Attribution of Climate Trends in the Presence of Natural Variability

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Spontaneous, internally-generated variability of the climate system is pervasive. On the multidecadal time scale it dominates the variability of surface air temperature averaged over extratropical land areas as large as the contiguous United States, and it may be strong enough to temporarily double or cancel the upward trend in global mean temperature in response to the buildup of greenhouse gases. The existence of unforced variability imposes limitations on the degree of confidence that can be attached to assessments and predictions of human-induced climate change.

I will discuss results of some recent studies based on large ensembles of numerical integrations run with a suite of different atmospheric initial conditions but with the same prescribed external forcing scenario. The future trajectory of the real climate system is, in some sense, like the trajectory of an individual member of such an ensemble. The diversity of the trends among the different ensemble members is a measure of the irreducible uncertainty inherent in projections of future climate change. I will show how statistical methods can be used to diagnose the causes of this diversity, most of which is in response to member-to-member diversity in the atmospheric circulation trends, as reflected in the associated patterns of the sea-level pressure trends. Interactions between the atmosphere, oceans, and land also contribute to the variability of surface air temperature trends on the multidecadal time scale. I will argue that in the face of such large uncertainties in the attribution of climate change in the extratropics, more attention should be focused on climate change in the tropics and on the broader suite of environmental issues that impact food security and the viability of ecosystems.