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Application of the Tipping Point Concept to Dramatic Climate and Environmental Change Events in Earth History: Role of LIPs and Implications for Modern Climate Change

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There are rising concerns about the Earth modern climate system crossing tipping points leading to an irreversible change in climate. Recent studies have suggested that many regions of the world are currently approaching climate tipping points. To address these growing concerns, scientists are looking into the geological record where paleoclimate and environmental change proxies point to abrupt large-scale environmental and climate changes. Earth's history is replete with examples of the crossing of climatic tipping points and resulting in a dramatic climate change. Major global climatic and environmental events (representing tipping points) that have marked Earth's history include sudden hothouse periods, the Great Oxidation Event (GOE), Neoproterozoic Oxygenation Event (NOE), major glaciations including Snowball Earths, Ocean Anoxic Events (OAEs), ocean acidification, and resulting mass extinction intervals.

Large Igneous Provinces are now recognized to be a significant cause of climatic/environmental change through Earth history. Their temporal link to environmental and climate changes, and thus climate tipping points is becoming more powerful with the current precise absolute age-dating techniques.

We consider their role in a tipping point context to develop new insights into their more specific contributions to both negative and positive feedbacks in driving the system across a tipping point. In many ways, LIPs events serve as the key to understanding present and future climate and related anthropogenic and natural environment changes, such as anthropogenic pollution, ocean acidification and development of ocean anoxia and understanding of positive and negative feedbacks and drivers. In addition, we provide an overview of the tipping point paradigm and its application to dramatic climate change events in Earth history. We consider the role of negative feedbacks (to prevent tipping points) and positive feedbacks and drivers (to cause tipping point events). By studying Earth's history of climatic tipping points (and characterizing the associated negative and positive feedbacks) we can develop new ideas for predicting and mitigating of modern climate change.