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Biogeosciences Discussions

Interactive comment on "On the application and interpretation of Keeling plots in paleo climate research – deciphering δ^{13}C of atmospheric CO_2 measured in ice cores" *by* P. Köhler et al.

Anonymous Referee #3

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General comments

While the fluctuations in atmospheric CO2 concentrations over the late Quaternary have been well known from ice core studies over the past decades, recent years have seen the additional development of records of 13C-CO2 from old and new ice cores. Analysis of this additional tracer begs the question: what does d13C-CO2 record on Quaternary timescales, and what can it tell us about the behavior of the interlinked global carbon cycle?

Since its first appearance more than 40 years ago, the "Keeling plot" has been an indispensable tool for the identification of carbon fluxes through the simultaneous measure-

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ment of CO2 concentrations and d13C. Using the Keeling plot approach, the authors hypothesize that the drivers behind glacial-interglacial changes in atmospheric CO2 concentrations may be explained.

This manuscript uses a series of simple and more complex models to interpret Keeling plots based on ice core measurements at times over the past ˜20ka. The manuscript is admirable in that it presents an exhaustive suite of analyses and attempts to address nearly every possible explanation for glacial-interglacial and recent dynamics of the global carbon cycle in terms of its Keeling plot expression.

Unfortunately, because of its exhaustive analysis and overwhelming presentation of results this manuscript is very difficult to read. The figures with many multi-colored and patterned lines are confusing and the important points are challenging to interpret. The text leaves the reader to infer the choice of parameter ranges or sensitivity tests based on previous knowledge of the problem and explanatory hypotheses, or sends the reader back to other papers by the current authors to find the rationale for the modeling experiments.

The manuscript could be made much more clear if it were streamlined, and presented in a somewhat modified form, where for example, completely inconclusive analysis and results are omitted from both the text and figures. It would be helpful if the authors presented each sensitivity test with the models as concisely as possible, with the attempt to confirm or debunk a specific hypothesis laid out possibly in this way:

1. outline a previous (or new) hypothesis about carbon cycle dynamics including a few references (e.g., southern ocean ice cover: who proposed it? why? what was the hypothesized range of possible behavior? slow terrestrial carbon cycle changes: who proposed it? why? what independent evidence exists?, etc.)

2. explain the expected impact on d13C and Keeling plot signature

3. describe briefly the modeling undertaken to address this hypothesis, and the choice

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of parameter ranges in light of previous measurements/assumptions

4. confirm, reject, or equivocate the hypothesis in light of the model result

Such an approach would leave much less for the reader to "guess" regarding the motivations for the author's approach in each of their case studies. The paper could also be more lucid in its conclusions if it only focused on two or three particularly illustrative examples.

Because the conclusions of the manuscript are that the Keeling plot approach (or d13C in general) cannot be effective in deciphering long-term carbon cycle dynamics, it would also be helpful to present some suggestions of cases where the Keeling plot technique might actually work in a paleo context (if at all). In this case, the authors could comment on the type of phenomenon (e.g., maybe a rapid climate change event) and sampling strategies that would be then necessary to (time resolution, appropriate accumulation rate, independent samples from other archives etc.) to make use of the methodology.

Minor comments

There are a large number of small mistakes in the English in the manuscript (tense, case, punctuation, use of colloquial expressions). The manuscript would benefit from a light editing job by a native English speaker.

Interactive comment on Biogeosciences Discuss., 3, 513, 2006.