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Using climate models to determine the causes of surface temperature change over the historical period

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Predicting climate changes and the impacts of these changes remains a challenge. Using the full historic record from 1850-2010 can help put the predicted and recently observed change into context and evaluate the relative roles of internal climate variability and external forcing on climate.

Using an optimal detection and attribution technique within a Bayesian framework we calculate a probabilistic estimate of the effect of external and internal variability on surface temperature over the past 160 years. This allows us to estimate the contribution of anthropogenic forcings, natural forcings and internal climate variability to several key historic periods in several different latitudinal bands. We focus on the early 20th warming, mid-century hiatus and late 20th century warming. By combining the results from different models and using an ensemble of observations we account for uncertainty in a more complete way than previous studies.

The probabilistic estimate of internal variability can be compared to the Coupled Model Intercomparison Project Phase 5 (CMIP5) control simulations as both a verification of the method and a test that the variability in the control simulations are realistic. We find that the internal variability of many models is consistent with our estimate of observed variability. However, some models exhibit variability which is too high while others have variability which is too low. This has important implications for both attribution and the estimate of uncertainty surrounding future projections.