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Reducing Uncertainty in Radiative Forcing and Projections of Climate Change

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Radiative forcing is a fundamental quantity for understanding both anthropogenic and natural changes in climate. It measures the extent that human activities and natural events perturb the flow of energy into and out of the climate system. This perturbation initiates all other changes of the climate in response to external forcings. Inconsistencies in the calculation of radiative forcing introduce unnecessary uncertainties in model projections of climate change that has persisted for more than two decades.

While several methods exist to estimate the effective radiative forcing (ERF) from idealized climate model simulations, the calculation of the instantaneous radiative forcing (IRF) is rarely computed explicitly. The intermodel spread in ERF is widely documented and accepted to be a substantial contributor to intermodel differences in their projections of historical and future climate change. Here we argue that much of the intermodel spread in ERF arises from differences in IRF. This applies for both well mixed greenhouses gases (WMGG) as well as aerosols.

The spread in IRF does not represent an uncertainty in radiative transfer theory, but rather the failure to implement that theory consistently in radiative transfer parameterizations. This introduces unnecessary noise into the model experiments that is difficult to remove. Because most users of these models are largely unaware of this problem, the unsatisfactory implementation of forcing propagates needlessly onto efforts to reduce uncertainty in projections of future climate change. The explicit calculation of radiative forcing and a careful vetting of radiative transfer parameterizations provide a straightforward means of significantly improving these projections.