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Nanoscale ice-nucleating particles in waterbodies in an agricultural area

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We examined the presence of ice nucleating particles (INPs) in the predominantly agricultural watershed of the Maumee River, with surveys extending to western Lake Erie in the North American Great Lakes region. Along the river, monthly samples were taken from March 2016 to July 2017, together with samples from actively flowing water in tile drains and ditches along field edges which were collected following rain events. The potential for river INPs to become aerosolized was measured from air samples collected on polycarbonate filters.

Concentrations of ice nucleating particles were determined using PCR trays which were cooled in baths, by either directly examining the liquid samples or, in case of the filters, by rinsing and resuspending them from the filter.

Abundant INPs were identified from surface waters of both the Maumee River and Lake Erie with freezing profiles spanning the entire temperature range tested from -3 °C to -20 °C. INPs that were found could largely be attributed to biogenic macromolecules (nano-INPs), based on tests done with heat denaturation and filtering through a 0.2 μm membrane. Higher concentrations were found in river samples compared to lake samples. However, the latter showed a broader increase in the freezing profile, pointing towards a larger variety of INPs being present in the lake. INPs that were ice active at -10°C (INP[-10]) were examined in more detail. They were found in samples from tile drains and ditches, too, where their concentrations was twice as high in the ditches than in the tile drains (that drained into the ditches). In the river, their concentration correlated with river discharge for the monthly samples, suggesting a watershed origin of these INP[-10].

A comparison of concentrations of INP[-10] from aerosols collected close to the river at a dam and at control locations further away generally revealed larger concentrations closer to the waters, suggesting that at least some of airborne biogenic INP are derived from rivers and lakes.