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Quantifying Future Climate Change

Supplementary Information

Glossary

Climate Model: A mathematical description of the climate system that may be used to make simulations of past or historical and future climate variables such as the mean state, variability and trends. The behaviour of the output of the model is controlled by internal model parameters and external forcing, for example, from greenhouse gases. Mathematically we write $c = M(p,R)$, where M is the model, c is a climate variable that the model simulations (vector or scalar), p is a vector of model internal parameters that control the behaviour of the model and R is the radiative forcing.

Complex Climate Model: A 3-dimensional climate model that solves the time-dependent equations of fluid motion in the atmosphere and the ocean in which sub-grid-scale and other processes are represented by parameterisation schemes. Experiments and outputs from complex climate models are coordinated by the Coupled Model Intercomparison Project (CMIP) and form the 'multi-model ensemble' or MME[4]. Complex Climate Models may simulate physical climate processes and feedbacks but increasingly they include representations of chemical and biological processes, in which case they may be termed Earth Systems Models.

Simplified Climate Model: Usually a 1-dimensional climate model written in terms of global mean quantities. Often derived from global energy balance considerations and therefore often called an **Energy Balance Model (EBM)**.

Metric: A measure of how well a climate model reproduces some observed or reconstructed climate, climate variability, climate process or climate trend. A root mean squared error formulation is often adopted. The concept of a metric is, at present, rather ill-defined in the climate modeling literature hence it is recommended that this is an area for future work.

Multi Model Ensemble (MME): A collection of the output of a coordinated set of climate model simulations produced by different climate modeling groups around the world. A typical example is the Coupled Model Intercomparison Project (CMIP). Each model in the ensemble is usually considered by the modeling group to be their 'best shot' at simulating the climate system i.e. to have the best combination of resolved and parameterized processes as limited by practical considerations of run time. Although some modeling groups now submit more than one version of their model.

Observational Constraint: The use of observations to define a range or distribution of model parameters. The observational constraint is derived from a metric that compares the model simulation of past or historical climate with that observed.

Parameter: A physical 'constant' that is input to and controls the behaviour of a climate model. In simple climate models, parameters may capture many physical processes e.g. the diffusion of heat through the global ocean. In complex climate models, parameters tend to relate more to specific physical processes e.g. the rate of entrainment of dry air into a cloud. While in principle, parameters may have measureable physical counterparts, in many cases they control approximations to the full complexity of that process.

Perturbed Physics Ensemble or Perturbed Parameter Ensemble (PPE): An ensemble in which a single model structure is used and parameters that control the unresolved parameterized processes are varied according to some strategy. More commonly a PPE is used to describe a perturbed ensemble of complex model experiments.