Table S1. Heterogeneous reactions in dust particles and reactive uptake coefficients

Heterogeneous Reaction	γ (unitless)	Reference
$O_3 \rightarrow$ products	2.7×10^{-5}	(*Zhu et al.*, 2010)
$HNO_3 + CO_3^{2-} \rightarrow NO_3^- + H_2O + CO_2$	$\dfrac{c \times RH}{(1 - RH) \times (1 - (1 - c) \times RH)} \times 0.018 \ (c = 8)$	(*Vlasenko et al.*, 2006; Wei, 2010)
$NO_2 \rightarrow 0.5HONO + 0.5HNO_3$	2.1×10^{-6}	(*Zhu et al.*, 2010)
$NO_3 \rightarrow HNO_3$	1.0×10^{-3}	(*Martin et al.*, 2003)
$N_2O_5 \rightarrow 2HNO_3$	3.0×10^{-2}	(*Zhu et al.*, 2010)
$OH \rightarrow$ products	1.0×10^{-1}	(*Zhu et al.*, 2010)
$HO_2 \rightarrow 0.5H_2O_2$	2.0×10^{-1}	(*Zhu et al.*, 2010)
$H_2O_2 \rightarrow$ products	$12 \times RH^2 - 5.95 \times RH + 4.08$	(*Pradhan et al.*, 2010)
$SO_2 \rightarrow SO_4^{2-}$	1.0×10^{-4}	(*Phadnis and Carmichael*, 2000)
$CH_3COOH \rightarrow$ products	1.0×10^{-3}	(*Zhu et al.*, 2010)
$CH_3OH \rightarrow$ products	1.0×10^{-5}	(*Zhu et al.*, 2010)
$HCHO \rightarrow$ products	1.0×10^{-5}	(*Zhu et al.*, 2010)

RH: relative humidity (unitless) in [0, 1].

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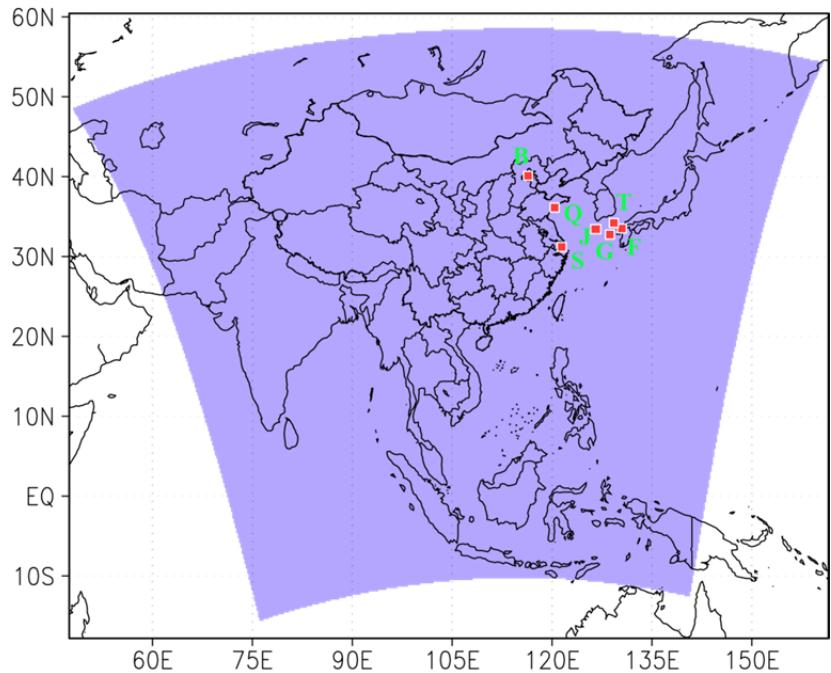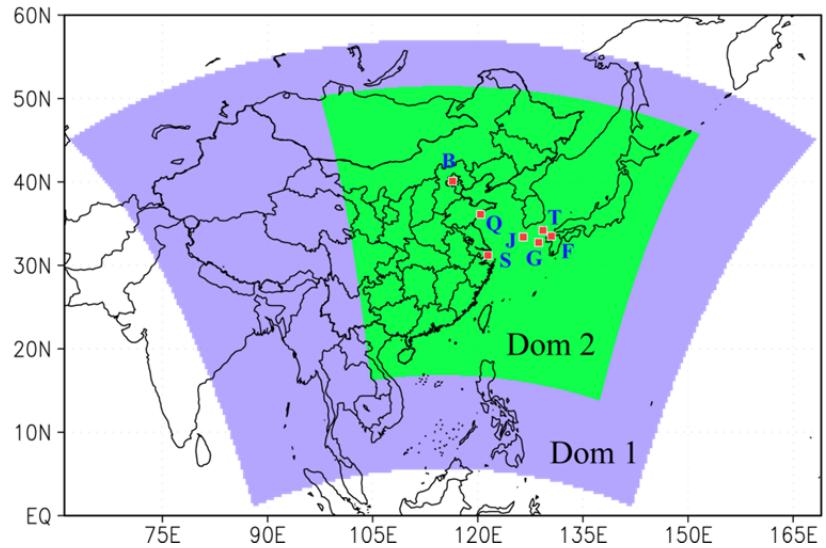
Fig. S1. Domains of (a) the Nested Air Quality Prediction Modeling System (NAQPMS) and (b) the Community Multi-scale Air Quality Model (CMAQ). Red marks indicate observation sites (B: Beijing; Q: Qingdao; S: Shanghai; J: Jeju; T: Tsushima; G: Goto; F: Fukuoka).
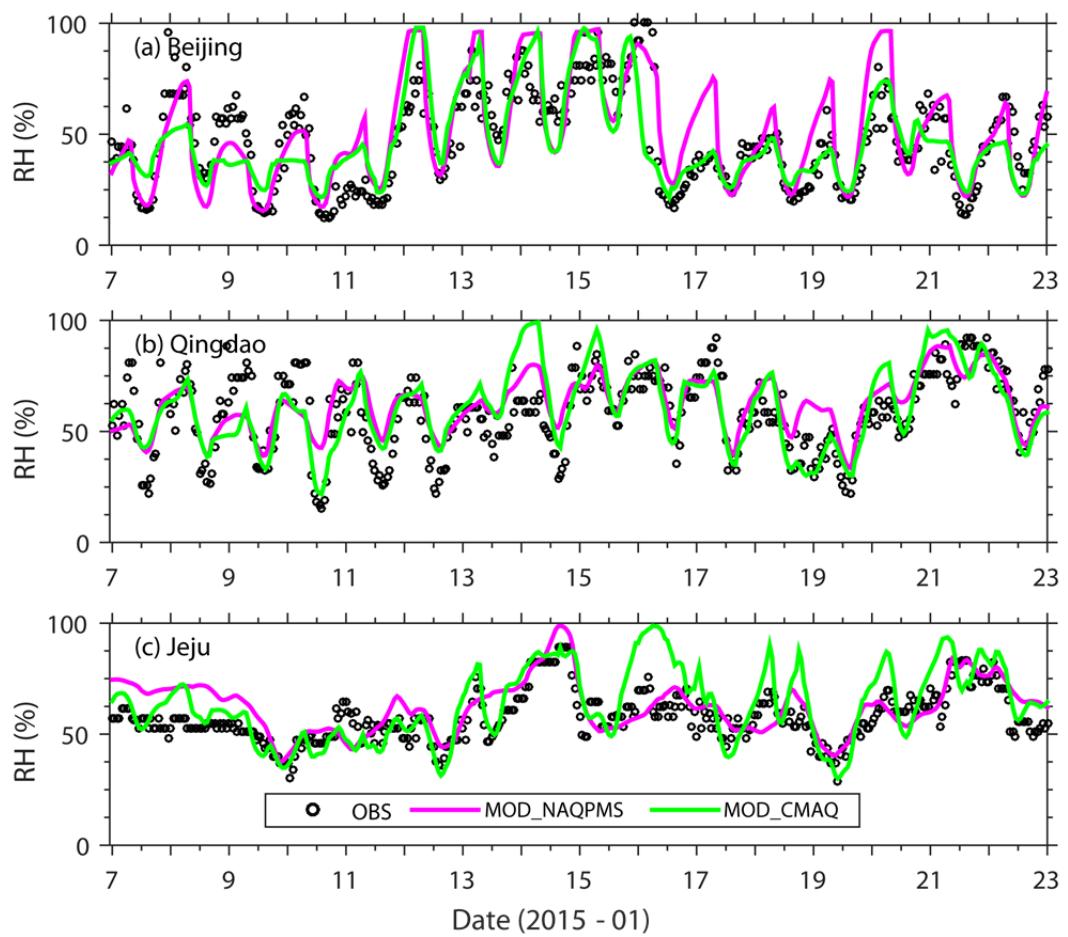
Fig. S2. Comparisons of RH at (a) Beijing; (b) Qingdao; and (c) Jeju.