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Development of a numerical system to improve particulate matter forecasts in South Korea using geostationary satellite-retrieved aerosol optical data over Northeast Asia

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To improve short-term particulate matter (PM) forecasts in South Korea, the initial distribution of PM composition, particularly over the upwind regions, is primarily important. To prepare the initial PM composition, the aerosol optical depth (AOD) data retrieved from a geostationary equatorial orbit (GEO) satellite sensor, GOCI (Geostationary Ocean Color Imager) which covers a part of Northeast Asia (113–146 E; 25–47 N), were used. Although GOCI can provide a higher number of AOD data in a semicontinuous manner than low Earth orbit (LEO) satellite sensors, it still has a serious limitation in that the AOD data are not available at cloud pixels and over high-reflectance areas, such as desert and snow-covered regions. To overcome this limitation, a spatiotemporal-kriging (STK) method was used to better prepare the initial AOD distributions that were converted into the PM composition over Northeast Asia. One of the largest advantages in using the STK method in this study is that more observed AOD data can be used to prepare the best initial AOD fields compared with other methods that use single frame of observation data around the time of initialization. It is demonstrated in this study that the short-term PM forecast system developed with the application of the STK method can greatly improve PM_{10} predictions in the Seoul metropolitan area (SMA) when evaluated with ground-based observations. For example, errors and biases of PM_{10} predictions decreased by ~ 60 and $\sim 70\%$, respectively, during the first 6 h of short-term PM forecasting, compared with those without the initial PM composition. In addition, the influences of several factors on the performances of the short-term PM forecast were explored in this study. The influences of the choices of the control variables on the PM chemical composition were also investigated with the composition data measured via PILS-IC (particle-into-liquid sampler coupled with ion chromatography) and low air-volume sample instruments at a site near Seoul. To improve the overall performances of the short-term PM forecast system, several future research directions were also discussed and suggested.