Connecting the sea to the sky in the high Arctic

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Credit: Stockholm University

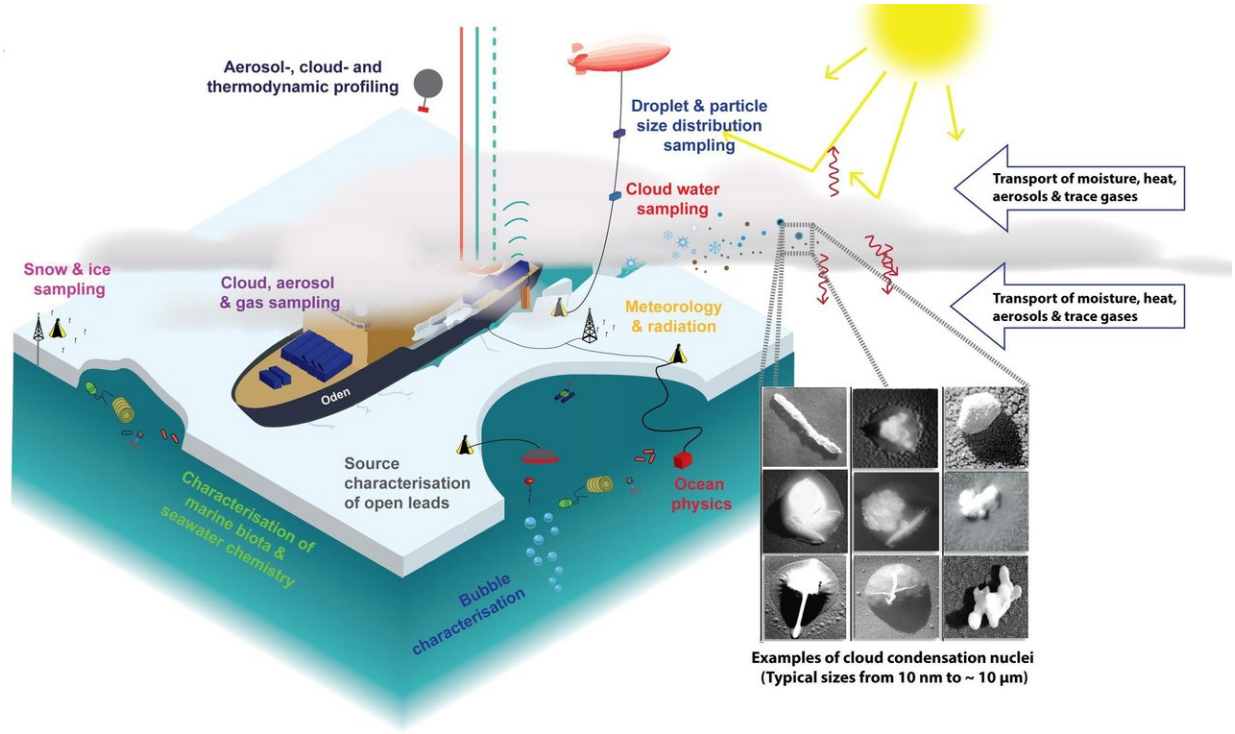
How important is marine microbiology to clouds in the summertime high Arctic and how important is this connection for climate in the region? This is a key focus of a research expedition on the Swedish icebreaker Oden that will take place in the high Arctic this summer where

Stockholm University will take a leading role.

That the Arctic climate is changing fast is clear for all to see. Indeed, the Arctic is warming at a rate of almost twice the global average. However, our understanding of what exactly controls this rapid climate change and the extent to which the Arctic climate will continue to change into the future is much more limited and a number of key questions remain unanswered. For example, what are the consequences of the dramatic loss of summer sea-ice for Arctic climate? Will the ice continue to disappear as the ocean absorbs increasing amounts of solar radiation? Or might conditions become more favorable for biological activity and associated cloud-formation, with a subsequent reduction in the amount of solar-radiation able to reach the surface ocean, possibly counteracting the ice melt? It is questions such as these that motivate a unique research expedition to the high Arctic aboard the icebreaker Oden.

"The goal is to provide unique measurements that will provide detailed information about basic processes for cloud formation in the Arctic. These results are necessary to understand the Arctic climate and its sensitivity and response to the changes in climate caused by human activity," says Caroline Leck, professor in chemical meteorology at the Department of Meteorology (MISU). Professor Leck is the chief scientist in charge of the expedition from Stockholm University together with Patricia Matrai from the Bigelow Laboratory for Ocean Science in the U.S.

Clouds play a vital role in the Arctic since they impact the amount of solar radiation that reaches the surface. For clouds to be formed, a certain amount of wind, humidity and temperature is required. However, the formation of clouds also requires the presence of small particles in the air, so called aerosols, which act as embryos for the cloud-water droplets.



"Our current understanding of the role clouds play in the Arctic is not sufficient to understand how they impact sea-ice melting and a key missing link is the role that life in the oceans play in cloud formation here," says Caroline Leck. "Of course, a key challenge is trying to unpick these complex relationships in a region that is extremely difficult to access – this is a logistical and technical challenge unlike any other," says Caroline Leck.

The expedition is a combined US and Swedish effort that includes 40 researchers from around the globe. On July the 20th the icebreaker Oden will depart Helsingborg in the southern part of Sweden before heading towards the North Pole. The main research will take place at around 90

degrees north during an ice-drift operation. Here, Oden will be parked next to a heavy ice floe where it will drift freely for around five weeks so that the researchers can collect samples from the ocean, the ice and the air.

Among other things, they want to find out how the clouds are connected to the microbiological life of the sea and the ice – something that is particularly prominent in the summer. It is in this period that the ice algae and bacteria are at their most active in the open leads between the ice floes. But what links the sea to the sky? The key to solving this piece of the puzzle is bubbles – bubbles that are present in the open leads rise to the surface where they burst, ejecting material present at the water surface into the atmosphere. A critical question the researchers want to resolve is whether this process is an important source of aerosols in the region and whether it may impact the clouds above.

"In the open leads, one can observe bubbles, which burst and eject aerosols into the atmosphere above. This leads to some very important questions that are yet to be answered: What processes control how many bubbles are reaching the water surface and bursting? How many particles do these bubbles produce? How large are these particles and what are they composed of? How important is this source of particles compared to other particle sources in the region? Are these particles playing a role in forming the low-level clouds found in the region during summer?" says Matt Salter, aerosol physicist at the Department of Environmental Science and Analytical Chemistry (ACES), who is part of the team.

To answer these questions the team will deploy a floating aerosol chamber in the open leads along with a bubble buoy designed to quantify the bubbles in the water. "Essentially we will deploy a floating tank in the open leads so that any aerosols coming out of the water surface following bubble bursting are trapped within it. By placing our instruments on top of the tank we will be able to suck these particles out

enabling us to count them and determine their size," says Matt Salter.

In order to determine whether the aerosols in the atmosphere and clouds above the open leads have their source in the ocean the team will deploy instrumentation on the Oden and on tethered balloons to sample the clouds.

"Like a vacuum cleaner, we will suck both aerosols and clouds inside a container onboard Oden where we will use a large suite of instrumentation to study the microphysical properties and chemical composition of the aerosols and cloud droplets. One can say that we will bring the Arctic clouds back to Sweden," says Paul Zieger, atmospheric physicist and assistant professor, ACES.

Researchers from Stockholm University have been involved in several expeditions to the Arctic over the last few years, but an expedition with a focus on aerosols and clouds has not taken place since 2008.

"As our research has a focus on the use of advanced technical equipment and advanced analytical methods that have never been deployed in the region before, the expedition this summer will allow us to take giant leaps forward in our understanding of the major changes occurring in the Arctic as a result of climate change caused by human activities. To that end, the expedition will also ensure that Sweden continues its long tradition of world-leading research in the region," says Caroline Leck.

Provided by Stockholm University