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Implications of intrinsic variability for economic assessments of climate change

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Integrated Assessment Models (IAMs) are widely used to evaluate the economic costs of climate change, the social cost of carbon and the value of mitigation policies. These IAMs include simple energy balance models (EBMs) to represent the physical climate system and to calculate the timeseries of global mean temperature in response to changing radiative forcing[1]. The EBMs are deterministic in nature which leads to smoothly varying GMT trajectories so for simple monotonically increasing forcing scenarios (e.g. representative concentration pathways (RCPs) 8.5, 6.0 and 4.5) the GMT trajectories are also monotonically increasing. By contrast real world, and global-climate-model-derived, timeseries show substantial inter-annual and inter-decadal variability. Here we present an analysis of the implications of this intrinsic variability for the economic consequences of climate change.

We use a simple stochastic EBM to generate large ensembles of GMT trajectories under each of the RCP forcing scenarios. The damages implied by each trajectory are calculated using the Weitzman damage function. This provides a conditional estimate of the unavoidable uncertainty in implied damages. It turns out to be large and positively skewed due to the shape of the damage function. Under RCP2.6 we calculate a 5-95% range of -30% to +52% of the deterministic value; -13% to +16% under RCP 8.5. The risk premia associated with such unavoidable uncertainty are also significant. Under our economic assumptions a social planner would be willing to pay 32 trillion dollars to avoid just the intrinsic uncertainty in RCP8.5. This figure rises further when allowance is made for epistemic uncertainty in relation to climate sensitivity. We conclude that appropriate representation of stochastic variability in the climate system is important to include in future economic assessments of climate change.

[1] Calel, R. and Stainforth D.A., “On the Physics of Three Integrated Assessment Models”, Bulletin of the American Meteorological Society, 2017.