Biogeosciences Discussions, 1, S152–S153, 2004
www.biogeosciences.net/bgd/1/S152/

Biogeosciences Discussions

Interactive comment on "CO_2 air-sea exchange due to calcium carbonate and organic matter storage: pre-industrial and Last Glacial Maximum estimates" *by* A. Lerman and F. T. Mackenzie

Anonymous Referee #3

Received and published: 13 September 2004

This manuscript addresses the production and release of CO2 from coastal ocean and open ocean surface waters due to formation and net storage of calcium carbonate and organic carbon. The precipitation of CaCO3 removes DIC and alkalinity, but increases the relative concentration of dissolved CO2. A fraction of this CO2 is exchanged with the atmosphere. The authors derive a relationship between the CO2 released per unit mass CaCO3 precipitated as a function of temperature and pCO2, considering external C inputs and internal processes. The work extends earlier studies by Frankignoulle et al. (1994). Results are consistent. The relationship is used to evaluate CO2 fluxes and global C cycle imbalances at the Last Glacial Maximum (LGM) and at pre-industrial times.

The approach relies on mass balances between reservoirs (classical geochemical approach). For the scope of the study, the ocean is conceptualized as a box limited to the euphotic zone. Without any doubt this approach has the potential to convey impor-

tant information. The manuscript provides a contribution to the debate on the changing natural global C cycle. I suggest that the authors extend the approach to address the future acidification of surface waters. What would be the effect of decreased calcification rates in response to anthropogenic CO2 invasion on air-sea exchange of CO2? The classical approach has also its weaknesses. Carbonate precipitation, organic matter production, mineralization, dissolution etc. all occur in the same location. While this might hold for the coastal ocean, these processes are separated on the spatial scale in the open ocean. The spatial separation, along with time scales associated with the processes modulates the response of the oceanic reservoir to changes in forcing. In order to apprehend changes of the global C cycle in response to natural and anthropogenic forcing, we need an improved understanding of its dynamics. The use of coupled earth-system models is expected to further our understanding.

The authors evaluate imbalances in the atmospheric, terrestrial, and oceanic reservoirs for the present and LGM global C cycles. Fluxes, reservoir sizes etc should be given along with estimates of the uncertainties. I doubt that the order of magnitude of imbalances is significant in the light of associated uncertainties. With out saying it clearly, the authors seem to come to the same conclusion (see Alternative pathways).

The paper is long and not well structured. The annexes overflow with information easily available in text books. The tables and figures are not referenced in a sequential order, which stresses the need for restructuring the manuscript. The authors should streamline the text by clearly focusing on their objectives. Their message is diluted and their main contributions are not easily identified by the reader. I do not include detailed editorial comments, since I do not expect the manuscript to be accepted without substantial revisions.

Interactive comment on Biogeosciences Discussions, 1, 429, 2004.