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Interactive comment on "GENIE-M: a new and improved GENIE-1 developed in Minnesota" *by* K. Matsumoto et al.

R. Marsh

rma@noc.soton.ac.uk

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First of all I second the comment of Dan Lunt, congratulating you on submitting the first paper to this bold new venture in publishing our models - something that has been lacking in recent years.

My general comment follows a comment of Dan Lunt, namely that the manuscript is written in fairly traditional style which may be developed in a novel way that is appropriate to ambition of GMD. That is, we have the opportunity at last to mention in GMD papers how code improvements are implemented. As an author of the "physical" part of GENIE-1, I want to know where exactly in the code you have made the improvements. For example, I presume the additional code for improved Kz appears in tstepo.F (and tstipo.F?) Where do you compute z_ml? These queries may seem trivial, but a few of

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us would like to know how the improvements were "engineered".

I have several specific comments that I list below in order of relevance as one reads the manuscript.

1) The title could be altered to be more appropriate. As one of the "founders" of C-GOLDSTEIN and GENIE-1, I am acutely aware of the need for improvement, but I feel that different improvements suit different applications. I therefore propose a title more along the lines: "GENIE-1-M: An alternative version of GENIE-1 for marine carbon cycle modelling" (if that is indeed the primary application). This avoids the (probably unintended) false impression that GENIE-1 is otherwise unimproved and has now been superseded by GENIE-M.

2) The improved scheme for vertical diffusivity has stood the test of time (as you imply). However, over the last 18 months others have implemented somewhat more sophisticated schemes in GENIE-1 (e.g., based on the Philander and Pacanowski scheme), of which you are probably unaware (as these are not yet published). Clearly, we need a hierarchy of parameterizations for key processes such as vertical mixing. I consider that your improvement is at an intermediate level in such a hierarchy. This could be clarified.

3) You state modification of the incoming SW radiation as an improvement, but this has been a (published) feature of GENIE-1 for several years, via the subroutine radfor.F (although this was not available at the time of Edwards & Marsh 2005). Indeed this improvement was required for varying orbital parameters in transient palaeoclimate simulations (Lunt et al., 2006).

4) While you obtain dramatic and very satisfying improvement in key tracer fields, you ultimately must increase the freshwater flux adjustment to 0.358 Sv. This flux adjustment has troubled us for a while now - it restricts the freedom of the climate system to respond to external forcing as a key part is fixed (the same of course goes for the prescribed winds, but that's unavoidable until we develop maybe a statistical-dynamical

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atmosphere fast enough for your purposes). We have sought in different ways to eliminate the flux correction. So far we think that it can be reduced (i.e., get the same Atlantic MOC as for higher flux correction in "standard" GENIE-1), in a variety of ways: by increasing resolution longitudinally and at high latitudes (using our 64x32 lon-lat mesh); by changing the Kz parameterization (although that work is ongoing); by setting flux correction to zero and tuning the remaining standard parameters with observed MOC intensity as a target (which I don't think has been tried yet). Seeing flux correction increased substantially is somewhat disappointing, although if necessary that is understandable. The "disappointment" could however be admitted in the current manuscript, as it constitutes a small step backwards (rather than an improvement).

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