7.1. McMurdo Station

The Antarctic "ozone hole" in the austral fall of 2002 was the smallest since 1988. The maximum total area in late September was about 19 million km^2, which is considerably less than the area of 26.5 million km^2 observed in 2001. The ozone hole was virtually gone by late-October, one of its earliest disappearances since more than a decade. The small size and early disappearance can be attributed to the occurrence of a comparatively large number of "planetary waves", which lead to a warming of the lower stratosphere. Warmer stratospheric temperatures lead in turn to a lower frequency of Polar Stratospheric Clouds, which help to transform inactive forms of chorine to ozone-destroying active forms. It should be pointed out that the small hole in 2002 is not an indication that the ozone layer is recovering. The small size is rather caused by an unusual global weather pattern in 2002.

Figure 7.1.1 shows total column ozone at McMurdo Station measured by TOMS. Between 9/21/02 and 9/22/02, ozone levels at McMurdo doubled. Shortly after this period, the ozone hole started to split in two, which lead to a substantial reduction of its overall size and depth. On 9/28/02, TOMS measured a total ozone column of 477 DU, which is by far the highest value on record for this day. The second highest TOMS ozone value for September 28 is 299 DU and was observed in 1988. This comparison underlines the unusual situation in 2002. Ozone levels at McMurdo remained 1.5 to 2.7 times larger than average until 10/12/02, and returned to average values for a short period between 10/13/02 and 10/22/02. During this period, the remnant of the hole were centered at the South Pole. During the end of October, its center moved toward South America, and ozone levels at McMurdo rose again to levels significantly higher than average values calculated from measurements of the years 1991 – 2001.

The high ozone levels lead to record low UV levels. With the exception of one week in mid-October, irradiance levels centered around 300 nm remained virtually zero between Polar Night and mid-November (Figure 7.1.2). Erythemal noon-time irradiance values (Figure 7.1.3) were amongst the lowest on record until December 3. In particular the period between 9/22/02 and 10/11/02 exhibited record-low erythemal UV. Daily doses of DNA-damaging radiation (Figure 7.1.4) and erythemally weighted daily doses (Figure 7.1.5) calculated for the period January through April 2002 were comparable to measurements of previous years. Doses observed between October and December 2002 showed a similar pattern than noon-time instantaneous measurements. For example, the DNA daily dose measured on 11/28/02 was 5 times lower than the record-high daily dose of 0.108 kJ/m^2 observed on 11/28/98, demonstrating the larger dynamic range in UV caused by ozone variations.

Radiation in the visible is only marginally affected by total ozone. Daily doses in the visible measured under cloudless skies during the Volume 12 period should therefore be similar to historical observations. Yet Figure 7.1.6 suggest that daily doses in the 400-600 nm wavelength range were about 10-15% lower in 2002 compared to the envelope formed by clear-sky observations from years prior to 2002. This discrepancy has two reasons. Between November 21 and January 21 (two-month period centered at solstice), there were about 22 clear sky days in 2001/2002 but only 6 days in 2002/2003. The relative low number of clear sky days in 2002/2003 is one of the reasons for the comparatively low radiation levels. The second reason is related to the collector upgrade performed during the site visit in January 2000 (see Volume 10 and 11 Operations Reports). Before the modification, the instrument's angular response exhibited an azimuth asymmetry that was most pronounced when the sun was in the North. Noon-time measurements in the visible were overestimated by about 5-10%. This also affected daily doses due to the large contribution of measurements taken around solar noon to the daily integral. The collector upgrade removed the azimuth asymmetry, but slightly increased the average cosine error. Measurements taken after the collector upgrade tend to be low by 3-5%. The diffuser modification therefore introduced a step-change of about 8-15% in time series of "visible" solar data. Measurements in the UV are less affected by this problem as the contribution of the direct solar beam to global irradiance is less in the UV. We estimate the step change in biologically weighted data to less than 5%. The effect of the collector modification on solar data is described in more detail in the introduction to Section 5. We are planning to reprocess our entire data set to remove step changes and improve overall data accuracy. See *Bernhard et al.* (2003) for details.

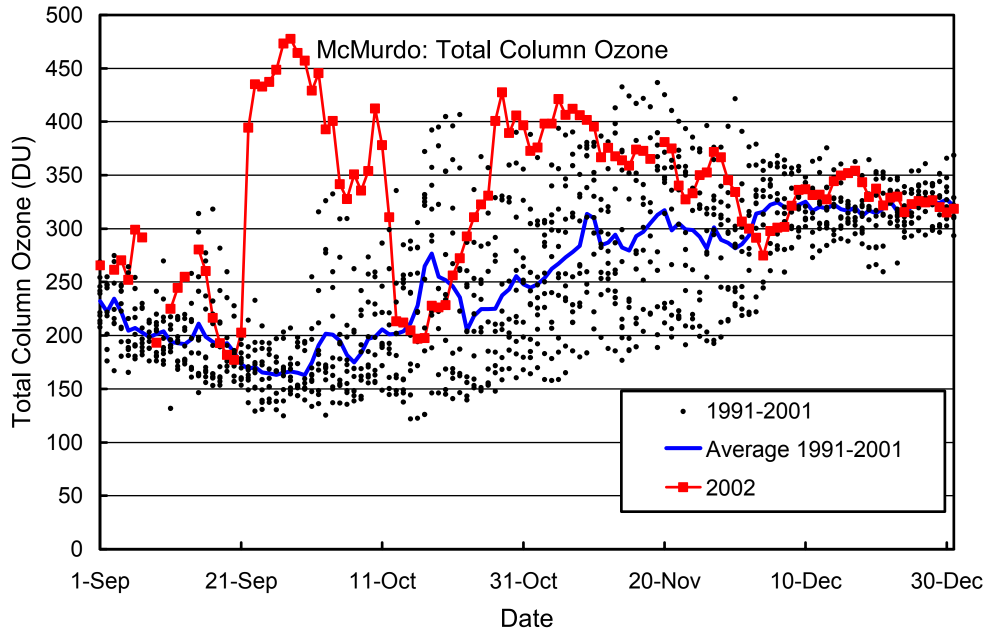

Figure 7.1.1. *Total column ozone in McMurdo. TOMS/Earth Probe measurements from 2002 are contrasted with ozone data from the years 1991-2000 recorded by TOMS /Nimbus-7(1991-1993),TOMS/ Meteor-3 (1993-1994), NOAA/TOVS (1995-1996), and TOMS/Earth Probe (1997-2001) satellites.*

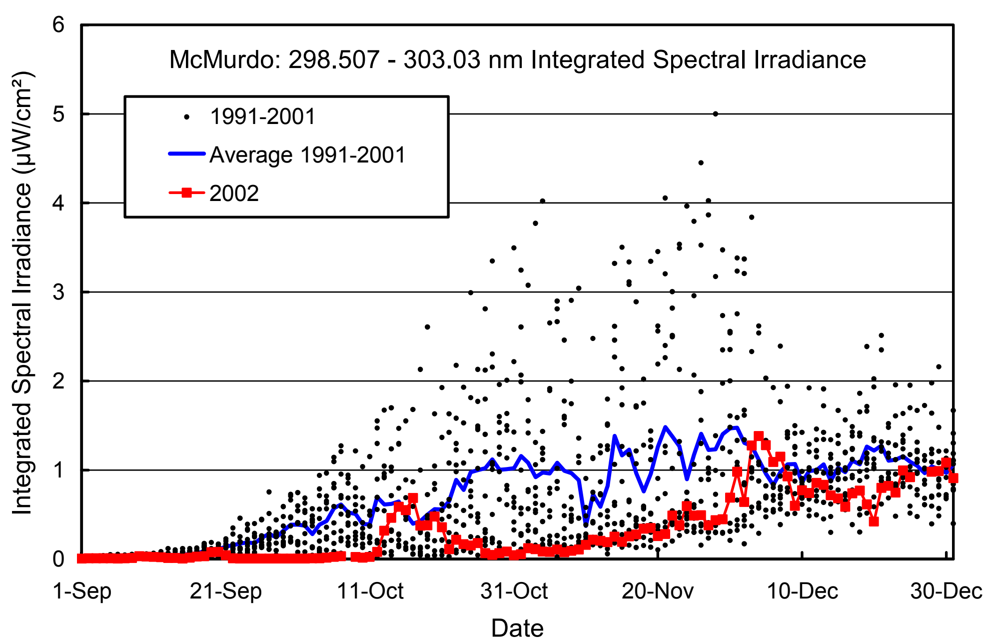

Figure 7.1.2. *Noontime integrated spectral UV irradiance (298.51 - 303.03 nm) at McMurdo. Measurements from 2002 (squares) are contrasted with individual data points and the average of measurements taken between 1991 and 2001.*

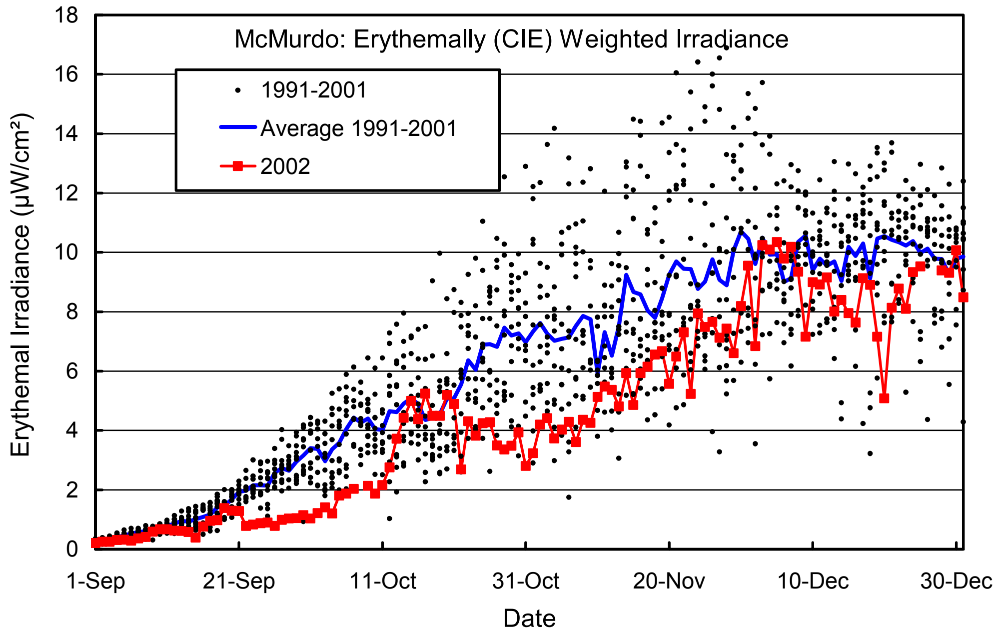

Figure 7.1.3. *Erythemally (CIE) weighted irradiance at McMurdo. Measurements from 2002 (squares) are contrasted with individual data points and the average of measurements taken between 1991 and 2001.*

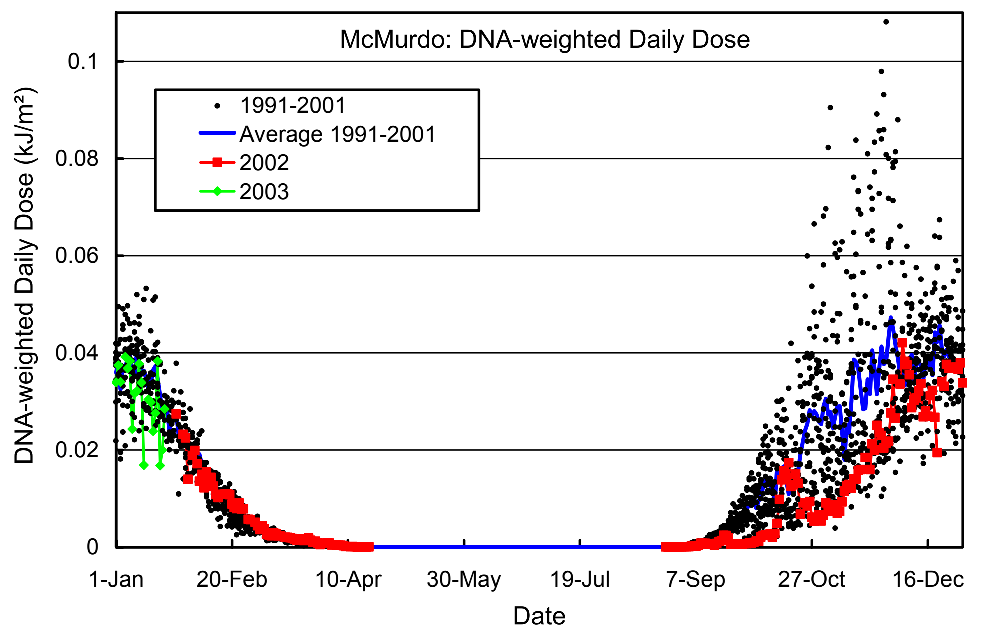

Figure 7.1.4. *Daily DNA-weighted dose for McMurdo. Volume 12 measurements from 2002 and 2003 are contrasted with individual data points and the average of measurements taken between 1991 and 2001.*

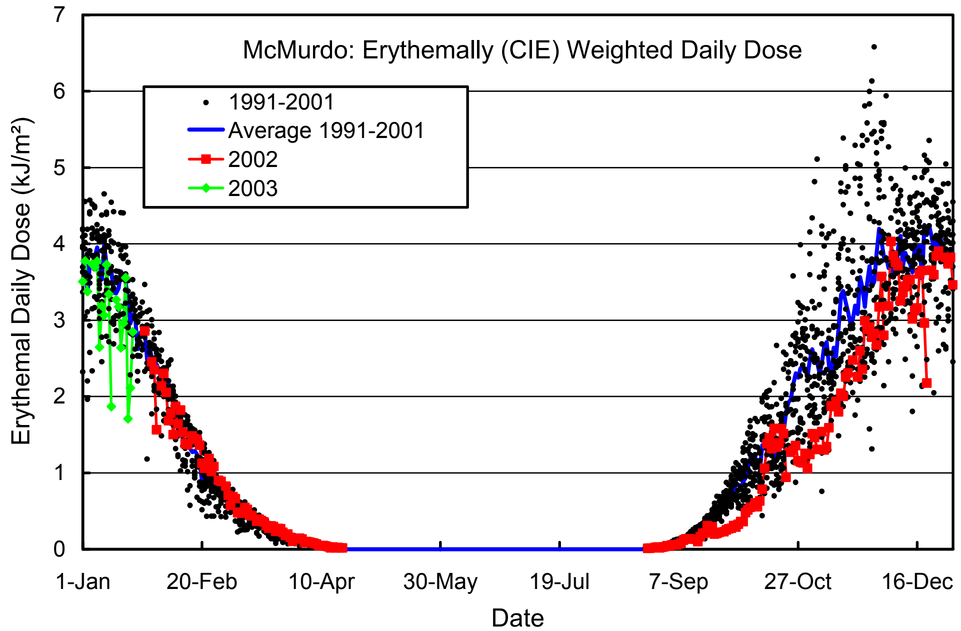

Figure 7.1.5. *Daily erythemal dose for McMurdo. Volume 12 measurements from 2002 and 2003 are contrasted with individual data points and the average of measurements taken between 1991 and 2001.*

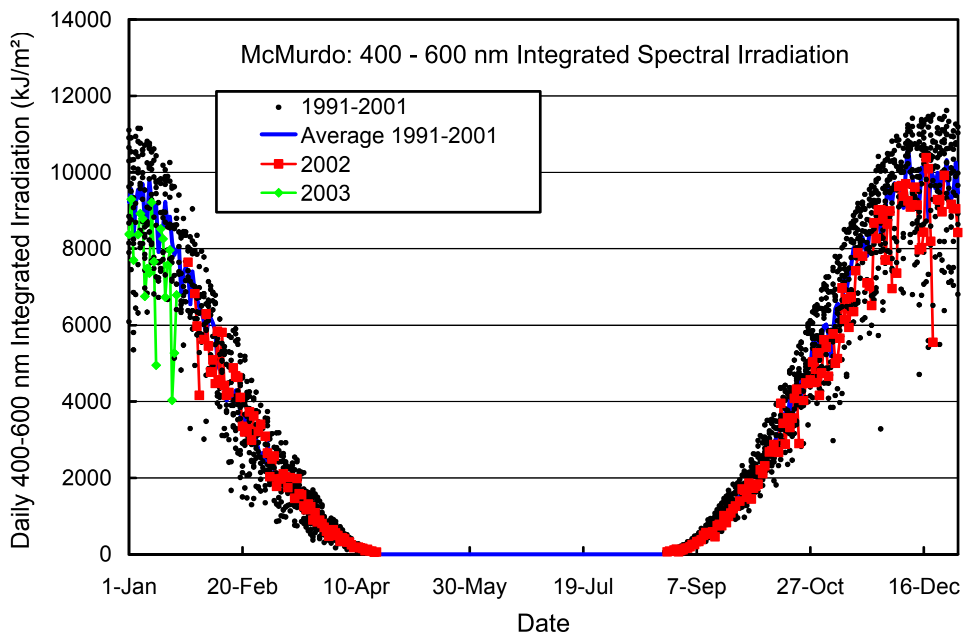

Figure 7.1.6. *Daily irradiation of the 400-600 nm band for McMurdo. Volume 12 measurements from 2002 and 2003 are contrasted with individual data points and the average of measurements taken between 1991 and 2001.*