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Investigating the incorporation of micro- and nanoplastics into young artificial sea ice

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Microplastics (MPs, 1 um to 5 mm) and nanoplastics (NPs, <1 um) are accumulating in the Arctic Ocean. They can pose hazards to polar organisms and impact biogeochemical cycles. Therefore, it is crucial to determine the transport pathways of MPs and NPs in the Arctic Ocean, including their incorporation into sea ice. Due to climate change, Arctic sea ice is increasingly young and thin. Since, the formation of young sea ice strongly redistributes concentrations of dissolved and particulate species, we investigated how MPs and NPs are engulfed or expulsed from a freezing front. We hypothesised that particles' density and effective size (i.e., the size of a single particle if dispersed or of aggregated particles) will govern the extent of their enrichment in sea ice. We used a novel experimental design which mimics the freezing of seawater to systematically assess to what extent and by which processes particles are accumulated in sea ice. This design allows us to control the system temperature, salinity, and pressure, which constitutes a significant improvement compared to other experimental designs. We used artificial Arctic Central Basin surface waters (32 g/L, pH 7.97) and model MPs (63-125 um and <63 um) and NPs (174 ± 42 nm) that were doped with metal tracers, allowing them to be quantified in low concentrations by ICP-MS. We plan to study carbon black to compare how particle size and chemistry influences engulfment by the growing ice front. Each freezing experiment was conducted in triplicate with a temperature gradient from -6 to 1ºC. The ice core was removed and centrifugated at -2.3ºC to separate the connected brine while preserving the ice core structure. This allowed us to i) obtain a mass balance of particles in the brine, brine-free ice and underlying liquid separately and ii) analyze the structure of the ice by micro-computed tomography (u-CT). By combining this unique data we gain insight into how the formation of young sea ice impacts particle transport.