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Assessment of Air Pollutants in China Based on Geostationary Satellites and Machine Learning

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The rapid development of urbanization in China has led to an increase in emissions of various pollutants. Additionally, the long-distance transport of dust (LRTD) from arid and semi-arid areas also has a significant impact on China's atmospheric environment each year. This study obtained hourly atmospheric particulate matter (PM2.5 and PM10) and gaseous pollutants (O3, CO, NO2, and SO2) in China using direct top-of-atmosphere radiation (TOAR) data from geostationary satellites (FY-4A/4B, Himawari-8/9) and employed an interpretable deep learning model (deep forest model). The overall performance of the model is commendable, with hourly R2 of 0.83-0.88 for the TOAR-PM2.5 model, and the optimal hourly R2 of the TOAR-PM10 model reaching 0.85. The TOAR and Boundary layer height are both essential features that contribute greatly to the model. Moreover, using the same TOAR and other auxiliary data, the deep forest model performs better than other machine learning models like Decision Tree, Random Forest, and Extreme Tree. The assessment results of PM2.5 pollution status indicate significant urban-rural differences in distribution. The concentration of PM10 in spring in northern China is higher than that in southern China, which may be related to LRTD. Excluding periods of dust weather, areas with high PM10 values in China are mainly located in large cities and suburban areas, which are related to local human activities. During dust weather, LRTD increased PM10 in northern China by 80.4%. During haze periods, both LRTD and local pollution are important for atmospheric particulate matter

pollution. Overall, geostationary satellites have shown great potential in estimating the spatial distribution of pollutants in China, offering high precision, high spatiotemporal resolution, and comprehensive coverage.