High Arctic Ultraviolet (UV) Radiation Levels in the Spring of 2011 Caused by Unprecedented Chemical Ozone Loss

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Ozone concentrations in the Arctic stratosphere during March 2011 were the lowest ever recorded. The record loss was mostly caused by chemical destruction of ozone, attributed to the existing stratospheric burden of ozone-depleting halogens and favored by an unusually prolonged cold period in the lower stratosphere in 2011. The low levels of total ozone led to elevated UV levels throughout the Arctic and sub-Arctic as shown in the figure below. UV radiation is characterized here in terms of the UV Index, which is a measure of the ability of UV radiation to cause sunburn in human skin. Changes in the UV Index anti-correlate with changes in total ozone (compare 2011 data in center and bottom panels). Noontime UV Indices of March 2011 exceeded historical measurements for this month at all Arctic sites where ground-based UV monitoring systems are located. The maximum enhancement of the UV Index relative to the climatological average was 122% (panel c). While these large relative changes are unprecedented, the absolute increases in UV levels were modest at all Arctic sites (e.g., increase by less than two UV Index units) because the low-ozone event occurred early in spring when the solar elevation was still small. However, larger absolute increases of UV Indices occurred at lower latitudes during excursions of the polar vortex in April. These larger increases were potentially harmful to life.

This presentation was motivated by an essay on Ozone and UV Radiation prepared for the "2011 NOAA Arctic Report Card", available at http://www.arctic.noaa.gov/reportcard/ozone_uv.html. It contains additional material not included in this presentation.

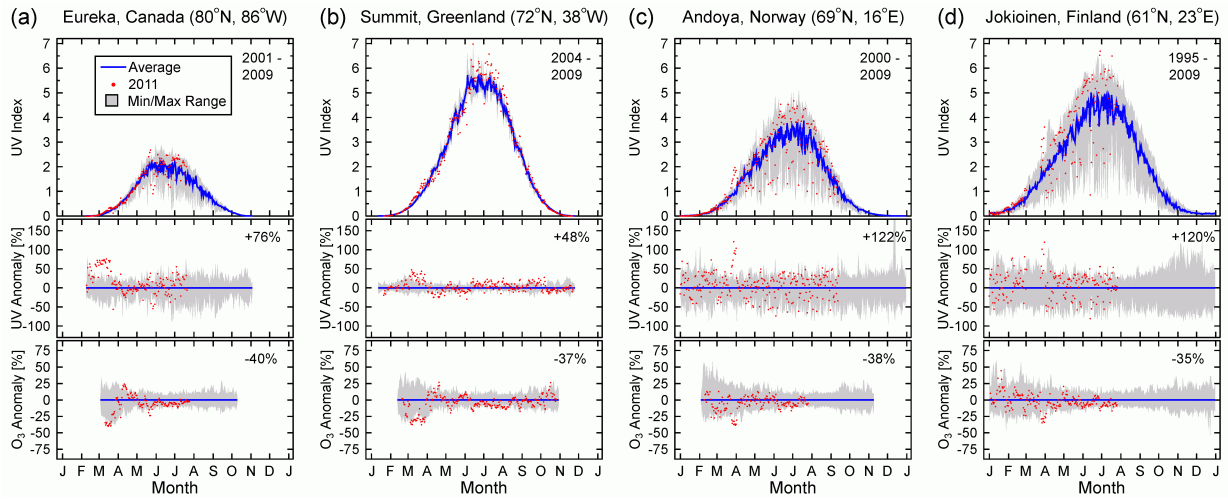

Figure 1. Seasonal variation of the noontime UV Index for four Arctic and sub-Arctic sites measured by ground-based radiometers. The upper panels compare the climatological average (blue line) with the measurements in 2011 (red dots), and historical minima and maxima (shaded range). Center panels show the anomaly in the UV Index, calculated as the percentage departure from the climatological average. Bottom panels show a similar anomaly analysis for total ozone derived from satellite measurements (TOMS and OMI).