7.4. Ushuaia, Argentina

Figure 7.4.1 shows total column ozone over Ushuaia as measured by TOMS. Ozone values are usually within the range of minimum and maximum values of previous years (1991-1994). There are two periods, however, that stick out from the general pattern. On 10/17/98, ozone values dropped by more than 150 DU. Ozone remained low until 10/23/98 until the previous level of 365 DU was reached on 10/26/98. The second prominent event was the decrease in ozone on 12/8/98 ,when column ozone values dropped below minimum values typical for this period. This drop in ozone in early December was observed at all austral sites. Apparently, the ozone hole did not recover as quickly in 1998 as it had in previous years.

The two low-ozone events led to two distinct peaks in noontime UV values on 10/21/98 and 12/08/98. These peaks can be seen in the time series of the 298.51 - 303.03 nm integral (Figure 7.4.2) as well as DNA-weighted irradiance (Figure 7.4.3). The influence of ozone is less obvious in UV-B irradiance (Figure 7.4.4) because of the large day-to-day variations caused by changing cloudiness, which is typical for this site. Clouds are also the dominant factor in the variability of irradiance in the 400-600 nm band, as Figure 7.4.5 shows. Measurements in the visible in 1998 are generally quite comparable to measurements from previous years.

A pattern similar to that observed for noontime values is also seen in daily doses, i.e., irradiance integrated over one day. The DNA-weighted dose time-series also shows peaks on 10/21/98 and 12/08/98, similar to those of the noontime values (Figure 7.4.6). There is also a peak on 12/08/98 in erythemal-dose (Figure 7.4.7); the peak on 10/21/98 is less pronounced because erythemal dose is less sensitive to changes in column ozone than DNA dose. Daily doses in the 400-600 region (Figure 7.4.8), are well within the $\pm 2\sigma$-limits calculated from the years 1991-1997, indicating no significant difference in cloud cover in 1998.

In Figure 7.4.9, 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. There is no clear asymmetry between spring and fall, as is typical for the Antarctic sites. DNA-dose, however, shows greater spread between winter and summer than the daily dose in the visible. The curves of both datasets coincide in summer but during winter (May-July) DNA dose is almost zero, while radiation in the 400-600 nm band is well above the detection limit.

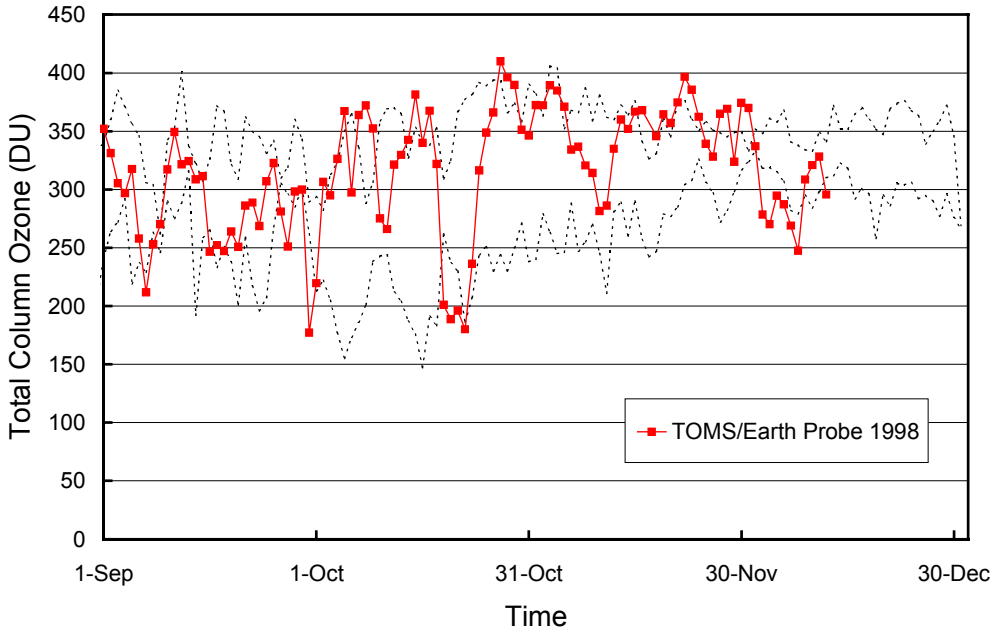

Figure 7.4.1. *Total column ozone in Ushuaia. TOMS/Earth Probe measurements from 1998 are contrasted with minimum and maximum values (broken lines) from the years 1991-1994 recorded by TOMS onboard NASA's Nimbus-7 and Meteor-3 satellites. A one-and-a-half year gap in data occurred after the loss of the Meteor-3 satellite in December 1994. No ozone values exist between 12/13/98 and 12/31/98 because of TOMS instrument problems.*

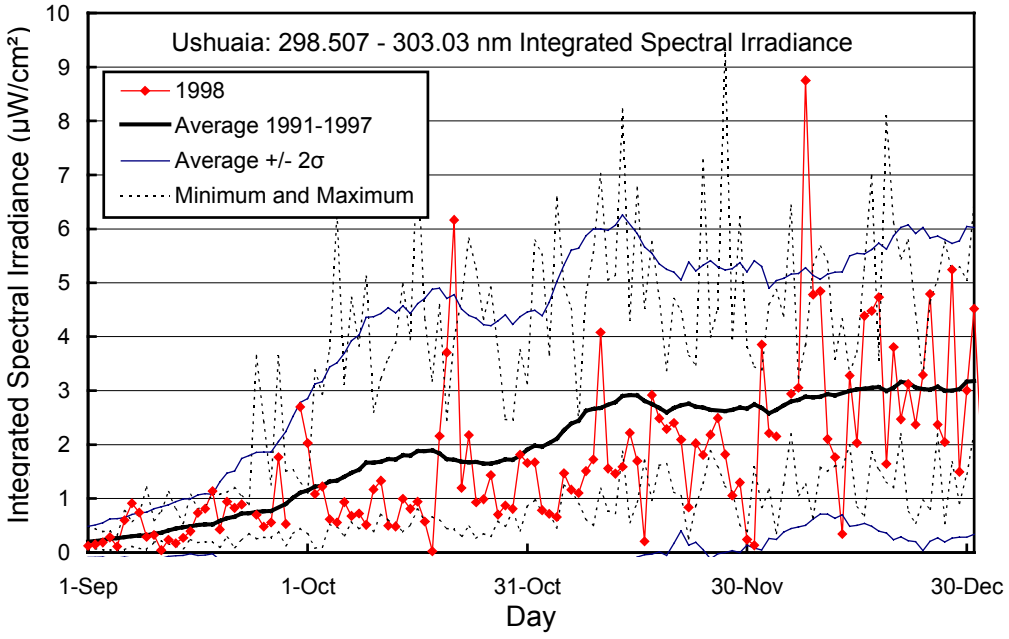

Figure 7.4.2. *Noontime integrated spectral UV irradiance (298.51 - 303.03 nm) at Ushuaia. The measurements from 1998 (diamonds) are contrasted with the mean of measurements taken between 1991 and 1997 (thick line). The thin lines are the mean ±2 standard deviation (mean±2σ) limits, also calculated from 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.*

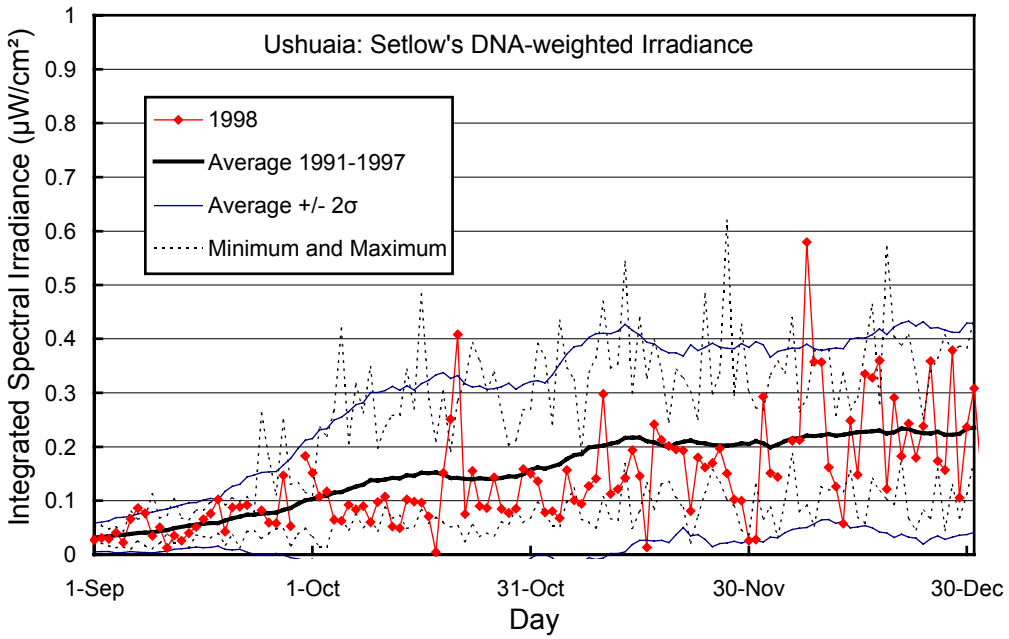

Figure 7.4.3. *Setlow's DNA-weighted irradiance at Ushuaia. Measurements from 1998 are contrasted with the mean of measurements taken between 1991 and 1997 (thick line). Thin lines and broken lines represent the mean±2σ limits, and historical minima and maxima values as in Figure 7.4.2.*

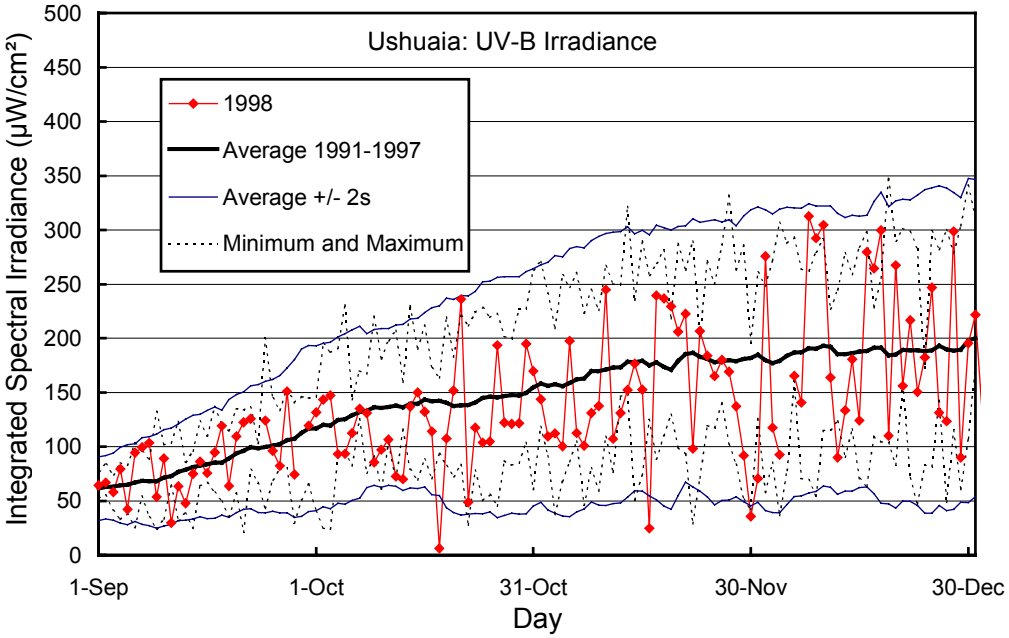

Figure 7.4.4. *Noontime Ushuaia UV-B Irradiance. Measurements from 1998 are contrasted with the mean of measurements taken between 1991 and 1997 (thick line). Thin lines and broken lines represent the mean±2σ limits and historical minima and maxima values as in Figure 7.4.2.*

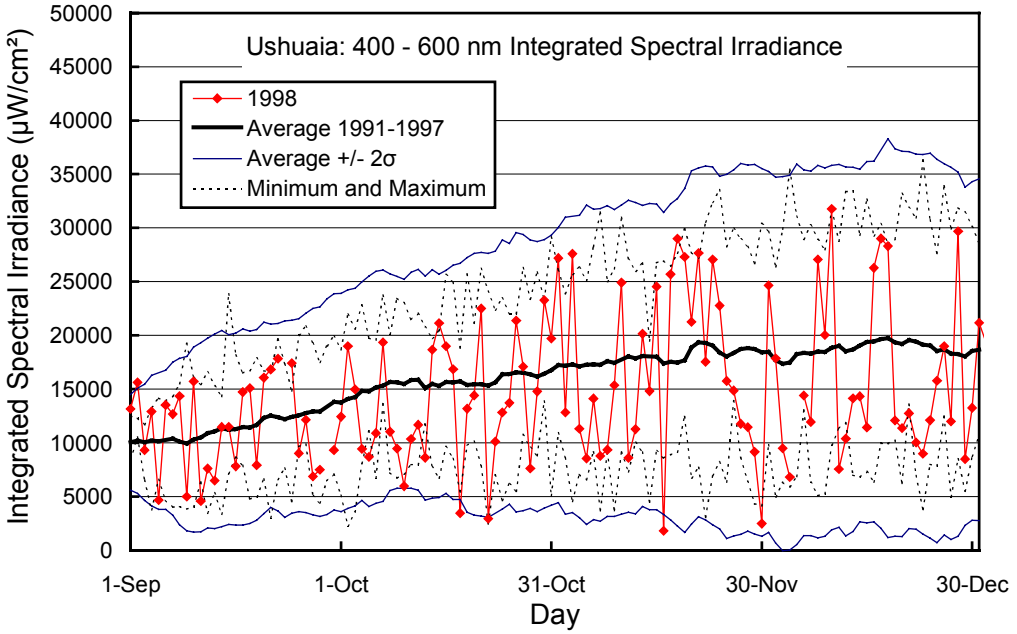

Figure 7.4.5. *Noontime broadband visible irradiance (400 - 600 nm) at Ushuaia. Measurements from 1998 are contrasted with the mean of measurements taken between 1991 and 1997 (thick line). Thin lines and broken lines represent the mean±2σ limits, and historical minima and maxima values as in Figure 7.4.2.*

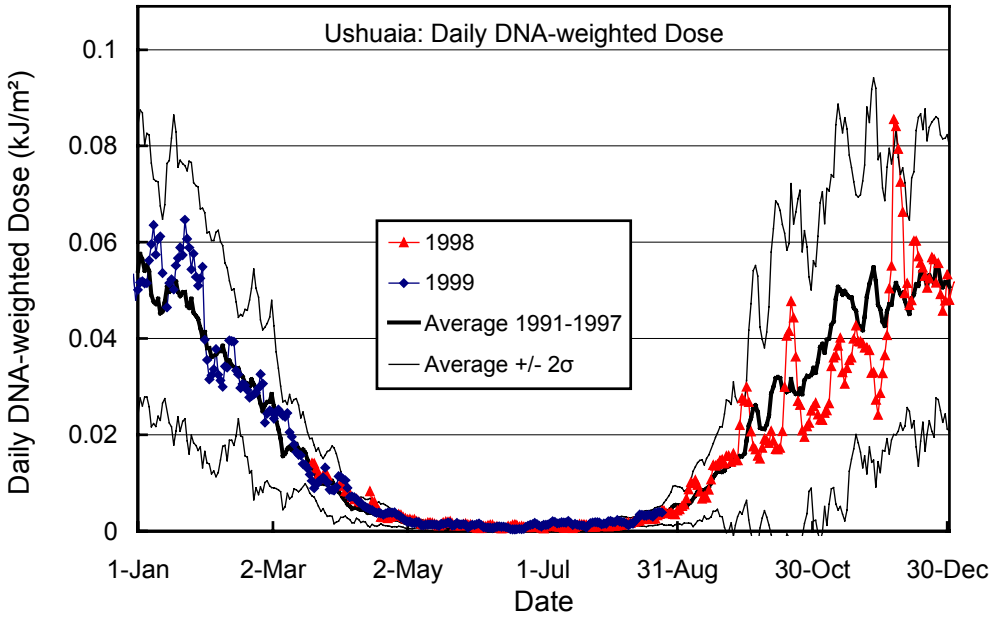

Figure 7.4.6. *Daily DNA-weighted dose for Ushuaia. The measurements from 1998 are contrasted with the mean of measurements taken between 1991 and 1997 (thick line). The thin lines are the mean ±2 standard deviation (mean±2σ) limits, also calculated from the 1991-1997 period. A five-day running average was applied to all curves to reduce day-to-day fluctuations and make the presentation clearer.*

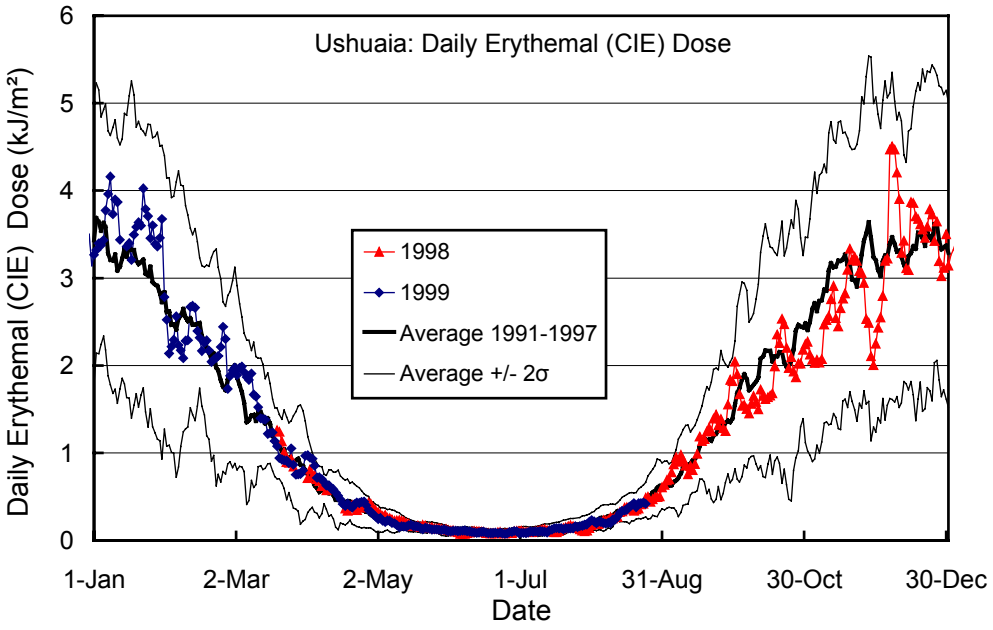

Figure 7.4.7. *Daily erythemal dose for Ushuaia. Measurements from 1998 are contrasted with the mean of measurements taken between 1991 and 1997 (thick line). Thin lines represent the mean±2σ as in Figure 7.4.6.*

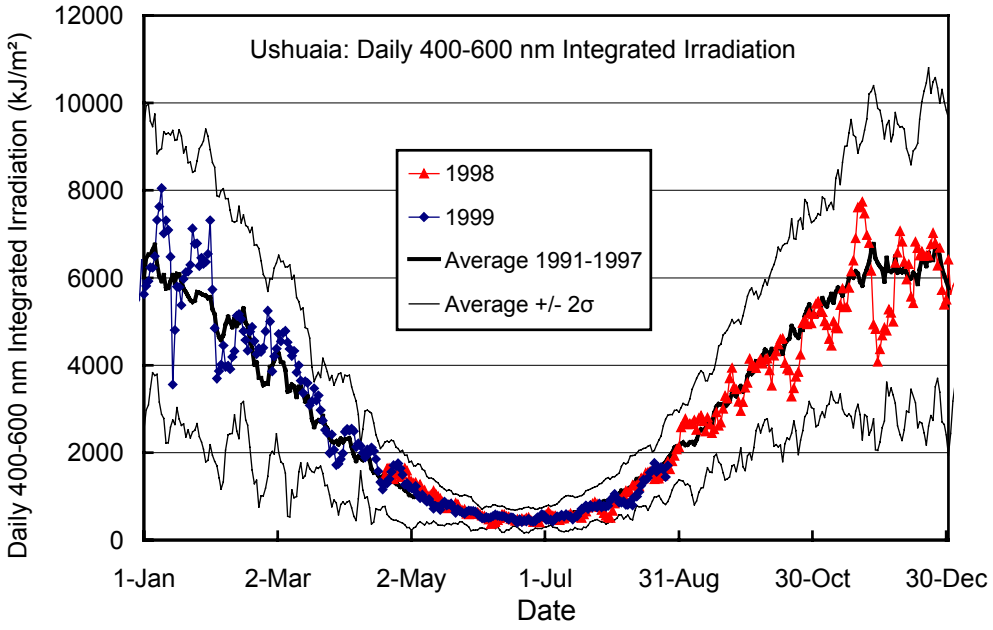

Figure 7.4.8. *Daily irradiation of the 400-600 nm band for Ushuaia. Measurements from 1998 are contrasted with the mean of measurements taken between 1991 and 1997 (thick line). Thin lines represent the mean±2σ as in Figure 7.4.6.*

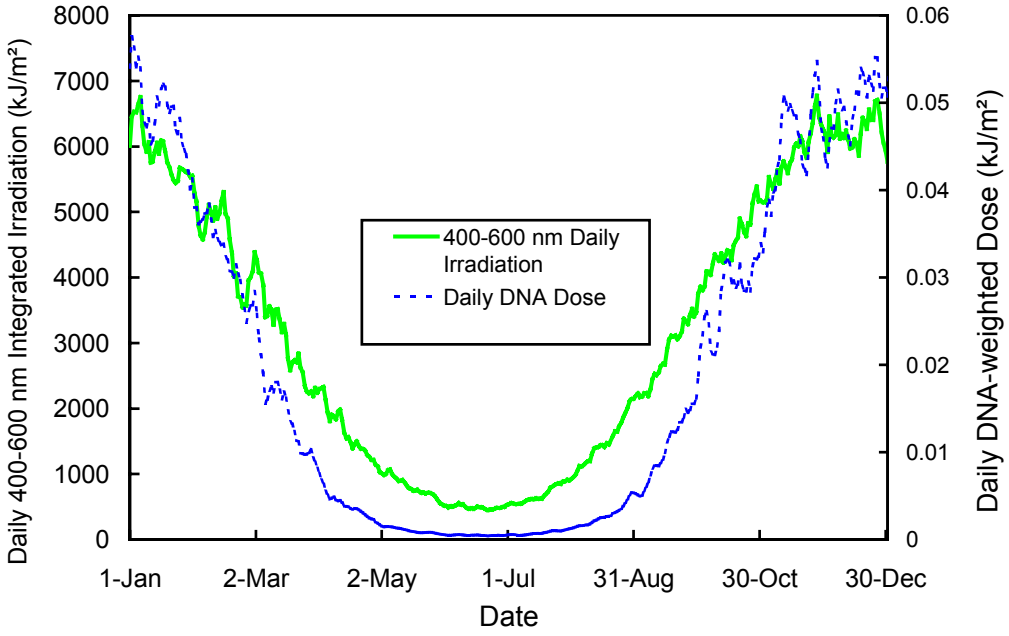

Figure 7.4.9. *Comparison of DNA-weighted dose (right axis) with daily irradiation in the 400-600 nm spectral range (left axis) at Ushuaia. Both curves represent the mean values from the period 1991-1997 with a 5-day running average smoothing applied.*