***Supplement of***

**OMI measured increasing SO2 emissions due to energy industry expansion and relocation in Northwestern China**

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**Uncertainty analysis for SO2 emission derived by OMI measurements**

**Table S1**. Coefficients of variation (*CV*, %) of input parameters for the uncertainty analysis (McLinden et al., 2014, 2016; Fioleto et al; 2016) in estimations of SO2 emission derived from OMI measurements.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Air mass factor (AMF) | Mass | Σ | *τ* |
| *CV* (%) | 18 | 5 | 35 | 35 |

Mass: total SO2 mass as determined from a linear regression.

σ: standard deviation of the width or spread of SO2.

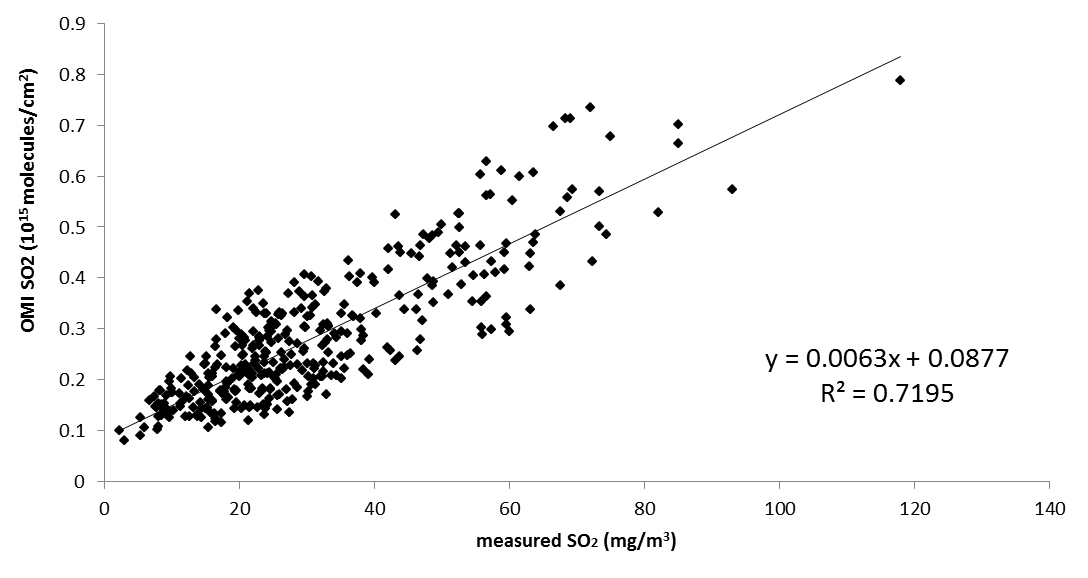
*τ*: decay time of SO2.

**Comparisons between measured ambient concentration data and SO2 VCD**

The OMI retrieved SO2 PBL VCD were further evaluated by comparing with ambient air concentration data of SO2 from routine measurements by local official air quality monitoring stations (http://www.aqistudy.cn/historydata/). These measured data include daily averaged air concentrations of SO2 from 2014 to 2015, covering 188 major cities in China. We compared monthly averaged SO2 VCD over all grid points (0.25×0.25 latitude/longitude resolution) with the monthly averaged monitored concentrations of SO2 in 188 cities. Result is shown in Figure S1. The OMI retrieved SO2 VCD match well with the measured SO2 concentrations at a correlation coefficient of *r* =0.85 (p<0.001).

**Table S2** Statistics between satellite derived SO2 VCD and monitored SO2 annually averaged air concentrations during 2014-2015 at 188 operational air quality monitoring stations across China. In the table, *r* is the correlation coefficient, RE is the relative error, FB is the fractional bias, NMB is the normalized mean bias, and RMSE is the root mean square error, respectively.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *r* | RE | FB | NMB | RMSE |
| 0.85 (p<0.05) | 0.25 | 0.0003 | 0.119 | 9.65 |



**Figure S1** Comparisons between monthly averaged concentration of SO2 and OMI retrieved SO2 VCD from 2014 to 2015. *n* is the number of data points used in correlation analysis, *r* is the correlation coefficient, and *p* is the significance level.

**Reference**

McLinden, C. A., Fioletov, V., Boersma, K. F., Kharol, S. K., Krotkov, N., Lamsal, L., Makar, P. A., Martin, R. V., Veefkind, J. P., and Yang, K.: Improved satellite retrievals of NO2 and SO2 over the Canadian oil sands and comparisons with surface measurements, Atmos. Chem. Phys., 14, 3637–3656, doi:10.5194/acp-14-3637-2014, 2014.

McLinden, C. A., Fioletov, V., Shephard, M. W., Krotkov, N., Li, C., Martin, R. V., Moran, M. D., and Joiner, J.: Space-based detection of missing sulfur dioxide sources of global air pollution, Nature Geosci., 9, 496-500, doi: 10.1038/ngeo2724, 2016.

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