Project:
Project title: **Paleo Dust in the Atmosphere: Insights from ICON-ART Modeling**
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## Abstract

Understanding the role of atmospheric dust in past climates is essential for reconstructing historical climate dynamics and improving predictions of future climate scenarios. Dust, as one of the most significant scattering aerosols in the atmosphere, heavily influences the Earth's radiation balance and affects both regional weather patterns and global climate. Furthermore, shifts in dust deposition patterns over the oceans can profoundly impact marine bioproductivity and influence the interpretation of oxygen isotope proxies, which are vital for reconstructing paleoclimatic conditions. However, the pathways, lifetimes, and deposition mechanisms of dust under varying climatic conditions remain inadequately characterized.

Within the Planetary Boundaries framework, the boundary for atmospheric aerosol loading, including dust, is still not well established. A clear understanding of dust aerosol variability in historical climates is critical for defining a baseline, which is essential for estimating Earth's boundary limits related to atmospheric aerosol loads.

In our study, we utilize the ICON-ART model to simulate dust aerosol dynamics and their interactions with Earth's radiation balance. First, we perform present-day AMIP-style experiments using the "raddust" configuration provided by the Deutscher Wetterdienst (DWD) as a baseline for dust simulation. Subsequently, we conduct sensitivity experiments by systematically modifying initial dust source parameters, allowing us to assess how different climate scenarios and changes in the extent of dust sources influence dust transport pathways, atmospheric lifetime, and deposition patterns. Finally, we run simulations for the mid-Holocene (~6 ka) and Pliocene (~3 Ma) epochs, which represent warmer and colder climates in Earth's history, to examine shifts in dust dynamics under these paleoclimatic conditions. These experiments aim to provide a robust baseline for understanding the Planetary Boundary related to atmospheric aerosol loading, contributing valuable insights into dust variability, its climate feedbacks, and its long-term impacts on the Earth system.