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A hierarchy of climate sensitivities inferred from mid-Pliocene warm period data and their implications for the understanding of climate futures

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We seek to contribute a mid-Pliocene perspective to the ongoing efforts to understand the climate system's sensitivity at various timescales using multiple lines of evidence. The mid-Pliocene (∼3 mya) was geographically very similar to the present-day and atmospheric pCO_2 was no greater than the modern value of ∼400 ppmv. Despite these similarities the mid-Pliocene was characterized by extensive global warmth (Chandan and Peltier, 2017; Dowsett et al., 2013; Haywood et al., 2013), and consequently, considerably reduced polar ice cover (Dolan et al., 2012). The similarities in the boundary conditions between the mid-Pliocene and the present day, together with the globally elevated temperatures, make the mid-Pliocene an ideal palaeo time period from which to derive inferences of climate sensitivity and assess the impacts of various timescale dependent feedback processes.

We assess a hierarchy of climate sensitivities of increasing complexity to explore the response of the climate over a very large range of timescales (Chandan and Peltier, in-prep). The various sensitivities that we calculate provide insight on not only how the climate responds to a given forcing over a short timescale, but also on intermediate and very-long timescales. In the latter category, we include the impact of oceanic heat uptake and the feedback from the glacial isostatic adjustment of the Earth's surface in response to the melting of the polar ice sheets. We are able to perform this analysis because of the simulations that we have previously performed for the Pliocene Modelling and Intercomparison Project (one PI control, one modern-day control, two mid-Pliocene experiments and five sensitivity experiments; collectively ∼20,000 model years at $1^\circ \times 1^\circ$ resolution using the University of Toronto version of the CCSM4 model) that allow us to compute the various quantities required in the computation of this range of climate sensitivities.

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