

ATS/CIRA Colloquium

Scott Denning

Colorado State University

A stool with Three Legs: Sources of Uncertainty in the Climate of the 21st Century

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ATS room 101; Discussion will begin at 3:30pm

Refreshments will be served at 3:00pm in the coffee lounge

Reliable projections of future climate are hard to make. Atmospheric composition is changing rapidly, with concentrations of greenhouse gases higher than they have been in many millions of years. Enhanced downward longwave radiation will certainly warm the Earth's surface unless negative feedbacks counteract it. The degree of warming to expect and the associated changes in other aspects of the climate system, however, is very difficult to predict. There are three leading sources of uncertainty in projections of future climate, all of similar magnitude.

Working Group 1 of the Intergovernmental Panel on Climate Change highlighted uncertainties associated with the strength of climate feedbacks to enhanced greenhouse forcing, especially those related to clouds. Many cloud processes are unresolved in global climate models, and involve very strong interactions among radiation, vertical motion, energy transport, and the hydrologic cycle that have the potential to modulate climate change. These effects will amplify or damp greenhouse forcing, but climate science is currently unable to confidently predict which or how much.

A second and very substantial source of uncertainty in projections of future climate is the future emissions of additional greenhouse gases by human societies. Economists and social scientists have developed a large suite of scenarios or "story lines" regarding future changes in population, economic development, international trade, and technology that lead to very different visions of future emissions. Used in climate models, the range of these emission scenarios produces a range of future climates that is even larger than the range associated with uncertainties in climate feedbacks due to clouds, aerosols, and other aspects of the physical climate system.

Even given a certain scenario of greenhouse gas emissions and physical climate sensitivity, the response of the Earth's biogeochemical cycles to changes in emissions is highly uncertain. The range of projections of future levels of greenhouse forcing for a given emission scenario is also very large, due to uncertain behavior of the carbon cycle both on land and in the oceans in response to changing climate. Previous calculations have almost certainly overestimated future land sinks of CO₂ because of a subtle but one-sided error in the treatment of ice core data. The range of future greenhouse forcing due to these uncertainties is comparable to that associated with uncertain social science, and produces climate uncertainty comparable to that arising from uncertain physics