

Interactive comment on “The efficient global primitive equation climate model SPEEDO” by C. A. Severijns and W. Hazeleger

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We thank the referee for his comments. Our responses to the referee’s comments are given below.

General comments

The referee has concerns about four problems in the model of which the first three would deserve further explanation. These are:

1. the lack of ENSO: we added a reference to Oldenborgh et al. (2005) at page 1124, line 24 to indicate that ocean resolution is the problem. The atmosphere-only model does show a realistic Walker cell and trade winds. In experiments where Speedy was coupled to a linear ENSO model, variability occurred in the tropical Pacific.

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2. the weak AMOC/NADW production: an explanation of the low production of NADW has been added to page 1123, line 23. Two possible causes are the lack of convection in the Labrador Sea and the weak exchange between the Arctic and North Atlantic Oceans. The lack of convection in the southern Labrador Sea which contributes about a third of the total NADW formation is due to the large winter sea-ice extent which is now mentioned as cause on page 1124, line 6.

3. The low summer sea ice concentration: we have tried to improve this in the model in several ways. A description of this has been inserted in section 2, on page 1119 after line 5.

– Specific Comments

pg1118, line 25

The text from pg. 1118, line 26 to pg. 1119, line 2 has been rephrased. Details on how the surface heat budget was closed have been added.

pg1119, line 16

This sentence was modified. It now refers to the decreasing grid cell dimension near the North pole in a regular lat-lon grid now and the numerical problems this causes.

pg1120, line 4

The spinup was a continuation of a 4000 year long test run in which some model parameters were varied. This is now included in the text.

pg1120, line 25

A new figure was added before Figure 1 showing showing the time series of the global mean ocean temperature and salinity. Both quantities vary only by a small amount and show now drift over the 1000 year period of the control run.

pg1120, line 26

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We have added information on the possible causes of the energy loss in the atmospheric component model on page 1120, line 27. Possible causes are the advection scheme or the corrections for the dry air and tracer mass.

pg1121, line 8

This sentence was modified to explain more clearly that the combination of a fresh water flux with a constant ocean volume implies that the total salinity must vary in time.

pg1121, line 25

The time period, i.e., 1960 to 2000, over which the SPEEDO data is averaged is explicitly mentioned in the sentence now. This is the same period as for the observational data.

pg1122, line 8

Indeed the corrections of the TOA and surface heat fluxes do not add to the comparison as suggested by the referee. We have reformulated the text at this location.

pg1123, line 9

References have been added to papers by Dai et al. (2001), Schmidt et al. (2006) and Johns et al. (2006).

pg1123, line 15

A reference to Meehl et al. (2007) was added.

pg1123, line 22

The referee is correct. We have replaced "probably" with "most likely".

pg1124, line 1

The sentence was changed to reflect that the Atlantic MOC is varying by 0.05 Sv. The atmospheric heat transport was added both in the figure and a discussion was added

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at this location in the text.

pg1126, line 20

This sentence was modified to state that the atmosphere component is in equilibrium with the upper ocean.

– Technical Corrections

pg1119, line 16

This sentence was modified. It now refers to the decreasing grid cell dimension near the North pole in a regular lat-lon grid and the numerical problems this causes.

pg1127, line 22

Although the CO₂ concentration keeps increasing from 2100 and reaches a maximum in 2282, the rate of increase does decrease as the text states (see Fig. 20). The text has been modified to express this more clearly.

pg1130, line 2

The spelling was corrected.

pg1130, line 3

The spelling was corrected.

Fig. 3, 5, 16, 17 and 18

A colour scale was added to these figures.

Fig. 14

We have changed to "regression of " to "regression coefficient of" and split the sentence in two to make clear that unit is not the unit of the overturning strength but of the regression coefficient. We also have changed the unit 10^{-6} s^{-1} to the equivalent unit $\text{Sv}/(10^{12} \text{ m}^3)$ for clarity.

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