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# Scaling analysis of stochastic climate sensitivities

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Climate sensitivity is usually defined as a deterministic quantity relating specific climate forcings and responses. While this definition may be appropriate for evaluating the outputs of (deterministic) GCM's it is problematic when the sensitivities are estimated from empirical data that often have large uncertainties.

In this presentation, we statistically define the climate sensitivity as the ratio of RMS temperature to RMS forcing fluctuations, and we evaluate it empirically it as a function of time scale over the range $\approx$ 30 yrs to 100 kyrs. Since there is only a statistical link between the forcing and response, stochastic sensitivities are only "potential" i.e. they give the correct average sensitivity given that the forcing is dominant. The stochastic sensitivity is thus an upper bound on the deterministic sensitivity.

To estimate the sensitivities, we used temperature data fro, instrumental surface series, multiproxy reconstructions and paleo temperatures; the forcings including several solar, volcanic and orbital forcings. Using Haar wavelet analysis, and with the exception of the orbital forcing, the temperature and forcing fluctuations were found to be roughly scaling so that the climate sensitivity was a power law function of resolution: $\lambda \approx \Delta t^{**}H$. We found that the only forcings that are consistent with constant (scale independent, H $\approx$ 0) feedbacks are the sunspot based solar reconstructions. The volcanic forcing and other solar reconstructions have H $\approx$ 0.7 implying scaling (hence scale dependent) feedbacks increasing strongly (as a power law) with scale.

We show how the neglected scale dependence of the sensitivities has important consequences for evaluating GCM's.