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Positive Feedbacks between the Aerosol Organic Evolution and Liquid Water Content during Haze Episodes in Beijing

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Aerosol liquid water (ALW) is ubiquitous in ambient aerosol and plays an important role in both inorganic and organic formation during haze episodes. To explore the interactions between ALW and aerosol organic components during haze formation and evolution, ALW was modelled using long-term measurements of non-refractory submicron aerosol (NR-PM_1) compositions from different seasons in Beijing. ALW contributed by inorganics (ALW_{inorg}) and organics (ALW_{org}) was respectively modelled by ISORROPIA v2.1 and κ-Köhler theory, where a real time hygroscopicity parameter of the organics (κ_{org}) calculated from the real time organic oxygen-to-carbon (O/C) was used. We found in Beijing that ALW_{org}, which was often neglected in traditional ALW modelling, contributed a significant fraction (18-32%) to the total ALW. The highest ALW_{org} fraction appeared in the cleanest days, when both the organic mass fraction in NR-PM_1 and organic hygroscopicity were relatively high. For high-ALW haze episodes, organic O/C and κ_{org} increased with the increase in ALW, indicating the formation of more soluble organics via aqueous/heterogeneous-phase process which in turn promoted water uptake. In contrast, no obvious increase in organic O/C and κ_{org} was observed during low-ALW episodes. The rapid increasing κ_{org}, together with the decreasing particle organic fraction in high-ALW episodes increased the particle overall hygroscopicity (κ_{total}), forming a positive feedback loop that contributed to the rapid haze formation in Beijing.