

Climate change during historical times: lessons from the past and relevance to regional-scale climate change

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Studies of paleoclimate record indicate substantial decadal-centennial scale climate variability during the last few thousand years. Over the last millennium, where the data are most comprehensive, model-data comparisons suggest that about 50% of the decadal-scale variance in large-scale surface temperature reconstructions can be explained by a linear response to radiative forcing perturbations from volcanoes, the sun, and (to a small degree), greenhouse gases. The "Little Ice Age" is primarily due to such perturbations. However, the total contribution from "natural forcing" explains only a small amount of 20th temperature variability - the rest is primarily due to anthropogenic greenhouse gas increases.

Analysis of past time intervals that are well-simulated on the largest scales provides potential insight into the regional dynamical response to radiative-forcing perturbations. Two volcanically induced cold intervals in the early 19th century show different regional responses - the first is characterized by a strong El Nino/PNA pattern, the second by a NAO-type response. It is speculated that the different regional responses to similar radiative forcing perturbations reflects the fact that the warm periods antecedent to these two cold intervals were different - the first cold interval substantially cooled the North Atlantic, possibly accounting for the different regional response when the system cooled again ten years later.

Initial work is in progress on extending radiative forcing time series back at least 4,000 years ago. Preliminary work suggests cooling around 1400-1200 BC, 800-700 BC, and the early Middle Ages. These simulations agree with paleoclimate reconstructions and also provide an interesting climatological background to certain historical trends - for example, disruptions in Aegean and Near East civilization around 1300-1200 BC, the rise of Classical Greece, the "Roman Warm Period" in the first few centuries of the first millennium AD, and the subsequent "Dark Ages" from about 550-850 AD.