

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. Please find a list of our responses to the referee's comments below.

– Specific Comments

Title

The first version of SPEEDO included a regional ocean model. This second version uses a global ocean model. We have included the version number 2.0 in the title of the paper. There will be no further developments of SPEEDO at KNMI because our focus has shifted to the EC-Earth model.

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pg1116, line 3

Whether SPEEDO is a true EMIC or not is in our opinion a matter of taste. It probably is close to the boundary between EMICs and GCMs. SPEEDO is certainly more complex than models like CLIMBER but not much more complex than the EMIC ECBilt-CLIO that also contain a fully three dimensional atmosphere and ocean model. In addition, the physical parameterizations used in SPEEDO are much simpler than those used in state-of-the-art GCMs. We changed the wording on line 19 of page 1117 to express this in the text.

pg1116, line 8

We have added an indications of the length of the runs that in our opinion are practically feasible (in the order of 10000 years will take about five months of computing time on our hardware). What is feasible depends of course on the hardware that is available, whether experiments can be done in parallel and the amount of time that one is willing to spend on the experiment.

Section 2 and elsewhere

We have inserted information on the parameterizations used in the Speedy atmosphere model on page 1118, line 19 and in the CLIO ocean/sea-ice model at line 6 of page 1119.

pg1119, line 22

The component models of SPEEDO are all single CPU applications. Line 12 on page 1119 has been modified from "... SPEEDO exchange ..." to "... SPEEDO run each on a single CPU and exchange ..." to explicitly state this.

Section 3.2.1

The model description in section 2 now explicitly mentions that the model does not include greenhouse gases other than CO₂, nor does it include volcanoes and aerosols.

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However, the impact of these gases could be included by changing the optical thickness. We have included this information at line 19, page 1118.

pg1122, line 4

Line 18 to 20, page 1118 was extended with information on how the short wave absorption by ozone in the stratosphere is implemented in SPEEDO and a description of how a tropopause is imposed in the upper two layers (at 100 and 50 mbar) in the atmosphere model. In addition, Figure 2 was added in section 3.2.1 which shows the air temperature profiles in SPEEDO and the NCEP/NCAR reanalysis data.

pg1126, line 21

The referee is correct that deep ocean needs much longer than 200 years to reach equilibrium under 2xCO₂ conditions. This is indeed reflected in the TOA and surface energy budgets and neither of them is stable at the end of this experiment. However, the T2m timeseries does show that the atmosphere is in equilibrium with the upper ocean. The text on page 1126, lines 20 to 21 now states this explicitly.

pg1126, line 22

We added a picture of the ensemble mean two meter air temperature response and its standard deviation from the CMIP3 2xCO₂ experiments to Figure 16. We also added more details to the comparison at this location in the text.

– Technical Corrections

throughout

The unit "Sv" is introduced on page 1123, line 20 and used in the remainder of the paper.

pg1117, line 9-13

The reference to Claussen et al. (2002) has been moved to line 7 and references to

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papers by Brovkin et al. (2002), Joos et al. (2001) and Weaver et al. (2001) have been added.

pg1118, line 13

This sentence was modified to clarify that the Molteni paper describes parameterizations in the atmosphere model only.

pg1118, line 22

The names 'Speedy' and CLIO are now introduced at the beginning of the paragraph on line 10, page 1118.

pg1119, line 17

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.

pg1119, line 19-20

This sentence has been rephrased to clarify how river outflows are implemented in the coupler: the river outflows are sent from the land to the ocean model as a list of numbers instead of a two-dimensional runoff data.

pg1120, line 16

"... the model is in ..." has been changed to "... the model was in ...".

pg1123, line 9

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

pg1123, line 24

A reference to the observational data by Orsi et al. (1999) was added where estimates for the production of AABW are given based on observations.

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pg1124, line 13

The PNA and NAO patterns computed for the NCEP-NCAR Reanalysis data from 1960 to 2000 have been added to Figure 9.

pg1124, line 19-26

References were added to McPhaden et al. (1998) for the ENSO, Sutton and Hodson (2005) for the AMO, and Hurrell (1995) for the NAO.

pg1124, line 27

Changed "... the AMO is shown ..." to "... the AMO in SPEEDO is shown ...".

pg1125, line 7

This sentence has been removed and lines 7 to 18 on this page have been rewritten.

pg1129, line 11

The text now includes references to Molteni (2003), Hazeleger and Haarsma (2005), Hazeleger et al. (2005), Bracco et al. (2005), Kucharski et al. (2006), and Breugem et al. (2007).

Fig. 3,5,16,17,18

A colorbar was added to each figure.

Fig. 15

The figure has been corrected.

Fig. 10,11,13

The power spectrum of an AR(1) process and the 95% confidence intervals have been added to figures.

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