Earth's Variable Climatic Past

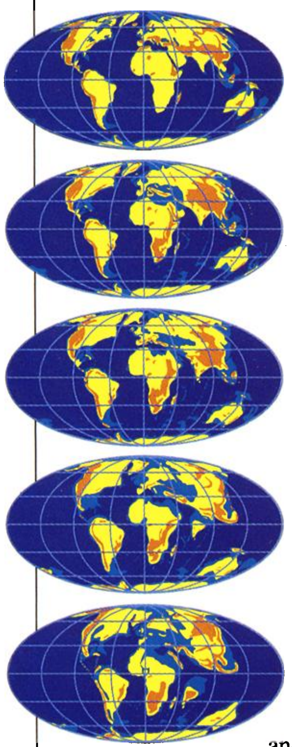
Global climate usually changes little over the course of a human lifetime, but a large and rapidly growing body of research has begun to reveal just how variable it is on longer time scales. Three hundred and fifty years ago, the world was in the depths of a prolonged cold spell called the "Little Ice Age," which lingered for nearly half a millennium. Fifty thousand years ago, in the middle of the last glacial period, large continental ice sheets covered much of North America, Northern Europe, and Northern Asia. Fifty million years ago, global temperatures were so high that there were no large ice sheets at all. The speed at which climate can change has also recently become clear: Transitions between fundamentally different climates can occur within only decades. In order to understand these variations, we need to reconstruct them over a wide range of temporal and geographical scales. The importance of this task is underlined by the growing awareness of how profoundly human activity is affecting climate. As with so many other complex systems, the key to predicting the future lies in understanding the past. In this special issue, we present five Reviews and two News stories that examine some of the causes and effects of past climate change.

There are few direct records of paleoclimate, so we therefore must rely on proxies—measurable parameters that provide quantitative information about variables such as temperature, rainfall, or ice volume—to reconstruct it. Erik Stokstad (p. 658) presents an overview of important paleoclimate proxies and their uses. In another News story, Richard A. Kerr (p. 660) discusses the possibility that the tropical oceans, once thought to be a minor player in long-term climate change, are actually a major, if not dominant, force on decadal to millennial time scales.

The climate of the recent past is most relevant to the near future, because boundary conditions today are similar to those of the past few thousand years. Jones *et al.* (p. 662) summarize what is known about changes in temperatures and in two major circulation features (El Niño–Southern Oscillation and the North Atlantic Oscillation) over much of the past 1000 years. Looking slightly farther back in time, deMenocal (p. 667) combines archaeological and paleoclimatic records in four case studies of New and Old World civilization that document societal responses to prolonged drought. Over the 2 million years of the Quaternary Period, terrestrial plants have had to adapt to rapid changes of climate as ice sheets grew and shrank. Davis and Shaw (p. 673) discuss how the resulting strong selection pressures likely caused adaptive genetic differentiation of tree taxa, in addition to forcing species to change the latitude or elevation range in which they grew. One of the most recognizable consequences of the glacial cycle is sea level change. Lambeck and Chappell (p. 679) describe the complex spatial and temporal pattern of this process and discuss how it depends on the growth and decay of ice sheets and the mantle response to changes in surface loading. Finally, Zachos *et al.* (p. 686) examine the past 65 million years of Earth's climate through the lens of deep-sea sediment cores, chronicling the gradual warming and cooling trends driven by tectonic processes, periodic cycles driven by orbital processes, and rare rapid aberrant shifts and extreme climate transients.

These articles cover just a fraction of the range of topics connected to the study of paleoclimate. Despite all we now know about past climates, we have only scratched the surface of what we need to understand before we can predict our climatic future.

—JESSE SMITH AND JULIA UPPENBRINK



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