

## Herold et al. supplementary material

All datasets are provided as NetCDF<sup>1</sup> files and scripts were created using the National Center for Atmospheric Research (NCAR) Command Language<sup>2</sup>. These products are freely available. See paper for methods and source datasets used in the construction of these files. All data are presented at 1°x1° resolution.

### Topography

*herold\_etal\_eocene\_topo\_1x1.nc*

Eocene topography and bathymetry.

### Standard deviation of sub grid cell elevations

*herold\_etal\_stddev\_subgrid\_etopo1\_to\_eocene\_1x1.nc*

Eocene estimate of the variation of sub grid scale elevations (file variable *paleo\_stddev\_subgrid\_topo*). Created with the following NCL script.

*herold\_etal\_stddev\_subgrid\_topo\_regression.ncl*

Uses the ETOPO1 dataset<sup>3</sup> and a provided paleotopography to create an estimate of the variability of sub grid cell elevations.

### Tidal dissipation

*Green\_Huber\_eocene\_tidal\_dissipation\_1x1.nc*

Modern and Eocene simulated tidal dissipation (*mod\_tidal\_dissipation* and *eo\_tidal\_dissipation* respectively) from Green and Huber (2013).

### Vegetation

*herold\_etal\_eocene\_biome\_1x1.nc*

Three BIOME4 vegetation datasets are stored in this file. *prei\_biome* represents the pre-industrial distribution of biomes simulated by BIOME4. *eocene\_biome* represents the Eocene distribution of biomes simulated by BIOME4, using climate output from the CESM (see manuscript for details). *eocene\_biome\_zonal* represents a zonally constant biome distribution based on *eocene\_biome*, where the most common (mode) biome for each latitude is used, with minor adjustments based on statistical artefacts (Fig. S1). *eocene\_biome\_zonal* allows users to represent the broad characteristics of Eocene vegetation – namely, the effect of a much lower equator to pole temperature gradient and warmer global climate – without representing the finer, zonal details simulated by BIOME4.

The 27 biomes simulated by BIOME4 (excluding ice) and available in *herold\_etal\_eocene\_biome\_1x1.nc* are identifiable via the list below.

- 1 'Tropical evergreen forest',
- 2 'Tropical semi-deciduous forest',
- 3 'Tropical deciduous forest/woodland',
- 4 'Temperate deciduous forest',
- 5 'Temperate conifer forest',
- 6 'Warm mixed forest',

---

<sup>1</sup><http://www.unidata.ucar.edu/software/netcdf/>

<sup>2</sup><http://www.ncl.ucar.edu/>

<sup>3</sup>[http://www.ngdc.noaa.gov/mgg/global/relief/ETOPO1/data/ice\\_surface/cell\\_registered/netcdf/ETOPO1\\_Ice\\_c\\_gmt4.grd.gz](http://www.ngdc.noaa.gov/mgg/global/relief/ETOPO1/data/ice_surface/cell_registered/netcdf/ETOPO1_Ice_c_gmt4.grd.gz)

- 7 'Cool mixed forest',
- 8 'Cool conifer forest',
- 9 'Cold mixed forest',
- 10 'Evergreen taiga/montane forest',
- 11 'Deciduous taiga/montane forest',
- 12 'Tropical savanna',
- 13 'Tropical xerophytic shrubland',
- 14 'Temperate xerophytic shrubland',
- 15 'Temperate sclerophyll woodland',
- 16 'Temperate broadleaved savanna',
- 17 'Open conifer woodland',
- 18 'Boreal parkland',
- 19 'Tropical grassland',
- 20 'Temperate grassland',
- 21 'Desert',
- 22 'Steppe tundra',
- 23 'Shrub tundra',
- 24 'Dwarf shrub tundra',
- 25 'Prostrate shrub tundra',
- 26 'Cushion-forbs, lichen and moss',
- 27 'Barren',
- 28 'Land ice'

*herold\_etal\_eocene\_sewall\_biomes\_1x1.nc*

We provide the vegetation distribution of Sewall et al. (2000) interpolated and mapped to the Eocene topography presented in section 2.1 (Fig. S2), and assigned based on the plant functional types of the Community Land Model (Oleson et al., 2010). For this we utilize a land mask of our new Eocene topography and for each land grid cell we select the vegetation from the closest grid cell in latitude and longitude from Sewall et al.'s (2000) original 2°x2° dataset. Substantial efforts have been made in recent years at synthesising data globally (Utescher and Mosbrugger, 2007) and regionally (Quan et al., 2012a, b) using robust methodologies, and ideally such information will eventually be integrated into 'data-based' boundary conditions such as that provided by Sewall et al. (2000).

## **Aerosols**

*http://roskilde.eas.purdue.edu/~nick/misc/papers/eocene\_bc/herold\_etal\_eocene\_CAM4\_BAM\_aerosols.nc*

Eocene aerosol concentrations (sea salt, dust, SO<sub>4</sub>, organic and black carbon) simulated with the Community Earth System Model configured with the Community Atmosphere Model 4 and Bulk Aerosol Model (Neale and Co-authors, 2010).

## **River runoff**

*herold\_etal\_eocene\_runoff\_1x1.nc*

Eocene river directions stored as integers indicating directions rotating clockwise in 45° intervals, with north indicated by 1, northeast by 2 and so forth.

8↖	1↑	2↗
7←	ref	3→
6↙	5↓	4↘

## Supplementary references

- Green, J. A. M., and Huber, M.: Tidal dissipation in the early Eocene and implications for ocean mixing, *Geophysical Research Letters*, 40, 2707-2713, 10.1002/grl.50510, 2013.
- Neale, R. B., and Co-authors: Description of the NCAR Community Atmosphere Model (CAM 4.0) National Center for Atmospheric Research, 2010.
- Oleson, K. W., Lawrence, D. M., Bonan, G. B., Flanner, M. G., Kluzek, E., Lawrence, P. J., Levis, S., Swenson, S. C., Thornton, P. E., Dai, A., Decker, M., Dickinson, R., Feddema, J., Heald, C. L., Hoffman, F., Lamarque, J. F., Mahowald, N., Niu, G. Y., Qian, T., Randerson, J., Running, S., Sakaguchi, K., Slater, A., Stockli, R., Wang, A., Yang, Z. L., Zeng, X., and Zeng, X.: Technical Description of version 4.0 of the Community Land Model (CLM), National Center for Atmospheric Research, 2010.
- Quan, C., Liu, Y.-S., and Utescher, T.: Paleogene temperature gradient, seasonal variation and climate evolution of northeast China, *Palaeogeography, Palaeoclimatology, Palaeoecology*, 313-314, 150-161, <http://dx.doi.org/10.1016/j.palaeo.2011.10.016>, 2012a.
- Quan, C., Liu, Y.-S., and Utescher, T.: Eocene monsoon prevalence over China: A paleobotanical perspective, *Palaeogeography, Palaeoclimatology, Palaeoecology*, 365-366, 302-311, <http://dx.doi.org/10.1016/j.palaeo.2012.09.035>, 2012b.
- Sewall, J. O., Sloan, L. C., Huber, M., and Wing, S.: Climate sensitivity to changes in land surface characteristics, *Global and Planetary Change*, 26, 445-465, 2000.
- Utescher, T., and Mosbrugger, V.: Eocene vegetation patterns reconstructed from plant diversity — A global perspective, *Palaeogeography, Palaeoclimatology, Palaeoecology*, 247, 243-271, 10.1016/j.palaeo.2006.10.022, 2007.