Are GCMs Philosophically Robust?:
A discussion of model independence and robustness

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Seager et al. (2007) projection that the Southwestern United States will undergo a transition to hot and arid conditions comparable in magnitude to the Dust Bowl of the 1930s. The basis of their projection is the agreement of 18 out of 19 general circulation models utilized in the 4th IPCC report. This argument raises two interesting questions: 1.) to what extent do these GCMs actually converge (and how are we to evaluate this); and 2.) to what extent are GCMs independent of one another, such that their convergence is significant?

We draw on philosophy of science in order to begin exploring these questions. In 1966, Richard Levins developed a philosophical criterion of robustness as a strategy for population biology. After recognizing that "all models leave out a lot and are in that sense false, incomplete, inadequate," Levins advocates the development of independent, idealized models as tools of analysis. To illustrate the development of robust conclusions, Levins explored how multiple approaches from conceptually independent sub-disciplines were combined in order to establish the validity of the overall field of population biology. Levins says the resulting robust "truth is the intersection of independent lies," and shows that similarly robust modeling strategies are powerful tools to explore phenomena that are analytically intractable by other means. Given the complexity of the global climate and the primacy of general circulation models as principal modeling tools for its examination (Shackley 1998), we think robustness is a powerful and relevant framework for evaluating those models.

Can a robustness framework apply toward GCMs? While GCMs may converge or agree upon results of various forcings or on underlying causal processes of the climate system, it is not clear that this convergence is achieved through independent means. The very concept of independence between GCMs is not easily definable, for several reasons. The histories of GCMs indicate that many existing GCMs draw upon or descend from a small number of GCMs used in the late 1970s (Edwards 2000). These GCMs often use the same modeling strategies for specific phenomena, draw upon the same physical equations, and utilize much of the same observational data, all of which indicates a high level of interconnectedness. There are, of course, many reasons why GCMs could be considered independent. Some GCMs utilize vastly different grid scales, yet converge on the same answers. GCMs often use different parameterizations, initial conditions, and sometimes even incorporate different physical phenomena.

The notion of whether GCM agreement can be deemed robust, or as an intersection of independent lies, offers significant research questions. We will illustrate these broader questions using recent debates about GCM predictions of climate in the Southwest United States (Seager et al. 2007) for our discussion.

References:

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