

The Seasonal and Diurnal Variability of Atmospheric Carbon Dioxide (CO₂) over a Semi-Urban Site in the Indo-Gangetic Plain

Vimal Jose Vazhathara

Centre for Atmospheric Sciences, Indian Institute of Technology Delhi, New Delhi, India

Author list (excluding presenting author)

Ravi Kumar Kunchala, Sajeev Philip, Jaswant Rathore, Dilip Ganguly, Shahzad Gani, Sagnik Dey

Abstract

Atmospheric carbon dioxide (CO₂) is a greenhouse gas (GHG) that plays a pivotal role in Earth's radiative forcing and climate change. The primary cause of the increase in atmospheric CO₂ levels is anthropogenic activities, with fossil fuel burning and cement manufacturing being the major contributors. The Indo-Gangetic Plain (IGP) is one of the hotspots for GHG concentrations. There is a severe lack of continuous measurements of GHGs over IGP. To overcome this limitation, for the first time, continuous measurements of CO₂ have been made at Sonipat, a suburban site in the IGP region, using a state-of-the-art laser-based cavity ring-down spectroscopy technique from February 2023 to February 2024. Our initial analysis reveals that this suburban measurement site, located upwind from the Delhi National Capital Region, is affected mostly by industrial, vehicular, and local/non-local emissions. The observed annual average concentration of atmospheric CO₂ is 422.3 ± 26.52 ppm. The concentration of CO₂ shows strong seasonal variability with lower concentrations (404.9 ± 25.95 ppm) during the monsoon (June-July-August-September) and higher concentrations (438.8 ± 27.73 ppm) during the post-monsoon (October-November) season. Irrespective of the seasons, consistent diurnal variations in CO₂ concentration are observed. The influence of prevailing meteorology (boundary layer height, air temperature, wind speed, wind direction, and relative humidity) on GHGs has also been investigated. Investigation reveals that the primary drivers of the diurnal cycles of CO₂ are convective mixing, rush-hour traffic, and the influence of biospheric fluxes.

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