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Arctic ozone: Signs of chemical destruction

Not to be outdone, the Arctic is now stealing from Antarctica the attention of atmospheric scientists, who have spent three years scrutinizing the much-publicized ozone hole centered over the South Pole. A group of researchers who spent several weeks in northern Greenland in February report finding the first evidence of ozone-destroying chlorine chemistry in the stratosphere near the North Pole. Meanwhile, scientists from the United States, Europe and the Soviet Union are planning campaigns next winter to study the fate of Arctic ozone.

In the stratosphere over Thule, Greenland, the U.S. researchers measured high levels of chlorine dioxide, a chemical also found over the Antarctic during the dramatic seasonal loss of ozone. At mid-latitudes, chlorine dioxide is so scarce it cannot be detected, says Ryan Sanders of the University of Colorado at Boulder. He and Roger Jakoubek traveled to Thule with George Mount and Susan Solomon from the National Oceanic and Atmospheric Administration's (NOAA) Aeronomy Laboratory in Boulder.

Although chlorine dioxide does not break apart ozone itself, scientists believe it participates indirectly in the ozone-destruction cycle – a series of chemical reactions fueled mainly by chlorine from human-made chlorofluorocarbons that are accumulating in the stratosphere.

Using spectrometers to detect atmospheric chemicals, the researchers also found another similarity between the two poles: extremely low levels of nitrogen dioxide. When present in the stratosphere in normal amounts, this compound stems ozone loss by converting an active chlorine compound into a harmless form.

"When you put those together, it strongly suggests that the same thing that is going on in Antarctica is also happening in the Arctic for a few months," Sanders says. He and his colleagues discussed their findings last month at a conference on polar ozone in Snowmass, Colo.

The Antarctic ozone hole is a large patch of ozone-depleted air that develops for several months over the high southern latitudes early each austral spring. Although some researchers have previously reported finding regions of ozone loss in the Arctic (SN: 10/4/86, p.215), scientists have scant ozone data for this region and there is debate over the accuracy of the earlier reports, says Robert Watson of NASA in Washington, D.C. "If there have been observed [Arctic] changes, which I believe there have been, they are much smaller in magnitude than in the Antarctic by a factor of 10," he says.

In the midlatitudes, between 40°N to 60°N, satellite and ground-based measurements are much better, and an international panel reported earlier this year that ozone levels over this part of the world do drop during the wintertime relative to their levels in 1969. The panel also announced that average global levels of life-protecting ozone have been falling – although on a much slower scale than what occurs each spring in the Antarctic.

The concern among scientists is that chlorine in the Arctic stratosphere may be involved in so-called heterogeneous chemical reactions, which are the key to the rapid ozone destruction in the Antarctic (SN: 10/10/87, p.230). As opposed to normal gas-phase reactions, heterogeneous reactions take place on the surface of cloud particles that appear in the dry stratosphere only when temperatures drop to around -80°C. These reactions are important for ozone destruction because they allow otherwise inert chlorine compounds to react and transform into ozone-destroying species.

Based on the chlorine dioxide observations, "there is very clear evidence that there's unusual chlorine chemistry taking place in the north," Sanders told SCIENCE NEWS. Moreover, other researchers flying in the Arctic have detected stratospheric cloud particles. However, it is still an open question whether heterogeneous chemistry is occurring there and whether chlorine is destroying ozone, Sanders adds.

Whatever is happening in the Arctic, clearly the northern effects do not rival the Antarctic's. Levels of chlorine dioxide measured over Thule were five times lower than in the south. As well, the winter stratosphere in the Arctic is not as cold or as isolated from invading air currents, which means heterogeneous chemistry cannot be as active in the north.

Scientists agree the Arctic presents a more subtle problem to comprehend than the Antarctic. To provide some necessary observations, more than 100 U.S. researchers are planning an airborne expedition for next January out of Stravanger, Norway. A similar campaign last year out of Punta Arenas, Chile, gave researchers many of the data they needed to understand the situation in the Antarctic. Coordinated by NASA and NOAA, the expedition will use a high-flying ER-2 that takes direct measurements within the stratosphere and a longer-ranged DC-8 that serves as a laboratory for remote sensing equipment, Watson says. European researchers will perform ground-based measurements.

According to Watson, the Soviets also plan to conduct some ground-based and airborne measurements in their own country at around the same time. Although the Soviet and U.S. experiments are separate, there have been discussions about coordinating the two, he says.

– R. Monastersky