Ozone depletion increases Antarctic snowfall, partially mitigates ice sheet loss

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Ozone layer depletion has increased snowfall over Antarctica in recent decades, partially mitigating the ongoing loss of the continent's ice sheet mass, new University of Colorado Boulder research finds.

The findings, published today in the journal *Geophysical Research Letters*, show a distinct signal linking stratospheric ozone loss above Antarctica with increased precipitation, even as those gains have been outpaced by an even greater ice loss rate due to warming oceans, contributing to sea level rise. The Antarctic Ice Sheet is the world's largest ice sheet and freshwater reservoir, containing the potential for hundreds of feet of sea level rise if all ice were to melt.

"Calving icebergs and melting ice shelves have gotten lots of attention because they're the most visible impact of ongoing climate change to Antarctica," said Jan Lenaerts, lead author of the research and an assistant professor in CU Boulder's Department of Atmospheric and Oceanic Sciences. "But the input side of the equation, which is precipitation falling in the form of snow, hasn't drawn the same level of study."

An ozone "hole," or a seasonal thinning of the ozone layer, forms above Antarctica in the austral summer, influencing atmospheric circulation and creating stronger circumpolar westerly winds.

While previous research has outlined some aspects of the relationship between ozone depletion and the climate of the southern hemisphere, the new study co-authored by Lenaerts, Jeremy Fyke of Los Alamos National Laboratory and Brooke Medley of NASA's Goddard Space Flight Center Cryospheric Sciences Laboratory has analyzed the effect on Antarctica specifically.

The results complement a separate NASA-led study, which was led by Medley and published today in the journal *Nature Climate Change*, which uses observations from ice cores to show that Antarctic snowfall has increased in the last 200 years and especially so in the past 30 years, suggesting that precipitation changes can be linked to man-made causes such as greenhouse gas emissions as well as the ozone hole.

In order to pinpoint the effect of ozone loss on Antarctic snowfall, Lenaerts and his colleagues compared two sets of eight climate modeling simulations, one set with observed ozone levels and one set with ozone values kept constant at levels before the ozone hole started, allowing the researchers to isolate the signal relative to natural climate variability.

The comprehensive analysis, which encompassed the years 1955-2005, revealed increased Antarctic precipitation during the austral summer that can be attributed to lower levels of stratospheric ozone, and which has in part buffered ice sheet mass loss.

Paradoxically, while the results suggest that ozone depletion (previously the focus of global conservation efforts such as the 1987 Montreal Protocol) helps to partially mitigate sea level rise by increasing Antarctic precipitation, those mass gains have been more than offset by increasing iceberg calving and melting.

"The pace at which snowfall is increasing is not keeping up with the ocean-induced losses," Lenaerts said. "The Antarctic Ice Sheet is still losing mass."

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