Northern Ozone Hole Deemed Likely

An ozone hole will likely form over populated regions of the northern hemisphere sometime within the next 10 years, according to a team of scientists involved in a six-month study of Earth's protective ozone layer. The new data, reported this week in Washington, D.C., also reveal that experts have overestimated the atmosphere's ability to defend itself against ozone-destroying chlorine pollution.

The researchers judged these findings so important that they released their results early, before the end of the experiment in March.

"We don't like what we see. This isn't good news," concludes project scientist James G. Anderson of Harvard University.

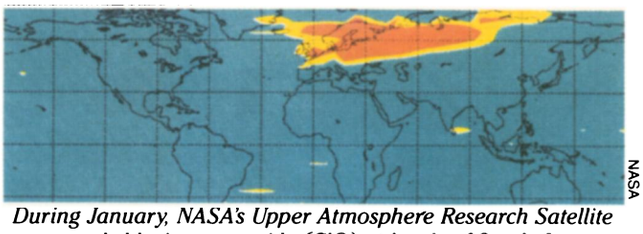
Involving 40 scientists, the NASA-run experiment began in October, with the aim of assessing the chances of a northern ozone hole and explaining a disturbing erosion — detected everywhere except the tropics — of Earth's stratospheric-ozone layer. In flights over northern New England and Canada on Jan. 20, instruments aboard NASA's high-altitude ER-2 aircraft detected record-setting levels of chlorine monoxide (ClO), the key molecule that destroys ozone. Concentrations ranged as high as 1.5 parts per billion (ppb), a value never before seen, even during flights into the Antarctic ozone hole, Anderson says.

The ER-2 instruments measured the high ClO concentrations at a time when the Arctic Vortex — a region of extremely cold air — had shifted from its polar position toward the United States. Ozone destruction occurs most readily inside the vortex because air there is cold enough to form cloud particles that help harmless chlorine-containing compounds convert into dangerous ClO.

At levels above 1.5 ppb, ClO can destroy ozone at a rate of 1 to 2 percent per day — if sunlight is present. For an ozone hole to develop over the Arctic, weather in the stratosphere must remain stable, allowing the vortex to persist into March, when sunlight reaches the polar region.

NASA aircraft will continue to monitor the fate of Arctic ozone through March. Although they do not know if it will happen this year, project scientists say that during some year in the near future, the vortex will remain intact. As levels of chlorine climb each year, the chances of severe Arctic ozone depletions rise. "The probability for forming an ozone hole — that is, for significant ozone erosion in this vortex region — is very high for the decade to come," Anderson says.

An Arctic ozone hole would most directly affect regions underneath the vortex, allowing increased levels of biologically dangerous ultraviolet radiation to reach much of Canada and parts of the United States, Europe and Asia. But the aircraft mission also uncovered disturbing findings about the global ozone layer outside the vortex region. ER-2 flights as far south as the Caribbean detected ClO in the range of 0.1 ppb — five times the amount scientists expected.



NASA

During January, NASA's Upper Atmosphere Research Satellite measured chlorine monoxide (ClO) at levels of 2 ppb. Image from Jan. 11 shows northern Europe and Asia covered by high ClO concentrations (orange) above 1.5 ppb.

The stratosphere also holds far less hydrochloric acid — a safe form of chlorine — than expected, ER-2 observations indicate. This suggests the atmosphere is more efficient than scientists had thought at converting stable chlorine to destructive forms, Anderson says. Other ER-2 measurements reveal lower-than-expected levels of nitrogen oxides, chemicals that bind to ClO and thereby slow ozone destruction.

"The immune system of the atmosphere — its ability to suppress chlorine — is weaker than we expected," explains Anderson.

The data indicate that safe forms of chlorine pollution have been converting into ClO on the surfaces of sulfur particles, present in the stratosphere all around the world. While the eruption of Mt. Pinatubo last June spewed additional sulfur into the stratosphere and has enhanced ozone deterioration, this process went on before the eruption, according to ER-2 measurements made outside the volcanic debris. The mission scientists conclude that ClO, created on sulfur droplets, and a similar bromine chemical have caused the ozone erosion observed above midlatitude regions.

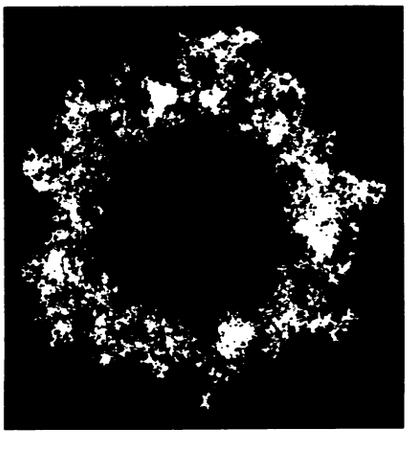
The ER-2 flights also passed through thin horizontal sheets of enhanced ClO, which appeared over the temperate latitudes as far south as the Caribbean. Anderson says the discovery of these unexplained sheets has concerned mission scientists, who plan to investigate them further. They suspect volcanic sulfur may have stimulated the growth of the layers, giving scientists a look at processes that could occur in the future as chlorine levels rise.

"This is really the tip of the iceberg. I think this is an early warning," says Anderson. — *R. Monastersky*

Bringing random walkers into new territory

The introduction of muskrats into central Europe in 1905 afforded ecologists a unique opportunity to study the spread of a population. Five surveys taken during the succeeding 23 years revealed an intriguing pattern of expansion. As the territory occupied by the increasing population of muskrats grew larger, its initially smooth boundary became increasingly convoluted.

A team of researchers has now developed a mathematical model that provides a new avenue for studying the spread of populations. This model suggests that the roughening of a territorial boundary, as demonstrated by the rambling muskrats, occurs naturally in any situation in which groups of diffusing



Stanley et al.

Below: Snapshots of the territory (yellow) covered by 1,000 random walkers (red squares) for a sequence of times increasing from left to right. Left: Successive colors show the progress of 1,000 random walkers starting at the center as they claim additional territory over several, consecutive time periods.