

Supplementary material of:

A Sulfur Dioxide Covariance-Based Retrieval Algorithm (COBRA): application to TROPOMI reveals new emission sources

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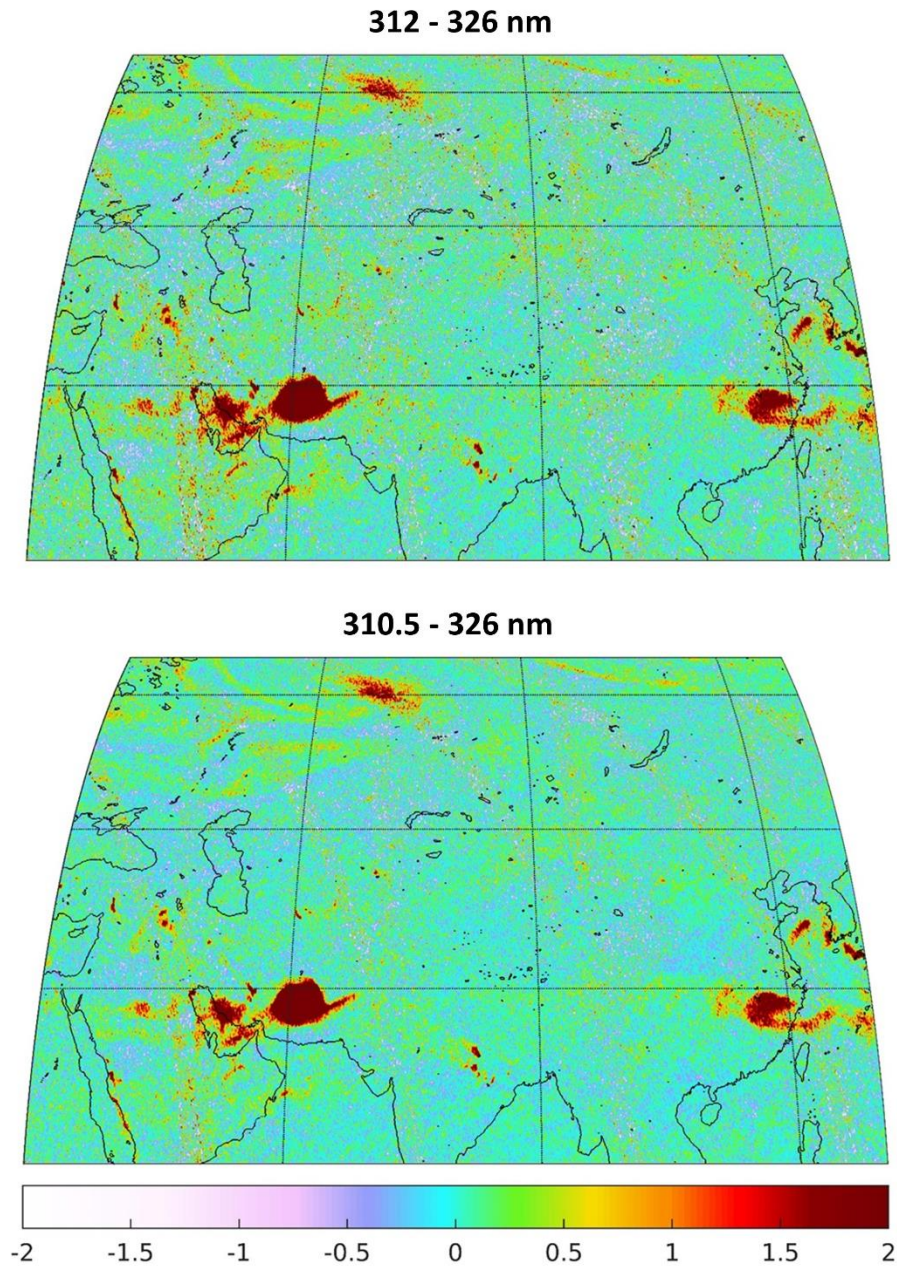
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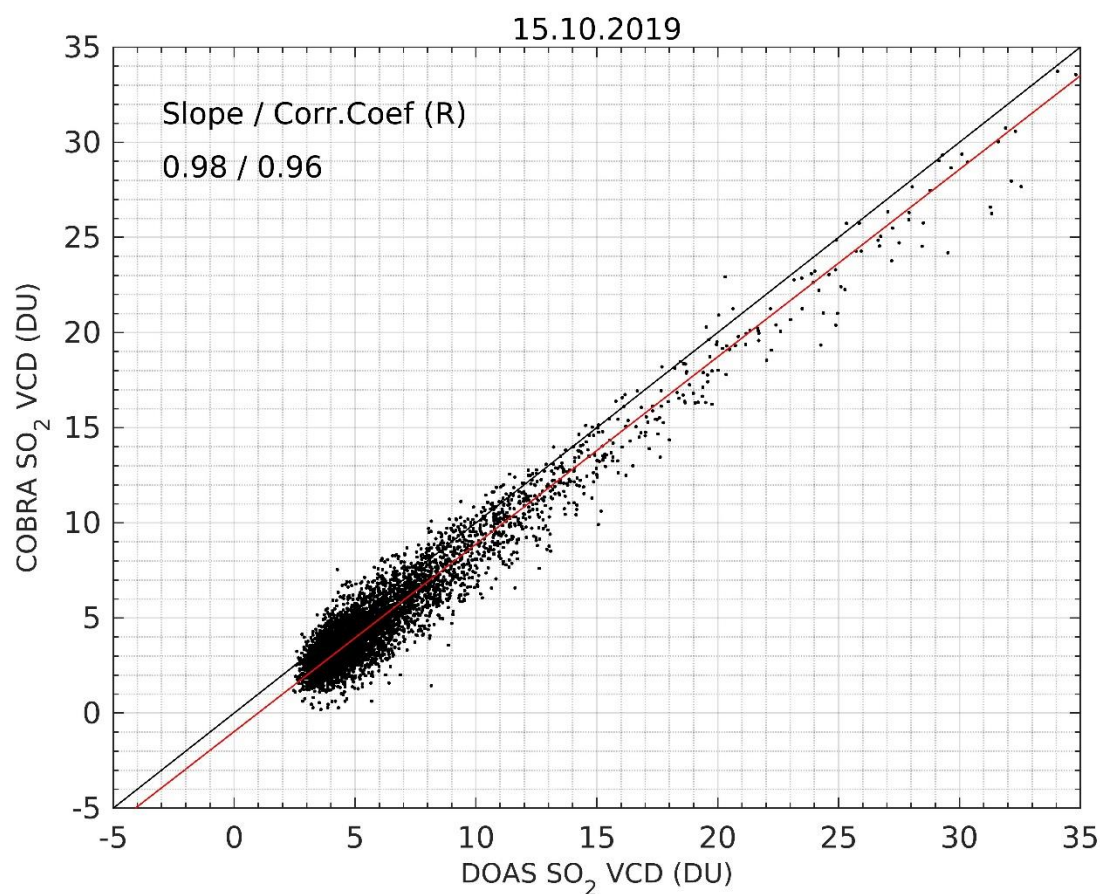
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SO₂ VCD (DU) 03 August 2019

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2 Figure S1. SO₂ vertical columns retrieved from TROPOMI measurements over Asia on 03 August
3 2019 by the COBRA using wavelength ranges: (top) 312-326 nm and (bottom) 310.5-326 nm. All
4 satellite pixels (for all rows) are used in the maps; a fixed AMF of 0.4 is applied for the SCD to
5 VCD conversion.



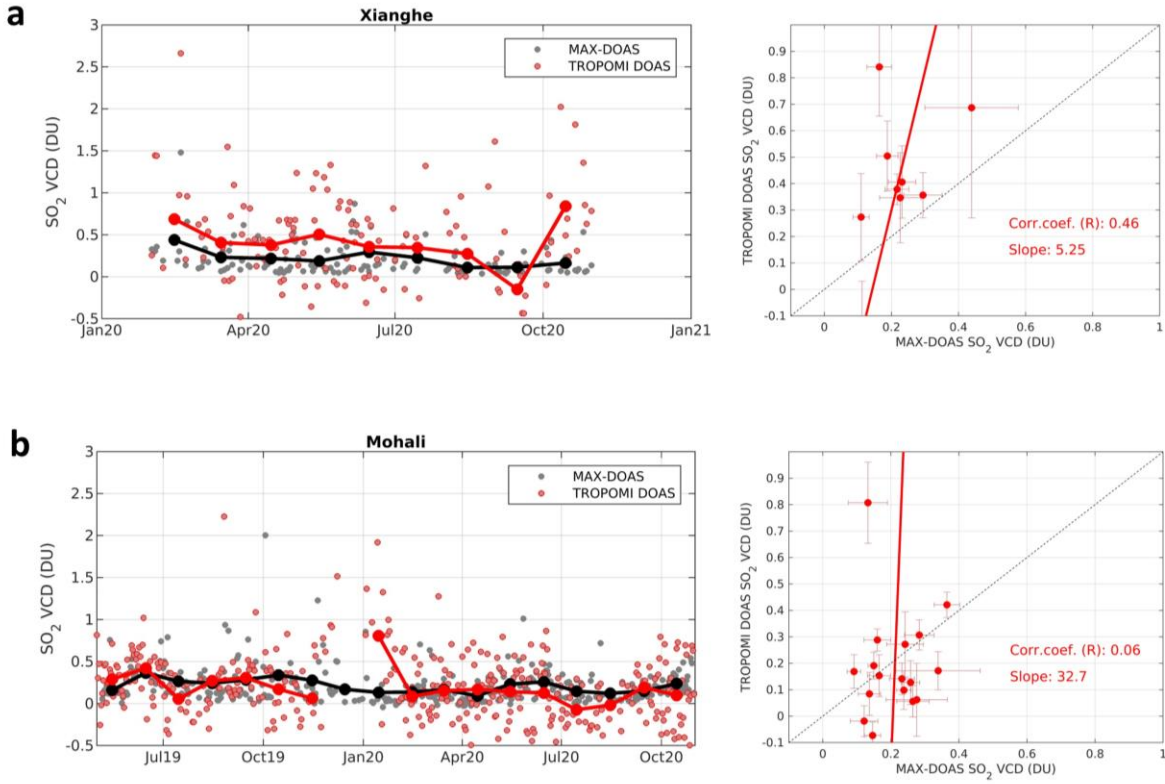
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2 Figure S2. Comparison of SO₂ columns from TROPOMI COBRA and DOAS retrievals for

3 October 15, 2019. Only the pixels with unambiguous detection of SO₂ were selected, based on the

4 SO₂ detection flag from the operational product. The correlation coefficient and slope of the

5 regression line are given as an inset.

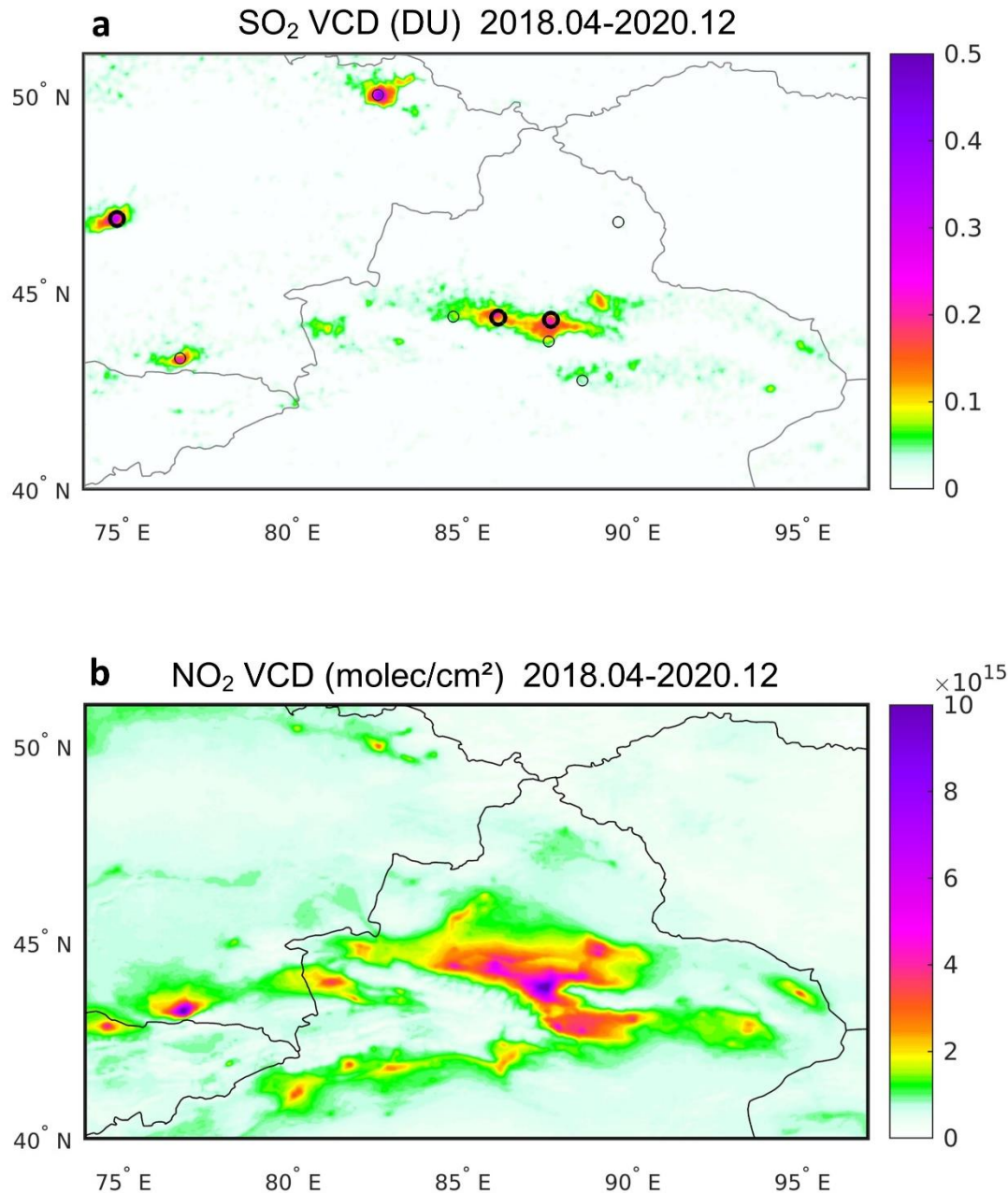


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3 Figure S3. (left) Comparison of monthly mean SO₂ columns from MAX-DOAS and TROPOMI
 4 DOAS for (a) Xianghe, and (b) Mohali. The grey and pale red dots correspond to the individual
 5 days. (right) Scatter plots of monthly mean SO₂ columns of TROPOMI DOAS vs MAX-DOAS
 6 observations. Error bars are the standard errors on the monthly average SO₂ columns. The
 7 correlation coefficient and slope of the regression line are given as an inset for each plot.

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2 Figure S4. (a) SO₂ vertical columns retrieved by COBRA for TROPOMI measurements from April
3 2018 to December 2020, over a region covering north Xinjiang province (China), east Kazakhstan,
4 and parts of Kyrgyzstan and Mongolia. Black circles indicate SO₂ sources (coal power plants and
5 smelters) detected by OMI (in bold for the 2018-2019 period, see text). (b) same as (a) for the
6 tropospheric NO₂ vertical columns from TROPOMI operational product (OFL and RPRO
7 combined).

1 **Supplementary file:**

2 The global SO₂ vertical column map discussed in section 4 is included as supplement in the form
3 of a geotiff file (S5P_COBRA_SO2_VCD_2018_04_2020_12.tif), compatible with Google Earth
4 viewer. The data is a long-term average of SO₂ columns over the period of April 2018 to December
5 2020, for the latitudinal band 51°S-72°N. The SO₂ vertical column is in Dobson Unit and
6 represented with the color scale below.

