Project description

ModE is the output of the PALAEO-RA project hosted at the Oeschger Centre for Climate Change Research between 2019 to 2023, funded by the European Research Council through the H2020 program (ERC Grant PALAEO-RA 787574).

The aim of PALAEO-RA was to create a monthly, 3-dimensional climate reconstruction of the past 600 years. The basis is a 20-member ensemble with a state-of-the-art atmospheric general circulation model. We assimilate all available historical climate information, including early instrumental data, documentary data, and proxy data with an offline data assimilation technique. For more information on the project, visit https://www.palaeo-ra.unibe.ch/.

The project output provided here consists of three parts: ModE-RA (main product), and ModE-RAclim (sensitivity experiment), and ModE-Sim, the original AGCM ensemble prior to data assimilation.

	ModE-RA	ModE-RAclim	ModE-Sim
Members	20	100	20*
Time dependent forcings	yes	no	yes
Assimilation	yes	yes	no
Variability	>71-year: model response to forcing <71 year: assimilated observations	>71-year: NO variability <71 year: assimilated observations	model response to forcing

*ModE-Sim has additional members. Here we refer to the 20 members used to generate ModE-RA

ModE-RA

ModE-RA is a monthly 3-dimensional reanalysis product covering the period from 1420 to 2009. Observed anomalies were assimilated with an offline Ensemble Kalman filtering technique. The assimilation was done twice per year reflecting the resolution of the available proxy data. This dataset provides the 20 individual ensemble members of ModE-RA, called members 041 to 060 ensemble and well as ensemble means, ensemble standard deviations and ensemble minima/maxima of the ModE-RA reanalysis product. The data are provided as monthly anomalies w.r.t. 1901-2000 climatologies computed for each member separately. For a detailed description of ModE-RA please refer to the documentation paper (reference provided in the summary at the experiment level).

ModE-RAclim

ModE-RAclim, is an alternative version of ModE-RA, the main reanalysis product of this project. ModE-RAclim uses 100 randomly picked years from ModE-Sim as a priori state thereby assuming stationarity in the covariance structure and eliminating the externally forced signal in the model simulations. In contrast, ModE-RA uses 20 distinct transient members of ModE-Sim, retaining the externally forced signal.

Please note: ModE-RAclim does not contain centennial scale climate variability. For most users the main product ModE-RA therefore should be used for regular studies on past climate.

ModE-Sim

ModE-Sim (short for Modern Era Simulations) is a medium-size ensemble of model simulations using the ECHAM6 atmosphere general circulation model (model version 6.3.5p2). Its setup is based on the PMIP4 experiments, but uses a forced AGCM rather than a fully coupled model. The ensemble uses observed/reconstructed forcings and boundary conditions, while accounting in uncertainties in these. Here we provide the 20 members of the larger ModE-Sim ensemble that serve as a basis for ModE-RA and ModE-RAclim. From 1420 to 1850 CE uses SST and sea ice reconstructions as boundary conditions and perturbed volcanic forcings from the easy volcanic aerosol (EVA) model to account for uncertainties in the strength and the timing of volcanic eruptions. For 1850 to 2009 ModE-Sim uses PMIP4 radiative forcings. As ocean boundary conditions the simulations use different realizations of HadISST2.

File names of ModE-RA, ModE-RAclim and ModE-Sim

Files are provided as NetCDF files, with one variable from one ensemble member per file for the whole period. Filenames are structured as in the following example:

ModE-RA_m041_geopoth_50000_anom_wrt_1901-2000_1421-2008_mon.nc, where

- ModE-RA is the experiment name.
- m041 is the member number or statistical property (e.g. «std» for standard deviation).
- geopoth_50000 is the variable name (geopoth) including, for 3D variables, the level (here: 500 hPa). A list of the variables can be found below.
- anom stands for anomalies.
- wrt_1901-2000 is the reference period for the anomalies.
- 1421-2008 is the period covered.
- mon means monthly time resolution.

List of variables

The following variables are included in the ensemble statistics, whereas the ensemble members are only provided for the first four variables:

slp	mean sea level pressure [Pa]
temp2	2m air temperature [K]
totprec	total precipitation [kg m-2 s-1]
geopoth_50000	500 hPa geopotential height [m]
geopoth_30000	300 hPa geopotential height [m]
geopoth_20000	200 hPa geopotential height [m]
u_50000	500 hPa u-wind [m s-1]
u_85000	850 hPa u-wind [m s-1]
u10	10 m u-wind [m s-1]
v_50000	500 hPa v-wind [m s-1]
v_85000	850 hPa v-wind [m s-1]
v10	10 m v-wind [m s-1]
omega_50000	500 hPa vertical velocity [Pa s-1]

References

ModE-RA and ModE-RAclim: Valler, Veronika, Franke, J., Brönnimann, S. et al., 2023 (in review): A 600-year long global monthly paleo-reanalysis of the Modern Era, submitted to Nature scientific data.

ModE-Sim: Hand, Ralf, Samakinwa, E., Lipfert, L., and Brönnimann, S., 2023 (in review): ModE-Sim – A medium size AGCM ensemble to study climate variability during the past 600 years, Submitted to Geoscientific Model Development.