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Long-term analysis of aerosol optical depth over Northeast Asia using a satellite-based measurement: MI Yonsei Aerosol Retrieval Algorithm (YAER)

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In 2010, the Korean geostationary earth orbit (GEO) satellite, the Communication, Ocean, and Meteorological Satellite (COMS), was launched including the Meteorological Imager (MI). The MI measures atmospheric condition over Northeast Asia (NEA) using a single visible channel centered at 0.675 [U+F06D]m and four IR channels at 3.75, 6.75, 10.8, 12.0 [U+F06D]m. The visible measurement can also be utilized for the retrieval of aerosol optical properties (AOPs). Since the GEO satellite measurement has an advantage for continuous monitoring of AOPs, we can analyze the spatiotemporal variation of the aerosol using the MI observations over NEA. Therefore, we developed an algorithm to retrieve aerosol optical depth (AOD) using the visible observation of MI, and named as MI Yonsei Aerosol Retrieval Algorithm (YAER).

In this study, we investigated the accuracy of MI YAER AOD by comparing the values with the long-term products of AERONET sun-photometer. The result showed that the MI AODs were significantly overestimated than the AERONET values over bright surface in low AOD case. Because the MI visible channel centered at red color range, contribution of aerosol signal to the measured reflectance is relatively lower than the surface contribution. Therefore, the AOD error in low AOD case over bright surface can be a fundamental limitation of the algorithm. Meanwhile, an assumption of background aerosol optical depth (BAOD) could result in the retrieval uncertainty, also. To estimate the surface reflectance by considering polluted air condition over the NEA, we estimated the BAOD from the MODIS dark target (DT) aerosol products by pixel. The satellite-based AOD retrieval, however, largely depends on the accuracy of the surface reflectance estimation especially in low AOD case, and thus, the BAOD could include the uncertainty in surface reflectance estimation of the satellite-based retrieval. Therefore, we re-estimated the BAOD using the ground-based sun-photometer measurement, and investigated the effects of the BAOD assumption. The satellite-based BAOD was significantly higher than the ground-based value over urban area, and thus, resulted in the underestimation of surface reflectance and the overestimation of AOD.

The error analysis of the MI AOD also showed sensitivity to cloud contamination, clearly. Therefore, improvements of cloud masking process in the developed single channel MI algorithm as well as the modification of the surface reflectance estimation will be required for the future study.