Temperature Change and Carbon Dioxide Change

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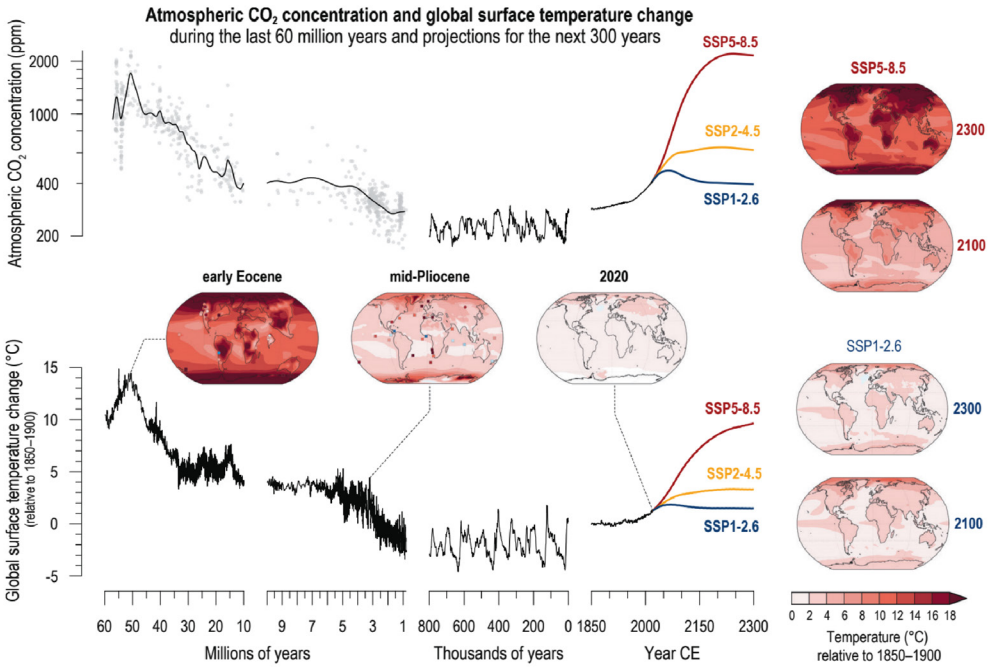
One of the most remarkable aspects of the paleoclimate record is the strong correspondence between temperature and the concentration of carbon dioxide in the atmosphere observed both for long-term trends over the last 60 million years, as well as during the glacial cycles of the past several hundred thousand years. When the carbon dioxide concentration goes up, temperature goes up. When the carbon dioxide concentration goes down, temperature goes down. This connection is consistent with the fact that greenhouse gases, such as carbon dioxide, trap heat in the atmosphere. Carbon dioxide is also coupled to temperature in other ways. For example, warmer temperatures cause soils and permafrost to release more carbon to the atmosphere. A warmer ocean absorbs less carbon dioxide from the atmosphere, further increasing atmospheric carbon dioxide concentrations. Dustier conditions during glacial periods provided more iron to the oceans, fertilizing marine phytoplankton and increasing their carbon uptake.



Reconstructed changes in atmospheric carbon dioxide and temperature from 60 million years ago to present (black), and projections of future changes based on three different scenarios of low, medium, and high emissions of greenhouse gases (yellow, red, blue). Graphic is from the Intergovernmental Panel on Climate Change Sixth Assessment Report. Data sources for reconstructions: Paleo pCO2 database, Bereiter et al. 2015, Bauska et al. 2015, Westerhold et al. 2020, Hansen et al. 2013, Snyder et al. 2016.

Paleoclimate data also reveal that climate change is not just about temperature. As carbon dioxide has changed in the past, many other aspects of climate changed too. During glacial times, snow lines were lower, continents were drier, and the tropical monsoons were weaker. Some of these changes may be independent; others tightly coupled to the changing level of carbon dioxide. Understanding which of these changes might occur in the future, and how large those changes might be, remains a topic of vigorous research. NOAA's National Centers for Environmental Information helps scientists document the changes that have occurred in the past as one approach to understanding future climate change.

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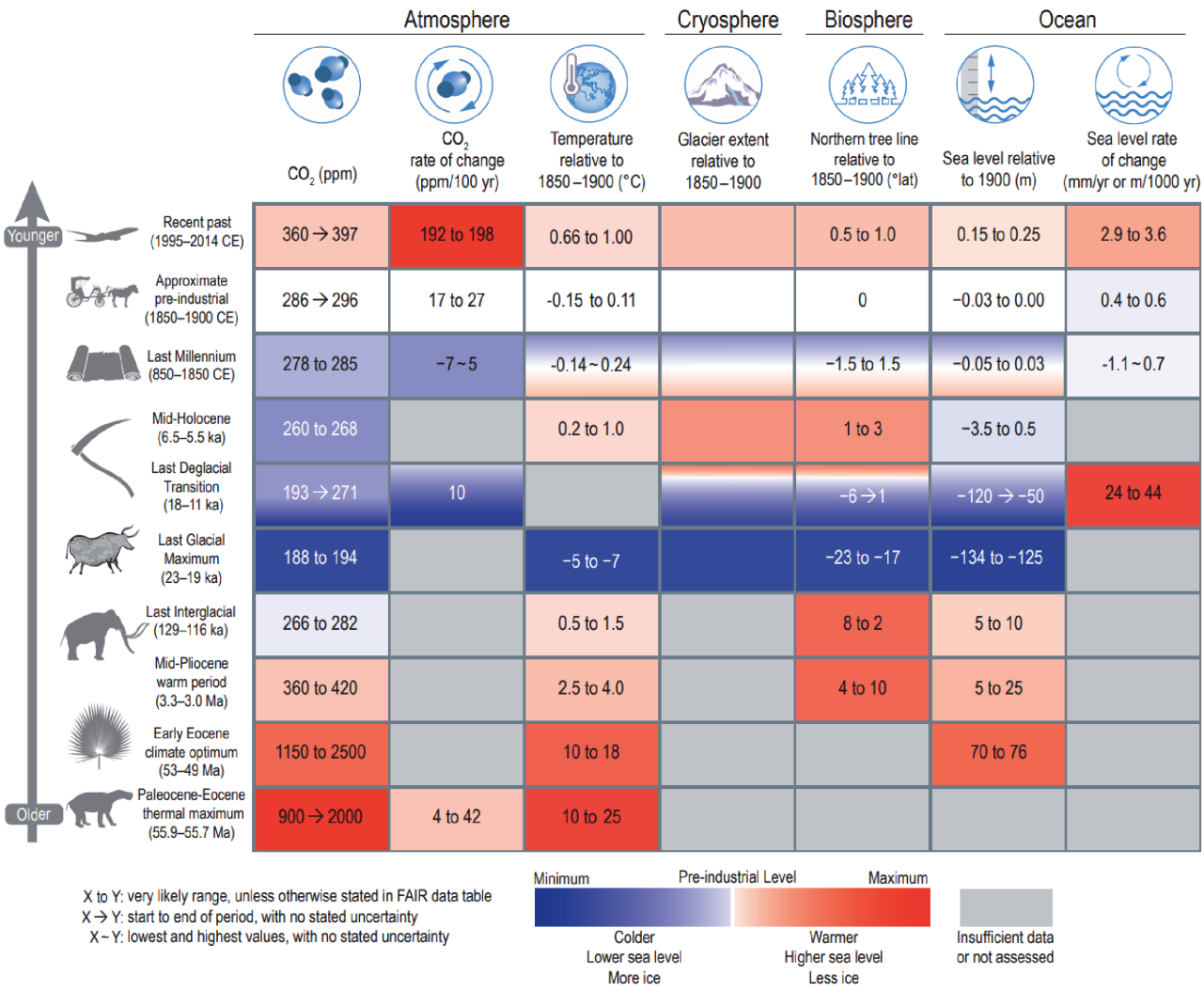
Selected large-scale climate indicators from the Cenozoic era to the recent past



Selected climate change indicators recorded by paleoclimate data over the last 60 million years. Graphic is from the Intergovernmental Panel on Climate Change Sixth Assessment Report.