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Changes in Day-to-day temperature variability in United States driven by cleaner air

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Day-to-day (DTD) temperature variability is an important characteristic of air temperature, which significantly affects human health and ecosystems. However, the changing trend of DTD under recent climate warming and its causes need to be further explored. Here, Using daily temperature observations, we examine the spatial heterogeneity of DTD and its long-term trends in the United States (US) over the last 26 years and find a significant increase in winter DTD in the central and eastern United States during the study period. In addition, by using the observed data and The Coupled Model Intercomparison Project Phase 6 (CMIP6) multi-model simulations, we further demonstrate that cleaner air leads to significant changes in DTD. Specifically, by comparing the contributions of greenhouse gases, anthropogenic aerosols, natural forcing, and total forcing, it is concluded that the reduction of anthropogenic aerosol concentrations in the United States after 1997 led to enhanced DTD . Of the 32 members used in this study, nearly 60% show positive trends in the DTD index during 1997–2022 in the historical simulations. The trends for the ensemble members range from -0.06 to 0.08 °C ·decade^{-1} with an ensemble mean of 0.008°C·decade^{-1} which encompasses the trend derived from the observations (0.08 °C·decade^{-1}) . The historical simulations reasonably capture the observed DTD trends except with a weaker magnitude. The increasing trend is also evident in the anthropogenic-aerosol-only historical simulations, where about 56% of the 32members show positive trends, with an ensemble mean of 0.01 °C·decade^{-1}. While contrary to the results of the anthropogenic-aerosol-only historical simulations (hist-aer), there was negative trends In the natural-only historical (hist-nat) and the greenhouse-gas-only historical (hist-GHG) simulations, only about 44% and 47% of the members showed the positive trends, The trend for the ensemble mean is -0.013/-0.015°C·decade-1 for the hist-nat / hist-GHG simulations. Therefore, the positive trend of the DTD index can be attributed to the anthropogenic aerosols , while the negative trend of which can be attributed to the natural forcing and greenhouse gas forcing. The observed DTD enhancement over 1997-2022 is dominated by the effect of anthropogenic aerosols, while natural forcing and GHGS partially counteract the effect of anthropogenic aerosols. That is, Based on climate modeling experiments, we demonstrate that the reduced aerosol emissions in US can contribute to the enhanced trend of DTD in USA.