

Short introduction to the use of Matlab programs for the DCESS Earth System Model

These programs and associated files can be used to run various model simulations with the Danish Center for Earth System Science (DCESS) model as presented in Shaffer et al. (2017). The programs represent an implementation of methane cycling in the DCESS model, which is a simplified but well tested Earth system model of intermediate complexity.

The executable program is `Thilda_M.m`. In this program initial conditions are called for the late Paleocene, 56 million years ago. Control parameters for the time integration are set in the beginning of the program, for instance the length of a run, the time step for integration, and the time interval for saving results (The latter two should not be changed from standard values to assure numerical stability and direct applicability of the plot programs provided).

Subsequently control parameters for a thermogenic methane release (remember that the DCESS model is a one hemisphere model).

When executed, `Thilda_M.m` performs a simple time stepping of the ocean sediment module and a fourth order Runge-Kutta integration of the atmosphere, ocean, land biosphere and lithosphere modules, using the program `ODE_M.m` that serves to couple these modules, and writes results to an output file, `OutThilda_M.mat`.

In the supplied files, `Thilda_M.m` is set to make a sample simulation over 10,000 years for a global methane release of 2,000 GtC ($\text{CH}_4^{\text{tot}}=1000$ for the one hemisphere calculation of the model). In this sample case the release is set to enter the ocean only ($\text{mfrac}=0$), to start 500 years after the simulation start ($\text{tCH}_4=500$) and to reach 75% of the total release 3500 years after its start ($\text{tfrac}=35000$). The output file, `OutThilda_M.mat`, is also supplied for this particular simulation.

Two programs are supplied for plotting model results, `Evol_M.m` and `Prof_M.m`. The program `Evol_M.m` plots time series of a number of key model variables and the program `Prof_R.m` provides an animation of the evolution of ocean and ocean sediment properties as a function of time and ocean depth.

All these programs have been extensively tested and should work well for Matlab version R2014 or higher. DCESS has very limited human resources and cannot provide support for users downloading these programs. However the programs are sufficiently straightforward and sufficiently well documented for users with reasonable Matlab skills to find their way through them and to adapt them for their particular applications.

We do like to hear from users on their experience with the program and/or with suggestions for improvement, which can be mailed to info@dcross.dk.

References

Shaffer, G., Olsen, S. M. & Pedersen, J. O. P. : Presentation, calibration and validation of the low order, DCESS Earth System model. *Geosci. Model Dev.*, **1**, 17-51 (2008).

Shaffer, G., Fernández Villanueva, E., Rondanelli, R., Pedersen, J. O. P., Olsen, S. M., and Huber, M.: Implementation of methane cycling for deep-time global warming simulations with the DCESS Earth system model (version 1.2), *Geosci. Model Dev.*, **10**, 4081-4103 (2017).

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