

Combined effects of organic aerosol loading and fog processing on organic aerosols oxidation and composition

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Fog is a natural meteorological phenomenon that occurs throughout the world, it contains substantial quantity of liquid water and generally seen as a natural cleansing agent but it also has the potential to form highly oxidized secondary organic aerosols (SOA) via aqueous processing of ambient aerosols. On the other hand higher organic aerosols (OA) loading tend to decrease the overall oxidation level (O/C) of the particle phase organics, due to enhanced partitioning of less oxidized organics from gas to particle phase. However, combined impact of these two parameters; aqueous oxidation and OA loading, on the overall oxidation ratio (O/C) of ambient OA has never been studied. To assess this, real time ambient sampling using HR-ToF-AMS was carried out at Kanpur, India from 15 December 2014 – 10 February 2015. In first 3 weeks of this campaign, very high OA loading is ($134 \pm 42 \mu\text{g}/\text{m}^3$) observed (termed as high loading or HL period) while loading is substantially reduced from 2nd January, 2016 ($56 \pm 20 \mu\text{g}/\text{m}^3$, termed as low loading or LL period) . However, both the loading period was affected by several fog episodes (10 in HL and 7 in LL), thus providing the opportunity of studying the combined effects of fog and OA loading on OA oxidation. It is found that O/C ratio is very strongly anti-correlated with OA loading in both the loading period, however, slope of this ant-correlation is much steep during HL period than in LL period. Source apportionment of OA revealed that there is drastic change in the types of OA from HL to LL period, clearly indicating difference in OA composition from HL to LL period. During foggy night continuous oxidation of OA is observed from early evening to early morning with 15-20% enhancement in O/C ratio, while the same is absent during non-foggy period, clearly indicating the efficient fog processing of ambient OA. It is also found that night time fog aqueous oxidation can be as effective as daytime photo chemistry in oxidation of OA. Fog seemed to be reducing the negative impact of OA loading on O/C ratio via oxidation through aqueous processing. Average O/C ratio difference between HL and LL period during no-fog condition is 0.13 while it is reduced to 0.06 during foggy condition. This indicates that fog processing to an extent negating the OA loading impact on O/C ratio. This is happening due to the fact that aqueous oxidation efficiency doesn't depend on OA loading but on fog LWC (liquid water content), RH, NO_x and presence/absence of transition metals. These findings indicate that only aerosol volatility based approach to predict particle phase concentration, composition and oxidation ratio of organics may result in some misleading outcome.