SynTraCE-21 Workshop

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Recent years have seen rapid advances in the study of climate changes during the last 21-ka driven both by new proxy evidence and new modeling activities. On the proxy reconstruction side, new high resolution records based upon speleothems, marine, and lacustrine sediments have documented a highly variable evolution of regional climate, with considerable spatiotemporal variability that includes responses to freshwater forcing (e.g. the Younger Dryas and Heinrich 1 events), greenhouse gas and orbital forcing, and coupled vegetation-climate changes. On the modeling side, climate models and computer power have been enhanced significantly in recent years such that the transient climate evolution can now be simulated with state-of-the-art fully coupled general circulation models (e.g. Fig. 1). The flood of new proxies and model data requires community-wide activities to critically assess and synthesize proxy reconstructions, and evaluate these in light of the comprehensive, global framework afforded by climate model simulations.

PAGES and the US NSF sponsored a SynTRaCE-21 (Synthesis and Transient Climate Evolution of the last 21 ka) workshop to discuss and plan a synthesis of proxy climate records and model simulations of the major features of global climate of the last 21 ka. The workshop, attended by 43 participants from five countries used plenary sessions and breakout discussions to define critical hypotheses and questions in the three following areas.

Tropical hydrology of the past 21 ka

Proxy data indicate that tropical precipitation exhibits complex spatio-temporal patterns during deglacial and Holocene times. These include north-south migration of the Intertropical Convergence Zone, as well as more poorly understood zonal reorganizations of the ocean-atmospheric circulation. Proxy records are now sufficiently dense to compare reconstructed patterns of deglacial precipitation changes in the tropics to transient model simulations. This allows the assessment of the response and sensitivity of zonal and meridional circulation in the tropics to deglacial climate forcings, including orbital forcing, radiative forcing from greenhouse gases, and glacial processes. Data-model comparison could also be used to investigate the evolution of millennial-scale precipitation changes in the tropics.

Deglacial ocean circulation change

Changes in ocean circulation are known to have played a critical role in the Earth's climatic and biogeochemical evolution during the last glacial termination. Marine sediment records also indicate important changes in deglacial ocean circulation in response to meltwater forcing. Despite these advances, many of the key mechanisms and circulation changes of the deglaciation are still poorly understood. Deglacial meltwater pulses, for instance, are known to have strong impacts on climate, but where do deglacial meltwater pulses go in the ocean, and how do they impact convection and circulation? Similarly, although changes in ocean circulation are known to have strong effects on global biogeochemical cycles, we know little about changes in the ocean's most biogeochemically active waters: the intermediate ocean. How did intermediate ocean circulation vary across the last glacial termination?

Abrupt changes in the Holocene

Many regions experienced abrupt climate changes during the Holocene due to feedbacks between climate, land surfaces, and sea surface temperature variations. The collapse of the North African "Green Sahara" ecosystem due to interactions between the African monsoon, subtropical Atlantic sea surface temperatures, and North African vegetation is a prime example. Key questions to be addressed through data-model comparison activities include the dynamics of abrupt climate changes during the Holocene (rates of change, spatial synchronicity), the role of vegetation feedbacks in amplifying or even triggering abrupt climate change, and the ability of climate models to simulate abrupt climate change in the Holocene in the absence of abrupt forcing.

These questions will be addressed by the SynTRaCE-21 working group through focused data-model activities in the coming year.

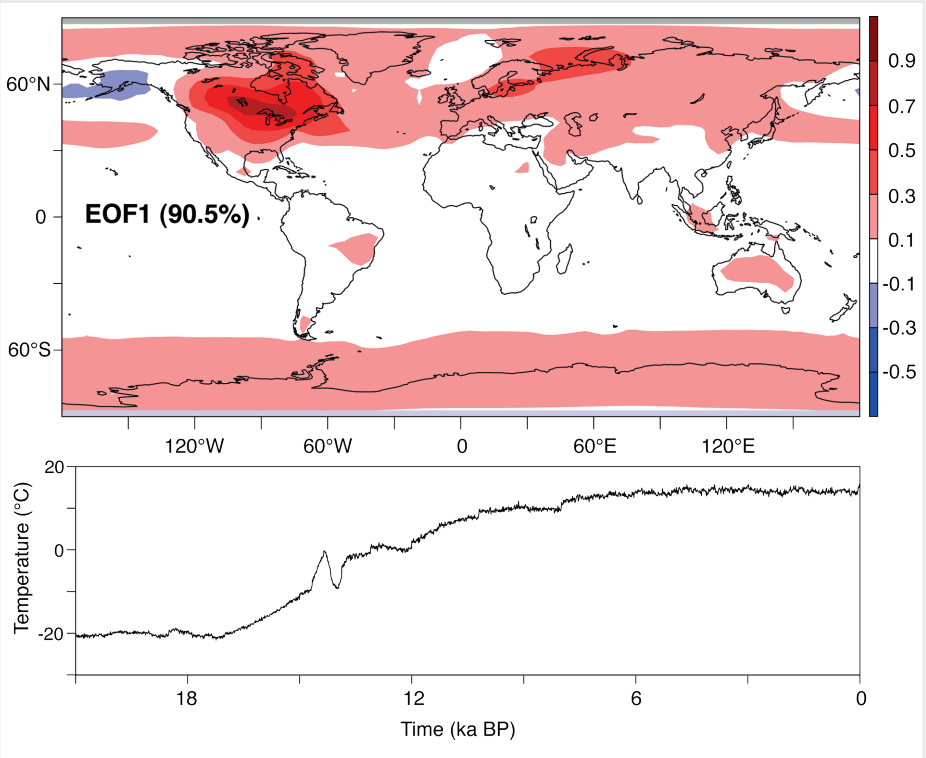

Figure 1: The first empirical orthogonal function of global temperature change from 21 ka BP to the present, simulated by CCSM 3. Nearly the entire planet warmed, with warming focused over the high latitudes, and North America and Northern Europe in particular, with both gradual and abrupt temperature changes occurring during the past 21 ka BP.

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