Instructions for running the models used in 'Inherent characteristics of sawtooth cycles can explain shifts in glacial periodicity'

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Below, there are brief technical instructions for running the models used in 'Inherent characteristics of sawtooth cycles can explain shifts in glacial periodicity'. An overview of the concepts behind the models and the model equations, variables, and parameters is given in Section 2 of the article. Please send an e-mail to omta@mit.edu, in case you encounter any problems with the models.

1 Calcifier-alkalinity model with (quasi-)periodic forcing

The MATLAB script CA_Forced.m contains code of the model with purely periodic forcing; also the parameter values are set in this script. The initial conditions and duration of the simulation are set in runCA_Fig3.m. Note that the unit of time is kyr. To run the model in MATLAB, simply give the command runCA_Fig3. The results should correspond to Figure 3a of the article.

The MATLAB script CA_Forced_QuasiPer.m contains code of the model with the quasi-periodic forcing taken from Appendix 1 of [1]. The initial conditions and duration of the simulation are set in run_CA_QP.m. To run the model, give the command run_CA_QP. The results should correspond to Figure 7a of the article. To plot the alkalinity xy(:,1) and the calcifiers xy(:,2), respectively, as a function of time:

```
plot(t,xy(:,1))
plot(t,xy(:,2))
```

2 Calcifier-alkalinity model with periodic and white-noise forcings

The FORTRAN code is in CAnoise.f, including the parameter values. Under Unix, the code is compiled with

f95 -o CAn CAnoise.f

and the executable CAn is run as a background process with

./CAn &

The results should correspond to Figure 6 of the article.

3 Multi-box model with periodic forcing

The FORTRAN code is in MultiboxCA.f; the parameter values are read into the model from the file inparam.dat. The first two values in inparam.dat are the number of time steps and the time step size in seconds, respectively. The initial values of the variables are in the file invalues.dat. The last value in invalues.dat is the time in seconds at the beginning of the simulation. During a simulation, output is written to the files time_boxAW.dat and time_boxAW2.dat for some of the variables. The parameter write_years in inparam.dat (line 37) is the number of years between subsequent write-outs. At the end of each simulation, the values of all the variables are written to output_boxAW.dat. Atmospheric pCO_2 and the high-latitude calcifier concentration as a function of time should correspond to the first 75 kyr of Figure 9a of the article.

Under Unix, the code is compiled with

f95 -o MCA MultiboxCA.f

and the executable MCA is run as a background process with

./MCA &

Before restarting the simulation, time_boxAW.dat and time_boxAW2.dat need to be moved to a different directory and output_boxAW.dat needs to be renamed invalues.dat. The equations of the ecological model are in the main program; the ocean tracer transport and the air-sea exchange of carbon are evaluated in the separate subroutines ocean_transport and carbon_air_sea.

References

[1] de Saedeleer, B., Crucifix, M. & Wieczorek, S., Is the astronomical forcing a reliable and unique pacemaker for climate? A conceptual model study. *Climate Dynamics* **40,** 273–294 (2013).