Modeling the Long-Range Transport of Particulate Matters During Winter in East Asia using NAQPMS and CMAQ

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Two regional chemical transport models (NAQPMS and CMAQ) were used to simulate several episodes of high $PM_{2.5}$ concentration observed in January 2015 over China and Japan. Simulation results from both models reasonably explained observed $PM_{2.5}$ levels, as well as the variation observed within three sites in both China and Japan. Some bias existed between these models due to differences in frameworks, including model domains, horizontal resolution, vertical layers, and emissions.

Based on the model results and the synergetic aerosol observations in Fukuoka, Japan, three types of LRT of air pollutants were observed. The first episode showed increased fNO_3^- concentrations relative to fSO_4^{2-} (type N), indicating the importance of NO_3^- LRT in winter. The second episode showed fSO_4^{2-} concentrations, which were ~3.4-fold greater than fNO_3^- (type S). The third episode showed high dust concentrations mixed with anthropogenic pollutants (type D), indicating that the LRT of dust was also important in winter, as well as spring.

Both models reasonably explained variations in aerosol components during episodes N and S. Simulated spatial distribution variations indicated the outflow of fSIA from continental Asia to western Japan, consistent with the corresponding $PM_{2.5}$ peak at Qingdao and over Japan. During episode S, RH was significantly higher than episode N, therefore, SO_4^{2-} formed quickly due to aqueous-phase reactions under high RH conditions.

During episode D, mineral dust transported from continental Asia was quickly transported to downwind regions, stagnating over the south of Japan for three days (See Figure). Measurements showed high cNO_3^- concentrations and high cNO_3^-/fNO_3^- ratio during episode D. These findings were well reproduced by the NAQPMS model after considering heterogeneous reactions on dust particles, which indicates the importance of heterogeneous processes for the LRT of dust and anthropogenic pollutants over East Asia. During this period, both models underestimated fSO_4^{2-} levels, indicating that current models may miss certain emissions of SO_2 and mechanisms promoting the conversion of SO_2 to SO_4^{2-}.

Keywords: Secondary inorganic aerosol, Dust, Air quality model, Long-Range Transport, East Asia