Pliocene climate variability over glacial-interglacial timescales (PlioVAR) working group

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The Pliocene epoch (~2.6-5.3 million years ago) is arguably the best-resolved example of a climate state in long-term equilibrium with current or predicted near-future atmospheric CO_2 concentrations. It was characterized by a globally warmer climate (Fig. 1), reduced continental ice volume, and reduced ocean/atmosphere circulation intensity. Data derived from natural archives can be constrained in time to the Pliocene by multiple stratigraphic frameworks. Orbital forcing of solar radiation is known precisely, and many of the species extant today were also present then. As a result, detailed understanding of climate forcings and feedbacks is possible through both data analysis and data-model integration.

Pleistocene paleoclimate studies have demonstrated the value of understanding climate variability on orbital timescales, whereby the unique spatial and temporal signatures of individual interglacials or glacial-interglacial cycles highlight sensitive regions or climate systems. Recent modeling work confirms that such variability (and regional non-synchronicity) should also be expected in the Pliocene. However, Pliocene data density is lower than for the Pleistocene, and stratigraphical correlation may be more challenging (e.g. benthic $\delta^{18}O$ oscillations are more muted). To create a globally distributed, orbitally-resolved synthesis of Pliocene climate variability a community effort is required, ensuring high quality data sets can be integrated using a robust stratigraphy, which is essential to underpin future data-model comparisons.

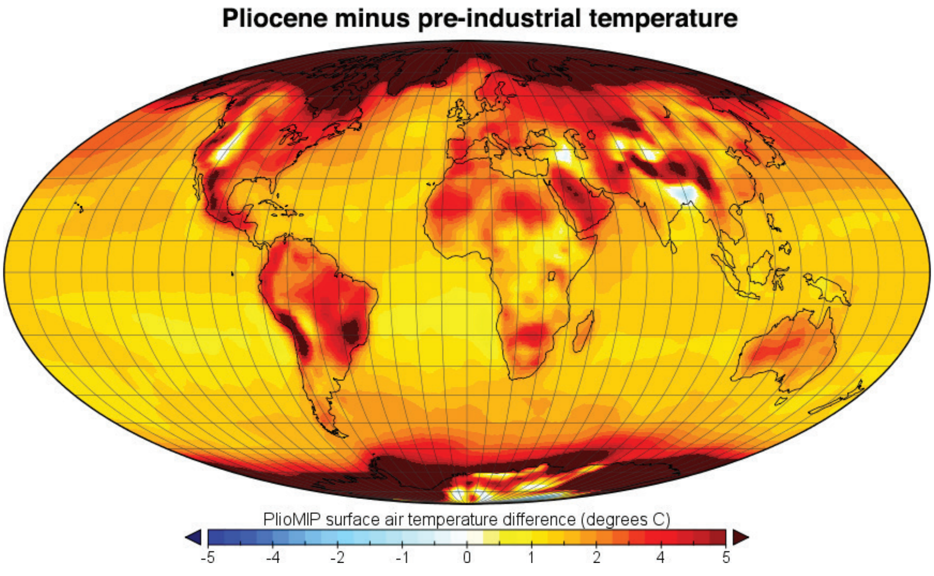

Figure 1: Annual mean surface air temperature change in Celsius (Pliocene minus pre-industrial) from the PlioMIP ensemble (redrawn from Haywood et al. 2013).

The PlioVAR working group

The overall aim of PlioVAR is to coordinate a synthesis of terrestrial and marine data to characterize spatial and temporal variability of Pliocene climate. We are seeking datasets and scientific expertise with global reach, to increase our understanding of climate sensitivity to forcings in the past with both regional and global perspectives. We will examine marine and terrestrial evidence for e.g. temperature change, hydrology, and nutrient cycling, with the aim of understanding the interactions between different components of the climate system, including ocean-atmosphere circulation and continental ice volume. Within PlioVAR we also aim to explore the biotic response to Pliocene climate variability, and the links between marine and terrestrial ecosystems.

Our program builds on key priorities identified by the community at a PAGES-sponsored workshop in Barcelona, 2014 (Rosell-Melé et al. 2015). Our initial focus will be the late Pliocene, for which we have the greatest data density and constraints for model simulations, but the longer-term goal is to extend these efforts to earlier intervals of the Pliocene epoch. We have three over-arching goals:

- Synthesize late Pliocene climate data with orbital and sub-orbital scale resolution.
- Examine tools and experimental design for new climate modeling studies to characterize Pliocene climate variability, including transient model simulations.
- Identify early Pliocene intervals to which the approaches of (1) and (2) can be applied in later stages of PlioVAR, to compare and contrast the long-term evolution of Pliocene climate and consider the role of ocean gateways and CO_2 forcing in the evolution of the Earth system.

Within PlioVAR we aim to create a database of late Pliocene marine and terrestrial data, which enables regional and global syntheses of spatial and temporal climate variability. This will include coordinating efforts to address missing data, evaluating chronostratigraphic tools and their constraints, and recommending protocols on stratigraphic reporting for database metadata. We will quantify and compare uncertainties in proxies, and develop methods for assigning and reporting confidence in proxy records for database metadata. Finally, we aim to quantify late Pliocene climate variability over time and at both regional and global scales through data synthesis, modeling experiments, and data-model integration.

We will shortly be circulating a white paper to PlioVAR members that addresses the chronostratigraphic tools and approaches used in Pliocene research, and which will make recommendations for the PlioVAR data synthesis. A workshop to discuss Pliocene modeling approaches is also scheduled for early 2016 in Leeds, UK, and we plan several proxy-led workshops for data synthesis and discussion. To learn more about PlioVAR and to join the working group please see our webpages (www.pages-igbp.org/ini/wg/pliovar) or contact any of the members on the PlioVAR steering committee.

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