# Fossil fuel emissions impact Arctic snow chemistry, scientists find

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Scientists built a monitoring station in remote northern Alaska and found elevated levels of chlorine atoms when fossil fuel polluted air traveled in from the direction of a nearby city and a large oil field. Credit: Jose Fuentes

Perennial sea ice is rapidly melting in the Arctic, clearing the way for

new shipping routes and fossil fuel extraction. This increased activity could have unexpected impacts on the natural chemistry of the polar region, according to researchers.

A team of scientists from Penn State, the University of Michigan, Purdue University and the University of Alaska Fairbanks found nitrogen dioxide, a pollutant produced by the extraction and burning of fossil fuel, led to higher levels of atmospheric chlorine at a remote site in Alaska located near the northern-most city in North America and a major oil field.

"We know that the Arctic is changing rapidly, but we need more observations to understand how our economic decisions, related to development and shipping, impact the natural system through links that may not immediately be obvious," said Kerri Pratt, assistant professor of chemistry at the University of Michigan, and lead author on the study.

Nitrogen dioxide undergoes a series of reactions in the atmosphere, ultimately leading to the reaction of dinitrogen pentoxide ($N_2O_5$) with aerosols produced by natural sea spray, linking the fossil fuel and natural emissions, which are both increasing in the rapidly warming Arctic, the researchers said.

"This study shows that if we continue burning fossil fuels in the Arctic and producing these gases, it will further impact this beautiful balance we have had there for ages," said Jose D. Fuentes, professor of atmospheric science at Penn State. "And that could accelerate the environmental changes we are seeing in the Arctic."

Arctic chlorine also enters the atmosphere through natural processes involving reactions within the snowpack, and can act as a detergent, breaking down harmful greenhouse gases. But it's unclear what impact the increased production of atmospheric chlorine linked to fossil fuel

emissions, and coupled to this natural production, has on the environment, the researchers said.

The researchers reported observing elevated levels of several chlorine precursors in the study, published recently in the journal *Environmental Science and Technology*.

Concentrations of the gases were at their highest when air masses traveled from the direction of Utqiaġvik, Alaska, formerly named Barrow, about a mile and a half away, and from the North Slope of Alaska (Prudhoe Bay) oil fields, about 200 miles to the southeast, according to the study.

One of the gases, nitryl chloride ($ClNO_2$), builds up and spreads at night, away from the presence of sunlight. During the day, sunlight converts the gas into highly reactive chlorine atoms that rapidly react with atmospheric pollutants.

Additional studies downwind of major Arctic fossil fuel emission sources during polar night and sunrise are necessary to further examine potential regional impacts, said the researchers, who added that those impacts could continue to grow if shipping and oil and gas extraction activities increase in the Arctic due to melting sea ice caused by the changing climate.

"This research tells people what could be expected to happen in the Arctic, but not just at the northern fringes of Alaska—at a much broader scale," Fuentes said. "This could happen throughout the Arctic where fossil fuel burning happens."

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