7.3. Amundsen Scott South Pole Station

Figure 7.3.1 shows total column ozone over Amundsen-Scott South Pole Station as measured by TOMS. During the entire austral spring of 1998 ozone values were either close to the minimum values observed in the period 1991-1994 or were significantly lower. In mid-November 1998, when the ozone hole usually starts to recover, ozone values dropped again, reaching 159 DU on November 29. A similar drop in ozone was observed at all austral network sites between the end of November and the beginning of December. Ozone values at South Pole Station finally recovered around December 9th but values of total column ozone remained about 50 DU lower than typical for the 1991-1994 period. No ozone values exist between 12/13/98 and 12/31/98 because of TOMS instrumental problems.

The low ozone levels in 1998 led to higher-than-average UV values throughout the austral spring at South Pole. Between 11/22/98 and 12/05/98 noontime values of the 298.51 - 303.03 nm integral were about twice as high as maximum values observed during the period 1991-1997 (Figure 7.3.2). Also the low ozone values around 11/6/98 caused a peak in shortwave UV, exceeding levels measured during previous years.

Because of the low ozone values in 1998, DNA-weighted irradiance (Figure 7.3.3) and UV-B-irradiance (Figure 7.3.4) were well above maximum levels observed historically between mid- and late-November. Note that the record UV levels in November 1998 are significantly 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 7.3.5 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 to be 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. Between 11/21/98 and 12/2/98 both DNA-weighted dose (Figure 7.3.6) and erythemal-dose (Figure 7.3.7) exceed the 2σ-limit of doses typical for this period. There is also a local maximum of both doses on day 11/8/98, corresponding to low ozone values. Daily doses in the 400-600 region (Figure 7.3.8) 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 7.3.9, 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 between September and mid-November. This can be explained by the ozone hole, which leads to increased DNA dose values in the second half of the year only.

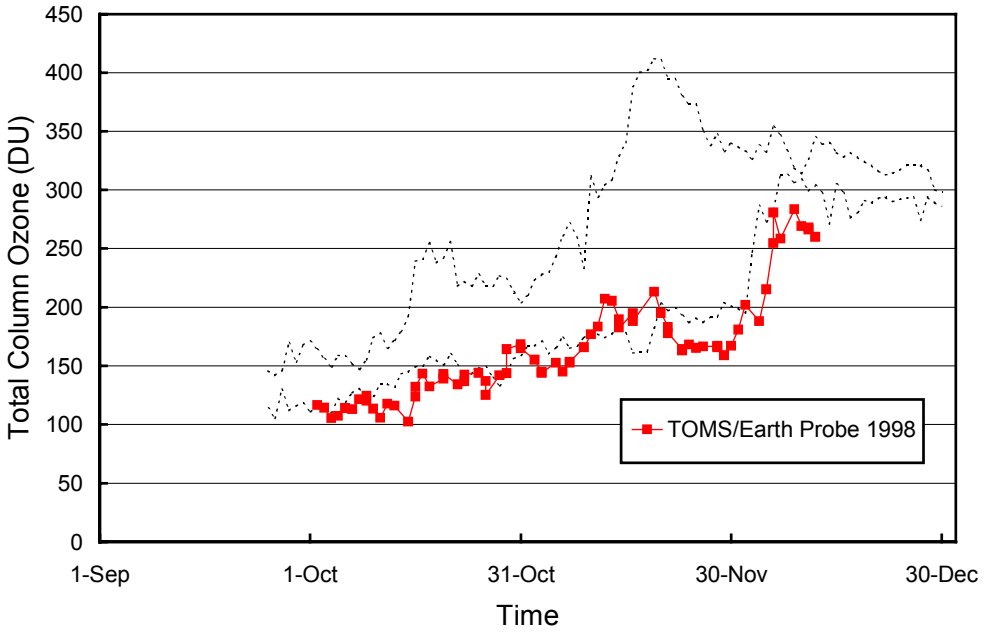

Figure 7.3.1. *Total column ozone in South Pole. TOMS/Earth Probe measurements from 1998 are contrasted with minimum and maximum values (broken lines) from the years 1991-1994 recorded by TOMS onboard NASA's Nimbus-7 and Meteor-3 satellites. A one-and-one-half year gap in data occurred after the loss 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.*

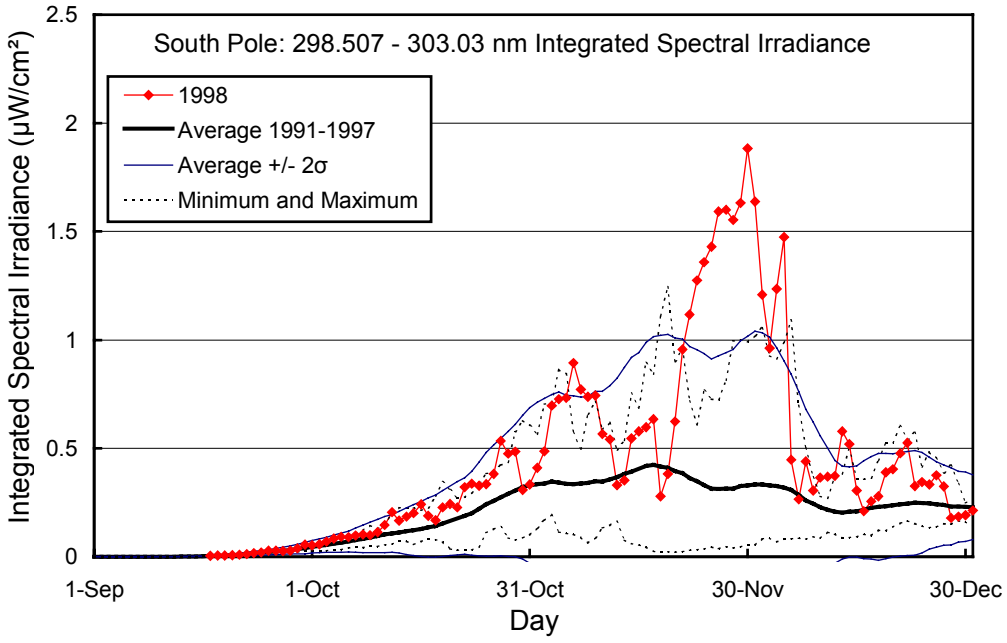

Figure 7.3.2. *Noontime integrated spectral UV irradiance (298.51 - 303.03 nm) at South Pole. The measurements from 1998 (diamonds) are contrasted with the mean of measurements taken between 1991 and 1997 (thick line). The thin lines are the mean ±2 standard deviation (mean±2σ) limits, also calculated from the 1991-1997 period. A ten-day running average was applied to both mean and mean ±2σ 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.*

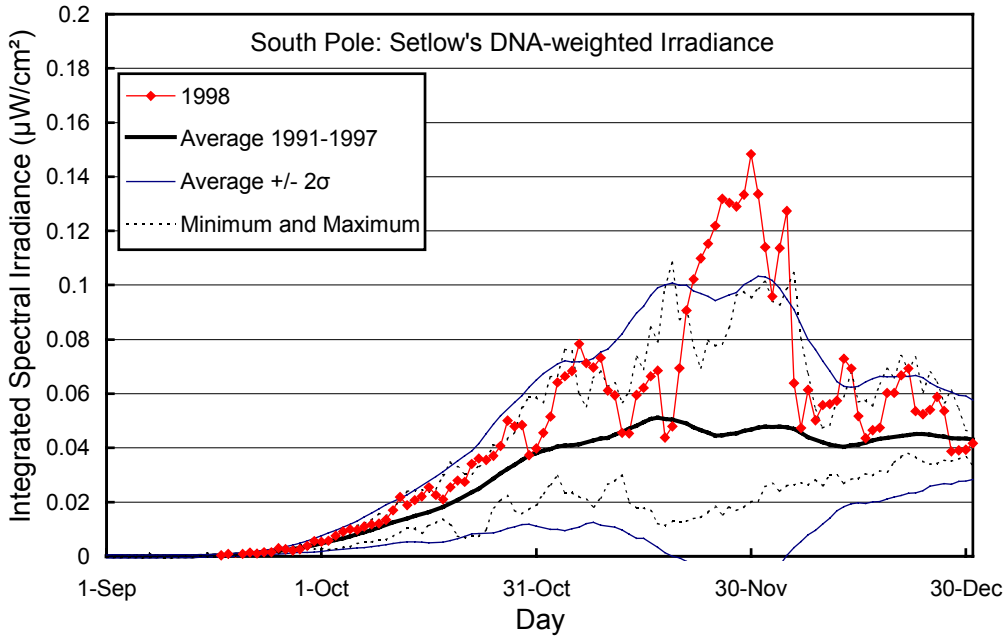

Figure 7.3.3. *Setlow's DNA-weighted irradiance at South Pole. Measurements from 1998 are contrasted with the mean of measurements taken between 1991 and 1997 (thick line). Thin and broken lines represent the mean±2σ limits, and historical minima and maxima values as in Figure 7.3.2.*

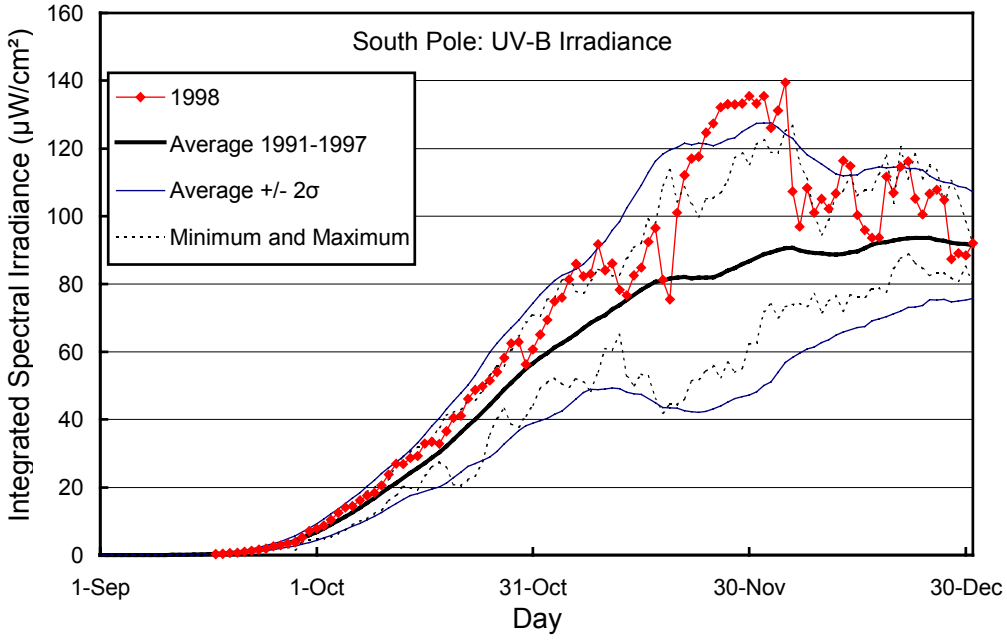

Figure 7.3.4. *Noontime UV-B Irradiance in South Pole. Measurements from 1998 are contrasted with the mean of measurements taken between 1991 and 1997 (thick line). Thin and broken lines represent the mean±2σ limits and historical minima and maxima values as in Figure 7.3.2.*

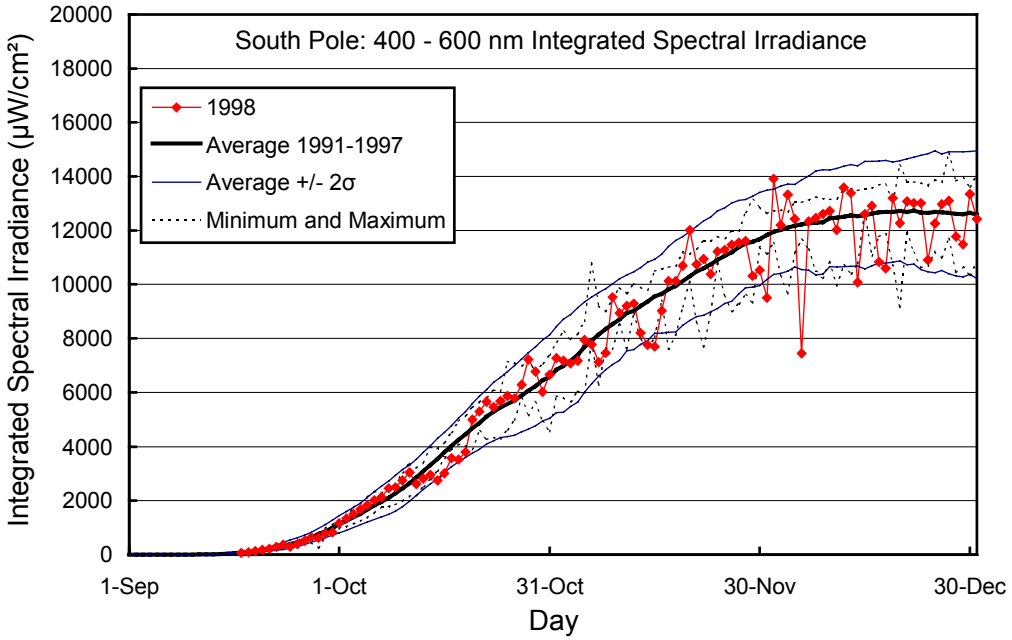

Figure 7.3.5. *Noontime broadband visible irradiance (400 - 600 nm) at South Pole. Measurements from 1998 are contrasted with the mean of measurements taken between 1991 and 1997 (thick line). Thin and broken lines represent the mean±2σ limits, and historical minima and maxima values as Figure 7.3.2.*

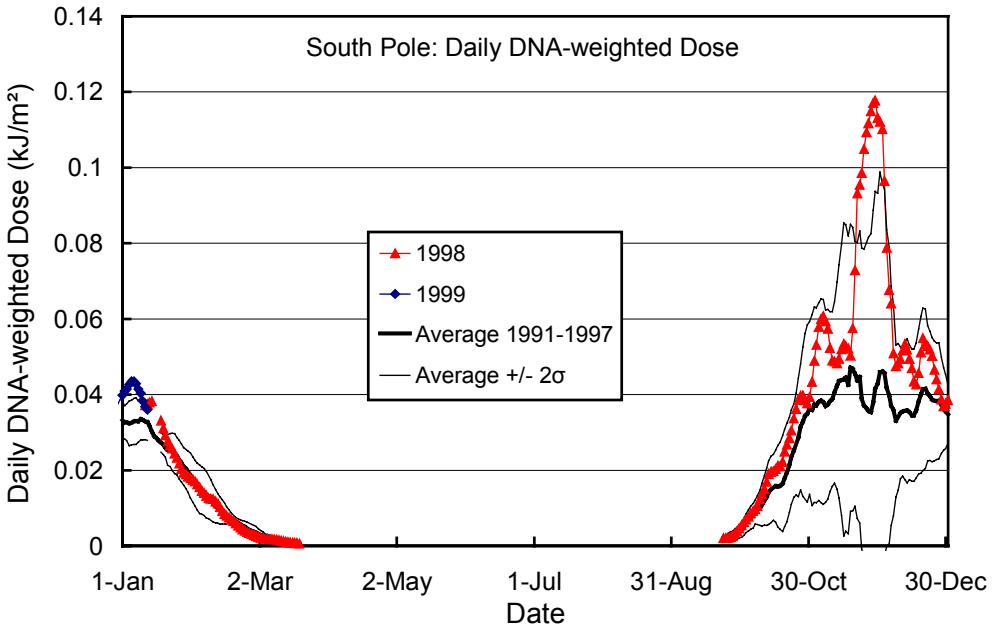

Figure 7.3.6. *Daily DNA-weighted dose for South Pole. The measurements from 1998 are contrasted with the mean of measurements taken between 1991 and 1997 (thick line). The thin lines are the mean ±2 standard deviation (mean±2σ) limits, also calculated from the 1991-1997 period. A five-day running average was applied to all datasets to reduce day-to-day fluctuations and make the presentation clearer.*

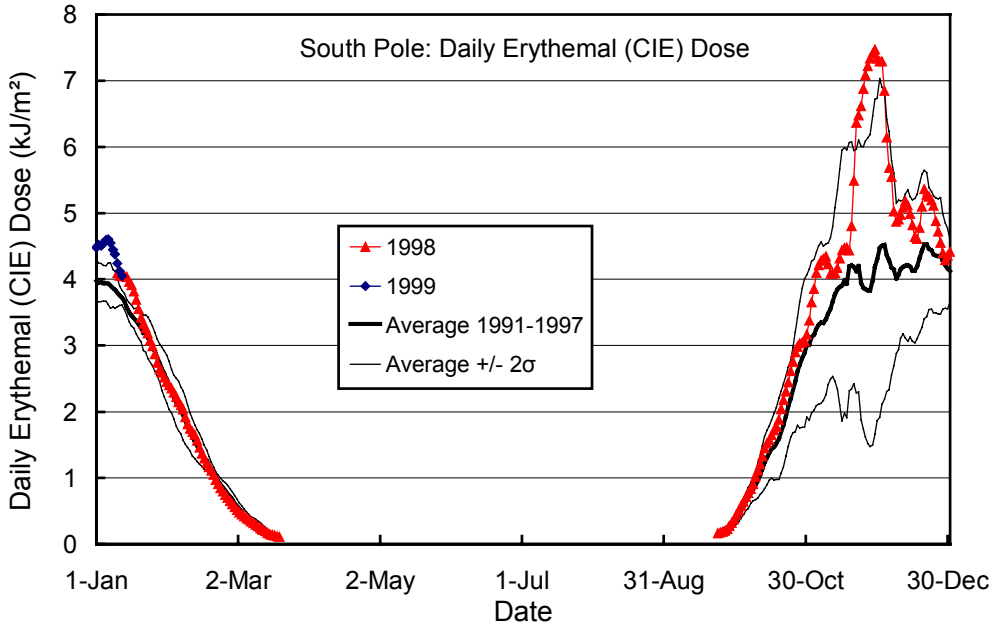

Figure 7.3.7. *Daily erythemal dose for South Pole. Measurements from 1998 are contrasted with the mean of measurements taken between 1991 and 1997 (thick line). Thin lines represent the mean±2σ as in Figure 7.3.6.*

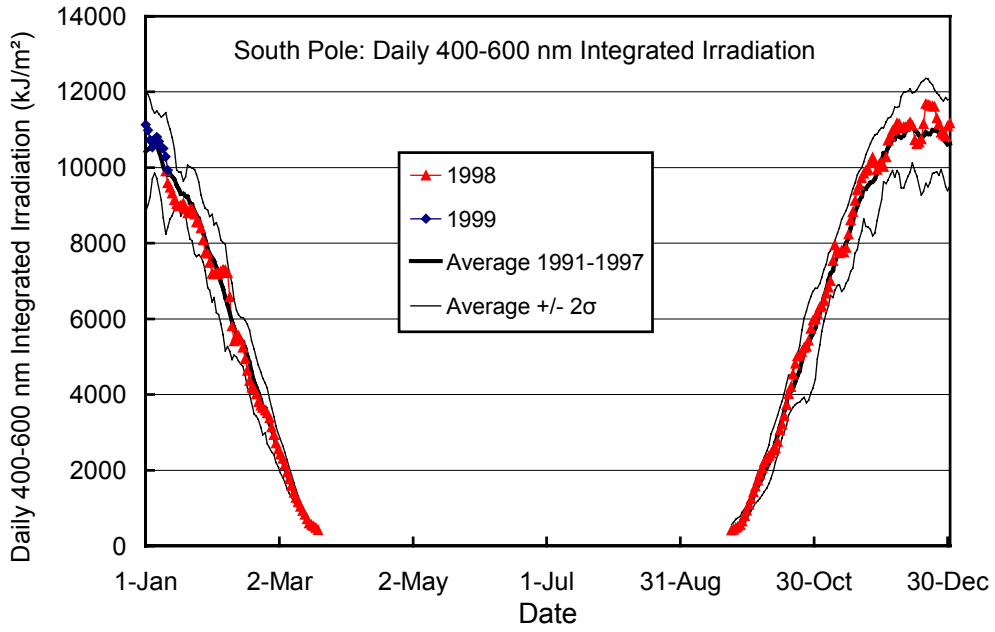

Figure 7.3.8. *Daily irradiation of the 400-600 nm band for South Pole. Measurements from 1998 are contrasted with the mean of measurements taken between 1991 and 1997 (thick line). Thin lines represent the mean±2σ as in Figure 7.3.6.*

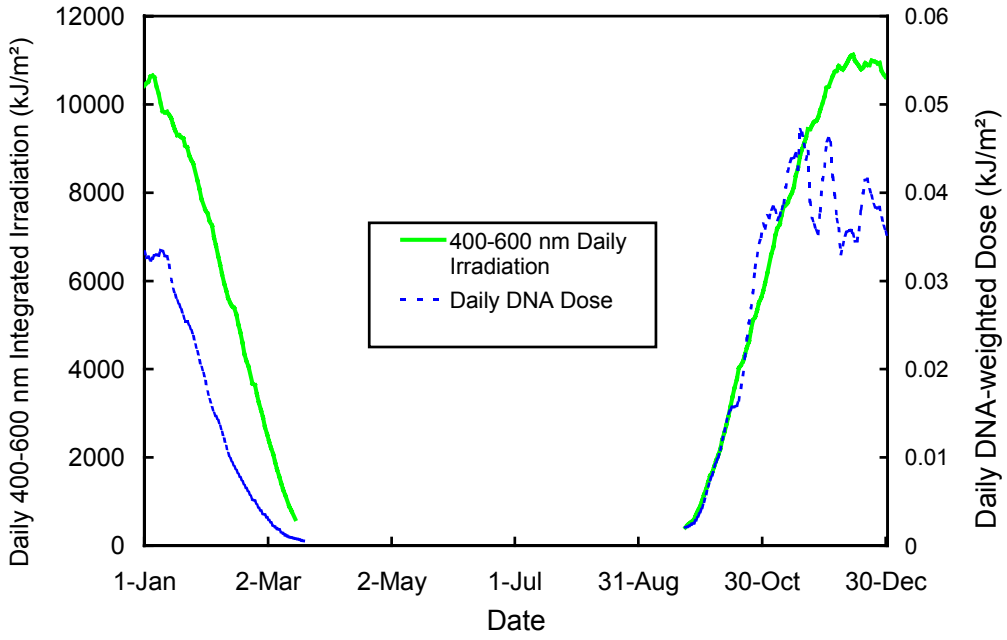

Figure 7.3.9. *Comparison of DNA-weighted dose (right axis) with daily irradiation in the 400-600 nm spectral range (left axis) at South Pole. Both curves represent the mean values from the period 1991-1997 with a 5-day running average smoothing applied.*