7.6. Barrow, Alaska

UV data from Barrow differ from the austral high latitude sites in several ways. For example, the "ozone-sensitive" data products, particularly biologically effective dose-rates and the integral around 300 nm, show much smaller short-term variability than at the austral sites due to less severe ozone depletion in the Arctic.

In Figure 7.6.1, recent column ozone data from the Ozone Monitoring Instrument (OMI) onboard NASA's AURA satellite are compared with ozone records from the years 1991-2009. There is a strong seasonal dependence: ozone columns are generally higher and have a larger variability during spring than autumn. Total ozone columns between 3/4/10 and 3/15/10 were exceptionally large compared to measurements of previous years. Total ozone remained above the long-term average (blue line) until mid-April 2010. Total ozone scattered about the average between May and September 2010, and was again above average in October.

The high ozone values of March and April led to unusually low UV intensities during the two months. For example, 2010 measurements of spectral irradiance integrated over 298.51 - 303.03 nm (Figure 7.6.2) are the lower limit of the enveloped formed by measurements of the years 1991 - 2009. Note that the maximum value of this integral occurred on 7/8/10 when total ozone was significantly below the long-term mean. The spike on 8/2/10 was also caused by low ozone.

The daily maximum UV Index (Figure 7.6.3) is considerably less affected by total ozone than the 298.51 - 303.03 nm irradiance integral. Most day-to-day variability is introduced by clouds. The summer-time UV Index did not exceed 3.7 and remained significantly below the overall maximum UV Index of 4.8, which was observed in 2000.

Figure 7.6.4 and Figure 7.6.5 show the annual cycles of DNA- and erythemally-weighted daily dose, respectively. Daily irradiation in the 400-600 nm band is shown in Figure 7.6.6. Visible radiation is much more affected by clouds during summer and autumn than during spring.

Factors affecting the annual cycles in UV and visible radiation at Barrow have recently been analyzed in great detail (*Bernhard et al.*, 2007). The annual ozone cycle was found to be the dominant parameter modifying UV-B irradiance, but the combined effects of albedo and clouds compensate for most of the ozone influence. High surface albedo caused by snow cover may increase UV irradiance by up to 57%. Aerosols lead to reductions of 5% typically, but larger reduction was observed during Arctic haze events, particularly during spring. For erythemal irradiance, and measurements in the UV-A and visible, annual cycles of albedo and clouds are responsible for a pronounced seasonal asymmetry.

An example of the different characteristics of DNA-damaging and visible radiation is shown in Figure 7.6.7. Daily irradiation in the 400-600 nm spectral range is not centered at the summer solstice but shifted by about 15 days towards spring. The DNA curve on the other hand is nearly symmetrical with respect to the solstice. The reason for this distinct difference can be explained as follows: surface albedo is larger and clouds are less prevalent in spring than in autumn. This enhances radiation levels in spring and is the reason of the apparent shift of measurements in the visible. Higher albedo and less cloudiness also leads to larger DNA-damaging radiation, but the larger total ozone column in spring (Figure 7.6.1) compensates the enhancement. As a consequence, DNA-damaging radiation is of similar magnitude in spring and autumn.

Reference:

Bernhard, G., C. R. Booth, J. C. Ehramjian, R. Stone, and E. G. Dutton (2007), Ultraviolet and visible radiation at Barrow, Alaska: Climatology and influencing factors on the basis of version 2 National Science Foundation network data, J. Geophys. Res., 112, D09101, doi:10.1029/2006JD007865

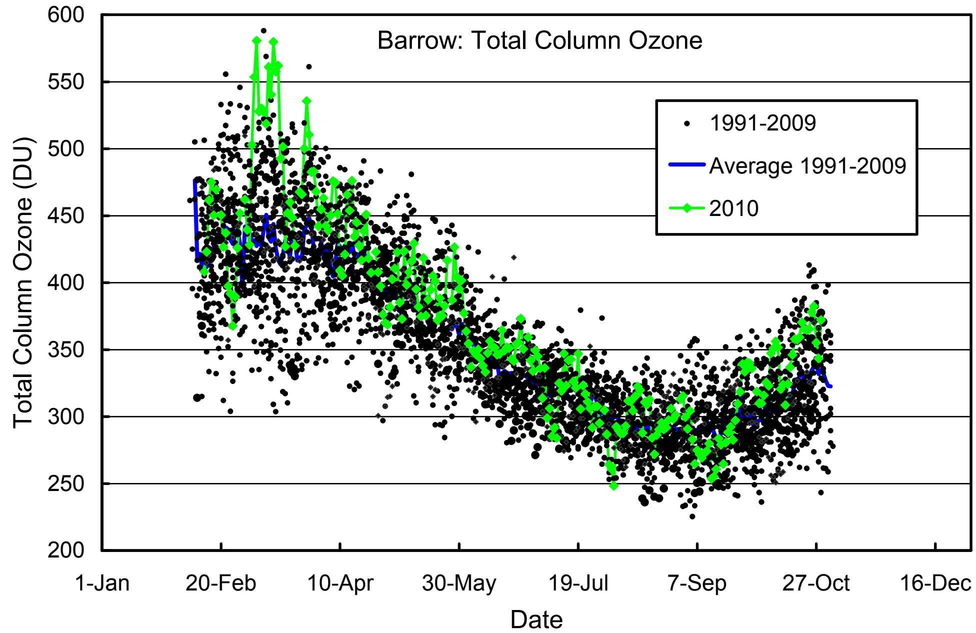

Figure 7.6.1. *Total column ozone at Barrow. OMI measurements from 2010 are contrasted with ozone data from prior years recorded by TOMS on Nimbus-7 (1991-1993), Earth Probe (1996-2004), and OMI (2005-2009) satellites. TOMS data are from the Version 8 data set.*

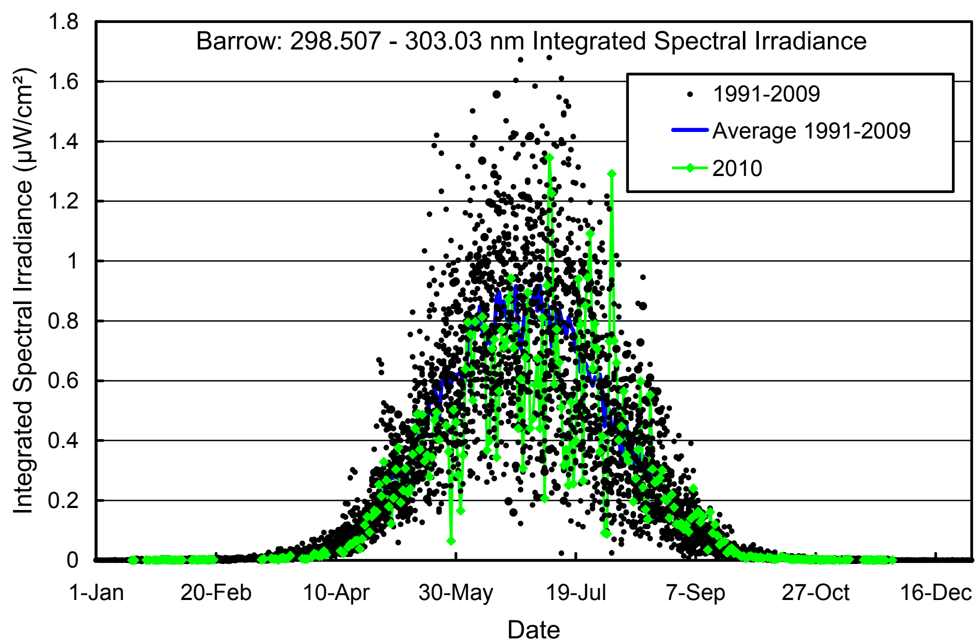

Figure 7.6.2. *Noontime integrated spectral UV irradiance (298.51 - 303.03 nm) at Barrow. Measurements from 2010 are contrasted with individual data points and the average of measurements taken between 1991 and 2009.*

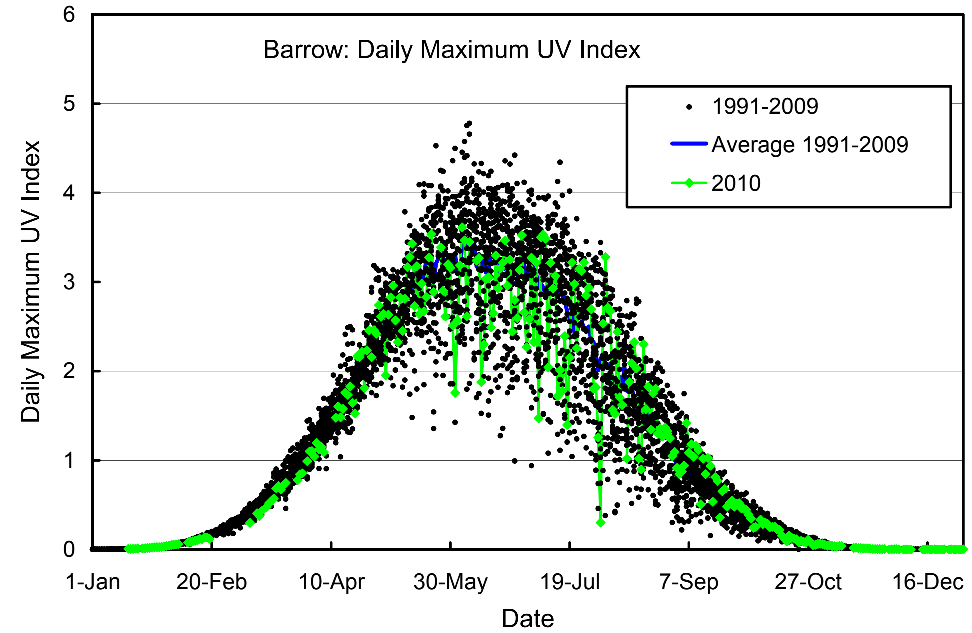

Figure 7.6.3. *Daily maximum UV Index at Barrow. Measurements from 2010 are contrasted with individual data points and the average of measurements taken between 1991 and 2009.*

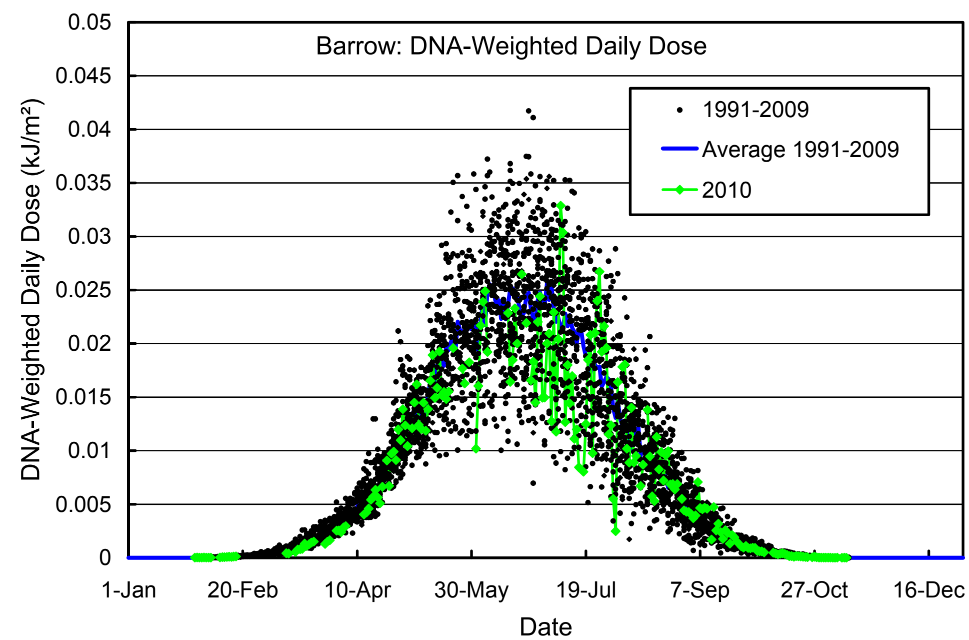

Figure 7.6.4. *Daily DNA-weighted dose at Barrow. Volume 20 measurements from 2010 are contrasted with individual data points and the average of measurements taken between 1991 and 2009.*

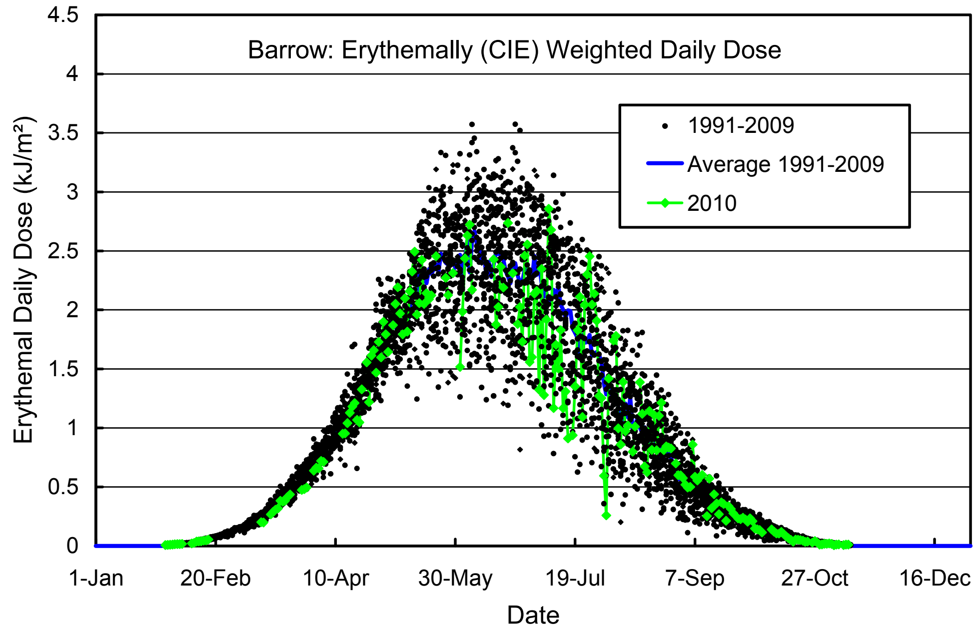

Figure 7.6.5. *Daily erythemal dose at Barrow. Volume 20 measurements from 2010 are contrasted with individual data points and the average of measurements taken between 1991 and 2009.*

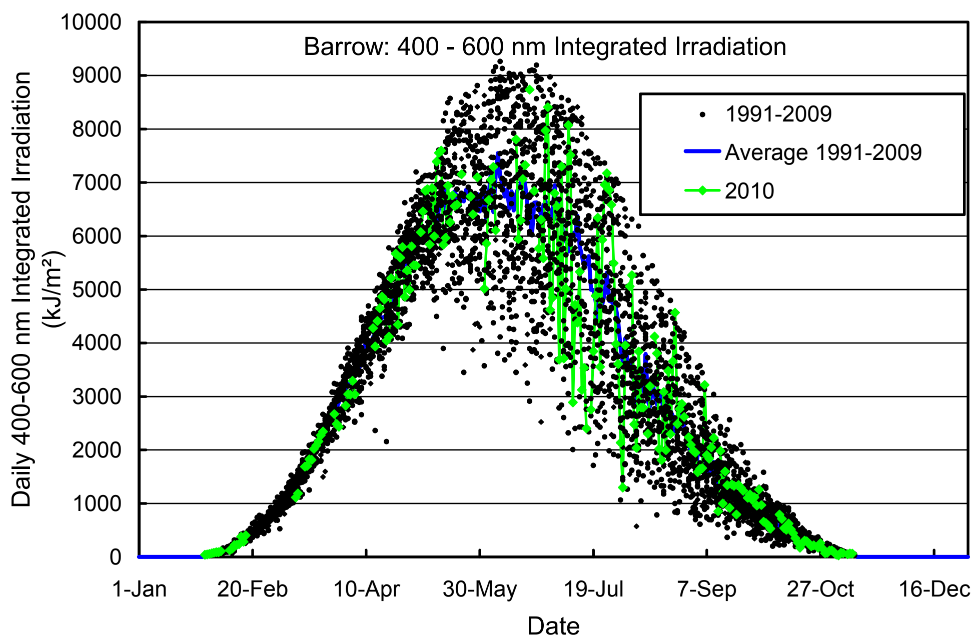

Figure 7.6.6. *Daily irradiation of the 400-600 nm band at Barrow. Volume 20 measurements from 2010 are contrasted with individual data points and the average of measurements taken between 1991 and 2009.*

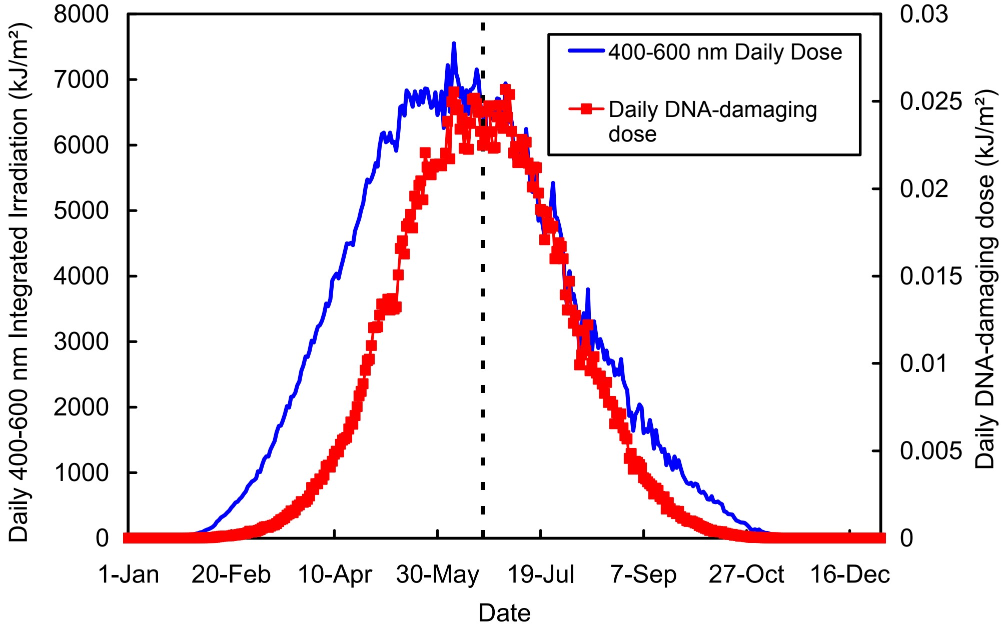

Figure 7.6.7. *Comparison of DNA-weighted dose (right axis) with daily irradiation in the 400-600 nm spectral range (left axis) at Barrow. Both curves are average values for the period 1991-2010.*