

Contribution of ammonium nitrate to aerosol optical depth and direct radiative forcing by aerosols over East Asia

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This study focused on the contribution of ammonium nitrate (NH_4NO_3) to aerosol optical depth (AOD) and direct radiative forcing (DRF) by aerosols over an East Asian domain. In order to evaluate the contribution, CTM-estimated AOD was combined with satellite-retrieved AOD, utilizing a data assimilation technique, over East Asia for the entire year of 2006.

Using the assimilated AOD and CTM-estimated aerosol optical properties, the DRF by aerosols was estimated over East Asia via a radiative transfer model (RTM). Both assimilated AOD and estimated DRF values showed relatively good agreements with AOD and DRF by aerosols from AERONET.

Based on these results, the contributions of NH_4NO_3 to AOD and DRF by aerosols (Φ_{AOD} and Φ_{DRF}) were estimated for four seasons of 2006 over East Asia. Both Φ_{AOD} and Φ_{DRF} showed seasonal variations over East Asia within the ranges between 4.7% (summer) and 31.3% (winter) and between 4.7% (summer) and 30.7% (winter), respectively, under clear-sky conditions, showing annual average contributions of 15.6% and 15.3%. Under all-sky conditions, Φ_{DRF} varied between 3.6% (summer) and 24.5% (winter), showing annual average contribution of 12.1% over East Asia. These annual average contributions of NH_4NO_3 to AOD and DRF are almost comparable to the annual average mass fractions of NH_4NO_3 in $\text{PM}_{2.5}$ and PM_{10} (17.0% and 14.0%, respectively). Φ_{AOD} and Φ_{DRF} were even larger in the locations where NH_3 and NO_x emission rates are strong such as the Central East China (CEC) region and Sichuan basin. For example, under clear-sky conditions, both Φ_{AOD} and Φ_{DRF} over the CEC region range between 6.9% (summer) and 47.9% (winter) and between 6.7% (summer) and 47.5% (winter), respectively.

Based on this analysis, it was concluded that both Φ_{AOD} and Φ_{DRF} cannot be ignored in East Asian air quality and radiative forcing studies, particularly during winter.

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