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Use of the fluctuation-dissipation theorem to predict tropospheric climate response.

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The response of the tropospheric circulation to sufficiently small external forcing, for example the effect of the solar cycle, is described by a linear operator. One approach to calculating this operator is via the Fluctuation-Dissipation Theorem (FDT) which takes account of the statistics of the unforced circulation, in particular the time decay of correlations. We report a detailed study of the usefulness of the FDT (in two different forms) in predicting the response of the circulation in a simple dry GCM, in particular to a zonally symmetric forcing. We pay particular attention to the following:

- The size of forcing required for the response to be within the linear regime.
- The convergence of the FDT prediction, quantified by the bias and the variance, as the length of the time series of the unforced circulation increases.
- The use of the zonal wind field alone to calculate the statistics and predict response.
- The implications of truncation in EOF space. (We find that the variance of the prediction is reduced by truncation, but that the bias introduced is significant.)

The overall conclusion is that the FDT fails to make an accurate prediction, with the predicted response being approximately double the actual response of the GCM. This failure is likely to be due to violation of the assumption of Gaussian statistics required for the FDT (in its simple and most usual form).