

## Response to Gavin Philips:

The subject of the paper is the uptake of dinitrogen pentoxide onto PM including the hydrolytic uptake on aqueous aerosol. The process is very likely to occur in GAC instruments and the resulting nitrate measured by the IC will very likely contain a substantial contribution from the hydrolysis of nitrogen pentoxide within the GAC sampling system, where two nitrate ion result from the sampling of one dinitrogen pentoxide molecule. In situations where the chemistry of the N<sub>2</sub>O<sub>5</sub>/nitric acid/PM system is being studied, I would think that a consideration of this issue would be important at the very least in estimating the uncertainties of the experimental approach.

A description of the effect as observed in the Applikon MARGA was published in Phillips, G. J., Makkonen, U., Schuster, G., Sobanski, N., Hakola, H., and Crowley, J. N.: The detection of nocturnal N<sub>2</sub>O<sub>5</sub> as HNO<sub>3</sub> by alkali- and aqueous-denuder techniques, Atmos. Meas. Tech., 6, 231–237, <https://doi.org/10.5194/amt-6-231-2013>, 2013. All instruments using the same or similar means of determining nitric acid will very likely suffer from this effect.

Have the authors considered this effect? What uncertainty does it introduce into the data analysis?

*[Thanks for your valuable comments about this interference of N<sub>2</sub>O<sub>5</sub> on HNO<sub>3</sub> detection of GAC-IC. We have tested the potential interference of N<sub>2</sub>O<sub>5</sub> in the studied period, and added the corresponding discussion into the revised manuscript.](#)*

*[To test the potential N<sub>2</sub>O<sub>5</sub> interference within investigated period, we re-grouped the measured dataset into the daytime \(7:00 ~ 18:00 LT\) and nighttime \(18:00 ~ 07:00<sup>+1</sup> LT\) periods. As the rapid photolysis of NO<sub>3</sub> radical and limited N<sub>2</sub>O<sub>5</sub> concentration during daytime, N<sub>2</sub>O<sub>5</sub> and its interference on GAC measurement are negligible during daytime. As shown in the revised Figure 4 below, we found a consistent pattern of molar ratio of particulate nitrate in the total nitrate \( \$m\_{\text{NH}\_4\text{NO}\_3} / \(m\_{\text{NH}\_4\text{NO}\_3} + m\_{\text{HNO}\_3}\)\$ \) as a](#)*

function of aerosol liquid water during the nighttime (green solid triangle) and daytime periods (red solid triangle). During the nighttime, the interference of  $N_2O_5$  contributes higher  $HNO_3$  in GAC measurement. That means, an underestimation of the  $m_{NH_4NO_3}/(m_{NH_4NO_3} + m_{HNO_3})$  during nighttime was expected. This is consistent with the slightly underestimation (about 4%~8%) of the  $m_{NH_4NO_3}/(m_{NH_4NO_3} + m_{HNO_3})$  during the nighttime when aerosol particle liquid water is less than  $10 \mu g/m^3$ , as shown in revised Figure 4.

As discussed above, the interference of  $N_2O_5$  on  $HNO_3$  observations is not expected to change the conclusions of our study during the investigated period in Beijing. We have added the discussion of this  $N_2O_5$  interference in the revised manuscript (line 312-317, revised clean version manuscript) as shown below:

“The function between the particulate nitrate fraction and aerosol liquid water is given in Figure 4. It is worth noting that  $N_2O_5$  hydrolysis during nighttime can contribute extra  $HNO_3$  in the wet denuding method within GAC-IC system. This effect might explain the slightly underestimation of the particulate nitrate fraction in the total nitrate during nighttime when aerosol liquid water is less than  $10 \mu g/m^3$  (Figure 4). However, the general consistency of this function between daytime and the nighttime (Figure 4) suggests a negligible influence of  $N_2O_5$  interference on our analysis during the investigated period.”

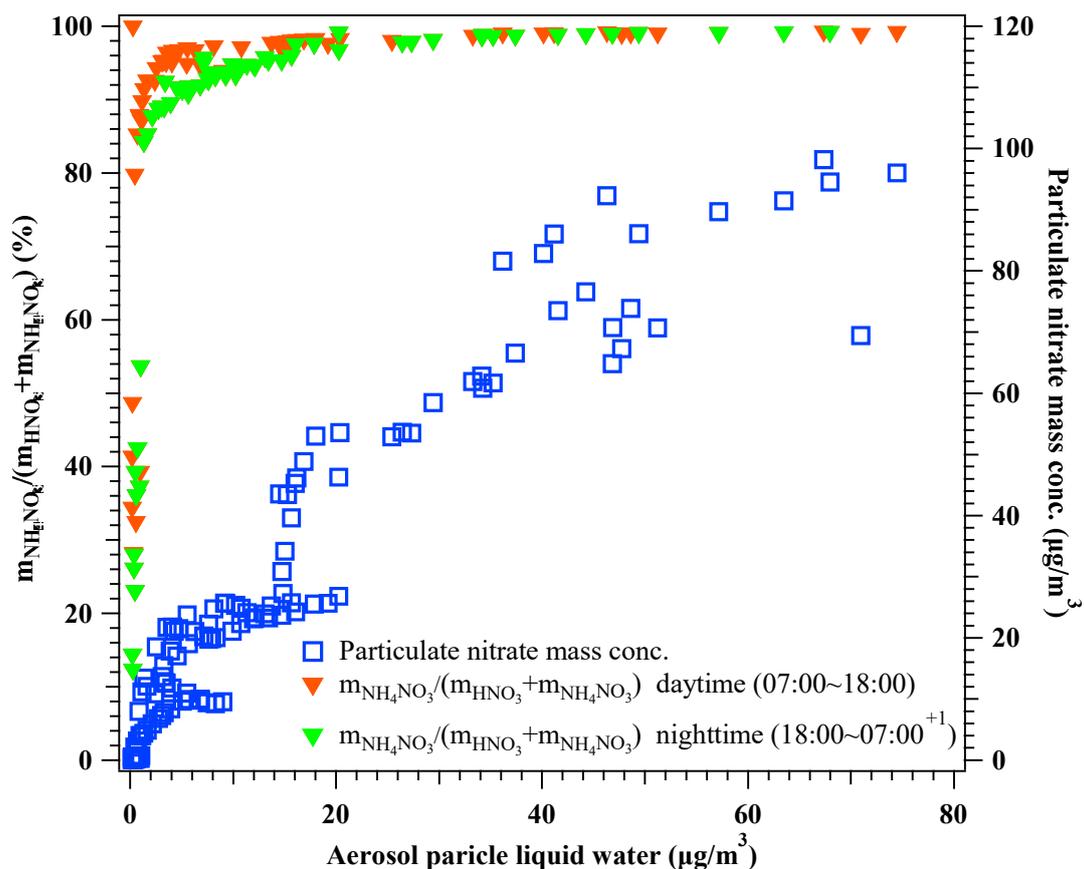


Figure 4: The relationship between aerosol particle liquid water and the molar ratio of particulate nitrate in the total nitrate,  $m_{\text{NH}_4\text{NO}_3}/(m_{\text{HNO}_3} + m_{\text{NH}_4\text{NO}_3})$  (left axis) during the nighttime 18:00~07:00+1 (green solid triangle) and the daytime at 07:00 ~ 18:00 (red solid triangle), and mass concentration of particulate nitrate as a function of aerosol liquid water (right axis) during the period of during February 29 to March 5, 2016. Here, particulate nitrate was measured by HR-ToF-AMS and the  $\text{HNO}_3$  in the gas phase was measured by GAC-IC. Aerosol liquid water was calculated by H-TDMA-derived method.