ANTARCTIC SCIENCE NEWS

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First signs of healing in the Antarctic ozone layer

September ozone hole has shrunk by 4 million square kilometers since 2000

Scientists have found the first 'fingerprints of healing' for the Antarctic ozone hole. The September ozone hole has shrunk by more than 4 million square kilometers since 2000, when ozone depletion was at its peak.

The team led by Solomon found that the September ozone hole has shrunk by more than 4 million square kilometers -- about half the area of the contiguous United States -- since 2000, when ozone depletion was at its peak. The team also showed for the first time that this recovery has slowed somewhat at times, due to the effects of volcanic eruptions from year to year. Overall, however, the ozone hole appears to be on a healing path.

The authors used "fingerprints" of the ozone changes with season and altitude to attribute the ozone's recovery to the continuing decline of atmospheric chlorine originating from chlorofluorocarbons (CFCs). These chemical compounds were once emitted by dry cleaning processes, old refrigerators, and aerosols such as hairspray. In 1987, virtually every country in the world signed on to the Montreal Protocol in a concerted effort to ban the use of CFCs and repair the ozone hole.

Signs before spring

In the 1980s, scientists from the British Antarctic survey noticed that the October total ozone was dropping thereby, thinning of the ozone above Antarctica. The damage was primarily attributed to gases known as chlorofluorocarbons (CFCs), which were then popularly used in air conditioning units, refrigerators and chemical sprays.

Ozone is sensitive not just to chlorine, but also to temperature and sunlight. Chlorine eats away at ozone, but only if light is present and if the atmosphere is cold enough to create polar stratospheric clouds on which chlorine chemistry can occur -- a relationship that Solomon was first to characterize in 1986. Measurements have shown that ozone depletion starts each year in late August, as Antarctica emerges from its dark winter, and the hole is fully formed by early October.

In a bid to protect the ozone layer, nations agreed to phase out the ozone-depleting substances through an international treaty known as the Montreal Protocol.

Now, scientists celebrate the success of this agreement as a new study revealed that the Antarctic ozone layer now shows signs of healing.

Solomon and her colleagues believed they would get a clearer picture of chlorine's effects by looking earlier in the year, at ozone levels in September, when cold winter temperatures still prevail and the ozone hole is opening up. The team showed that as the chlorine has decreased, the rate at which the hole opens up in September has slowed down.

A healing trend

The researchers tracked the yearly opening of the Antarctic ozone hole in the month of September, from 2000 to 2015. They analyzed ozone measurements taken from weather balloons and satellites, as well as satellite measurements of sulfur dioxide emitted by volcanoes, which can also enhance ozone depletion. And, they tracked meteorological changes, such as temperature and wind, which can shift the ozone hole back and forth.

They then compared their yearly September ozone measurements with model simulations that predict ozone levels based on the amount of chlorine that scientists have estimated to be present in the atmosphere from year to year. The researchers found that the ozone hole has declined compared to its peak size in 2000, shrinking by more than 4 million square kilometers by 2015. They further found that this decline matched the model's predictions, and that more than half the shrinkage was due solely to the reduction in atmospheric chlorine.

It's been interesting to think about this in a different month, and looking in September was a novel way. The team could actually see a chemical fingerprint, which is sensitive to the levels of chlorine, finally emerging as a sign of recovery.

The team did observe an important outlier in the trend: In 2015, the ozone hole reached a record size, despite the fact that atmospheric chlorine continued to drop. In response, scientists had questioned whether any healing could be determined. Going through the data, however, Solomon and her colleagues realized that the 2015 spike in ozone depletion was due primarily to the eruption of the Chilean volcano Calbuco. Volcanoes don't inject significant chlorine into the stratosphere but they do increase small particles, which increase the amount of polar stratospheric clouds with which the human-made chlorine reacts.

As chlorine levels continue to dissipate from the atmosphere, Solomon sees no reason why, barring future volcanic eruptions, the ozone hole shouldn't shrink and eventually close permanently by midcentury.

Solomon, whose research into chlorine and ozone spurred the Montreal Protocol. And this Science was helpful in showing the path, diplomats and countries and industry in charting a pathway out of these molecules.

Reference: Solomon et al. Emergence of Healing in the Antarctic Ozone Layer. *Science*, 2016