**The Importance of Modeling Deep Time Climates for Understanding Future Climate Change**

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Deep time climates provide a unique opportunity to evaluate climate models employed to study how Earth's climate will change in the future. Current projections of greenhouse radiative forcing indicate that by 2100 Earth will experience a radiative forcing of between 5 to 11 Watts per square meter. Earth's geologic record indicates that the last time Earth experienced this magnitude of forcing was tens of millions to hundreds of millions of years ago (early Mesozoic and Paleozoic). Thus, warm deep time climates provide an important test bed for evaluating climate models under conditions of elevated levels of greenhouse forcing.

In this presentation, I will review the key processes that are important for simulating past climates, including the various boundary conditions required for simulating these climates. The key model physical and geochemical processes will be described with emphasis on sources of uncertainty in accurately representing these processes. I will then discuss various techniques used to compare climate model simulations with paleoclimatological data and the challenges that persist in model-data integration. I will provide examples of these techniques for a number of warm deep time climates. I conclude the presentation with a description of a new paleoceanographic data assimilation method using the NCAR Community Climate System Model (CCSM3). The focus will be on data assimilations of paleo data from the Paleocene Eocene Thermal Maximum (PETM), but the technique is sufficiently general to be applied to other deep time climates.