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A rigorous MCMC estimation of PDFs of Climate System Properties

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We have revised the method for estimating the uncertainty in climate system properties from Forest et al. (2002, Science, v.295,p.113-117). To apply a fully Bayesian approach, we approximate the response of the MIT 2DLO climate model with a statistical model that provides a response surface in the uncertain parameter space. The three-dimensional parameter space is defined as climate sensitivity (CS), rate of deep-ocean heat uptake (KV), and the net aerosol forcing (FA) and have been identified as the three major uncertain quantities that affect the ability to simulate accurately the 20th century climate record. The availability of this response surface permits one to perform a full Markov-Chain Monte-Carlo (MCMC) sampling of the joint posterior distribution of the parameters. This approach facilitates the testing of methodologies for performing the more computationally intensive project using the complete MIT 2DLO climate model, which is infeasible with current computer resources.

Two main results will be presented. First, we develop a formal methodology for estimating the number of retained eigenvalues in the inversion of the noise covariance matrix. This result is fundamental to quantifying the goodness of fit statistics leading to the likelihood function estimates. Second, we will present a MCMC analysis of the probability distribution for the climate system properties and compare with previous results. The method will incorporate the errors from the estimated response surface.

Recent results include the climate system response to the combined anthropogenic and natural forcings for the twentieth century. The MCMC method will be applied to the response to anthropogenic-only forcings in addition to the newer results with the complete set of forcings. As in previous work, the climate change diagnostics, which provide the necessary observational constraints, will include changes in surface, upper-air, and deep-ocean temperatures.