



*Supplement of*

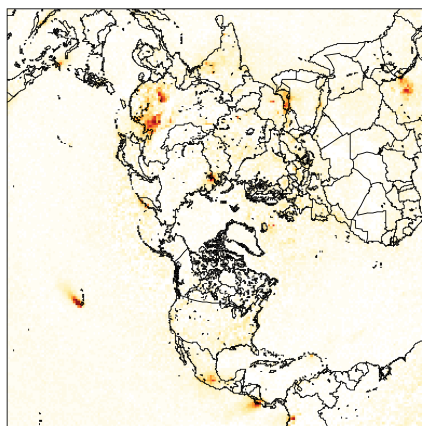
**Incorporation of volcanic SO<sub>2</sub> emissions in the Hemispheric CMAQ (H-CMAQ) version 5.2 modeling system and assessing their impacts on sulfate aerosol over the Northern Hemisphere**

**Syuichi Itahashi et al.**

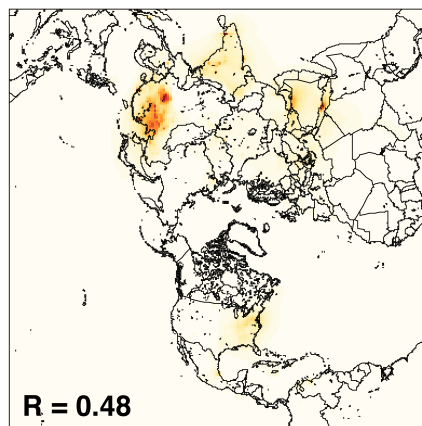
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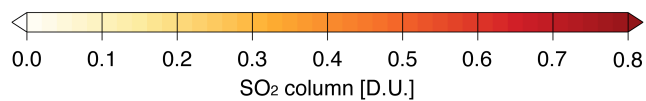
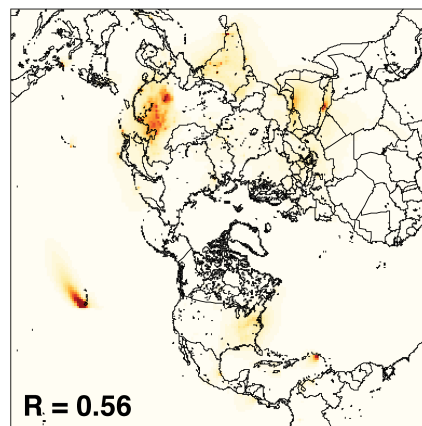
(a) OMI satellite observation



(b) Model (original H-CMAQ)



(c) Model (H-CMAQ with volcanic SO2)



**Figure S1.** Annual averaged SO<sub>2</sub> column in 2010 of (a) observed by OMI satellite and simulated by (b) original H-CMAQ and (c) H-CMAQ with incorporation of volcanic SO<sub>2</sub> emissions. The spatial correlation coefficient with satellite observation are noted at left-bottom corner of (b) and (c).

**Table S1. Statistical analysis of modeled SO<sub>2</sub> concentration with observations.**

	N	Mean		R	NMB	NME
		Observation	Model			
CASTNET						
–original H-CMAQ	4216	1.69	2.81	0.57***	+66.1%	94.7%
–incorporation of volcanic emissions			2.83	0.58***	+67.4%	94.9%

Note: The unit of mean for observations and simulations is ppbv. Significance levels by Students’ t-test for correlation coefficients between observations and simulations are remarked as \*p < 0.05, \*\*p < 0.01, and \*\*\*p < 0.001, and lack of a mark indicates no significance.

**Table S2. Statistical analysis of modeled SO<sub>4</sub><sup>2-</sup> concentration in precipitation and wet deposition with observations.**

	N	Mean		R	NMB	NME
		Observation	Model			
SO <sub>4</sub> <sup>2-</sup> concentration in precipitation						
EANET						
–original H-CMAQ	2657	4743.7	1152.5	0.35***	−75.7%	81.9%
–incorporation of volcanic emissions			1236.0	0.35***	−73.9%	81.6%
NADP						
–original H-CMAQ	7377	842.7	631.5	0.33***	−25.1%	61.9%
–incorporation of volcanic emissions			653.1	0.32***	−22.5%	61.6%
Precipitation						
EANET	4497	16.6	13.7	0.37***	−17.4%	56.3%
NADP	10670	21.4	16.5	0.55***	−23.1%	66.9%
SO <sub>4</sub> <sup>2-</sup> wet deposition						
EANET						
–original H-CMAQ	2676	406.7	122.0	0.45***	−70.0%	78.7%
–incorporation of volcanic emissions			131.5	0.44***	−67.6%	77.9%
NADP						
–original H-CMAQ	8154	160.4	99.3	0.46***	−38.1%	68.5%
–incorporation of volcanic emissions			103.6	0.47***	−35.4%	68.4%

Note: The unit of mean for observations and simulations is g/L for concentration in precipitation and g/ha for wet deposition. Significance levels by Students’ t-test for correlation coefficients between observations and simulations are remarked as \*p < 0.05, \*\*p < 0.01, and \*\*\*p < 0.001, and lack of a mark indicates no significance.