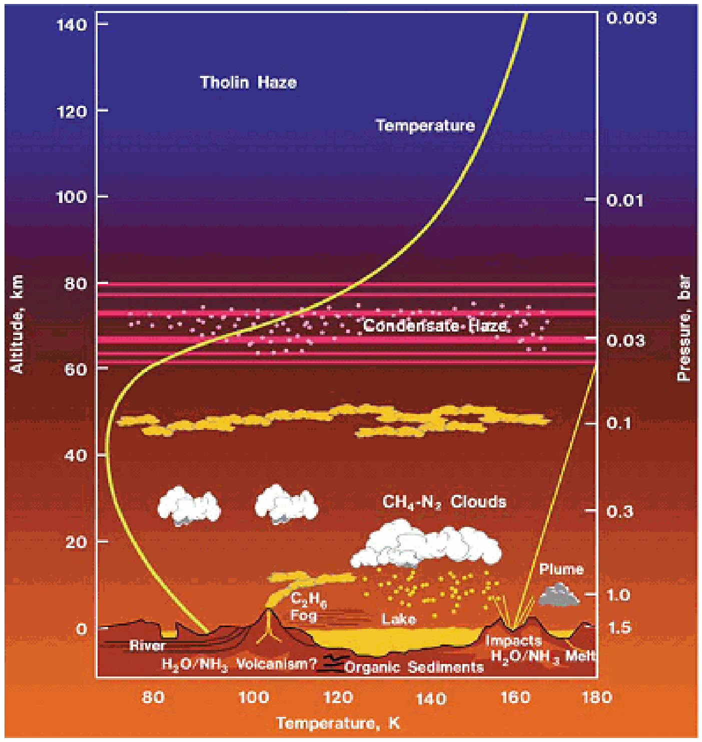
American Meteorological Society's Environmental Science Seminar Series

Recent Advances In Understanding and Measuring Changes in Earth's Vertical Temperature Profile



What are the most recent advances in our understanding of the observed changes in Earth's vertical temperature profile? Why is it important to measure the changes in Earth's vertical temperature profile with some degree of confidence, if ground-based measurements of surface temperature changes already exist? Are observations of surface and atmospheric temperature change consistent with the latest computer model results? What do these new observational datasets and climate model results tell us about the possible causes of recent temperature changes?

Public Invited

Wednesday, November 16, 2005, 11:30am - 1:30 pm
Location: Cannon House Office Building,
Cannon Caucus Room
Washington, DC

Reception Following

Moderator: Dr. Anthony Socci, Senior Fellow, American Meteorological Society

Speakers:

Dr. Ben Santer, Atmospheric Scientist, Lawrence Livermore National Laboratory (LLNL), U.S Department of Energy, Livermore, CA

Dr. Steven Sherwood, Associate Professor, Department of Geology and Geophysics, Yale University, New Haven, CT

Dr. Carl A. Mears, Senior Scientist, Remote Sensing Systems Company, Santa Rosa, CA

Revisiting the Earth's Vertical Temperature Profile: Context and Implications of Recent Re-Analyses:

There is abundant evidence that the temperature of Earth's surface has been warming in most locations over the past half century. Simple physical arguments and the results of climate models both suggest that similar or greater warming should also occur in the troposphere, the layer of the atmosphere closest to the Earth. Whether or not tropospheric warming actually occurred has been the subject of a lengthy scientific exchange.

The longest record of temperature in the troposphere comes from expendable weather balloons, or radiosondes, which have been launched globally since the late 1950s. Average temperatures reported by these devices rose substantially in the 1960s and 1970s, but changed little during the 80s and 90s while the surface was warming rapidly. These discrepancies are most pronounced in the tropics. Modifications in instrument design over time have often been suspected of contaminating the long-term changes in reported balloon temperatures, but this suspicion has been unconfirmed. New evidence shows that designs used before the 1980s read systematically too warm due to the effects of sunshine on the instrument itself. This problem decreased after the 1980s in a manner that would hide or reduce a true warming trend. The problem was most severe at tropical stations because they made far fewer nighttime observations and their observations have been less stable. If the solar heating error is removed from daytime observations, the balloon and surface changes become roughly consistent (though with significant remaining uncertainty in the balloon record).

Since 1979, weather satellites have been monitoring the temperature of thick layers of the atmosphere by measuring microwave emissions from the air. Since each satellite is in orbit for only a few years, the data from a number of satellites need to be patched together in order to construct a long-term data record suitable for evaluating changes in the Earth's climate. During this process, the data must be adjusted to account for slow drifts in the calibration of the satellites, and for slow changes in the time of day that the measurements are made. Long-term trends depend critically on how these adjustments are implemented. A previous analysis of the satellite data suggested that the troposphere did not warm as fast as the surface over the 1979-2005 period, and that the troposphere was in fact cooling in the tropics. A second complete analysis of the satellite data recently uncovered an error in the way that the first analysis accounted for changes in measurement time. When this error is corrected, the atmosphere in the tropics shows larger warming than at the surface, in rough accordance with expectations.

Computer models of the climate system are now our most important tool for forecasting future climate. An important test of these models is their ability to reproduce key features of past climate fluctuations, including the relationship between temperature changes at different altitudes. Simulations of 20th century climate performed with nearly 20 different models invariably project that temperature changes in the tropical troposphere are larger than at the surface. Results are similar for both rapid (month-to-month) and slow (decade-to-decade) changes. This "amplification effect" follows from basic physical principles. The older observational datasets were consistent with models and theory for rapid changes, but not for slow temperature changes over decades where results are most sensitive to data problems. The new analyses of satellite and weather balloon data show amplification effects that are in accord with model expectations and basic theory, both for rapid and slow temperature changes. These results suggest that identifying and adjusting for important errors in satellite and weather balloon temperature measurements has helped us to remove a large stumbling block in our understanding of the nature and causes of climate change.

Biographies

Dr. Ben Santer is an atmospheric scientist at Lawrence Livermore National Laboratory (LLNL). His research focuses on such topics as climate model evaluation, the use of statistical methods in climate science, and identification of natural and anthropogenic "fingerprints" in observed climate records. His work on the climatic effects of combined changes in greenhouse gases and sulfate aerosols contributed to the "discernible human influence" conclusion of the 1995 Report by the Intergovernmental Panel on Climate Change (IPCC). Dr. Santer holds a doctorate in climatology from the University of East Anglia in England, where he studied under Prof. Tom Wigley. After completion of his Ph.D. in 1987, he spent five years at the Max-Planck Institute for Meteorology in Germany, where he worked with Prof. Klaus Hasselmann on the development and application of climate fingerprinting methods. In 1992, Dr. Santer joined the Program for Climate Model Diagnosis and Intercomparison at LLNL. He served as convening Lead Author of the climate-change detection and attribution chapter of the 1995 IPCC report, an experience best described as "character building". His awards include a MacArthur Fellowship (1998), the Norbert Gerbier-MUMM international award from the World Meteorological Organization (1998), the U.S. Dept. of Energy's E.O. Lawrence Award (2002), and a U.S. Dept. of Energy Distinguished Scientist Fellowship (2005). Dr. Santer has over sixty publications in the peer-reviewed scientific literature, and has contributed to ten books.

Dr. Steven Sherwood joined Yale University in January 2001 and is currently an associate professor in the department of Geology and Geophysics. His research includes theoretical and observational study of physical processes in the atmosphere and how they interact with climate. Previously he worked as a scientist at NASA Goddard Space Flight Center in Greenbelt, Maryland. He received his Ph.D. in 1995 from the Scripps Institution of Oceanography in La Jolla, California, and a B.S. in Physics from MIT in 1987.

Dr. Sherwood is known primarily for his work on atmospheric water vapor, particularly in the tropical stratosphere and crucial upper-troposphere region where water vapor is an important, natural greenhouse gas. This work includes studies of how cumulus clouds interact with the boundary of the troposphere and stratosphere to control temperature, how mixing processes of all kinds affect atmospheric water vapor amounts, and how this vapor in turn influences the development of precipitating weather systems. Dr. Sherwood has also developed novel statistical methodologies to interpret historical climate records more accurately. While still early in his career, Dr. Sherwood is the author of approximately twenty-seven peer-reviewed scientific publications, and in 2005, was awarded the American Meteorological Society's Meisinger Award.

Dr. Carl A. Mears is a Senior Scientist at Remote Sensing Systems, a privately held research company. He received Ph.D. in Physics from University of California, Berkeley (1991), where his thesis research focused on the development of superconducting microwave receivers. He joined Remote Sensing Systems in 1998. Dr. Mears's research interests include calibration and validation of microwave satellite instruments, algorithm development, analysis of data from microwave satellite instruments in order to provide climate quality datasets of atmospheric temperature, water vapor and wind speed, and intercomparison of these data with climate model output. He is a coordinating lead author for the Climate Change Science Program report on Temperature Trends in the Lower Atmosphere, and a contributing author to the AR4 2007 IPCC assessment. Dr. Mears is the Author or co-author of more than 40 scientific papers.

This seminar is open to the public and does not require a reservation.
Please feel free to forward this notice.

The **Next Seminar** is tentatively scheduled for **December 14, 2005.**
Topic: Are We Adequately Prepared for the Future: Selected Lessons from Recent Natural Disasters

Please see our web site for seminar summaries and future events:
www.ametsoc.org/atmospolicy

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