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Chaos in Estimates of Climate Change Impacts

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Estimates of physical, social and economic impacts of climate change are less accurate than usually thought because the impacts literature has largely neglected the internal variability of the climate system. Climate change scenarios are highly sensitive to the initial conditions of the climate system due to the chaotic dynamics of weather. As the initial conditions of the climate system are unknown with a sufficiently high level of precision, each future climate scenario – for any given model parameterization and level of exogenous forcing – is only one of the many possible future realizations of climate. The impacts literature usually relies on only one realization randomly taken out of the full distribution of future climates. Here we use one of the few available large scale ensembles produced to study internal variability and an econometric model of climate change impacts on United States (US) agricultural productivity to show that the range of impacts is much larger than previously thought. Different ensemble members lead to significantly different impacts. Significant sign reversals are frequent. Relying only on one ensemble member leads to incorrect conclusions on the effect of climate change on agriculture in most of the US counties. Impacts studies should start using large scale ensembles of future climate change to predict damages. Climatologists should ramp-up efforts to run large ensembles for all GCMs, for at least the most frequently used scenarios of exogenous forcing.