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Using observations of IR radiance fluctuations to estimate climate sensitivity

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The availability of high spatial and spectral resolution infrared radiances from instruments such as AIRS places renewed emphasis on the development of analytic tools for the comparison of model output and climate data. It has previously 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. Here we use a simple climate model to test the utility of this approach. We analyze the simulated outgoing infrared radiance of a 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 compare the equilibrium model sensitivity to these forcings with the sensitivity derived using the lag-covariance based measures, in order to demonstrate the precision and accuracy of these methods as a function of model parameter settings and time-series length. We show that these measures can produce estimates with a high correlation to climate sensitivity, but that it usually requires at least as long as the model adjustment time to make an accurate prediction. We discuss the implications of these results for the use of the FDT as a tool in climate model validation.