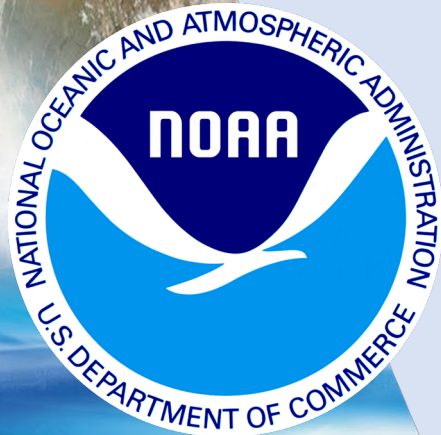


# Contributions of fire emissions to air quality, climate, and their linkage

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# Highly anomalous fire emissions from the 2019–2020 Australian bushfires

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**Keywords:** Australia, biomass burning, fire intensity, emissions, smoke

Supplementary material for this article is available [online](#)

## Abstract

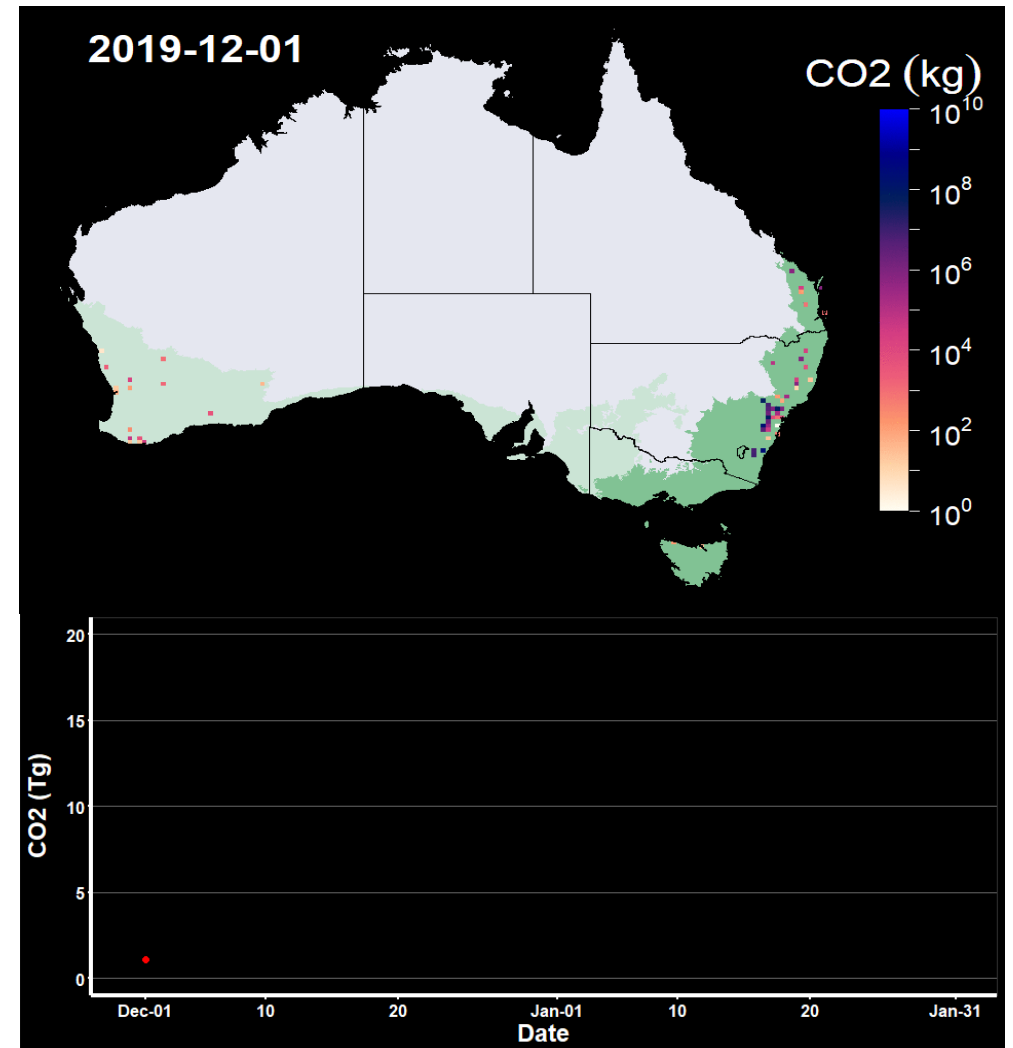
While it is widely recognized that extreme fires have been increasing under warming and drying climate, knowledge regarding the magnitude and intensity of extreme fires is very limited. Moreover, fire emissions reported by existing emissions inventories show large discrepancies due to different approaches and parameters. In this study, we analyzed the fire intensity and emissions magnitude of the 2019–2020 Australian bushfires using fire observations from multiple satellites. The results show that the bushfires were extreme in both their number and intensity, which were higher by a factor of 25 and 19, respectively, compared to the past two-decade seasonal mean. The 2019–2020 bushfires burned a total of 112.3 Tg biomass and released  $178.6 \pm 13.6$  Tg CO<sub>2</sub> (carbon dioxide),  $1.71 \pm 1.28$  Tg PM<sub>2.5</sub> (particulate matter with a diameter  $<2.5 \mu\text{m}$ ), and  $0.061 \pm 0.04$  Tg BC (black carbon) across eastern and southern Australia. The CO<sub>2</sub> emissions are 35% of Australia's greenhouse emissions from all sectors combined in 2020. Furthermore, the extreme fires in the most severe day and hour released 10% and 1.4% of the entire seasonal emissions, respectively. Our findings provide quantitative information for investigating the impacts of smoke emissions on air quality, ecosystem, and climate.



***Biomass burning is a significant source of greenhouse gases.***

- In a warming and drying climate, fire activity across the globe is increasing and leading to enhanced greenhouse gas (GHG) emissions.
- GHG emissions from fires contribute significantly to nations' annual budgets. For example, CO<sub>2</sub> emissions from bush fires in Australia contributed to 35% of its annual emissions.
- NOAA began generating long-term satellite data record of GHG emissions from fires to understand trends, contributing factors to these trends, and how new land management policies can potentially be developed to reverse the trend.

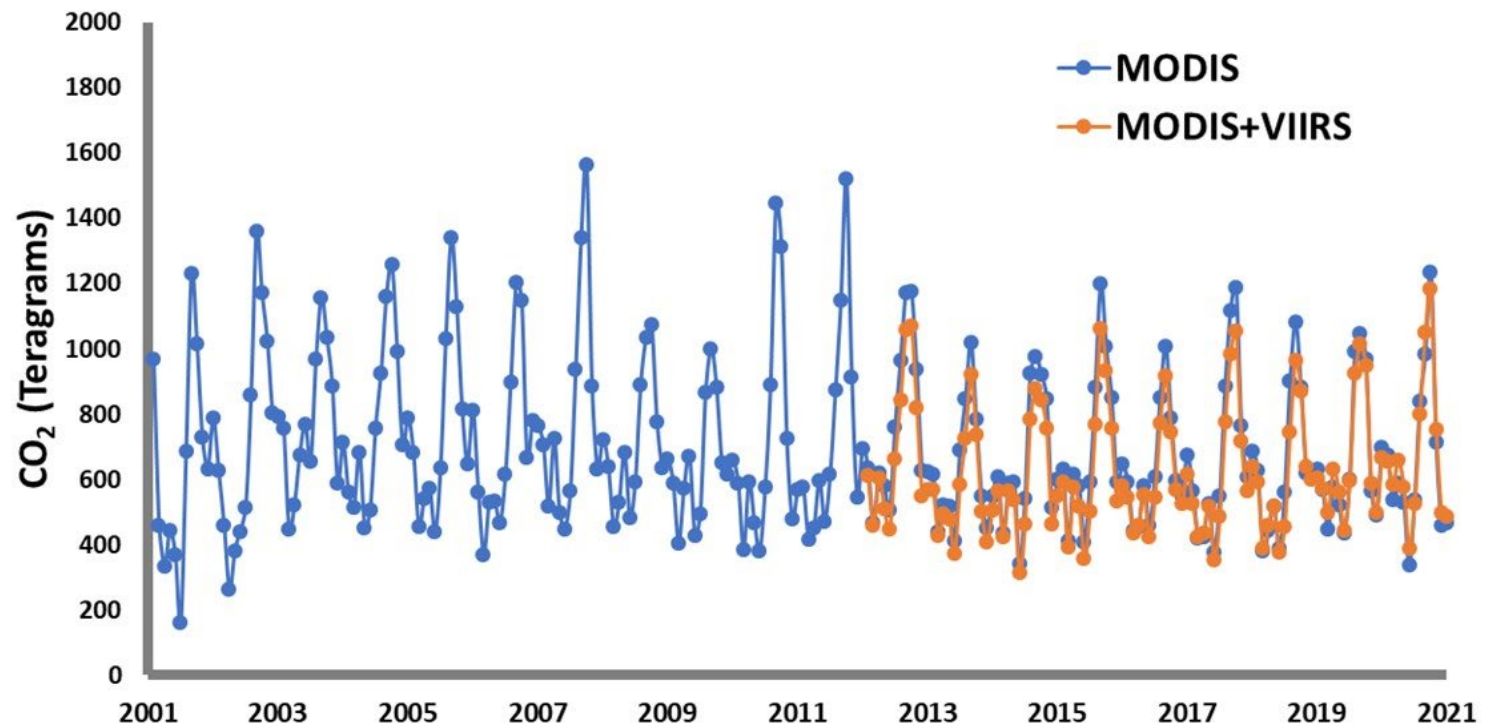
***CO<sub>2</sub> emissions generated using NOAA and NASA satellite data*** →



# Generation of long-term GHG emissions record

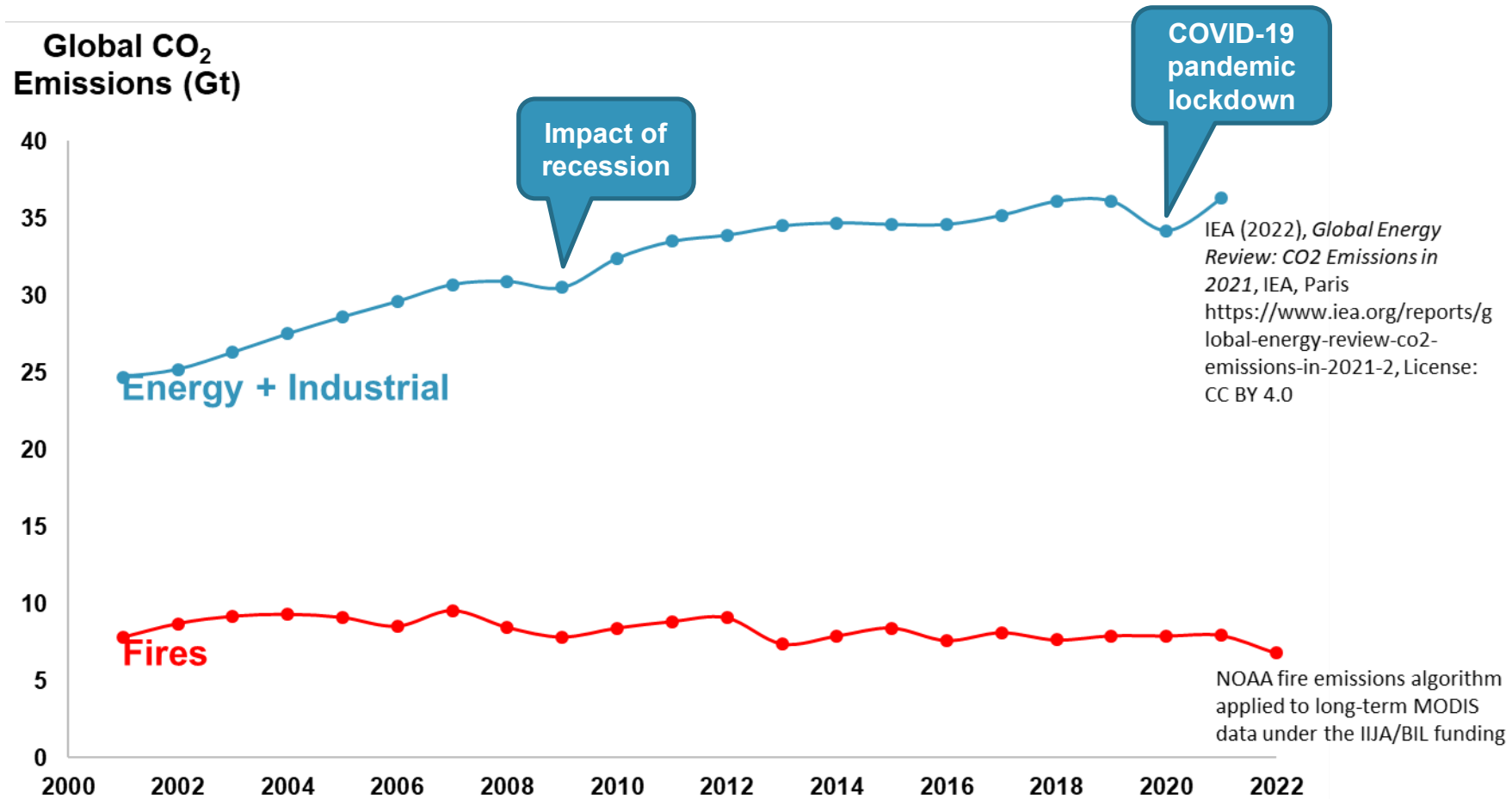
- ✓ NOAA's Global Biomass Burning Emissions eXtended (GBBEPx) algorithm was run on the entire Aqua and Terra MODIS fire record.
- ✓ VIIRS instrument on SNPP and JPSS satellite series will continue the data record.
- ✓ NOAA is already delivering near real time GHG emissions from fires to support the scientific community with its GHG budget work.

Global Monthly Biomass Burning Emissions

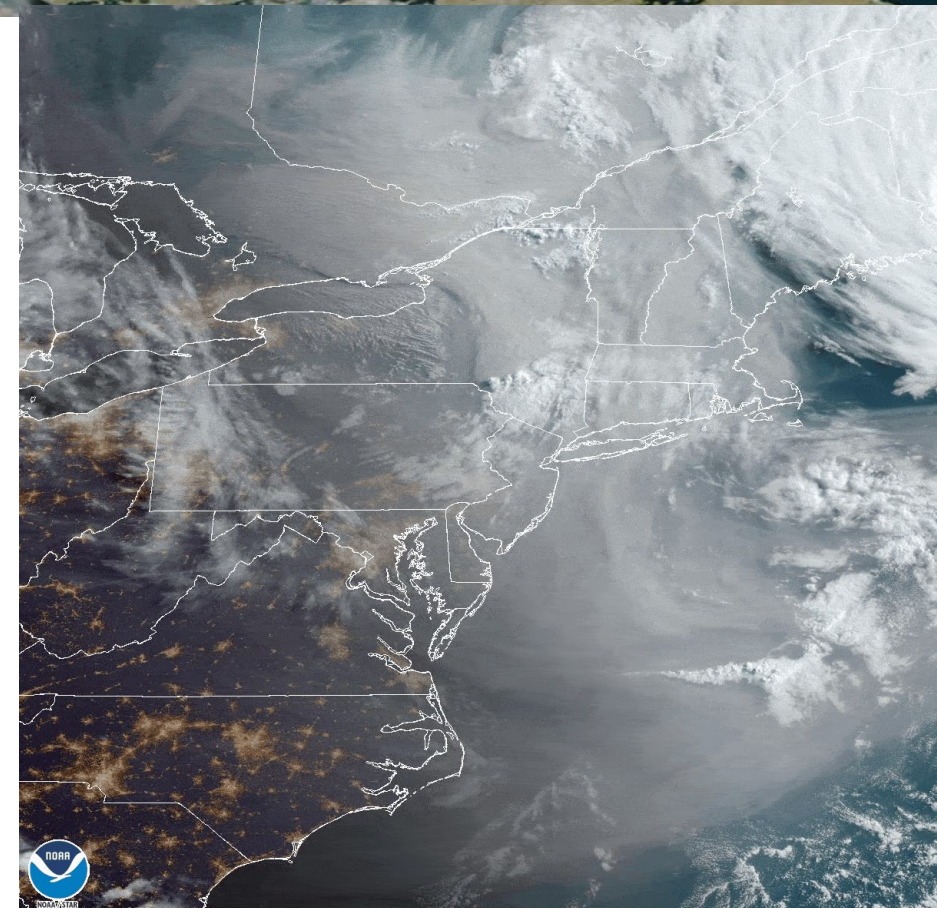


NASA MODIS: MODerate resolution Imaging Spectrometer  
NOAA VIIRS: Visible Infrared Imaging Radiometer Suite

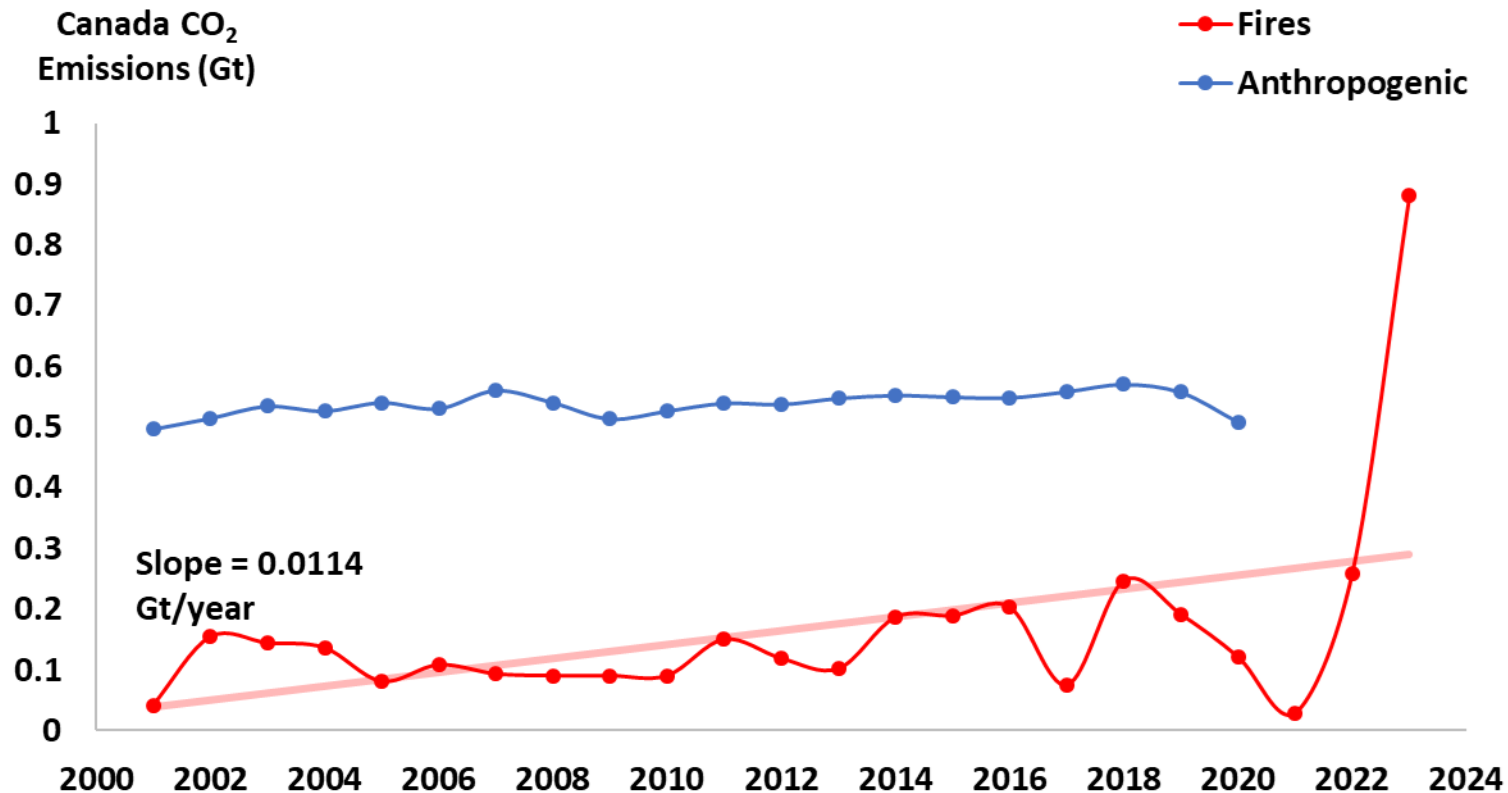
Contribution of fires to global GHG budget is not insignificant



*Regionally, contribution of fires to GHG budget can surpass anthropogenic sources as was the case for 2023 Canadian fires.*



Canada CO<sub>2</sub> Emissions (Gt)



The key benefit of deriving GHG emissions from fires is to document the contributions of different types of fires to air quality and climate in the United States along with an assessment of the role that fires play in enhancing each nation's greenhouse gas emissions negating any gains from anthropogenic emissions reductions.

- Continuous processing of the global fire products in near real time and delivering the CO<sub>2</sub> and CH<sub>4</sub> fire emissions data on a monthly cadence to the US GHG center will support the national GHG strategy.
- Analysis of NOAA's hourly GHG emissions product can shed light on contributions of agricultural fires vs. wildfires to national and global GHG budget.

## Up in smoke: California's greenhouse gas reductions could be wiped out by 2020 wildfires<sup>☆</sup>



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Economic impacts

### ABSTRACT

In this short communication, we estimate that California's wildfire carbon dioxide equivalent (CO<sub>2</sub>e) emissions from 2020 are approximately two times higher than California's total greenhouse gas (GHG) emission reductions since 2003. Without considering future vegetation regrowth, CO<sub>2</sub>e emissions from the 2020 wildfires could be the second most important source in the state above either industry or electrical power generation. Regrowth may partly of fully occur over a long period, but due to exigencies of the climate crisis most of the regrowth will not occur quickly enough to avert greater than 1.5 degrees of warming. Global monetized damages caused by CO<sub>2</sub>e from in 2020 wildfire emissions amount to some \$7.1 billion USD. Our analysis suggests that significant societal benefits could accrue from larger investments in improved forest management and stricter controls on new development in fire-prone areas at the wildland-urban interface.

# CO<sub>2</sub> from Fires

2020

