CLOUD at CERN reveals the role of iodine acids in atmospheric aerosol formation

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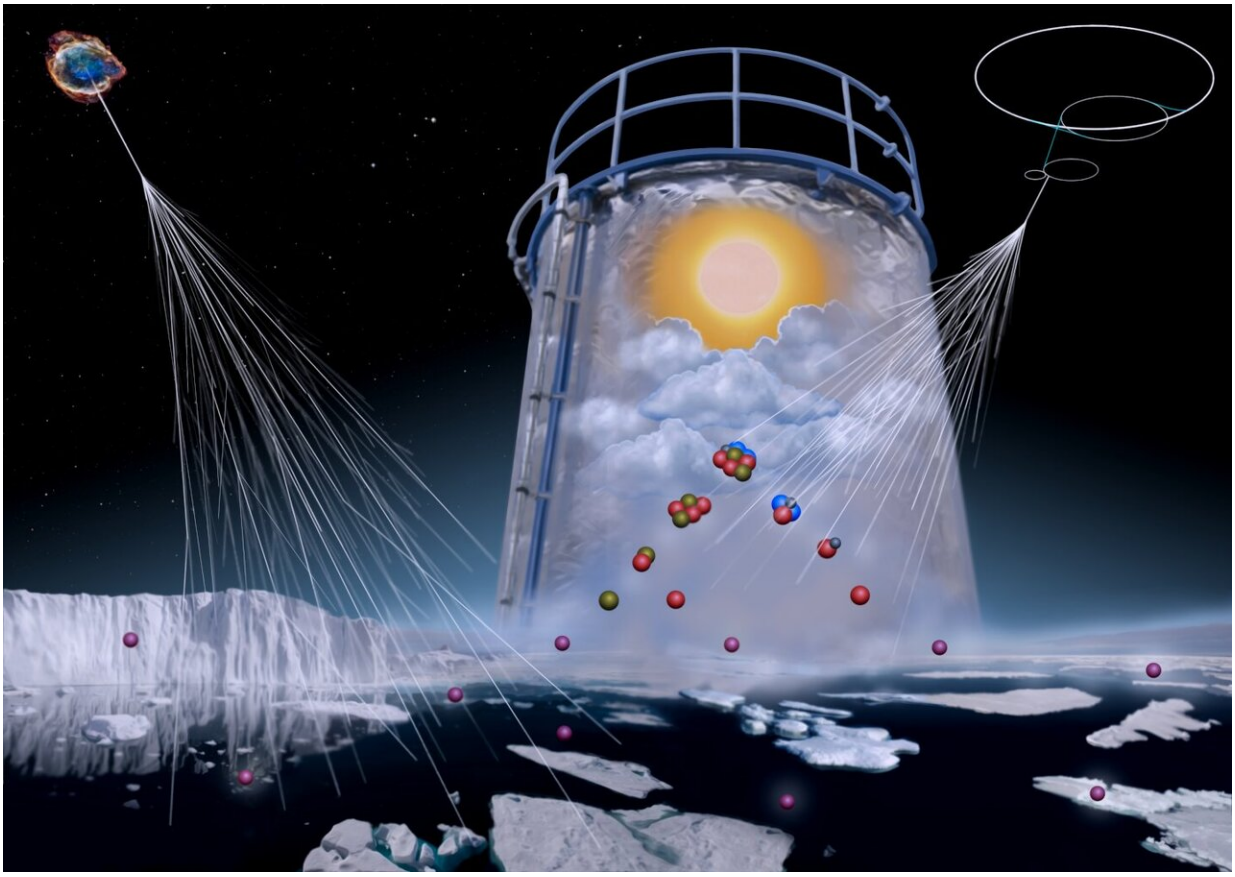

Simulation of the marine atmosphere in the CLOUD chamber. Iodine emitted from the sea and ice is converted by ozone and sunlight into iodic acid and other compounds. These form new particles and increase clouds, warming the polar climate. Cosmic rays strongly enhance the particle formation rates. Credit: Helen Cawley

In a paper published today in the journal *Science*, the CLOUD collaboration at CERN shows that aerosol particles made of iodic acid can form extremely rapidly in the marine boundary layer—the portion of the atmosphere that is in direct contact with the ocean. Aerosol particles in the atmosphere affect the climate, both directly and indirectly, but how new aerosol particles form and influence clouds and climate remains relatively poorly understood. This is particularly true of particles that form over the vast ocean.

"Iodic acid particles have been observed previously in certain coastal regions, but we did not know until now how important they may be globally," says CLOUD spokesperson Jasper Kirkby. "Although most atmospheric particles form from sulfuric acid, our study shows that iodic acid may be the main driver in pristine marine regions."

CLOUD is a one-of-a-kind experiment. It's the world's first laboratory experiment to achieve the technical performance required to measure the formation and growth of aerosol particles from a mixture of vapours under precisely controlled atmospheric conditions. In addition, the experiment is able to study how ions produced by high-energy particles called cosmic rays affect aerosol particle formation, using either the steady flux of natural cosmic rays that rains down on the CLOUD chamber or—to simulate higher altitudes—a beam of particles from the CERN Proton Synchrotron.

In its new study, the CLOUD team has investigated how aerosol particles form from vapours originating from molecular iodine under marine-boundary-layer conditions. They found that the particle formation and growth is driven by iodic acid (HIO_3), and that iodous acid (HIO2) plays a key role in the initial steps of the formation of neutral particles—those with no electrical charge.

In addition, the researchers found that the iodic acid particles form

extremely rapidly—even more rapidly than sulfuric acid-ammonia particles at similar acid concentrations. They also found that ions from cosmic rays originating from our galaxy accelerate the particle formation rate to the maximum possible, which is limited only by how frequently molecules collide.

"Iodic acid particle formation is likely to be particularly important in pristine marine regions where sulfuric acid and ammonia concentrations are extremely low," says Kirkby. "Indeed, frequent new-particle formation over the pack ice in the High Arctic has recently been reported, driven by iodic acid with little contribution from sulfuric acid."

The results have important ramifications. The ocean surface, sea ice and exposed seaweed are major sources of atmospheric iodine, and global iodine emissions at high latitudes have increased threefold during the past seven decades and are likely to continue to increase in the future as sea ice becomes thinner.

"In polar regions, aerosols and clouds have a warming effect because they absorb infrared radiation otherwise lost to space and then radiate it back down to the surface. Increased iodic acid aerosol and cloud-seed formation could therefore provide a previously unaccounted positive feedback that accelerates the loss of sea ice in the Arctic," explains Kirkby.

More information: Xu-Cheng He et al. Role of iodine oxoacids in atmospheric aerosol nucleation, *Science* (2021). DOI: 10.1126/science.abe0298

Provided by CERN