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Observation-based Estimate of Climate Sensitivity with a Scaling Climate Response Function

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To properly adress the anthropogenic impacts upon the earth system, an estimate of the climate sensitivity to radiative forcing is essential. Observation-based estimates of climate sensitivity are often limited by their ability to take into account the slower response of the climate system imparted mainly by the large thermal inertia of oceans, they are nevertheless essential to provide an alternative to estimates from global circulation models and increase our confidence in estimates of climate sensitivity by the multiplicity of approaches. It is straightforward to calculate the *Effective Climate Sensitivity*(EffCS) as the ratio of temperature change to the change in radiative forcing; the result is almost identical to the *Transient Climate Response*(TCR), but it underestimates the *Equilibrium Climate Sensitivity*(ECS). A study of global mean temperature is thus presented assuming a *Scaling Climate Response Function* to deterministic radiative forcing. This general form is justified as there exists a scaling symmetry respected by the dynamics, and boundary conditions, over a wide range of scales and it allows for long-range dependencies while retaining only 3 parameter which are estimated empirically. The range of memory is modulated by the scaling exponent H. We can calculate, analytically, a one-to-one relation between the scaling exponent H and the ratio of EffCS to TCR and EffCS to ECS. The scaling exponent of the power law is estimated by a regression of temperature as a function of forcing. We consider for the analysis 4 different datasets of historical global mean temperature and 100 scenario runs of the *Coupled Model Intercomparison Project Phase 5* distributed among the 4 *Representative Concentration Pathways*(RCP) scenarios. We find that the error function for the estimate on historical temperature is very wide and thus, many scaling exponent can be used without meaningful changes in the fit residuals of historical temperatures; their response in the year 2100 on the other hand, is very broad, especially for a low-emission scenario such as RCP 2.6. CMIP5 scenario runs thus allow for a narrower estimate of H which can then be used to estimate the ECS and TCR from the EffCS estimated from the historical data.