Linking Climate Change Across Time Scales

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Researchers use sediment cores like this one to look back in time and reconstruct past climates. The cores provide clues to changes in climate, ocean circulation patterns, volcanic eruptions, and other environmental and geological events. Photo by Tom Kleindinst, Woods Hole Oceanographic Insitution

What do month-to-month changes in temperature have to do with century-to-century changes in temperature? At first it might seem like not much. But in a report published in this week's *Nature*, scientists from the Woods Hole Oceanographic Institution (WHOI) have found some unifying themes in the global variations of temperature at time scales ranging from a single season to hundreds of thousands of years. These findings help place climate observed at individual places and times into a larger global and temporal context.

"Much of the work went into assembling the different types of records needed to study such diverse time scales," said Peter Huybers, a

paleoclimatologist in the Geology and Geophysics Department at WHOI and lead author on the study. “Data from instruments from around the world are available for recent periods, but it is not so easy for earlier times. We have few instrumental records before the 19th century, so we have to use measurements in corals, ice cores, and sediment cores to estimate past temperatures.”

These measurements and data compilations were made by scientists at WHOI and other research institutions. “While none of the measurements we use are new,” Huybers said, “putting them together told us more than we could learn from any single record.”

Huybers and coauthor William Curry, a senior scientist and paleoceanographer at WHOI, found that temperature variations are more intimately linked across time scales than had previously been thought. For example, places that have a large annual cycle in temperature, like the high latitudes, also have a lot of interannual and decadal temperature variability. In fact, the relationship is so strong Huybers says you can fairly well predict how much decadal temperature change occurs at a given location simply by knowing the size of the annual cycle.

At longer time scales, however, a different relationship seems to hold. Temperature variations at thousands and tens-of-thousands of years seem to follow temperature variations at the Milankovitch cycles. Milankovitch cycles are named after the Serbian mathematician Milutin Milankovitch who argued that periodic changes in the Earth's orbit around the Sun cause the advance and retreat of massive ice sheets. The changes in Earth’s orbit cause redistributions in how much sunlight the Earth receives at different locations and seasons.

“The overall impression is that energy is put into the climate system at the annual and Milankovitch time scales, causing temperature variations at those time scales, but also at the neighboring time scales,” said

Huybers. In the tropics the amplitude of the annual and Milankovitch cycles tends to be smaller than at high latitudes and, correspondingly, there is less tropical temperature change across interannual to thousand year time scales. Another notable feature is that the variability of temperature appears most similar globally at those time scales furthest removed from the annual and Milankovitch periods, indicating that away from these forcing periods climate relaxes to a more uniform background state.

Climate varies at all time scales, from months to millions of years and longer. These changes are often studied independently of one another, but we now have a clearer idea of how climate change is linked across time scales. “These insights may help us to better understand past temperature changes, improve our models of the climate, and maybe even predict future climate change,” Huybers said.

Source: Woods Hole Oceanographic Institution