

# Important Contributions of Natural Gas to Atmospheric Nitrate Aerosols in China

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## Abstract

Natural gas has become substitute energy in China over the last decade. As nitrogen oxides ( $\text{NO}_x$ ) is a byproduct, combustion of natural gas is expected to be a potential source of atmospheric nitrate ( $\text{NO}_3^-$ ) aerosols. However, the contributions of natural gas to nitrate remained unclear due to the absence of direct observational evidence. Here, we measured the nitrogen ( $\delta^{15}\text{N}-\text{NO}_3^-$ ) and oxygen isotopes ( $\Delta^{17}\text{O}-\text{NO}_3^-$ ) of nitrate aerosols in Beijing to quantify the contributions of natural gas to nitrate. The results showed that the  $\delta^{15}\text{N}-\text{NO}_3^-$  and  $\Delta^{17}\text{O}-\text{NO}_3^-$  values were  $17.9 \pm 4.6 \text{ ‰}$  and  $29.5 \pm 4.4 \text{ ‰}$ , respectively. Using the Bayesian model, the fraction of natural gas to nitrate was estimated to be 8 % and this fraction has been rising in the past years. In addition, we also examined the spatial distributions of natural gas to nitrate by compiling the observed  $\delta^{15}\text{N}-\text{NO}_3^-$  datasets in the different Chinese cities. The results showed that the contributions of natural gas to  $\text{NO}_3^-$  increased from 6 % in northern cities to 43 % in southern cities. Based on the isotope mass balance and bottom-up calculations, the average  $\text{NO}_x$  emission factor of natural gas was further estimated to be  $6.2 \pm 0.8 \text{ g m}^{-3}$ , up to 5.4 times higher than those used in the China's emission inventory, suggesting that the total  $\text{NO}_x$  emissions in China might be underestimated. These findings highlighted the important role of natural gas to  $\text{NO}_3^-$  and provided direct evidence for considering reduction of  $\text{NO}_3^-$  concentrations from natural gas.

## Early Career Scientist

NO, I am not an early career scientist.

## IGAC Regional Working Groups