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What's Happening To Stratospheric Ozone Over The Arctic, And Why?

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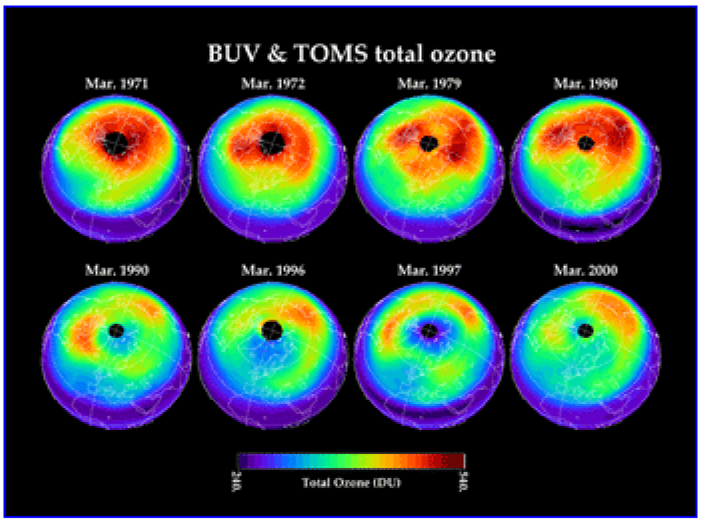
Is Arctic stratospheric ozone presently undergoing depletion? Is this an unusual, unique or unanticipated phenomenon? Are the underlying causes of this phenomenon the same as those that are responsible for the Antarctic ozone hole? If not, how are they different? Does climate change (i.e., global warming) play a role? Do these factors alter the projected timing of recovery of the stratospheric ozone layer to 1979 levels? If so, what is the new projection for recovery of the stratospheric ozone layer in the Arctic region?



INTRODUCTION:

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Summary

Over the last decade, some very low ozone levels have been observed over the Arctic during the late winter and early spring. These low values have heightened concerns that human activity may be seriously impacting the Arctic stratosphere and raise questions regarding the nature and timing of ozone recovery over the next few decades.

In 1985, large ozone losses were observed over the Antarctic region. NASA satellite observations showed that this ozone loss covered an extensive region, coining its name, the Antarctic ozone hole. The Antarctic ozone hole was subsequently shown to result from chlorine and bromine destruction of stratospheric ozone. The stratospheric chlorine and bromine levels primarily come from human produced chemicals such as chlorofluorocarbons (CFCs) and halons whose concentrations had been increasing throughout the 1970s and 80s. Naturally occurring, extremely cold temperatures over Antarctica cause the formation of very tenuous clouds (polar stratospheric clouds or PSCs). Certain chlorine and bromine compounds are then converted from benign forms into ozone destructive forms when they come into contact with the surfaces of the cloud particles. Hence, the massive ozone loss over Antarctica results from the unique meteorological conditions and the high levels of human produced chlorine and bromine. Because production of CFCs and halons has been curtailed, the Antarctic ozone hole is expected to return to 1979 levels late in this century.

The Arctic stratosphere is considerably different than the Antarctic stratosphere. First, natural ozone levels in the Arctic spring are much higher than in the Antarctic spring. Second, Arctic spring stratospheric temperatures are much warmer than those in the Antarctic stratosphere. Because of the warmer Arctic stratospheric temperatures, polar stratospheric clouds are much less common than over Antarctica. However, measurements of chlorine compounds in the Arctic stratosphere measured in 1989 and 1991-92 showed that chlorine levels could lead to massive ozone losses if the stratospheric cold winter conditions persisted into the mid-to-late spring.

Observations and modeling over the last decade have shown that conditions for severe ozone loss are directly related to the severity and persistence of the Arctic winter. The persistence of cold temperatures leads to the formation of extensive polar stratospheric clouds which in turn activate chlorine and lead to large ozone losses. Since high levels of chlorine compounds will be common over the next 50-70 years, the prediction of ozone levels is dependent on the detailed physics of the formation of these polar stratospheric clouds and on the prediction of future temperatures in the stratosphere. Current projections suggest that climate change may lead to large cooling of the stratosphere, leading to more extensive PSC formation and greater ozone loss. Thus, ozone layer recovery may not track the slow decline of industrial halogen compounds in the atmosphere.

During the 1999-2000 winter, the NASA sponsored SAGE III Ozone Loss and Validation Experiment (SOLVE) and the European Union sponsored Third European Stratospheric Experiment on Ozone (THESEO 2000) obtained measurements of ozone and other atmospheric gases and particles using satellites and aircrafts, large, small and long duration balloons, and ground-based instruments throughout the Arctic. Ozone losses of over 60% were observed in the Arctic stratosphere near 18 km altitude during one of the coldest stratospheric winters on record. These losses were a direct result of chlorine and bromine species activated on the surfaces of polar stratospheric clouds.

BIOGRAPHY

Dr. Paul Newman has been with NASA since1990. He is now a senior level atmospheric physicist at NASA's Goddard Space Flight Center in the Atmospheric Chemistry and Dynamics Branch. Prior to his joining NASA, he served as a National Research Council fellow, and served for a time with the Applied Research Corporation and the Universities Space Research Associates. Dr. Newman is principally involved in the analysis of stratospheric meteorological and trace gas observations. He was a co-project scientist of the SAGE III Ozone Loss and Validation Experiment, and is actively engaged in a number of other experiments related to understanding and modeling processes governing the transport of chemical species throughout the atmosphere, and monitoring, measuring and modeling tropospheric and stratospheric ozone in various regions of the globe.

Public education is a principal goal of NASA and as such, Dr. Newman helped put together a web-based document on stratospheric ozone issues.

Dr. Newman is a member of the American Meteorological Society, Middle Atmosphere Committee (1998-present), and has served on the American Meteorological Society's Committee on Polar Meteorology and Oceanography (1989-1992). Dr. Newman is also a member of the American Geophysical Union and is an associate editor of the Journal of Geophysical Research.

Dr. Newman's awards include: the L. H. Brown Pre-Doctoral Fellowship; a National Research Council Postdoctoral Fellowship; several NASA group Achievement Awards going back to 1990; several NASA Goddard Space Flight Center (GSFC)

Outstanding performance awards from1991-1999; the Naval Research Laboratory's Alan Berman Research Publication Award, the American Geophysical Union Excellence in Reviewing Award for Journal of Geophysical Research; and a GSFC Special Act award for his work on SOLVE (2000). Dr. Newman is a Seattle native who graduated from Seattle University in1978 with a B.S. in Physics and a minor in mathematics. He completed his doctorate in physics at Iowa State University in 1984.