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## A Comparison of Holocene Climatic Optimum Periods: Are they as Warm as the Post–Little Ice Age Period and are Greenhouse Gas Concentrations Similar?

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### ABSTRACT

There have been a number of studies that have observed that there is a variability of temperature as indicated from analysis of stable isotope data throughout the Holocene. The Holocene includes six warm periods (including the current one) and five cool periods, some of which have been named. Named warm periods include Holocene Climate Optimum, first portion, 6200 to 7700 years before present (BP); Holocene Climate Optimum, second portion, 3500 to 4700 BP; Roman Climate-Optimum, 300 BC to 400 *anno domini* (AD); and Medieval Warm Period, 700 to 1300 AD. Named cool periods include Dark Age, 400 to 700 AD; and Little Ice Age, 1300 to 1850 AD. Another unnamed period is a cool period that was between 750 and 300 BC. The question to consider is how similar is each of the periods to the current Modern Warm Period in terms of temperature and concentrations of greenhouse gas and other measured properties as recorded in either ice cores, cave formations, or fossils.

This involved compiling records of greenhouse gas concentrations, temperature data from oxygen isotope data, sulfate, and total dust concentrations and comparing distribution of these concentrations among the different climate periods within the Holocene by two statistical tests: Mann-Whitney ranks and Wilcoxon rank sum used to determine the statistical confidence of the differences between climate periods. That is, is the current warm period similar to other warm periods?

It appears that the current warm period has statistically significant higher concentrations of greenhouse gases than earlier warm periods. However, the temperature data appear to be more equivocal. Overall, it appears that solar irradiance has had more of an effect on temperature than greenhouse gases.