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Climate of the Past Discussions

Interactive comment on "Comparing transient, accelerated, and equilibrium simulations of the last 30 000 years with the GENIE-1 model" *by* D. J. Lunt et al.

Anonymous Referee #2

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This manuscript briefly compares results from several equilibrium and long transient model integrations. It suggests minimum integration times to reach equilibrium and tries to quantify errors due to time "acceleration" techniques. The paper is interesting and reasonably well written but I find its relevance limited. I would consider it publishable only after major revisions.

General Comments.

EMICs are wonderful tools for exploring climate model sensitivity and for conducting longer simulations than can be done with more complex, coupled climate models. However, one always must be careful in designing experiments and interpreting results to

ensure that the results are not contaminated by model inadequacies.

The main question that has not been answered adequately is, how relevant are the results to other climate models?

The authors compare their equilibrium results to a more comprehensive climate model (HADSM3) and demonstrate that their model is at least able to simulate three different climates reasonably well. This is a good start but there is no evidence that the transient response of GENIE is similar to a more comprehensive model. This is difficult for long integrations but there are some model intercomparison experiments that look at the transient response of models to either changing CO2 or to fresh water anomalies. It would be interesting to know how GENIE performs in transient integrations compared to other higher resolution or more complete climate models. GENIE not only has simplified climate model components but also much lower resolution than most comprehensive climate models. Has the sensitivity of GENIE to resolution ever been investigated? I have not seen any publications that address this issue.

One of the questions the paper tries to answer is, how long does a model need to be integrated to reach equilibrium? A related question is, how close is a transient simulation to equilibrium? In general this means how close the ocean is to equilibrium since the other components equilibrate within a few decades (excluding icesheets and dynamic vegetation which were not included here). When the ocean reaches equilibrium with surface conditions depends to a large extent on ocean mixing. So the obvious question is, how sensitive is the time to equilibrate the system to various parameterizations of ocean mixing? How sensitive is the model response to resolution, especially in the vertical? GENIE integrates quickly and would be a good model to use to try to answer these questions.

Specific Comments.

Sec 2.1 - The paper is relatively short, perhaps lacking relevant detail in places, so is there any reason to waste space on describing exactly how CO2 was interpolated? I

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think you could just say it was interpolated from Dome C and Vostok data.

I am a little sceptical of using dO18 from Vostok directly as a proxy for ice volume. Has anything been done to remove the temperature signal from the dO18 time series? Are the resulting spikes realistic? I have doubts. Has this been checked against sea level reconstructions? Maybe using benthic dO18 from ocean cores would have been better - at least temperature contamination is reduced. I think a more detailed description is needed and perhaps more careful consideration should be applied in reconstructing ice volumes and areas.

Since ocean mixing is a crucial factor in determining how quickly a model will reach equilibrium, it would be useful to add a brief description of how the model parameterizes mixing.

Sec 2.2 - It is interesting that GENIE does not seem to show any bistability while most EMICS (Rahmstorf et al. 2005) and possibly some AOGCMs do (Stouffer et al. 2006)? Has this been explored? This might be taken as a warning that the response of the model is different from others. It might be good to know why. I thought Marsh et al. (2004) had found bistability. Maybe clarify this.

Sec 3.1, page 271, line15+ - If the "tuning" of Hargreaves et al. (2004) or use of the ENTS land surface scheme would have removed some of the model biases, then why were they not used?

Sec 3.1, page 272, line24+ - Here is were I really have problems. Can these simulations really "be used to provide a guide"? I still need to be convinced. The results may depend on model resolution and certainly on mixing parameters. The times given would also depend on the "arbitrary" equilibrium criteria and on initial conditions. GENIE could be used to explore some of these sensitivities but to suggest the presented model times are a reasonable guide is hard to accept.

Sec 3.2 - I think the acceleration results are the most interesting part of the paper. Do

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you think the Southern Ocean sensitivity might indicate that sea ice variability is not being well represented which in turn affects bottom water formation? Is it related to convection? Is this a resolution issue? Is the ACC different? Some analysis of why the south is more affected by acceleration would add to the paper.

Figure 1b) - Mean orography is an unusual way to display what I think should be ice volume. Do I need to multiply by the surface area of the Earth and then subtract off present day, to get ice volume changes? Ice area is probably the more climatically important variable to show.

Figure 3b) - The Y axis should not be labelled "SST", if this is supposed to be "for the deep ocean (approximately 5km)".

In summary, I see this paper as a useful guide for people that are using GENIE at its current resolution. I am not so sure it is useful in general. To be more generally applicable it is necessary to show (or reference) how the transient response of GENIE compares with other models and the sensitivity of the results to ocean mixing and model resolution.

Interactive comment on Clim. Past Discuss., 2, 267, 2006.