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Key Points:
- Annual burned area in California increased fivefold during 1972–2018, mainly due to summer forest fire
- Anthropogenic warming very likely increased summer forest fire by drying fuels; this trend is likely to continue
- Large fall fires are likely to become increasingly frequent with continued warming and possibly gradual declines in fall precipitation

Supporting Information:
- Supporting Information S1

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Observed Impacts of Anthropogenic Climate Change on Wildfire in California

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Abstract Recent fire seasons have fueled intense speculation regarding the effect of anthropogenic climate change on wildfire in western North America and especially in California. During 1972–2018, California experienced a fivefold increase in annual burned area, mainly due to more than an eightfold increase in summer forest-fire extent. Increased summer forest-fire area very likely occurred due to increased atmospheric aridity caused by warming. Since the early 1970s, warm-season days warmed by approximately 1.4 °C as part of a centennial warming trend, significantly increasing the atmospheric vapor pressure deficit (VPD). These trends are consistent with anthropogenic trends simulated by climate models. The response of summer forest-fire area to VPD is exponential, meaning that warming has grown increasingly impactful. Robust interannual relationships between VPD and summer forest-fire area strongly suggest that nearly all of the increase in summer forest-fire area during 1972–2018 was driven by increased VPD. Climate change effects on summer wildfire were less evident in nonforested lands. In fall, wind events and delayed onset of winter precipitation are the dominant promoters of wildfire. While these variables did not change much over the past century, background warming and consequent fuel drying is increasingly enhancing the potential for large fall wildfires. Among the many processes important to California's diverse fire regimes, warming-driven fuel drying is the clearest link between anthropogenic climate change and increased California wildfire activity to date.

Plain Language Summary Since the early 1970s, California's annual wildfire extent increased fivefold, punctuated by extremely large and destructive wildfires in 2017 and 2018. This trend was mainly due to an eightfold increase in summertime forest-fire area and was very likely driven by drying of fuels promoted by human-induced warming. Warming effects were also apparent in the fall by enhancing the odds that fuels are dry when strong fall wind events occur. The ability of dry fuels to promote large fires is nonlinear, which has allowed warming to become increasingly impactful. Human-caused warming has already significantly enhanced wildfire activity in California, particularly in the forests of the Sierra Nevada and North Coast, and will likely continue to do so in the coming decades.

1. Introduction

In the western United States, annual area burned increased substantially in recent decades due to increased frequency and size of large wildfires (Abatzoglou & Williams, 2016; Balch et al., 2018; Dennison et al., 2014; Westerling, 2016). It is well established that this observed increase in wildfire activity was promoted in many areas by reduced fuel moisture due to warming-induced increases in evaporative demand, reduced snowpack, and reduced warm-season precipitation frequency (Abatzoglou & Williams, 2016; Holden et al., 2018; Kitzberger et al., 2017; Westerling, 2016). These recent climate trends are broadly consistent with those expected from anthropogenic climate change (Abatzoglou & Williams, 2016), but anthropogenic climate effects on wildfire can vary greatly across space and time due to confounding factors such as natural climate variations, land and fire management practices, ignitions from humans, spatial diversity in vegetation type, and the complex ways in which these processes interact (Williams & Abatzoglou, 2016). Therefore, location-