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## El Niño variability mediates 21st century growth effects of climate change

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Understanding the effect of climate change on global economic growth is critical to informing optimal mitigation and adaptation policy. Many recent efforts have been made to empirically quantify the roles of weather and climate in economic growth, but these efforts have generally focused on changes in mean climate rather than changes in climate variability. Climate change is expected to alter modes of climate variability, so fully quantifying the costs of climate change requires both understanding the effects of climate variability on economic growth and constraining how this variability will evolve under forcing. Here we combine historical climate and economic data with multiple climate model ensembles to quantify the economic growth effects of El Niño and examine how these effects evolve in the 21<sup>st</sup> century. Preliminary results show substantial negative effects of El Niño on growth, with historical events reducing growth by >5 percentage points over 5 years in countries whose temperature variability is tightly correlated with ENSO. We then examine how climate change influences El Niño and its growth effects in both multi-model and single-model ensembles, allowing us to isolate the role of internal climate variability in shaping the evolution of ENSO statistics in the 21<sup>st</sup> century. Climate change is generally projected to increase El Niño frequency and thus the resulting growth penalties, but internal variability generates a wide spread of responses, all of which are consistent with the same forcing. These results highlight how internal variability can influence both interannual El Niño occurrence and long-term changes in its statistics, with consequences for future economic growth. Moreover, these results illustrate the range of climate impact trajectories that are consistent with the same emissions, providing critical information for adaptation decision-makers needing to construct robust socioeconomic systems in the face of 21<sup>st</sup> century climate change.