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Regional Features of Long-Term Exposure to PM_{2.5} Air Quality over Asia under SSP Scenarios Based on CMIP6 Models

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This study investigates changes in fine particulate matter (PM_{2.5}) concentration and air-quality index (AQI) in Asia using nine different Coupled Model Inter-Comparison Project 6 (CMIP6) climate model ensembles from historical and future scenarios under shared socioeconomic pathways (SSPs). The results indicated that the estimated present-day PM_{2.5} concentrations were comparable to satellite-derived data. Overall, the PM_{2.5} concentrations of the analyzed regions exceeded the WHO air-quality guidelines, particularly in East Asia and South Asia. In future SSP scenarios that consider the implementation of significant air-quality controls (SSP1-2.6, SSP5-8.5) and medium air-quality controls (SSP2-4.5), the annual PM_{2.5} levels were predicted to substantially reduce (by 46% to around 66% of the present-day levels) in East Asia, resulting in a significant improvement in the AQI values in the mid-future. Conversely, weak air pollution controls considered in the SSP3-7.0 scenario resulted in poor AQI values in China and India. Moreover, a predicted increase in the percentage of aged populations (>65 years) in these regions, coupled with high AQI values, may increase the risk of premature deaths in the future. This study also examined the regional impact of PM_{2.5} mitigations on downward shortwave energy and surface air temperature. Our results revealed that, although significant air pollution controls can reduce long-term exposure to PM_{2.5}, it may also contribute to the warming of near- and mid-future climates.