Development of aerosol effective height retrieval algorithm using O4 air mass factor from Ozone Monitoring Instrument (OMI): Effects of spatiotemporal O4 column densities and temperature-dependent O4 absorption cross section

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An aerosol effective height (AEH) retrieval algorithm has been developed using the O4 air mass factor (AMF) at 477 nm from the hyperspectral Ozone Monitoring Instrument (OMI). The magnitude of change in O4 vertical column density (VCD) was topographically and seasonally investigated in Northeast Asia. Its effect on AEH retrieval accuracy has been evaluated using our AEH retrieval algorithm. In addition, the effect of a temperature-dependent cross-section for O4 (TDCS) on AEH retrieval accuracy was quantified. TDCS is found to enhance AEH retrieval accuracy compared with an O4 absorption cross-section at a single temperature of 293 K (SCS), when spatial and seasonal dependency of O4 VCD is applied to the LUT in our algorithm. In comparison between the retrieved AEH and those from ground-based lidar network for the period from January 2005 to June 2009, when both the TDCS and seasonal and topographical O4 VCDs are applied, a Root Mean Square Error (RMSE) is 0.44 km for both smoke and dust types. However, when both a TDCS (SCS) and a single O4 VCD value were applied to the LUT, the RMSE for both aerosol types is 0.52 km (0.51 km). It implies that TDCS contributes most to AEH retrieval accuracy when accurate O4 VCDs are applied to the LUT. For smoke aerosols only, both TDCS and multiple O4 VCD (SCS and single O4 VCD) applications had RMSE value of 0.46 km (0.66 km). Based on synthetic radiances, we also estimated the effects of uncertainties in our algorithm input data such as O4 VCD, TDCS, aerosol type, AOD, and surface reflectance on AEH retrieval error. It was found that large errors are attributable to uncertainties in O4 VCD, AOD, and surface reflectance compared with those of TDCS and aerosol type. Especially, an O4 VCD uncertainty of about 140% caused AEH errors more than 4.3 km. The large improvement of the retrieval performance is expected when the realistic O4 VCD (versus several O4 VCD values in the LUT) is used in the algorithm.