

7.1. McMurdo Station

Figure 7.1.1 shows total column ozone over McMurdo Station as measured by TOMS. Between September and November, ozone values in 1998 were generally close to or lower than the minimum values observed in the period 1991-1994. In fact, in the first and last week of November 1998 ozone levels were more than 50 DU below the historic values. A similar drop in ozone was observed at all austral network sites between the end of November and beginning of December. This indicates that the ozone hole took longer to recover in 1998 than in previous years.

The low ozone levels in November lead to record high UV levels. Between 11/23/98 and 11/29/98 noontime values of the 298.51 - 303.03 nm integral were about twice as high as maximum values observed previously in this part of the year (Figure 7.1.2). Also the drop in ozone around 11/4/98 caused a peak in short-wave UV, clearly exceeding levels measured during the years 1991-1997. On the other hand, ozone values between 11/8/98 and 11/19/98 were comparable to the values in previous years and so were the irradiance levels of the 298.51 - 303.03 nm integral.

Because of the low ozone values, DNA-weighted irradiance (Figure 7.1.3), and UV-B irradiance (Figure 7.1.4) were also well above maximum levels historically observed. Note that the record UV levels in November 1998 are even higher than the UV levels in the month of October of previous years, although total column ozone is usually lowest in October. This is because the sun is higher in the sky in November than in October. Figure 7.1.5 confirms that the high radiation levels are due to ozone and not, for example, unusually low cloud cover. The variability of irradiance in the 400-600 nm band in 1998 does not appear systematically different from previous years.

A pattern similar to that observed for noontime values is also visible in daily doses, i.e., irradiance integrated over one day. In early and late November 1998 both DNA-weighted dose (Figure 7.1.6) and erythemal dose (Figure 7.1.7) exceed the 2σ -limit of doses typical for this period. There is also a local maximum of both doses on day 10/24/98, corresponding to low ozone values. Daily doses in the 400-600 nm region (Figure 7.1.8) on the other hand, are within the $\pm 2\sigma$ -limits calculated from the years 1991-1997, indicating no significant difference in cloud cover in 1998.

In Figure 7.1.9, finally, average daily DNA doses are directly contrasted with radiation levels in the 400-600 nm range. Both curves were averaged over the period 1991-1997, allowing a comparison of the general pattern of both doses beyond year-to-year variability. The asymmetry of DNA doses can clearly be seen. DNA values in February and March are always below the curve for the 400-600 nm integral while the DNA curve equals or exceeds the integral in the visible in September and October. This can be explained by the ozone hole, which leads to increased DNA dose values in the second half of the year only.

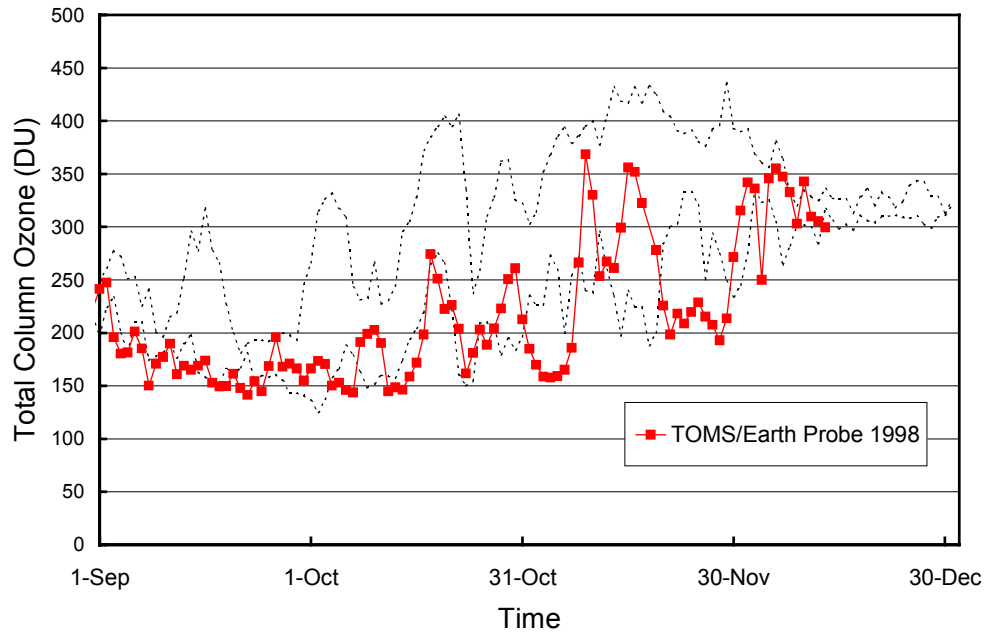


Figure 7.1.1. Total column ozone in McMurdo. TOMS/Earth Probe measurements from 1998 are contrasted with minimum and maximum values (broken lines) from the years 1991-1994 recorded by TOMS onboard NASA's Nimbus-7 and Meteor-3 satellites. A one-and-one-half year gap in data occurred after the loss of the Meteor-3 satellite in December 1994. No ozone values exist between 12/13/98 and 12/31/98 because of TOMS instrumental problems.

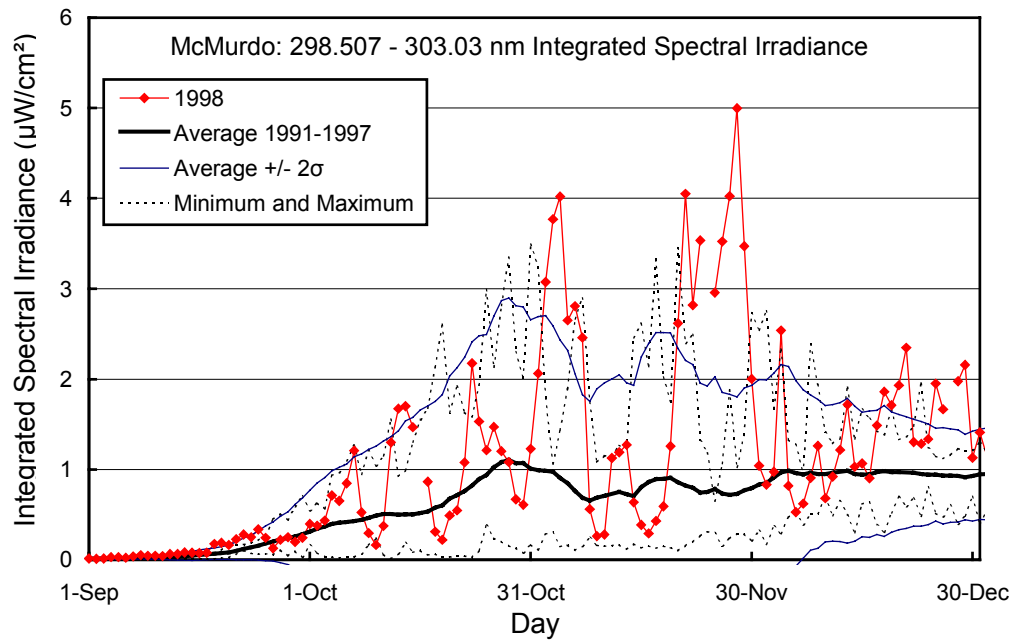


Figure 7.1.2. Noontime integrated spectral UV irradiance (298.51 - 303.03 nm) at McMurdo. The measurements from 1998 (diamonds) are contrasted with the mean of measurements taken between 1991 and 1997 (thick line). The thin lines are the mean ± 2 standard deviation (mean $\pm 2\sigma$) limits, also calculated from the 1991-1997 period. A ten-day running average was applied to both mean and mean $\pm 2\sigma$ to reduce day-to-day fluctuations in order to make the presentation clearer. The broken lines represent historical (1991-1997) minima and maxima without further smoothing.

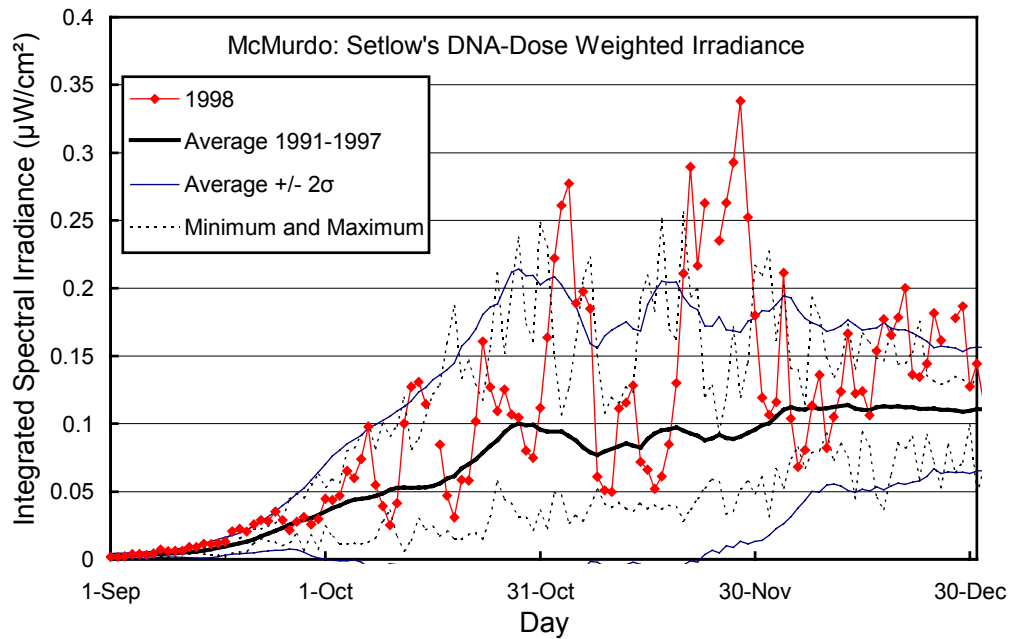


Figure 7.1.3. Setlow's DNA-weighted irradiance at McMurdo. Measurements from 1998 are contrasted with the mean of measurements taken between 1991 and 1997 (thick line). Thin and broken lines represent the mean $\pm 2\sigma$ limits and historical minima and maxima values as in Figure 7.1.2.

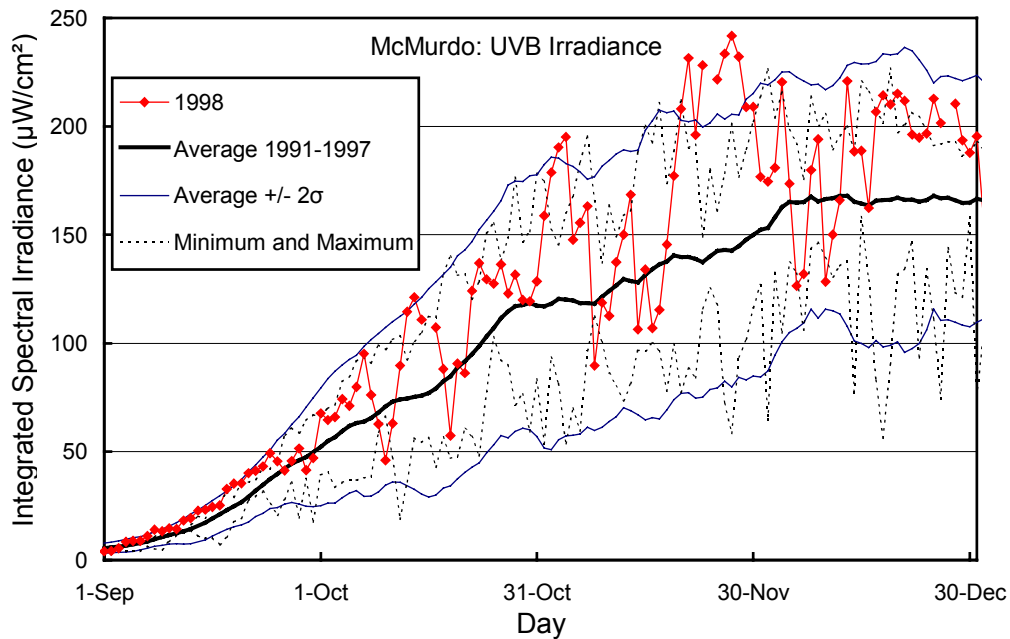


Figure 7.1.4. Noontime UV-B irradiance in McMurdo. Measurements from 1998 are contrasted with the mean of measurements taken between 1991 and 1997 (thick line). Thin and broken lines represent the mean $\pm 2\sigma$ limits and historical minima and maxima values as in Figure 7.1.2.

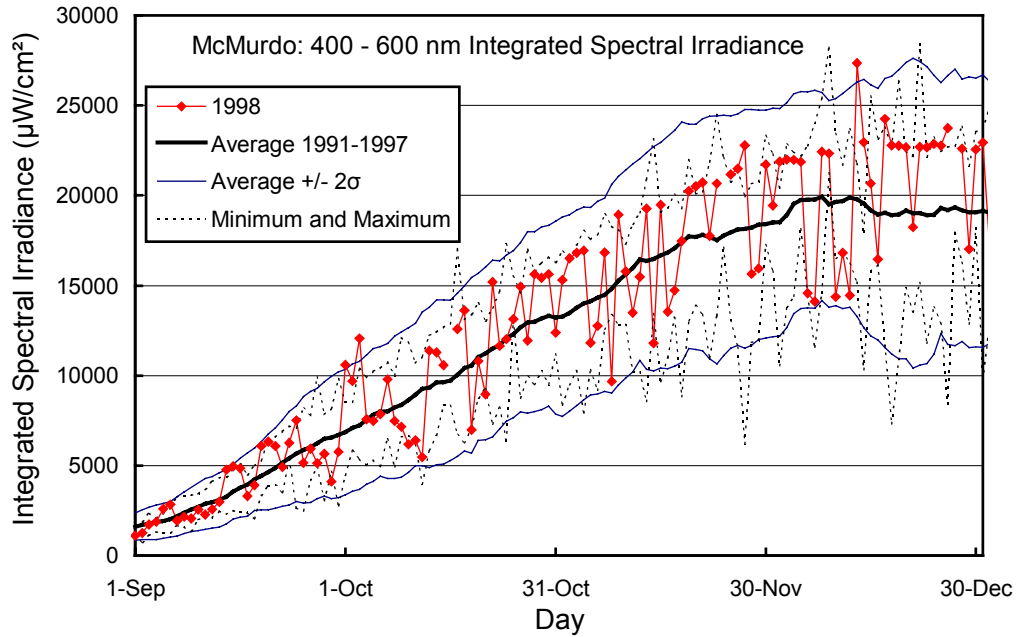


Figure 7.1.5. Noontime broadband visible irradiance (400 - 600 nm) at McMurdo. Measurements from 1998 are contrasted with the mean of measurements taken between 1991 and 1997 (thick line). Thin and broken lines represent the mean $\pm 2\sigma$ limits, and historical minima and maxima values as Figure 7.1.2.

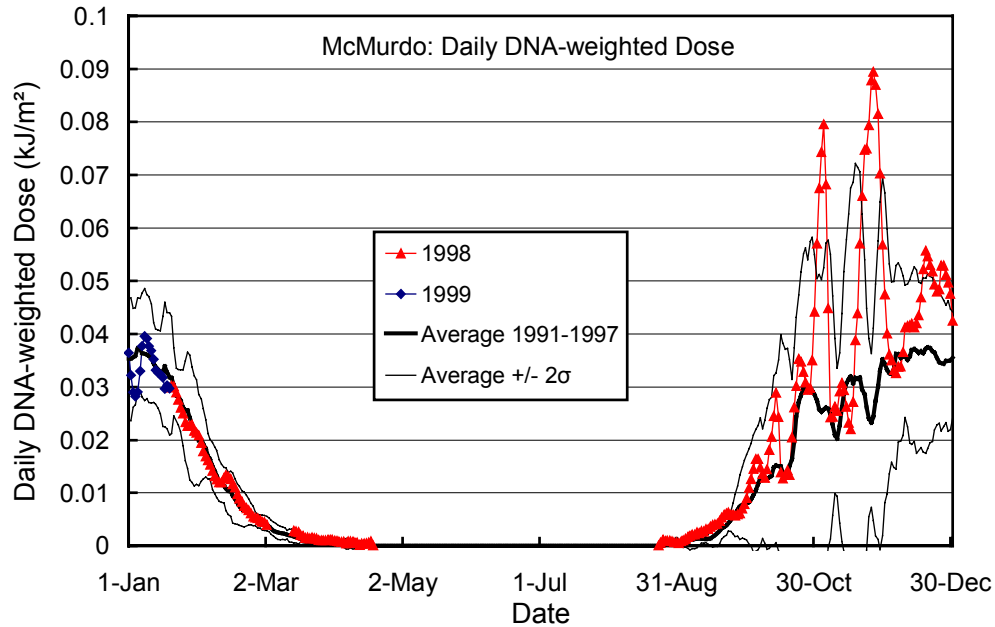


Figure 7.1.6. Daily DNA-weighted dose for McMurdo. The measurements from 1998 and 1999 are contrasted with the mean of measurements taken between 1991 and 1997 (thick line). The thin lines are the mean ± 2 standard deviation (mean $\pm 2\sigma$) limits, also calculated from the 1991-1997 period. A five-day running average was applied to all datasets to reduce day-to-day fluctuations and make the presentation clearer.

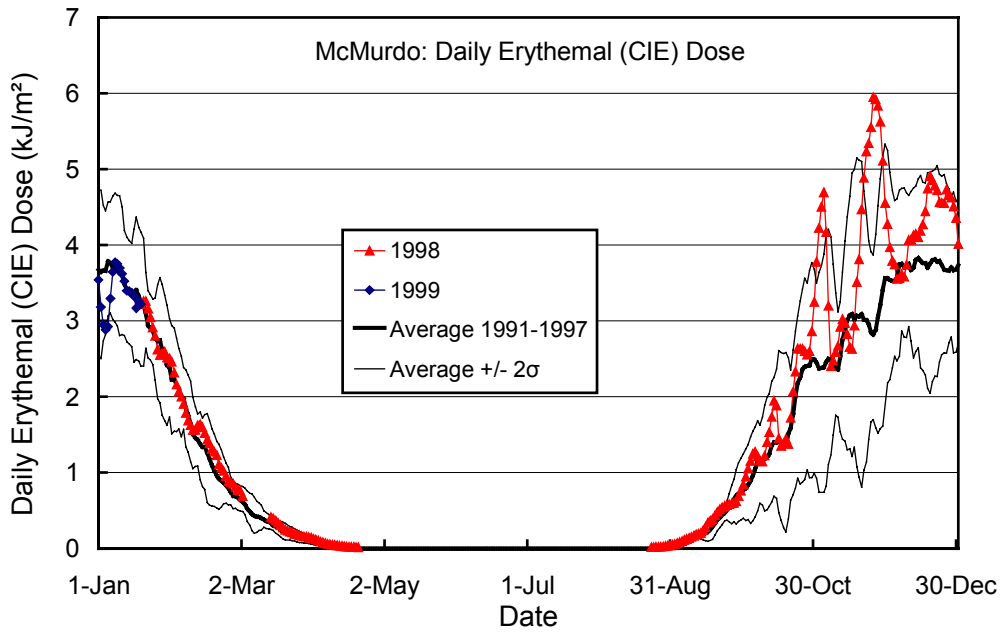


Figure 7.1.7. Daily erythemal dose for McMurdo. Measurements from 1998 and 1999 are contrasted with the mean of measurements taken between 1991 and 1997 (thick line). Thin lines represent the mean \pm 2 σ as in Figure 7.1.6.

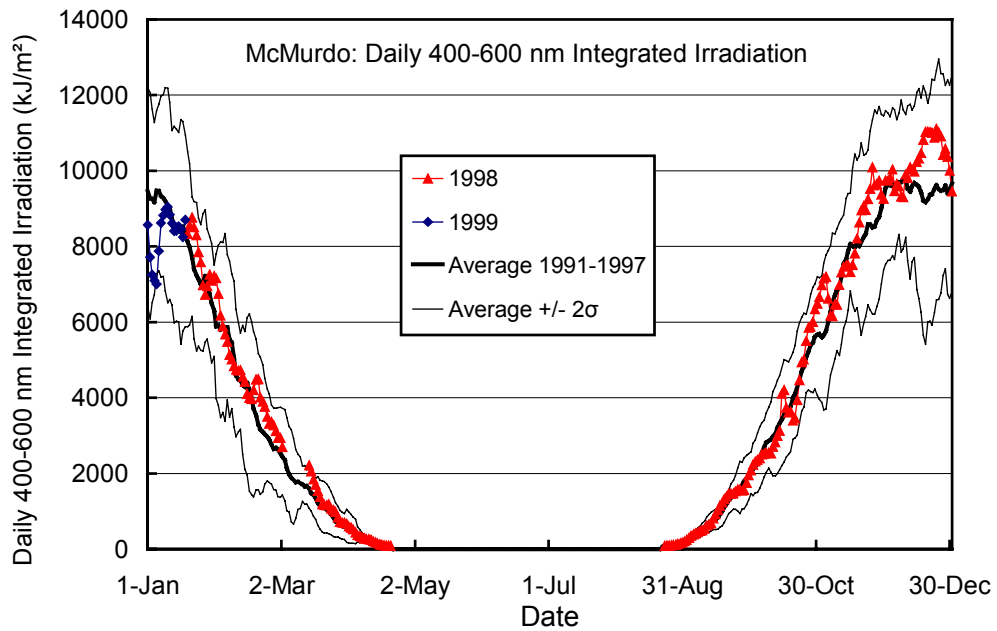


Figure 7.1.8. Daily irradiation of the 400-600 nm band for McMurdo. Measurements from 1998 and 1999 are contrasted with the mean of measurements taken between 1991 and 1997 (thick line). Thin lines represent the mean \pm 2 σ as in Figure 7.1.6.

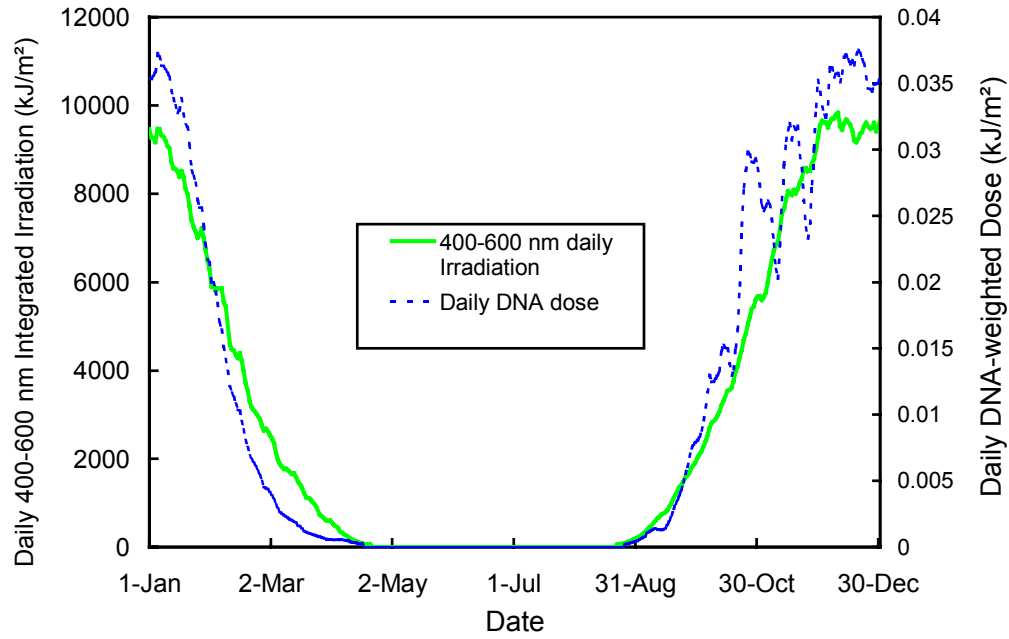


Figure 7.1.9. Comparison of DNA-weighted dose (right axis) with daily irradiation in the 400-600 nm spectral range (left axis) at McMurdo. Both curves represent the mean values from the period 1991-1997 with a 5-day running average smoothing applied.