

EGU21-6897

<https://doi.org/10.5194/egusphere-egu21-6897>

EGU General Assembly 2021

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Spatial and molecular distributions of dicarboxylic acids, oxocarboxylic acids, and α -dicarbonyls in snow in China

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Snow acts as efficient scavenger of the ambient contaminants, bringing considerable amounts of dissolved organic matter (DOM) from the atmosphere to the freshwater and marine environments. Low molecular weight organic acids are important and ubiquitous chemical constituents in the atmosphere. However, very limited studies so far focused on the distributions of these organic compounds in snow. To investigate the spatial and molecular distributions in snow DOM over North China, twelve fresh snow samples were collected at eight sites including urban, rural and Changdao Island during January-February 2019. The snow samples were analyzed for dicarboxylic acids and related compounds together with dissolved organic carbon (DOC). The DOC concentrations ranged from 0.99 to 14.6 mgC L⁻¹ in melt snow, which exhibited considerable spatial variation that was affected by terrestrial/anthropogenic inputs. Total diacids were very abundant varying from 225 to 1970 $\mu\text{g L}^{-1}$, whereas oxoacids (28.3–173 $\mu\text{g L}^{-1}$) and α -dicarbonyls (12.6–69.2 $\mu\text{g L}^{-1}$) were less abundant. Molecular distributions of diacids were characterized by the predominance of oxalic acid (C₂, 95.0–1030 $\mu\text{g L}^{-1}$). Contrary to the results of other studies, the second largest amount of diacid in the snow samples showed a distinct spatial variation. Higher concentrations of phthalic acids (Ph) in snow samples in Tianjin and Beijing than those in other urban and rural regions suggest significant emissions from vehicular exhausts and incomplete combustion of fossil fuels in megacities. Glyoxylic acid (15.4–116 $\mu\text{g L}^{-1}$) was the major oxoacids while methylglyoxal (MeGly) was the major α -dicarbonyl. The mass concentration ratio of C₉ to total diacids was found to be highest in Changdao Island, indicating a significant input of marine derived unsaturated fatty acids such as oleic acid. These spatial distributions are consistent with photochemical production and the subsequent accumulation under different meteorological conditions. C₂ diacid constituted 40–54% of total diacids, corresponding to 1.5–2.6% of snow DOC. The total measured water-soluble organic components represent 5.5–10% of snow DOC, which suggests that there are large amounts of unknown organics that need further investigations.