南極域での上部成層圏オゾン破壊の気候変動に対する影響

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The effect of climate change on the upper stratospheric ozone depletion from Umkehr measurements over Antarctica

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Analyses of stratospheric ozone data recorded by Dobson Umkehr measurements since 1977 at the Syowa (69.0S, 39.6E), Antarctica station reveal a significant decrease in ozone above 4 hPa during the 1990s. Extremely low ozone values are persistent in the most recent years. The November averages of ozone data at 4-2 hPa (layer 8) taken at Syowa station between 1999 and 2009 - are found to be highly anticorrelated with CPC stratospheric temperature record interpolated to 5 hPa atmospheric pressure. With the reduction of atmospheric chlorine levels (decline in the EESC concentrations) ozone is expected to recover. However, changes in upper stratospheric ozone at Syowa over the last 10 years do not agree with the EESC predicted changes. It is expected that the CO_2 increase should have a positive effect on ozone through the cooling of the stratosphere, and thus increase ozone concentrations [*Stolarski et al*, 2010]. On the other hand we have shown that the correlation between CO_2 growth rate and ozone has increased over the last 10 years. The Southern Hemisphere Annular Mode (SAM) is highly correlated with ozone in polar regions. The observed change in Syowa upper stratospheric ozone is likely related to the increase in the concentration of greenhouse gases, such as CO_2, that cause the upper stratospheric cooling and alter the rate of the chemical ozone loss cycle.

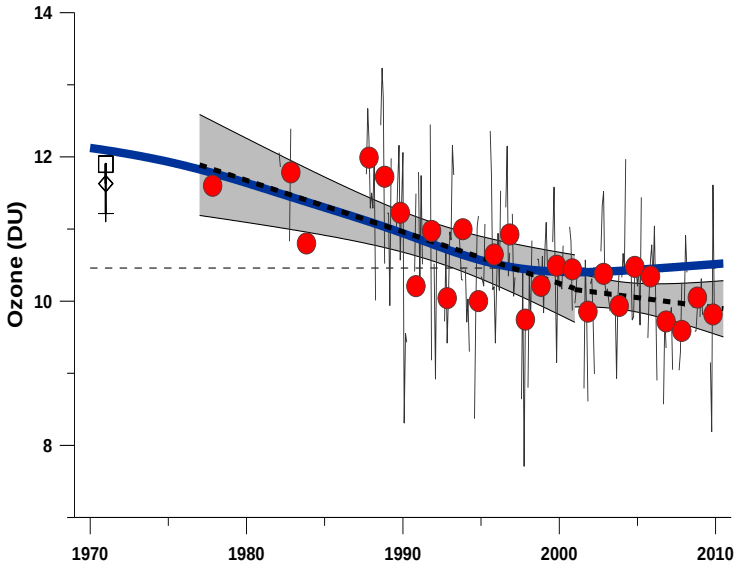

Figure 1. Long-term variations of annual mean ozone amount in layer 8+9+10 (above 4 hPa or 40 km altitude) at Syowa. The blue line shows the EESC curve representative of effective stratospheric chlorine load at high latitude. The annual cycle, effects of solar activity, QBO, CO_2 and SAM signals were removed from the data prior to the ozone record trend analysis. A symbol on the left edge of the plot represents averaged ozone from 3 stations, Faraday (65S), King Baudoin (70S), and Halley (73.5S), measured between 1957 and 1972, and represents annual mean ozone.

References

Stolarski, Richard S., Anne R. Douglass, Paul A. Newman, Steven Pawson, Mark R. Schoeberl, Relative Contribution of Greenhouse Gases and Ozone-Depleting Substances to Temperature Trends in the Stratosphere: A Chemistry–Climate Model Study. J. Climate, 23, 28-42, 2010.