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Spatio-Temporal Distribution of Aerosols Over Kerala: A Satellite-Based Assessment in Polluting Climate

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ABSTRACT

India has seen an increase in the extreme rainfall events (EREs) over the years, which is likely to continue due to global warming. The rising frequency of EREs is often linked to increasing atmospheric pollution, particularly atmospheric aerosols, which are one of the key components of the climate system. The recent increase in EREs over Kerala leading to extensive flooding and landslide has demonstrated the consequences of the combined impact of global warming and atmospheric pollution. Studies reveal that the recent EREs are particularly characterized by highly polluted (aerosol-rich) scenarios, supporting cloud invigoration with moisture convergence leading to EREs. In the current era of global warming, where the atmospheric water holding capacity is expected to increase, the prime question is whether there will be sufficient aerosols (as cloud condensation nuclei) to support precipitation? In this context, the present study is dedicated to understanding the spatial and temporal distribution of aerosols over the state of Kerala. Monthly average Aerosol Optical Depth (AOD, 550 nm) from Collection 6.1, level 3 AOD products (1° × 1°) derived from Terra's MODIS measurements for 21 years (2001 – 2021) is discussed in this study, while data from 2001 to 2019 is utilized for the analysis. Spatio-temporal analysis of the district-wise AOD data is carried out along with a trajectory analysis to ascertain probable aerosol sources. Time series analysis indicates a significant increasing trend in AOD over Kerala. A higher rate of increase in AOD is observed among the northern districts, with Kozhikode recording the fastest growth. AOD is particularly heavier during certain months, and the wind trajectory analysis performed reveals the direction of the wind which might have carried the possible sources like dust, sea salt, smoke, etc., during the observed monthly aerosol loading during highest and lowest concentrations. Further, the frequency analysis shows that the frequency of aerosol-pollution-episodes (AOD > 0.4) has increased alarmingly from 13.3 % (2001-2005) to 53.3% (2015-2019). Further, a classification of the districts based on mean AOD through 4 sub periods: 2001-2005, 2006-2010, 2011-2015, and 2016-2019 reveals that none of the districts were safe zones (AOD<0.3) after the 2001-2005 period. Eventually in recent years 2016-2019, Kozhikode district had turned highly vulnerable (AOD>0.5), while districts including Kasaragod, Kannur, Thrissur, Palakkad, Ernakulam, Kottayam, Alappuzha, and Pathanamthitta were vulnerable zones (0.4<AOD<0.5), and remaining districts continued as less vulnerable zones (0.3<AOD<0.4).