Arctic Air Primed to Destroy Ozone

An international team of scientists has found surprisingly high concentrations of ozone-destroying chemicals in the stratosphere above the Arctic. While they cannot yet assess the harm of these chemicals, the researchers say this finding increases their concern that chlorine and bromine from human-made compounds are eating away at the protective ozone layer in the Arctic during the early springtime.

"The [Arctic] atmosphere is primed for a large destruction of ozone. Whether it will occur or not depends effectively on how the atmosphere behaves over the next few weeks," says Robert T. Watson from NASA headquarters in Washington, D.C.

The scientists have just returned from a six-week project in which two instrument-laden planes flew out of an airfield in Stavanger, Norway. Costing over $10 million, the research campaign involved more than 100 scientists and technicians and was sponsored principally by NASA and the National Oceanic and Atmospheric Administration (NOAA).

Ozone in Earth's stratosphere normally absorbs ultraviolet radiation harmful to humans and to many other forms of life. However, human-made compounds — most notably chlorofluorocarbons and halons — have carried unnatural amounts of chlorine and bromine into the high atmosphere, where they are slowly eroding the global ozone shield. While this process works gradually, the scientific community has discovered in the past three years that a much faster mechanism involving the same chemicals destroys massive amounts of ozone over the Antarctic each spring, creating the much-publicized "ozone hole."

While researching the Antarctic's ozone problem, scientists found that these fast reactions require cloud particles in the stratosphere, which form only in extreme cold. Knowing that these clouds, called polar stratospheric clouds (PSCs), develop over the Arctic, scientists became concerned that the accelerated PSC chemistry might also destroy ozone there (SN: 10/15/88, p.249). Wintertime levels of ozone in the stratosphere of the far North have dropped about 6 percent since 1970, and the slow process can account for only about a third of the observed Arctic loss.

During the recent Arctic airborne mission, investigators focused their study on a region called the polar vortex — a pattern of swirling winds that surrounds and isolates a large patch of the polar stratosphere. Inside the vortex, air temperatures drop enough for PSCs to form.

Researchers on the recent project did find PSCs in the vortex and observed that the concentrations of atmospheric chemicals in this region were highly abnormal. Most important, air patches in the vortex contained up to 50 times the normal amount of chlorine monoxide, a key chemical in the chain of ozone-destroying reactions. These levels, much higher than what scientists expected in the North, are similar to those seen over the Antarctic.

The researchers also found that air in the vortex held abnormally low levels of hydrochloric acid and chlorine nitrate, called reservoir species because most of the chlorine in the stratosphere normally appears in the form of these chemicals. The reservoir chemicals are not involved in ozone destruction. Their low concentration supports the idea that PSC reactions in the Arctic convert inactive chlorine compounds into active ones.

Taken together, the new findings suggest the Arctic hosts many of the same processes that destroy ozone over Antarctica. Yet scientists believe any ozone problem over the Arctic will be much more subtle. They are not ready to decree that PSC chemistry is causing the observed long-term loss in the North. Watson says the investigators will analyze the new data and compare them against computer models in an effort to link unequivocally the Arctic's perturbed chemistry to its ozone loss.

They will also study how the polar vortex breaks up, a process that allows outside air to inactivate the ozone-destroying chemicals in the vortex. The chemical reactions that deplete ozone require sunlight, yet the Arctic vortex breaks up around the time when the spring sun returns to the North. So far this year, the vortex has survived. "What we've got set up now is a situation where there is a race," says Adrian Tuck of NOAA in Boulder, Colo., the project scientist for the Arctic expedition.

Tuck says the project members were more concerned about ozone loss in the Arctic when they left Norway than when they arrived. An international treaty that will take effect this year limits the use of chemicals that lead to ozone destruction. But this treaty was negotiated before scientists knew that PSC reactions could accelerate the destruction of ozone.

— R. Monastersky

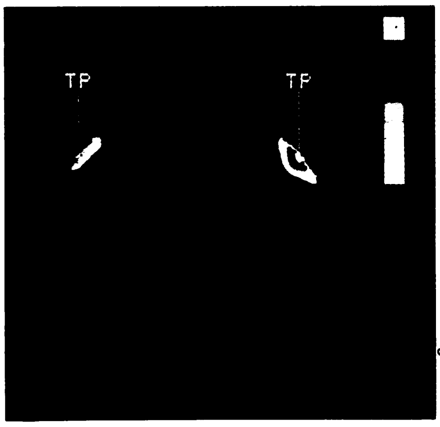
PET pictures produce a palette of anxiety

Scientists are going with the flow — blood flow, that is — to illuminate how the brain generates anxiety and fear. When experiment volunteers are told they will soon receive a painful electric shock, blood flow surges in their temporal poles, located in both brain hemispheres at the tips of the temporal lobes just behind the eyes, according to a report in the Feb. 24 SCIENCE.

It remains unclear if this experimentally induced "shock" anxiety duplicates more common forms, such as the queasy feeling before a root canal operation. But the evidence suggests the temporal poles may be crucial in brain processes that tag situations with a sense of uncertainty, helplessness or danger, say psychiatrist Eric M. Reiman and his colleagues at Washington University School of Medicine in St. Louis.

"A final common pathway in the brain for both normal and pathological anxiety may involve the temporal poles," Reiman adds.

The investigators took positron emission tomography (PET) measurements of cerebral blood flow in eight healthy volunteers before, during and after anticipation of a painful electric shock. Subjects were injected with water containing minute amounts of a radioactively labeled oxygen isotope. This tracer remains active in the body for only a few minutes. An array of tubes around the head picks up gamma rays emitted by the decaying isotope, and a computer transforms the information into color-coded images of blood flow.



Reiman/Washington Univ.

PET scan shows average blood flow for all subjects awaiting electric shock. Greatest blood flow is in temporal poles (TP).

Before-and-after data provided a baseline for blood flow and controlled for anxiety produced by the PET procedure itself. Subjects received a mild electric shock after the second PET measurement period.

Only the temporal poles showed signif-