Laughing gas is biggest threat to ozone layer

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Nitrous oxide, commonly known as laughing gas, is now the dominant ozone-depleting substance emitted by humans – and is likely to remain so throughout the century, a new study suggests.

Researchers suggest use of the compound – which is produced by the breakdown of nitrogen in fertilisers and sewage treatment plants – should be reduced to avoid thinning the protective ozone layer that blankets the Earth.

The ozone layer shields Earth from the sun's ultraviolet rays, which increase the risk of cancer and threaten crops and aquatic life.

Human-produced chemicals called chlorofluorocarbons (CFCs) made headlines in the 1980s when it became clear they were eating a hole in the ozone layer above Earth's polar regions. An international treaty called the Montreal Protocol regulated production of CFCs and certain other ozone-depleting gases in 1987, and they were phased out completely by 1996.

Since then, Earth's ozone – both the polar hole and the atmospheric layer around the whole planet – has been on the mend. But the emission of nitrous oxide, which is not regulated by the Montreal Protocol, could reverse those gains – and could even make the situation worse.

"Right now, nitrous oxide is the most important ozone-depleting gas that is emitted," says A. R. Ravishankara of the US National Oceanic and Atmospheric Administration, lead author of the new research. "It will continue to be so unless something is done."

Greenhouse gas

Nitrous oxide is also a heat-trapping greenhouse gas in the league of methane or carbon dioxide, so regulating it would also be good for the climate, he says.

Nitrous oxide (N_2O) is produced naturally when nitrogen in soil or water is eaten by bacteria. It rises into the stratosphere, where most of it is broken down into harmless molecules of nitrogen and oxygen by the sun's rays.

But some of it remains, and can survive for hundreds of years. The compound reacts with high-energy oxygen atoms to produce a deadlier compound, nitric oxide (NO). This then goes on to destroy ozone, a molecule made up of three oxygen atoms.

Nitrous oxide has no effect on the hole in the ozone layer, Ravishankara points out, but it makes the global layer thinner.

Abundant gas

This chemical process has been known since the 1970s, when scientists were worried about the

environmental effects of flying supersonic planes, which emit N_2O. Ravishankara and his colleagues are the first to put hard numbers on the role of nitrous oxide in ozone depletion.

To do so, they modelled the atmosphere and the chemical reactions that take place inside it. They found that nitrous oxide's potential to deplete ozone is comparable to other ozone-depleting substances, called hydroCFCs, that replaced CFCs but are also in the process of being phased out.

But although the depletion potential is roughly equivalent, nitrous oxide could have a more damaging effect because it is much more abundant. Global human emissions of N_2O are roughly 10 million tonnes per year, compared to slightly more than 1 million tonnes from all CFCs at the peak of their emissions.

On the rise

Scientists say humans' role in producing the harmful gas has largely been overlooked. Thanks to fossil fuel combustion, which produces the gas, as well as nitrogen-based fertilisers, sewage treatment plants and other industrial processes that involve nitrogen, about one-third of the nitrous oxide emitted per year is anthropogenic.

Although supersonic transport never got off the ground, current emissions are equivalent to flying 500 such planes a day. Emission levels have increased by 0.25 per cent a year since pre-industrial times.

"Nitrous oxide is kind of the forgotten gas," says Don Wuebbles of the University of Illinois at Urbana-Champaign, who invented the method of quantifying a chemical's ozone-depletion potential but was not involved in this work. "It was always thought of as a natural thing. People have forgotten that it's been increasing."

And as CFC levels abate, nitrous oxide could become even more powerful. Nitrogen and chlorine compounds counteract each others' effects on ozone – the more chlorine there is, the less effective nitrogen becomes at destroying ozone, and vice versa. As CFCs are purged from the atmosphere, nitrous oxide will become 50 per cent more potent than it was before, Ravishankara says.

"People were expecting that ozone was just going to recover from the results of human activities that resulted in CFCs," Wuebbles says. "Nitrous oxide could prevent that from happening."

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