Mitigation and Adaptation Emissions Embedded in the Transition to a Stable Climate

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Abstract

Climate change necessitates an immediate and sustained global effort to reduce greenhouse gas emissions while adapting to the climate risks caused by historical emissions. This transition to a stable climate will involve many mass global interventions such as the installation of solar and wind capacity, coastal protection and retreat due to sea-level rise, and enhanced demand for cooling energy due to warming, which will result in CO_2 emissions from energy and materials use. Yet, the magnitude of these emissions remains largely unconstrained, leaving open the potential for conflict and feedbacks between mitigation and adaptation goals. In this study, we bring together a suite of sectoral models to estimate the global CO_2 emissions embedded in the transition to a stable climate not exceeding 2°C of warming. We estimate that coastal retreat and protection and adaptive cooling demand will emit ~1.5GtCO_2 through 2100. Emissions from energy investment into renewable capacity are much larger at ~94GtCO_2, equivalent to over two years of current global emissions and ~8% of the remaining carbon budget for 2°C. These embedded transition emissions roughly double under a more gradual transition (2.7°C warming by 2100), mainly because the transition draws on more CO_2 intensive energy. Our results provide the first holistic constraint on the carbon cost of the transition, illuminating important interactions between the trajectories of energy decarbonization, climate impacts, and adaptation. We argue that the emissions embedded in the transition to a stable climate are of sufficient magnitude to compel greater integration of adaptation and mitigation in the realms of both climate science and policy.