Ozone recovering, but unlikely to stabilize at pre-1980 levels

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While Earth's ozone layer is slowly being replenished following an international 1987 agreement banning CFCs, the recovery is occurring in a changing atmosphere and is unlikely to stabilize at pre-1980 levels, says a new University of Colorado at Boulder study.

The recovery is a result of the 1987 Montreal Protocol banning chlorine pollutants from the atmosphere, said Betsy Weatherhead, a researcher with the Cooperative Institute for Research in Environmental Sciences, a joint institute of CU-Boulder and the National Oceanic and Atmospheric Administration. But by the end of the century, ozone levels could be slightly higher or slightly lower than before 1980 because of high natural variability and human caused changes like warming temperatures, said Weatherhead.

A paper by Weatherhead and Signe Bech Andersen of the Danish Meteorological Institute in Copenhagen is featured on the cover of the May 4 issue of *Nature*.

"We now have some confidence that the ozone layer is responding to the decreases in chlorine levels in the atmosphere due to the leveling off and decrease of CFCs, and most of the improvements are in agreement with what we had hoped for with the Montreal Protocol in place," she said. "But we are not out of the woods yet, and the ozone recovery process still faces a number of uncertainties."

At high latitudes, for example, warmer temperatures at Earth's surface can trigger colder conditions in the lower stratosphere and promote the formation of polar stratospheric clouds, which can contribute to severe ozone depletion. "During the next few years, ozone levels in the Arctic will be strongly influenced by stratospheric temperature, possibly resulting in delayed recovery or record-low observations," the authors wrote in Nature.

The new study shows a larger than expected recovery of ozone in the northern mid-latitudes in recent years, she said. The increase may be partially a result of natural variability, including shifts in air temperatures and atmospheric transport, the influences of the 11-year solar cycle and an absence of major volcanic activity on Earth. The 1993 eruption of Mt. Pinatubo in the Philippines, for example, caused ozone levels to backslide for several years, Weatherhead said.

Future ozone levels likely will be dominated by air temperature, atmospheric dynamics and an abundance of trace gases, she said. Trace gases include significant amounts of nitrous oxide, or N2O -- a result of fertilizer production on Earth -- and could lead to significant depletion of protective ozone molecules.

"In another 50 years CFCs won't be the dominant factor controlling ozone," she said. "Instead, we think it will be factors like greenhouse gases, N2O and methane."

The Nature study, which shows ozone levels have stabilized or increased slightly in the past 10 years, used data from satellites and ground stations to compare changes in the ozone layer to past depletion levels. The researchers used data from 14 modeling studies published by scientific groups from around the world for the study.

The ozone data was collected by a suite of NASA and NOAA satellites and ground stations. The new study follows a 2005 study led by Weatherhead indicating the ozone layer was no longer in decline following nearly two decades of depletion from harmful chemicals.

While ozone depletion has been most severe at the poles, there has been a seasonal decline of up to 10 percent of ozone at mid-latitudes, the location of much of North America, South America and Europe. "Since the full recovery of the ozone layer is probably decades away, the amount of UV radiation reaching Earth is likely to remain elevated for some years," she said. "People still need to take precautions when spending time in the sun."

Scientific evidence indicates ozone was relatively stable over the past few thousand years, said Weatherhead. The Arctic is the only place in the world where indigenous people were spurred to develop protective mechanisms to shield their eyes from UV radiation, and fossil pigments of plants imply UV radiation has been stable for thousands of years. "It is the past few decades that have been unusual," said Weatherhead.

Now ratified by more than 180 nations, the Montreal Protocol established legally binding controls for nations on the production and consumption of halogen gases containing chlorine and bromine. The

primary source of ozone destruction is CFCs, once commonly used in refrigeration, air conditioning, foam-blowing equipment and industrial cleaning.

About 90 percent of the ozone measured in the study, known as total-column ozone, is found between 10 miles to 20 miles above Earth's surface in the stratosphere, Weatherhead said. The ozone layer protects the planet from the harmful effects of UV radiation, including skin cancer and cataracts in humans and damaging effects on ecosystems.

Source: National Oceanic and Atmospheric Administration