New findings: Differences in particulate matter might reshape air pollution studies

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A fog event in Gucheng, Hebei province in winter 2018. Credit: ZHAO Xiaoxuan

Current air pollution studies largely rely upon aerosol mass spectrometers, most of which can only measure submicron aerosol (PM_1) species—particulate matter with aerodynamic diameter less than 1 μm.

In many studies, PM_1 aerosol species are therefore used to validate those of $PM_{2.5}$ (particulate matter with aerodynamic diameter less than 2.5 μm) in chemical transport models, and estimate particle acidity (pH) and aerosol water content which are key parameters in studying heterogeneous reactions.

However, are there chemical differences between PM_1 and $PM_{2.5}$? Will the differences bring uncertainties into air pollution studies, especially in highly polluted environment?

Prof. Sun Yele and his team from the Institute of Atmospheric Physics (IAP) of the Chinese Academy of Sciences tried to answer these questions by characterizing the chemical differences between PM_1 and $PM_{2.5}$ in a highly polluted environment in north China in winter using a newly developed $PM_{2.5}$ Time-of-Flight Aerosol Chemical Speciation Monitor. Their study was published in *Geophysical Research Letters*.

They found that the changes in $PM_1/PM_{2.5}$ ratios as a function of relative humidity (RH) were largely different for primary and secondary aerosol species.

"If organics is the dominant component (> 50%) of particulate matter and RH is below 80%, the chemical species in PM_1 would be highly correlated with those in $PM_{2.5}$. PM_1 can be representative of $PM_{2.5}$," said SUN, the first and corresponding author of this study.

"However, if sulfate, nitrate, and secondary organic aerosol that are formed from secondary formation are dominant components, there would be large chemical differences between PM_1 and $PM_{2.5}$ at RH > 60%. The major reason is that these secondary species have higher hygroscopicity and can uptake more water during higher RH periods," he said.

Sun also evaluated the impacts of chemical differences between PM_1 and $PM_{2.5}$ on the predictions of pH and aerosol water content with thermodynamic modeling. According to the study, the chemical differences between PM_1 and $PM_{2.5}$ have negligible impacts on pH prediction, but have a large impact on prediction of aerosol water content by up to 50-70%.

"Our findings are important because current air pollution studies in highly polluted environment, particularly during severe haze events with high RH must consider the chemical differences between PM_1 and $PM_{2.5}$," said SUN, "Validation of model simulations in chemical transport models also need to consider such differences."

More information: Yele Sun et al. Chemical Differences between PM 1 and PM 2.5 in Highly Polluted Environment and Implications in Air Pollution Studies, *Geophysical Research Letters* (2020). DOI: 10.1029/2019GL086288

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