Towards a community platform for paleoclimate data and temperature gradients over the last 540 million years

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Earth’s climate shows a remarkable variability on geological timescales, ranging from widespread glaciation to ice-free greenhouse conditions over the course of the Phanerozoic, i.e. the last 540 million years. Earth system modelling allows us to better understand and constrain the drivers of these changes and provides valuable reference data for other paleoclimate disciplines (e.g., chemistry, geology, hydrology). However, the sheer volume and complexity of these datasets often prevents direct access and use by non-modellers, limiting their benefits for large parts of our community.

We present the online platform “climatearchive.org” to break down these barriers and provide intuitive access to paleoclimate data for everyone. More than 100 global coupled climate model simulations covering the entire Phanerozoic at the stage level build the backbone of the web application. Key climate variables (e.g. temperature, precipitation, vegetation and circulation) are displayed on a virtual globe in an intuitive three-dimensional environment and on a continuous time axis throughout the Phanerozoic. The software runs in any web browser — including smartphones — and promotes visual data exploration, streamlines model-data comparisons, and supports public outreach efforts. We discuss the current proof of concept and outline the future integration of new sources of model and geochemical proxy data to streamline and advance interdisciplinary paleoclimate research.

We also present ongoing efforts for an integrated model-data synthesis to quantify changes in meridional and zonal temperature gradients throughout the Phanerozoic and to address the relative roles of individual forcings (greenhouse gases, solar, geography). While substantial effort has been made to quantify the evolution of global mean temperatures over the last 540 million years, changes in the large-scale temperature gradients and their causes are comparably less constrained. As a fundamental property of the climate system, changes in the spatial patterns of surface temperature play a critical role in controlling large-scale atmospheric and ocean circulation and influence hydrological, ecological, and land surface processes. The resulting best estimate product of meridional and zonal temperature gradients over the last 540 million years will represent a step change in our understanding of the drivers and consequences of past temperature gradient changes and will provide the community with a valuable resource for future climatological, geological, and ecological research.