Climate: Iodic acid influences cloud formation at the North Pole

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The Arctic is warming two or three times faster than the rest of the planet. This amplified warming is due to several factors, but the relative importance of each one remains still unclear. "We do know, however, that clouds could play an important role," says Julia Schmale, an EPFL professor who heads the Extreme Environments Research Laboratory and holds the Ingvar Kamprad Chair. "By reflecting the sun's rays back into space or trapping heat close to the Earth's surface like a blanket, clouds help either cool off or warm up the planet."

Schmale—along with scientists from the Paul Scherrer Institute's Laboratory of Atmospheric Chemistry and Stockholm University's Department of Environmental Science and Bolin Center for Climate Research—spent several weeks collecting data near the North pole in August and September 2018, as part of the US-Swedish expedition Arctic Ocean 2018 on board the Swedish icebreaker Oden. The scientists measured the chemical and physical properties of atmospheric molecules and aerosol particles to better understand the conditions leading to cloud formation.

How aerosols are formed in the Arctic

"One of our objectives was to investigate how new aerosol particles could form in the Arctic atmosphere," says Andrea Baccarini, a Ph.D. student at the Paul Scherrer Institute and now scientific collaborator in the extreme Environments research Laboratory. "Under the right conditions, gas molecules condense together into small clusters that can grow, eventually forming aerosols." If these aerosols grow even just a small amount larger, they can function as cloud condensation nuclei, which are essential for cloud formation.

In the Arctic summer and fall, the concentration of aerosols is extremely low. "The contribution of newly formed aerosols can be extremely important and even a small change in aerosol concentration in the high Arctic could have a major impact on cloud formation or alter clouds' radiative properties," says Baccarini. It is also still not clear how important local aerosol processes are to cloud formation in comparison to regional or long-range transport, for example. "With this expedition, we could investigate the exact sources of aerosol particles that are needed to form clouds" adds Paul Zieger, an assistant professor at Stockholm University who led the research project on aerosol-cloud processes of the 2018 expedition.

Iodic acid appears in early fall

The research team found that iodic acid, a chemical compound which had not previously been observed in the region, triggers the formation of new aerosols between late summer and early fall. "There is less ice in the Arctic at the end of the summer, a lot of open water and the concentration of iodic acid is very low at that point," says Schmale. "Towards the end of August the temperature drops and the water starts refreezing, marking the beginning of the so called freeze-up period. This is when the iodic acid concentration sharply increases leading to frequent new aerosol particle formation events."

The team developed a simple model to explain the variability of iodic acid in the atmosphere, which largely depends on local meteorological conditions. They were also able to describe the full chain of events that leads all the way from new particle formation to clouds, from the gas molecule that initially creates a particle to the formation of cloud condensation nuclei. "Observing and describing this process under real-world conditions was an extremely rare opportunity," says Schmale.

Their findings, recently published in *Nature Communications*, provide greater insight into the role of biogeochemical processes for cloud formation over the Arctic pack ice and potentially also for Arctic warming.

More information: Andrea Baccarini et al. Frequent new particle formation over the high Arctic pack ice by enhanced iodine emissions,

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