While ozone is recovering, we’re doing things to prolong the process

Enlarge / The Antarctic Ozone Hole on September 13, 2014, as observed by the Ozone Monitoring Instrument (OMI) on the Aura satellite.

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Good news for the ozone layer was widely reported in November 2018: global efforts to phase out ozone-depleting substances had resulted in a slow but persistent recovery. Should that continue, even the worst damage could be on track to be repaired in the next 50 years or so.

But all that good news is not necessarily going to continue. A paper in Nature Geoscience this week identifies quite a few possible spanners in the works, all of which could delay ozone recovery by anything from years to decades.

A growing, then shrinking, hole

Roughly 90% of the ozone in our atmosphere can be found between 15km and 35km above the Earth’s surface, in a band that plays a crucial role in absorbing harmful ultraviolet sunlight. In 1985, scientists detected dropping ozone levels in the stratosphere—the layer of the atmosphere that contains the ozone layer.

The problem came from stratospheric clouds that form above the Antarctic during winter, creating the ideal conditions for ozone-destroying chemical reactions that begin as the Sun returns. Some of the substances involved in these reactions have natural sources, but others have seen a sudden and dramatic increase as a result of human activity. These reactions take place around the globe, but the Ozone Hole above Antarctica is at the extreme end of ozone depletion.

In 1987, the Montreal Protocol kicked off the long process of phasing out the ozone-depleting substances (ODSs), such as CFCs, that were doing the damage. Subsequent amendments have added to the list of ODSs covered by the agreement, as well as the countries that signed up to the protocol.

The Ozone Hole took less than a decade to form, and the turnaround was nearly as swift, with depletion peaking in the 1990s and 2000s, after which recovery began to kick in. But because ODSs are long-lived, full recovery will trail behind the phasing-out of every damaging substance.

Mystery ODSs

The swiftest path of recovery would have the ozone layer returned to its 1980 level by the 2060s, but the recent paper by Xuekun Fang and his colleagues draws attention to a range of threats to this recovery rate.

One problem is that not everything is going entirely according to the Montreal Protocol, which called for a potent ODS called CFC-11 to be fully phased out by 2010. This phase-out has not materialized: in fact, there’s evidence of new production, the majority of which seems to be attributable to eastern China. CFC-11 is not the only rogue ODS, either: unexpected levels of a range of ODSs have been detected. Collectively, these could delay the recovery of the ozone layer by more than 20 years.

Other, more short-lived substances that aren’t yet covered by

the Montreal Protocol pose an additional threat, even though they degrade within six months. If these emissions continue at their 2015 levels, they could delay recovery by five years. But they are growing rapidly, and at their current growth rate, that delay could be more like 17 to 31 years.

There's a complex interaction between ODSs and greenhouse gases, too, with natural emission of ODSs set to increase as a result of climate change. On its own, this could lead to a recovery delay of around 20 years.

Even some possible measures to mitigate climate change could have knock-on effects on the ozone layer: the proposal to inject sulfate aerosol into the stratosphere would likely "cause the Antarctic Ozone Hole to persist into the next century," write Fang and his colleagues. Other possible geoengineering options like alkaline calcite could be less damaging, they note.

The scope of the problem

A huge problem, write Fang *et al.*, is that "a substantial proportion of the world—western China, South and Southeast Asia, and South America, for example—is not covered by existing atmospheric ODS measurement networks."

This makes the problem of the mystery ODSs difficult to tackle: before anything can be done to stop them, we need to figure out where they come from. So improving the current monitoring networks—and getting a better understanding of all the different ways that ozone depletion and climate change play into each other—are crucial steps in getting a better handle on the real future of ozone recovery.

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