Computer models show major climate shift as a result of closing ozone hole

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A new study led by Columbia University researchers has found that the closing of the ozone hole, which is projected to occur sometime in the second half of the 21st century, may significantly affect climate change in the Southern Hemisphere, and therefore, the global climate. The study appears in the June 13th issue of *Science*.

The Earth's ozone layer is located in the lower stratosphere, which lies just above the troposphere (which begins at the planet's surface and reaches up to about 12 km), catching harmful ultraviolet rays from the sun. Until late in the last century, widespread usage of household and commercial aerosols containing chlorofluorocarbons (CFC), unstable compounds which are carried into the stratosphere, lead to significant and rapid ozone depletion.

Due to the Montreal Protocol, signed by 191 countries, CFC production worldwide was phased out in 1996. Observations in the last few years indicate that ozone depletion has largely halted and is expected to fully reverse. As a consequence, the new study finds, the Southern Hemisphere climate change may also reverse. This would be a very tangible outcome of the Montreal Protocol, which has been called the single most successful international agreement to date, and would demonstrate how international treaties are able to make positive changes to the climate system.

"Our results suggest that stratospheric ozone is important for the Southern Hemisphere climate change, and ought to be more carefully

considered in the next set of IPCC model integrations," said Seok-Woo Son, lead-author of the study and a postdoctoral research scientist at Columbia's Fu Foundation School of Engineering and Applied Science (SEAS).

The team of 10 scientists compared results from two sets of climate models, the first one used by the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), released in late 2007, and the second from the Scientific Assessment of Ozone Depletion, published by the World Meteorological Organization in 2006. In their prediction of future climate, many IPCC models did not consider the expected ozone recovery and its potential impacts on climate change. The chemistry-climate models used for the 2006 Ozone Assessment, however, predict that the Antarctic ozone hole will achieve full recovery in the second half of this century, and that this may have profound impacts on the surface winds and, likely, on other aspects of the Earth's climate, including surface temperatures, locations of storm tracks, extent of dry zones, amount of sea ice, and ocean circulation.

In the past few decades, the tropospheric winds in the Southern Hemisphere have been accelerating closer to the planet's pole as a result of increasing greenhouse gases and decreasing ozone. This wind change has had a broad range of effects on the Earth's climate. The IPCC models predict that this effect will continue, albeit at a slower pace. In contrast, predictions made by the chemistry-climate models indicate that, as a consequence of ozone recovery—a factor largely ignored by IPCC models—the tropospheric winds in the Southern Hemisphere may actually decelerate in the high latitudes and move toward the equator, potentially reversing the direction of climate change in that hemisphere.

"We were surprised to find that the closing of the ozone hole, which is expected to occur in the next 50 years or so, shows significant effects on the global climate," said Lorenzo M. Polvani, one of two principle

investigators and professor of applied physics and applied mathematics at SEAS. "This is because stratospheric ozone has not been considered a major player in the climate system."

Polvani and Son state that more research needs to be conducted to validate their results, and to fully understand how complete ozone recovery will impact the planet's changing climate. While previous studies have shown that ozone hole recovery could lead to a warming of the Antarctic, much work remains. For instance, the chemistry-climate models used in the 2006 Ozone Assessment Report do not include a full ocean circulation, which might affect surface temperatures. The interactions between a recovering ozone hole, increasing greenhouse gases, ocean currents, and other components of the climate system must still be explored in order to better understand how the Earth's climate will change in the future.

Source: The Earth Institute at Columbia University