A Bayesian attribution analysis of global and regional changes in extreme temperatures during 1951-2010

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Human influences on the warming of extreme temperatures have been detected at global and regional scales which is based on a multiple linear regression between observations and model simulated patterns (e.g., Min et al. 2013; Kim et al. 2016). This study applies a Bayesian decision method (Min et al. 2004) to four extreme temperature indices (annual minima/maxima of daily minimum/maximum temperature, referred to as TNn, TXn, TNx, and TXx) during 1951-2010 using the HadEX2 observations and 13 CMIP5 multi-model simulations. CMIP5 simulations include experiments under natural plus anthropogenic forcing (ALL), natural forcing (NAT), and anthropogenic forcing (estimated as ALL-NAT). Pre-industrial control simulations (CTL) are also used to estimate internal variability. Spatial domains are considered from global, continental (North America, South America, Europe, Asia, and Australia), and eighteen sub-continental regions where sufficient observations exist. The Bayesian decision method provides a measure of signal amplitude by comparing the probability of observations in view of each forcing or scenario considered (likelihood). Results show that ANT and ALL signals are detected in global and most of the continental regions for four extreme indices. Generally, daily minimum temperature (TN) exhibits stronger evidences than daily maximum temperature (TX). Results for sub-continental regions show that, for cold extremes, ANT and ALL signals are detected mainly over North and South America, eastern Asia, and Australia. For warm extremes, ANT and ALL signals are detected in mid-high latitude regions (North America, Europe, Asia), in line with the continental-scale results. Further, we have quantified the contribution of NAT signal to the observed changes in extreme temperature by comparing the likelihood between ALL and ANT. The stronger signal amplitude in ALL than in ANT (due to NAT contribution) is found in the globe, North America, Europe, and Asia, more for warm extremes (TNx, TXx). As a whole, our Bayesian analysis results support previous findings, increasing robustness of the anthropogenic influence on the warming of extreme temperatures at continental and regional scales.

Key words: Detection and attribution, Bayesian decision, extreme temperature, anthropogenic forcing, natural forcing

References

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