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Investigation of simultaneous effects of aerosol properties and aerosol peak height on the air mass factors for space-born NO_2 retrievals

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We investigate the simultaneous effects of aerosol peak height (APH), aerosol properties, measurement geometry, and other factors on the air mass factor for NO_2 retrieval at sites with high and low NO_2 concentrations. In terms of the effects of aerosol properties and measurement geometry, we find that the effect of measurement geometry is more significant at the low-NO_2 site than at the high-NO_2 site, because normalized NO_2 values near the surface at the former are lower than those measured at the latter. A comparison of the effects of high and low surface reflectance reveals that NO_2 air mass factor (AMF) values over a snowy surface (surface reflectance 0.8) are generally higher than those over a deciduous forest surface (surface reflectance 0.05). Under high aerosol optical depth (AOD) conditions, the aerosol shielding effect over a high-albedo surface is revealed to reduce the path-length of light at the surface, whereas high single scattering albedo (SSA) conditions (e.g., SSA = 0.95) lead to an increase in the aerosol albedo effect, which results in an increased AMF over areas with low surface reflectance. We also conducted an in-depth study of the APH effect on AMF. For an AOD of 0.1 and half width (HW) of 5 km, NO_2 AMF decreases by 29% from 1.36 to 0.96 as APH changes from 0 to 2 km. In the case of high-AOD conditions (0.9) and HW of 5 km, the NO_2 AMF decreases by 240% from 1.85 to 0.54 as APH changes from 0 to 2 km. The AMF variation due to error in the model input parameters (e.g., AOD, SSA, aerosol shape, and APH) is also examined. When APH is 0 km with an AOD of 0.4, SSA of 0.88, and surface reflectance of 0.05, a 30% error in AOD induces an AMF error of between 4.85% and –3.67%, an SSA error of 0.04 leads to NO_2 VCD errors of between 4.46% and –4.77%, and a 30% error in AOD induces an AMF error of between –9.53% and 8.35% with an APH of 3 km. In addition to AOD and SSA, APH is an important factor in calculating AMF, due to the 2 km error in APH under high-SZA conditions which leads to an NO_2 VCD error of over 60%. Aerosol shape is also found to have a measureable effect on AMF under high-AOD and small relative azimuth angle (RAA) conditions. The diurnal effect of the NO_2 profile is also examined and discussed.