Supplementary Data published online for the paper entitled:

Understanding of Regional Air Pollution over China using CMAQ, Part I Performance Evaluation and Seasonal Variation

Xiao-Huan Liu[1, 2], Yang Zhang[2,*], Shu-Hui Cheng[1, 2], Jia Xing[3], Qiang Zhang[4], David G. Streets[4], Carey Jang[5], Wen-Xing Wang[1], and Ji-Ming Hao[3]

[1]Shandong University, Jinan, Shandong Province, 250100, P.R China

[2]North Carolina State University, Raleigh, NC 27695, U.S.A.

[3]Tsinghua University, Beijing, 100084, P.R China

[4] Argonne National Laboratory, Argonne, IL 60439, U.S.A.

[5] The U.S. Environmental Protection Agency, Research Triangle Park, NC 27711, U.S.A.

1. The modeling domain

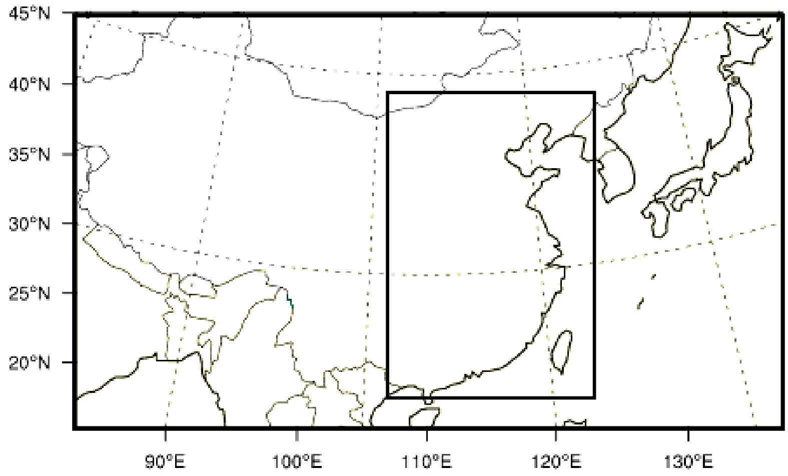

Fig. S-1. Simulation domains at 36-km over East Asia and 12-km over the eastern China.

[*] *Corresponding author:* Yang Zhang, Department of Marine, Earth, and Atmospheric Sciences, Campus Box 8208, NCSU, Raleigh, NC 27606, U.S.A. Phone 919-515-9688, Fax: 919-515-7802, e-mail: yang_zhang@ncsu.edu

2. Evaluation of column CO and NO_2 abundance

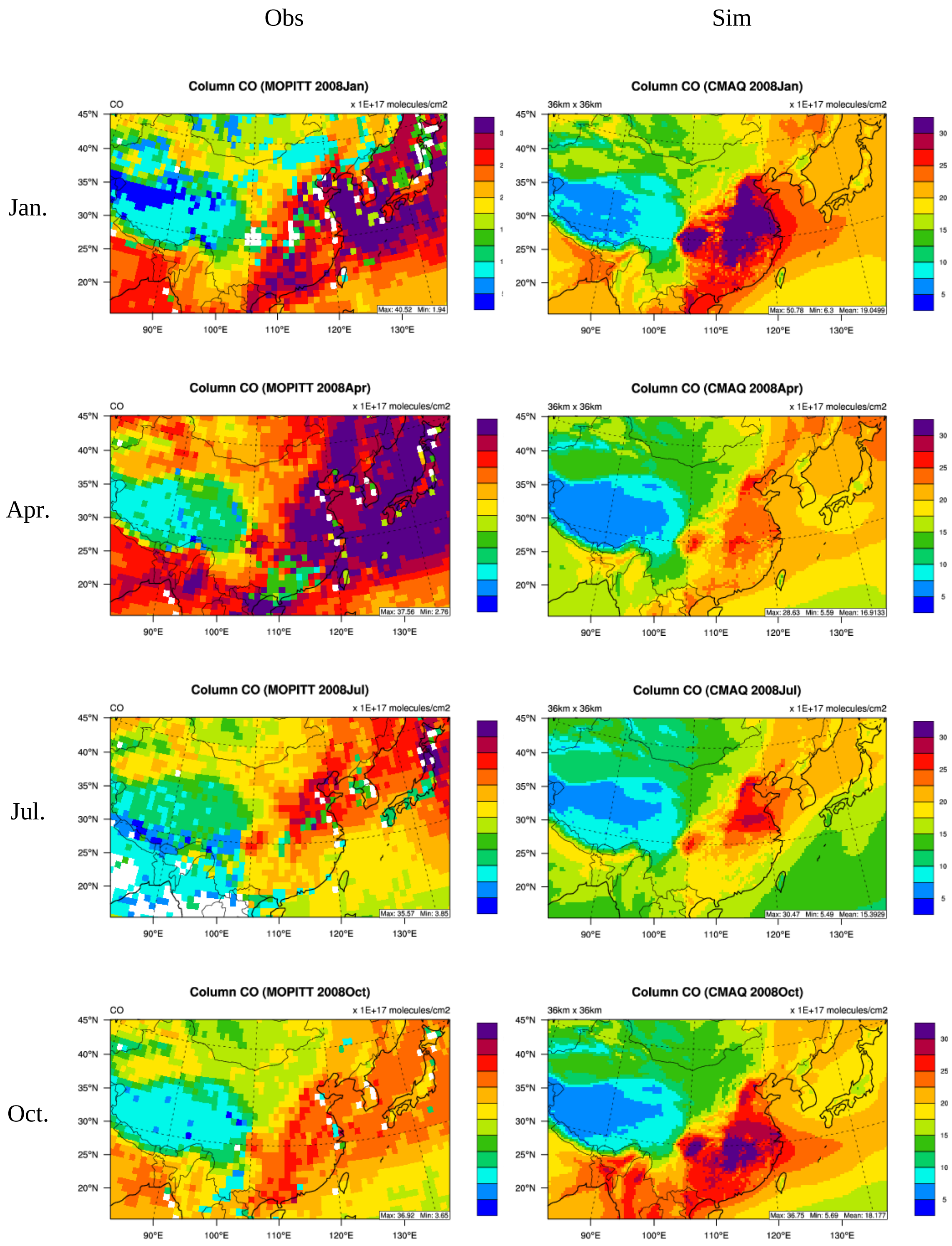

Fig. S-2. Spatial distributions of monthly-mean column CO concentrations from observations (left) and simulations (right) in Jan., Apr., Jul. and Oct. 2008.

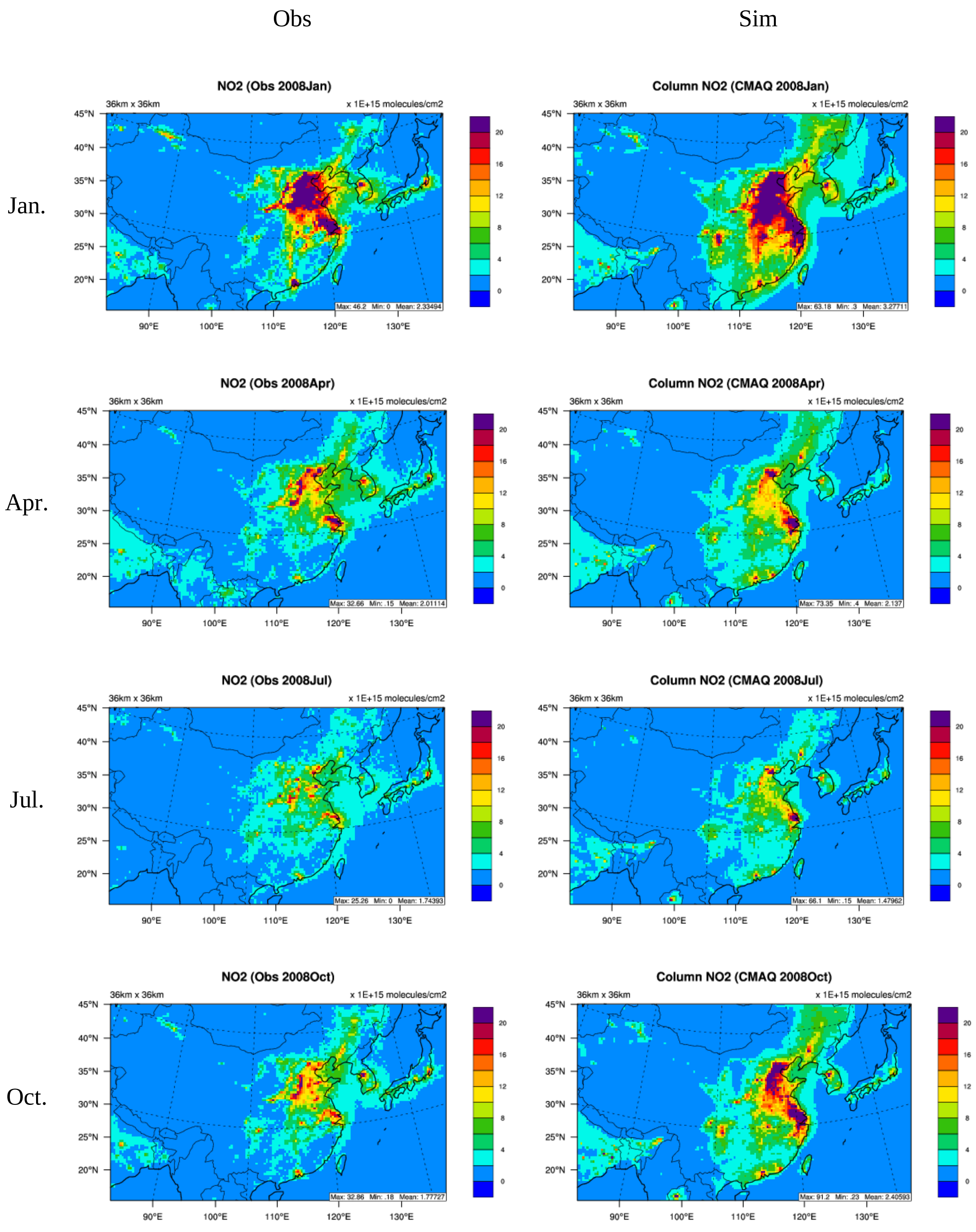

Fig. S-3. Spatial distributions of monthly-mean column NO_2 concentrations from observations (left) and simulations (right) in Jan, Apr, Jul and Oct 2008.

3. Difference of spatial distributions of variables simulated at 36- and 12-km

As shown in Figure S-4, surface concentrations of NO_2 in all four months show similar spatial patterns of percentage difference between 12- and 36-km simulations, with the largest discrepancy occurred in Jul. and lowest in Jan. over whole domain. The mountain areas in China (e.g., Mt. Changbai in the northeast of China, Mt. Taihang, Mt. Qinling, and Mt. Wushan in the central China, Mt. Wuling, Mt. Nanling, and Mt. Wuyi in the southern China) and Taiwan show relatively higher percentage differences (with large than 50% or lower than -50% discrepancy) in all four months. More than 50% difference is also found over the coastal areas along the borderline from PRD to Shanghai. These large differences indicate a greater sensitivity of NO_2 chemistry (thus concentrations) to regions with complex terrain or meteorology such as mountain and coastal areas. Difference between finer and coarse grid resolutions of surface O_3 concentrations in Jan. and Apr. are positive over the whole domain, with more than 15% and 3-9% higher O_3 mixing ratios at 12-km than those at 36-km in Jan. and Apr., respectively. Percentage differences are negative in Jul. and Oct. over most domain with 3-6% lower O_3 at 12-km than 36-km. Those differences may be caused by different O_3 production rates (Cohan et al., 2006) or different competing rates of chemistry and transport of NO_x (Jang et al., 1995) at a different grid resolution during different seasons. For example, O_3 chemistry is VOC-limited in Jan. but becomes NO_x-limited in Jul. (see Part II paper, Liu et al., 2010). O_3 formation is sensitive to emissions of VOCs in Jan. which may be higher at 12-km than at 36-km, leading to higher O_3 formation. In Jul., NO_x emissions at 12-km are also higher than at 36-km, which would enhance O_3 formation. On the other hand, however, higher NO emissions may lead to higher NO, thus higher rate of titration of O_3 at night, this effect may have dominated over the increase in O_3 formation due to higher NO_x emissions, leading to lower daily-mean 1-hr O_3 at 12-km. PM_{10} concentrations to grid resolutions in all four months show similar characteristics with surface NO_2, with more sensitive areas occurring over the mountain and coastal areas (differences > 20%). Higher PM_{10} concentrations occur primarily in the northeastern China in Jan. and throughout the eastern China in other months at 12-km than at 36-km. Similarly to surface NO_2, column NO_2 also shows no clear seasonal trend of spatial discrepancy at different grid resolutions. However, it is slightly more sensitive to grid resolution than surface concentrations of NO_2. Compared with the surface PM_{10}, AODs are less sensitive to grid resolutions. Larger differences in simulated AODs are found over the Mountain areas than the plain areas such as the North China Plain and YRD. Larger than 10% difference in AODs occur in Jul. over the northern and southeastern China such as Mt. Wuyishan area, which may be resulted from differences of simulated local circulations such as Asian monsoon circulation at different grid resolutions. Simulated AODs are quite sensitive to grid resolutions in Taiwan, with obvious lower AODs over mountains in the west and higher AODs over plain areas in the east at 12-km. Differences in land surface characteristics, such as terrain heights and land use at different grid resolutions may contribute to these differences, because they can influence the development and structure of local circulations and subsequently affect other factors such as precipitation amount and wet deposition. These findings are consistent with Queen and Zhang (2008) who reported the largest model sensitivity to horizontal grid resolutions at the mountain sites and larger difference in the precipitation amounts simulated at various resolutions over more complex terrain regions.

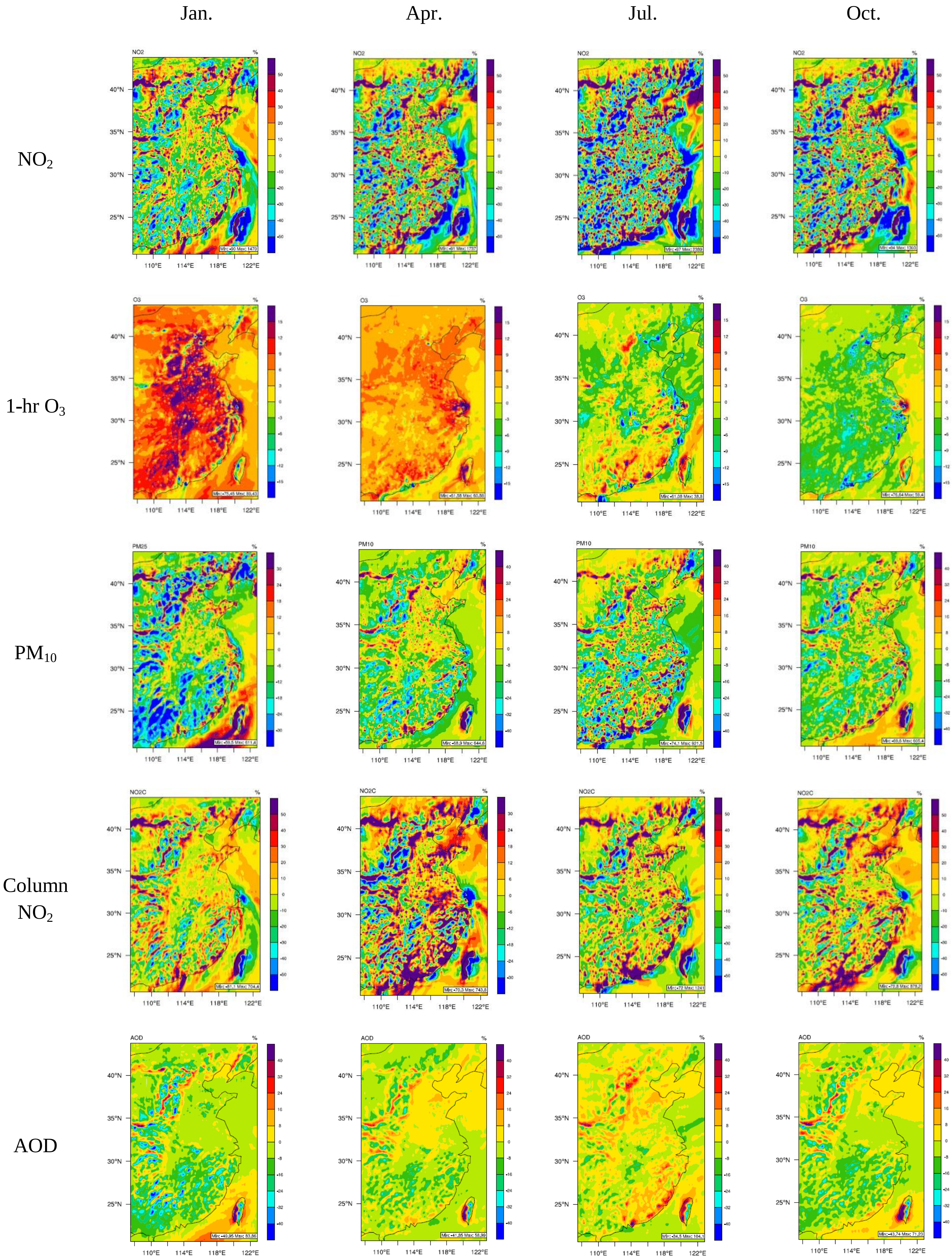

Fig. S-4. Percentage difference between predicted surface concentrations of NO_2, 1-hr max O_3, PM_{10}, column concentrations of NO_2, and AODs at 12- and 36-km (i.e., (Sim_12km - Sim_36km) *100/Sim_36km).