Abstract

A phenomenon of frequent SO2 noontime SO2 concentration peaks was discovered in a detailed analysis of the SO2 concentrations in the North China Plain (NCP). The possible causes and their contributions are analysed. The impacts of such a phenomenon on the sulphur cycle were studied and the implications of the phenomenon for atmospheric chemistry, cloud physics and climate were discussed. Different from the more common SO2 diurnal patterns with high nighttime concentrations, NCP witnessed high frequencies of SO2 noontime SO2 peaks, with an occurrence frequency of 50 to 72% at the four stations. Down-mixing of elevated pollution layers, plume transport processes, mountain-valley-winds and fog/high RH haze events were the possible causes. The contribution of each process varies from each other day to day and from station to station, however, neither none of those four processes can be neglected. SO2 peaks occurring during noontime instead of nighttime will lead to a 13--35% increase in sulphur dry deposition, 9--23% increase in gas phase oxidation and 8--33% increase in aqueous phase conversions, which will increase the hygroscopicity and the light scattering of aerosols, thus having important impacts on atmospheric chemistry, cloud physics and climate.

Change the format later in the manuscript, too. Separation of a range with "to" eliminates any possible confusion with the mathematical “minus” sign and is more readable.

Page 1

The diurnal variation of primary gas pollutants in polluted regions are typically characterized.

Page 3

Thus, the representativeness of such averaged profiles is unsure and how common such events were is uncertain. Similarly, what might have caused them or what the possible impacts such diurnal variation patterns might have is still not clear.

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To analyse how the SO2 diurnal variation pattern influences the sulphur cycle, the WQ

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higher values during the night and lower ones during the day, the NCP study has revealed a time reversal of SO2 variation characteristics.

However, how frequently such events occur,

Some confusion with Figures 3 and 4. Fig 3 inserted in text in three places as well as at end of manuscript.

The averaged diurnal variation pattern of group 3 shows lower peak values than group 2.
plume transport process is characterized by the cohesive-coherent variation of SO$_2$ and CO.