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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Stable sulfur isotope measurements to trace the fate of SO_2 in the Athabasca oil sands region" *by* Neda Amiri et al.

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Thanks for your comments. We have considered your comments in the corrected manuscript (supplement) as follows:

1.Although the data represent a short period of time and do not reflect the variability on a seasonal scale, Soares et al. (2018) showed that short-term measurements are more suitable for source identification. He mentioned that the source signals of NO2 and SO2 emissions are available in hourly to daily time scales and long-term observation may cause a loss in short-term variation.

2. Sulfate aerosols are known to impact ecosystems and climate through their deposition and radiative effects. The deposition of sulfate aerosols can cause acidification of

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soils and lakes (Gerhardsson, 1994). Furthermore, their direct and indirect radiative effects can change the radiative budget at regional scales and alter climate (IPCC, 2001). Sulfur dioxide (SO2) is converted to sulfate in homogeneous and heterogeneous reactions. The oxidation pathway is a very important factor to determine the effects of the sulfate formed on the environment.

3.Field studies suggested that TMI-catalyzed oxidation is the dominant sulfate formation pathway in polluted environments in winter (Jacob et al., 1984, 1989; Jacob and Hoffmann, 1983). Oxygen isotope measurements of sulfate aerosols collected at Alert, Canada (82.5°N, 62.3°W) showed that TMI-catalyzed SO2 oxidation is significant during winter (McCabe et al., 2006). Recent studies have shown that the TMI-catalyzed oxidation pathway is underestimated (more than an order of magnitude) in all current atmospheric chemistry models (Harris et al., 2013a, b). For example, Harris et al. (2013a) measured the sulfur isotopic composition of SO2 upwind and downwind of clouds and used the difference to calculate the fractionation that occurred for in-cloud SO2 oxidation. They showed that SO2 oxidation catalyzed by natural TMIs on mineral dust is the dominant in-cloud oxidation pathway and is underestimated by more than an order of magnitude in current atmospheric models. To the best of our knowledge, there is no study to investigate the importance of the TMI-catalyzed pathway in SO2 oxidation on the surface of aerosols in highly polluted areas such as the Alberta oil sands region during summer.

Please also note the supplement to this comment:
https://www.atmos-chem-phys-discuss.net/acp-2017-1023/acp-2017-1023-SC2-supplement.pdf

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