



Palaeoclimate modelling: opportunities and challenges for the future

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From the first numerical climate simulation of the Last Glacial Maximum in the 1980's, palaeoclimate modelling has grown to become a core research theme within Geoscience. Palaeoclimatology has provided a truly spectacular contribution to the understanding of the evolution of our planet, and has defined a wider operational range of the climate system far beyond that which direct observation and reconstruction of climate, based on instrumental or historical data alone, could provide. As such, palaeoclimate modelling has helped the scientific community put the anthropogenic modification of the climate system into a long-term geological context, and contributed to ongoing discussions regarding the definition of the Anthropocene. Geological data sets have been used to confront model outputs in ever more ingenious ways, in an effort to test the predictive ability of the same models used to simulate future climate change. The community has pushed forward the appreciation and understanding of rapid climate change, and the exploration of potential tipping points/elements in the earth system.

From a relatively restricted starting position (i.e. representations of the atmosphere only), climate models have developed to include more and more components of the earth system central to the regulation of climate. With each development (e.g. dynamic oceans, dynamic vegetation, aerosols and atmospheric chemistry, ice sheets, biogeochemistry) new opportunities have rapidly emerged to address existing scientific problems in novel ways (e.g. the geological drivers of glaciation), and to tackle entirely new issues that could not be addressed previously. The enhancing spatial resolution of models is enabling far greater detail to be obtained in simulations of past climates, forging a closer connectivity between site specific proxy reconstructions and model predictions.

The development of palaeoclimate modelling will ensure a growing contribution to geoscience in the future. However, clear scientific and technical challenges are present and emerging. These challenges threaten the continued development of scientific insight from the current and emerging capabilities of the latest generation of complex Earth System Models. Broader questions of future model development strategy, and how well current and emerging model developments can be incorporated into the advancement of palaeoclimate modelling must be posed, with several different avenues available to the community to explore solutions.