Atmospheric Chemistry and Physics
An Interactive Open Access Journal of the European Geosciences Union

Atmos. Chem. Phys., 9, 813-822, 2009
www.atmos-chem-phys.net/9/813/2009/

On the diagnosis of climate sensitivity using observations of fluctuations

D. B. Kirk-Davidoff
Department of Atmospheric and Oceanic Science, University of Maryland, College Park, MD 20742, USA

Abstract. It has been shown that lag-covariance based statistical measures, suggested by the Fluctuation Dissipation Theorem (FDT), may allow estimation of climate sensitivity in a climate model. Recently Schwartz (2007) has used measures of the decay of autocorrelation in a global surface temperature time series to estimate the real world climate sensitivity. Here we use a simple climate model, and analysis of archived coupled climate model output from the IPCC AR4 runs, for which the climate sensitivity is known, to test the utility of this approach. Our analysis of these archived model output data show that estimates of climate sensitivity derived from century-long time scales typically grossly underestimate the models' true climate sensitivity. We analyze the behavior of the simple model with adjustable heat capacity in two surface layers, subject to various stochastic forcings and for various climate sensitivities, modulated by albedo and water vapor feedbacks. We use our simple climate model to demonstrate:

1. that a much longer time series would be required to accurately diagnose the earth's climate sensitivity than is presently available

2. that for shorter time series there is a systematic bias towards underpredicting climate sensitivity,

3. that the addition of a second heat reservoir weakly coupled to the first greatly reduces the decorrelation timescale of short temperature time series produced by the model, aggravating the tendency to underestimate climate sensitivity, and

4. that because of this it is possible to have a selection of models in which the climate sensitivity is inversely related to the decorrelation time scale, as is true for the IPCC models.

Final Revised Paper (PDF, 629 KB) Discussion Paper (ACPD)

Citation: Kirk-Davidoff, D. B.: On the diagnosis of climate sensitivity using observations of fluctuations, Atmos. Chem. Phys., 9, 813-822, 2009. Bibtex EndNote Reference Manager