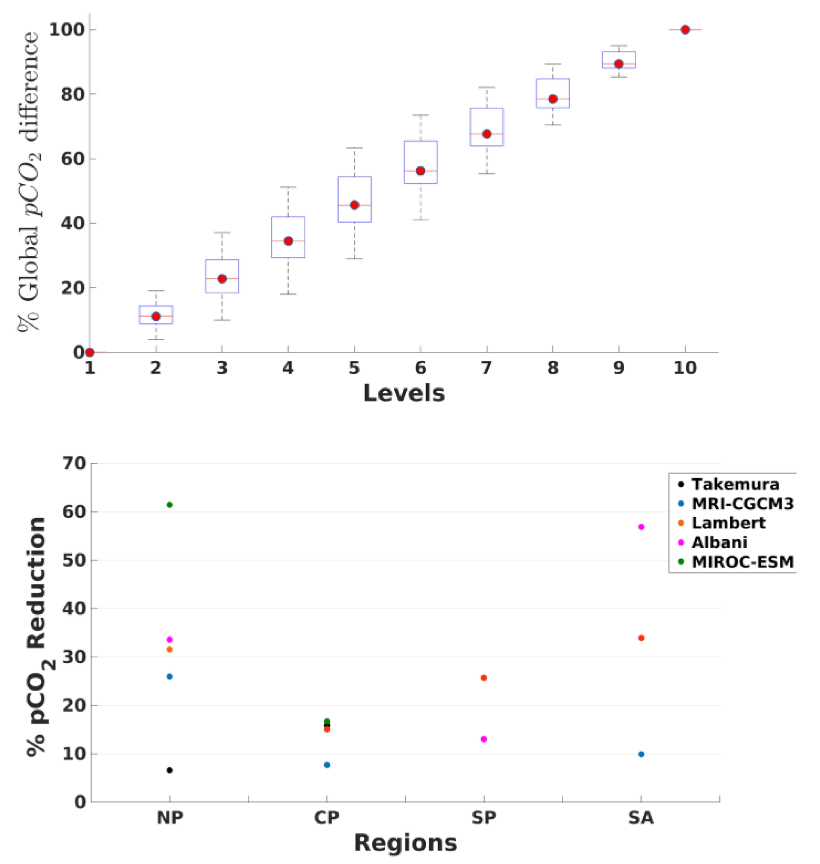

Figure 9: Results cGENIE, a) range percentage of pCO_2 reduction for global dust fluxes and, b) contribution of each HNLC region to global LGM to Holocene pCO_2 reduction.

CONCLUSION

There are only small changes in relative CO2 capture simulated by cGENIE due to different reconstruction or simulations of dust fluxes, both globally and regionally (Fig. 8 and 9a). Note that this small error is largely due to our removal of those model results that did not change southern hemisphere dust source emissions between Holocene and LGM.

The high-latitude oceans contribute most to CO2-drawdown during the LGM (Fig. 9b). This was expected since they are the main HNLC regions of the world's ocean and therefore very sensitive to the contribution of aeolian iron flux that influence on ocean biogeochemistry.

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