Abstract

Agricultural activities release various emissions into the environment, which come from several sources, including livestock, crop production and soil management. The main pollutants emitted from agricultural activities are ammonia (NH_3) and greenhouse gases (GHGs), which are major drivers of global warming and climate change. The growing population of the world is putting pressure on agricultural production systems to make more food globally. This surge in agricultural activities results in an increase in emissions of trace gases. These emissions have detrimental effects on plants and animals by making them more vulnerable to the attacks of insects/pests and diseases. Therefore, this study aimed at investigating the spatial and temporal variability of NH_3 and GHGs concentrations in India and their connection with farming activities. A holistic assessment of these emissions is presented using satellites and ground-based observations in this study. Satellite data are used to study NH_3 and GHG concentrations over India. The emission maps developed in this study will help pinpoint the major hotspot areas of these trace gases in different regions of India. Ammonia emissions are primarily associated with the application of chemical fertilizers, livestock farming and biomass burning. The key finding of this study is that Indo-Gangetic Plains (IGP) is one of the largest and rapidly growing NH_3 hotspots of India, with a growth rate of +1.2% yr^{-1} in Kharif season, due to intensive agricultural activities. The analyses show insignificant negative trends (2008-2016) in annual NH_3 (− 0.8% yr^{-1}) in India, suggesting positive action and commitment to the national missions to reduce emissions. A strong positive correlation between NH_3 and PM_{10} shows a close association between them. The changes in the atmospheric concentrations of two major GHGs (carbon dioxide and methane) were also assessed for the Indian region. The findings show that agricultural activities contribute significantly to the atmospheric methane (0.0765 ppm $decade^{-1}$ in the past decade). One of the primary reasons for these emissions is the application of chemical fertilizers to improve crop yield. Although vegetation acts as a strong sink for atmospheric carbon dioxide through photosynthesis, there has been a significant increase in atmospheric carbon dioxide (2.42 ppm yr^{-1}) from 2009 to 2020 in India, where agriculture and allied activities played a major role. The emissions found to be positively correlated with the total fertilizer consumption and therefore, the fertilizer application during cropping season in cultivated lands should be regulated. This study suggests for adoption of better fertilization practices to curb agricultural emissions to alleviate the adverse health effects and negative impacts on the ecosystem.

Keywords: Aerosols; Ammonia; GHG emissions; Greenhouse Gases Observing Satellite (GOSAT); Infrared Atmospheric Sounding Interferometers (IASI); Indian agriculture; Particulate matter