Data README for "Data from Climate Model Simulations for Triassic–Jurassic Orbital Climate Cycles"

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The data are supplementary material to:

J. Landwehrs, G. Feulner, M. Willeit, S. Petri, B. Sames, M. Wagreich, J. H. Whiteside, and P. E. Olsen. Modes of Pangean lake-level cyclicity driven by astronomical climate pacing modulated by continental position and pCO_2. *Proceedings of the National Academy of Sciences*, 119(46), Nov. 2022. URL https://doi.org/10.1073/pnas.2203818119

Abstract: In "Modes of Pangean Lake-Level Cyclicity Driven by Astronomical Climate Pacing Modulated by Continental Position and pCO_2" we study the effect of cyclic orbital parameter changes on Late Triassic to Early Jurassic paleoclimates. For this, in total 36 transient climate simulations are performed with reconstructed paleogeographies for 9 time slices in 5 Myr steps (230 to 190 million years ago) at 3 different atmospheric CO_2 values, each driven by a simplified orbital forcing over a 250,000 yr period. The data presented here is the model output on which the results of the main article are based. (The majority of further output data is not included due to its large size, but it can be made available upon request.) Also included are different model configuration files and the scripts to generate the included figures (using the Python programming language in a Jupyter Notebook). The model output is provided in different NetCDF files. The data is generated using the Earth System Model CLIMBER-X (see Willeit et al. (2022)) which simulates climate globally on a 5°x5° horizontal grid. Its coupled atmosphere, ocean, sea-ice and land surface have been used in this study. This Readme contains a short description of the included files. Please note that data from other research that is shown in the figures in Landwehrs et al. (2022) is not included in this data publication to avoid copyright issues.

Model Configuration and Output: simulations/

- **script_runs_MesoOrb-Newark.sh** was used to start the simulations with the respective configuration of boundary conditions, forcing file and namelist parameters.

- **MesoOrb-Newark_forcing_ecc-obl-per.nc** is the orbital forcing file used for all simulations. It contains annual values of eccentricity, obliquity and perihelion angle over a time period of 250,000 years.

- **paleogeography_input/** contains the paleogeography input files topog_*Ma_*.nc for all time slices from 230 to 190 Ma. These have been prepared based on the paleogeographic reconstructions by Marcilly et al. (2021) and Cao et al. (2017; 2018).

- ***Ma_*ppm_ecc-obl-per_*/** represent one directory for each climate simulation run that has been included in the analyses in the main paper. The name of the directory indicates the respective boundary conditions. For example, 225Ma_1500ppm_ecc-obl-per_Marcilly2021/ uses the geologic time slice 225 Ma, atmospheric CO_2 concentration 1500 ppm and the paleogeography based on Marcilly et al. (2021). "_ecc-obl-per_" indicates that the run is driven by an orbital forcing that modulates eccentricity, obliquity and precession of the perihelion. Each of these directories contains the following files:

  - ***.nml** summarize the namelist parameters for the different model components in the respective simulation run. Some of them are modified through the run submission command in script_runs_MesoOrb-Newark.sh while most are the default settings in the utilized model version.
  - **geo*.nc** contain the paleogeographies used in the simulations after internal processing of the input files.
  - **atm_reduced.nc** contain monthly and annual atmosphere model output data on the 5°x5° model grid. Output has been stored every 1000 model years. These files contain all model output data used for the analyses and figures in Landwehrs et al. (2022) and its supplement. Specifically, the variables "t2a" (air temperature at 2 m height), "prc" (precipitation), "evpa" (evaporation) and "solarm" (daily mean TOA incoming solar radiation) are used in the paper. Additionally, "cld" (cloud fraction), "convwtr" (column integrated moisture convergence), "faxwtr"/"faywtr"/"fdxwtr"/"fdywtr" (column integrated moisture fluxes) are used for supplementary figures.
  - **ocn_*.nc, sic_*.nc and lnd_*.nc** contain model output from the ocean, sea ice and land cover (incl. vegetation and soil) modules, respectively. These data have not been used for analyses in Landwehrs et al. (2022) but might be useful for further studies and other users.
  - **Note:** Many of the CLIMBER-X model output data variables have more than the standard four dimension (X, Y, Z and time). Here, the "time" dimension gives the model year during which output is stored every 1000 years of the 250,000 yr simulations. Additionally, variables have a "month"/"mon" dimension with 13 entries. 1,...,12 refer to monthly values for January to December, while 13 contains the annual mean. Some variables have an additional sixth dimension, for example when they integrate information about the different surface or vegetation types. This complex structure necessitates a reorganization of the data before tools relying on the CF-conventions can properly be applied (e.g. CDO, NCO, Ferret NOAA).
  - **allVars_*.txt** contain lists of all data variables in the original model output files. Variables considered less relevant have been excluded from the published *.nc files to reduce file size (therefore "_reduced.nc"). These additional data can be made available upon request.

Scripts for Analyses and Plots: analyses/

- **analyses.ipynb** is a Python Jupyter Notebook that contains code to generate the figures from Landwehrs et al. (2022) from the model output data. Python v3.9.2 was originally used. For analyses and plotting, data from the various simulations is aggregated and regional values are calculated

specifically for the Newark-Hartford Basin area. This processed data can either be loaded from the provided *.pkl files or aggregated again within the notebook. tools_*.py contain further helper functions.

Model Source Code: climberx_MesoOrb-Newark/

- **src/** and **nml/** contain the relevant model source code and namelist parameter files utilized by Landwehrs et al. (2022). These were obtained on 08-Oct-2021, commit e7b58adad8c798ef5c5e28c3b6d398a19c36f78a in PIK's institutional gitlab repository. The CLIMBER-X model is described in Willeit et al. (2022), its version 1.0 is archived at https://doi.org/10.5281/zenodo.6877358 (Willeit 2022), which is an update of the code used for these simulations.

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