Evaluation of air quality model performance for $PM_{2.5}$ simulation by focusing on long-range transport and local pollution in Japan

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The air quality standard for fine $PM_{2.5}$ in Japan is not attained at most of air pollution monitoring stations. Although air quality model (AQM) is useful to design effective air pollution control strategies, current AQM performance for $PM_{2.5}$ simulation is not adequate for the purpose. In order to improve AQM performance, it is essential to specify dominant factors causing error in $PM_{2.5}$ simulations. In this study, $PM_{2.5}$ simulation by CMAQ was evaluated by focusing on long-range transport (LRT) and local pollution (LP) in Japan. CMAQ v5.0.1 driven by WRF v3.5.1 was applied to Northeast Asia (domain 1) and Japan (domain 2) for a period from April 2010 to March 2011 (Japanese fiscal year 2010). Boundary concentrations of domain 1 were derived from MOZART-4. Emission data were produced from JATOP vehicle emission inventory, OPRF ship emission inventory, EAGrid2010-JAPAN, INTEX-B emission inventory v1.2, REAS v1.11, MEGAN v2.04 and FINN v1.5. CMAQ simulations were conducted in the following two cases: a baseline simulation case with the entire emission data (Ebase) and a case in which anthropogenic emissions outside Japan were set to zero (Ejapan). Ratios of simulated $PM_{2.5}$ sulfate concentrations (Ejapan/Ebase) were used to select top 10 days with dominant LRT influence (low Ejapan/Ebase) and top 10 days with dominant LP influence (high Ejapan/Ebase) at $PM_{2.5}$ monitoring stations in Japan. Figure 1 shows mean observed and simulated $PM_{2.5}$ concentrations for LRT and LP days. Although $PM_{2.5}$ concentrations were much higher in LRT days than LP days, $PM_{2.5}$ simulation errors were larger in LP days than LRT days, with the errors being 2.7 ± 8.0 and -5.0 ± 4.5 μg m^{-3} for LRT and LP days, respectively. The results indicate that model improvement in local primary emissions and/or local secondary formations is essential for better $PM_{2.5}$ simulation in Japan.

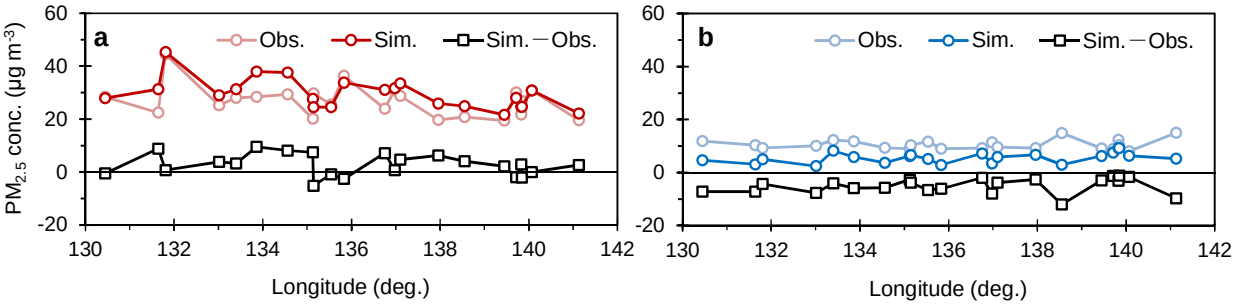

Figure 1. Mean $PM_{2.5}$ concentrations and simulation errors for LRT (a) and LP (b) days at $PM_{2.5}$ monitoring stations in Japan.

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