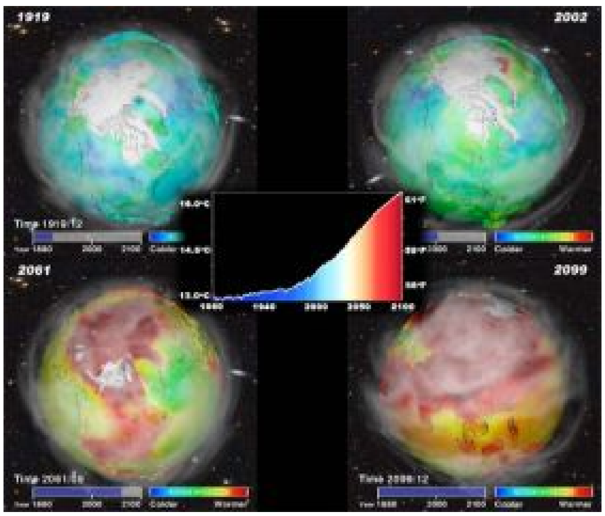
PHYS.ORG

Scientists resolve long-standing puzzle in climate science

October 10 2008



Climate visualizations 1919 - 2099. Image: LLNL

(PhysOrg.com) -- A team led by Livermore scientists has helped reconcile the differences between simulated and observed temperature trends in the tropics.

Using state-of-the-art observational datasets and results from computer model simulations archived at Lawrence Livermore National Laboratory, LLNL researchers and colleagues from 11 other scientific institutions have refuted a recent claim that simulated temperature trends in the tropics are fundamentally inconsistent with observations. This claim was based on the application of a flawed statistical test and the use of older observational datasets.

Climate model experiments invariably predict that human-caused greenhouse gas increases should lead to more warming in the tropical troposphere (the lowest layer of the atmosphere) than at the tropical land and ocean surface. This predicted “amplification” behavior is in accord with basic theoretical expectations.

Until several years ago, however, most satellite and weather balloon records suggested that the tropical troposphere had warmed substantially less than the surface.

For nearly a decade, this apparent discrepancy between simulations and reality was a major conundrum for climate scientists. The discrepancy was at odds with the overwhelming body of other scientific evidence pointing toward a “discernible human influence” on global climate.

A paper published online last year in the *International Journal of Climatology* claimed to show definitively that “models and observations disagree to a statistically significant extent” in terms of their tropical temperature trends. This claim formed the starting point for an investigation by a large team of climate modelers and observational data specialists, which was led by LLNL’s Benjamin Santer.

In marked contrast to the earlier claim, Santer’s international team found that there is no fundamental discrepancy between modeled and observed trends in tropical temperatures.

“We’ve gone a long way toward reconciling modeled and observed temperature trends in the problem area of the tropics,” said Santer, the lead author of a paper now appearing online in the International Journal of Climatology.

There are two reasons for this reconciliation.

First, the analysis that reported disagreement between models and observations had applied an inappropriate statistical test, which did not account for the statistical uncertainty in observed warming trends. This uncertainty arises because the human-caused component of recent temperature changes is not perfectly known in any individual observed time series – it must be estimated from data that are influenced by both human effects and the "noise" of natural climate variability. Examples of such "noise" include large El Niño and La Niña events, which have pronounced effects on the year-to-year variability of tropical temperatures.

The Livermore-led consortium applied this inappropriate test to randomly generated data. The test revealed a strong bias in the method toward "detecting" differences that were not real.

The consortium modified the test to correctly account for uncertainty in estimating temperature trends from noisy observational data. With this modified test, there were no longer pervasive, statistically significant differences between simulated and observed tropical temperature trends.

The second reason for the reconciliation of models and observations was the availability of new and improved observational datasets, both for surface and tropospheric temperatures. The developers of these datasets used different procedures to identify and adjust for biases (such as those caused by changes over time in the instruments and platforms used to measure temperature).

Access to multiple, independently produced datasets provided the LLNL-led consortium with a valuable perspective on the inherent uncertainty in observations. Many of the recently developed observational datasets showed larger warming aloft than at the surface, and were more consistent with climate model results.

Even with improved datasets, there are still important uncertainties in observational estimates of recent tropospheric temperature trends that may never be fully resolved, and are partly a consequence of historical observing strategies, which were geared toward weather forecasting rather than climate monitoring.

“We should apply what we learned in this study toward improving existing climate monitoring systems, so that future model evaluation studies are less sensitive to observational ambiguity,” Santer said.

Other researchers in this international consortium were Karl Taylor, Peter Gleckler and Stephen Klein (all at Livermore); Peter Thorne at the United Kingdom Meteorological Office Hadley Centre; Leo Haimberger at the University of Vienna; Tom Wigley and Doug Nychka at the National Center for Atmospheric Research; John Lanzante at the National Oceanic and Atmospheric Administration (NOAA)/Geophysical Fluid Dynamics Laboratory; Susan Solomon at the NOAA/Earth System Research Laboratory; Melissa Free at the NOAA/Air Resources Laboratory; Phil Jones at the University of East Anglia; Tom Karl at the NOAA/National Climatic Data Center; Carl Mears and Frank Wentz at Remote Sensing Systems; Gavin Schmidt at the NASA/Goddard Institute for Space Studies; and Steve Sherwood at Yale University.

Provided by Livermore National Laboratory