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Introduction

Earth’s climate is a complex, interactive system influenced by the atmosphere, land surfaces, water bodies, snow and ice, and living organisms. Natural factors such as solar radiation and volcanic eruptions have driven climate fluctuations throughout Earth’s history, but since the mid-20th century, human activities have become the dominant force. Widespread combustion of fossil fuel, industrial processes, and land use have dramatically increased concentrations of greenhouse gases (GHGs), altering the climate at a pace unlike any natural cycle.

Carbon dioxide (CO₂) is the largest contributor to human-induced climate change. Atmospheric CO₂ concentrations have increased approximately 150 parts per million (ppm) since the Industrial Revolution, rising from 315 ppm in 1958 to 426 ppm in 2025. Because CO₂ can persist in the atmosphere for centuries, these elevated levels will likely stay above 400 ppm even if GHG emissions were to stop today, contributing to continued warming for generations (Forster et al., 2026; IPCC, 2023). Increases in other GHGs, such as methane and hydrofluorocarbons, in addition to black carbon emissions, also contribute to warming. In California, rising GHG concentrations are reshaping air temperatures, snowpack and water resources, wildfire fuels, and public health.

The environmental impacts of climate change are increasingly affecting people’s lives, experienced disproportionately by low-income populations and communities of color, and California has moved aggressively to address the drivers. The state reached its target of reducing GHG emissions to 1990 levels by 2020, and emissions have continued to decline. The 2022 California Air Resources Board (CARB) Scoping Plan



charts a sector-by-sector pathway to carbon neutrality by 2045 or earlier, with co-benefits that include meaningful reductions in co-pollutant burdens and improved health outcomes for overburdened communities. California is also advancing nature-based solutions to enhance the capacity of natural lands to remove carbon from the atmosphere while supporting biodiversity and building community resilience.

The three chapters that follow – Greenhouse Gas Emissions, Atmospheric Greenhouse Gas Concentrations, and Atmospheric Black Carbon Concentrations – document the current state of these drivers and California’s ongoing efforts to reduce them.

References

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