General Comments:

In recent years, air pollution is seriously threatening the health of millions of people in China. Sulfate is one of the major chemical species in $PM_{2.5}$, and play a critical role in human health, and environmental chemistry. However, its formation in the atmosphere remains controversial. In this study, both observational data ($\delta^{34}S$ and $\delta^{18}O$ values) and laboratory simulation are used to constrain SO_2 oxidation pathways. The authors found that the sulfate in $PM_{2.5}$ was mainly formed from the oxidation of SO_2 by OH, H_2O_2 and TMI. This work provides a valuable dataset of $\delta^{34}S$ and $\delta^{18}O$ that add critical constraints for sulfate formation pathways.

Specific Comments:

1. Page 4, Lines 83-84 The authors mention that the sulfur isotopic fractionation factor of SO_2 oxidation by OH determined with laboratory experiments by Harris et al. (2012) was 1.0087. However, they discussed that "It is reported that sulfur isotope fractionation about SO_2 was -9‰ for homogeneous oxidation process (Tanaka et al., 1994)". The sulfur isotopic fractionation factor for homogeneous pathway (SO_2+OH) obtained by Tanaka et al. (1994) is different from the laboratory results by Harris et al. (2012). The authors need to compare these two values and explain which to be used for their discussion.
2. Page 17, lines 345-348 Their calculations displayed that the H_2O_2 pathway is predominated during heterogeneous oxidation of SO_2. Could the authors discuss the sources of H_2O_2 in atmosphere if it plays an important role in heterogeneous oxidation of SO_2?
3. The conclusion seems to be a bit dry. I suggest that the important implications for this work should be added, besides summarize the main points.

Technical corrections:

Page 8, Line 163 Please change "The concentrations of $PM_{2.5}$, SO_4^{2-} and SO_2" to "Variations in concentrations of $PM_{2.5}$, SO_4^{2-} and SO_2".

Page 9, Line 197 Please change "Sulfur isotope compositions in sulfate and SO_2" to "Variations in sulfur isotope compositions in sulfate and SO_2". In addition, the black solid circles represent the $\delta^{34}S$ values of sulfate instead of $PM_{2.5}$.