7.1. McMurdo Station

The ozone hole in the austral fall of 2000 was very unusual. Already in early August an exceptionally large area of very low stratospheric temperatures was noted over Antarctica, which set the state for the earlier than usual development of the annual Austral Spring ozone hole. After a particularly rapid growth during August, the ozone hole reached the largest size on record with an extent of close to 30 million km^2 on September 9. In early October , it was also the deepest with ozone losses exceeding 50% within most of the area of the ozone hole when compared to the pre-ozone-hole conditions. The hole in 2000 grew three weeks earlier than in 1999 and reached its peak one week earlier than in 1999. Its edge was located above southern South America several times in September and October, leading to record UV levels at Ushuaia (see Section 7.4.). After October 20, 2000, the ozone hole begun a very rapid, sustained decrease in size, closing between November 20 and 25. This was the earliest break-up since 1991 and took place almost a month earlier than in 1998 and 1999.[1]

Figure 7.1.1 shows total column ozone at McMurdo Station measured by TOMS. From the beginning of September 2000 until 10/1/00, ozone levels were lower than the 1991-1999 climatology. From then onward, ozone depletion over McMurdo Station rapidly decreased as the center of the ozone hole moved toward South America. The first day of October was also the last day of the year with total ozone at McMurdo below 220 DU. Ozone values in December were similar to the average values observed during the 1990s.

The effect of the unusual ozone hole can clearly be seen in UV data. The 298.51 - 303.03 nm integral (Figure 7.1.2) exhibits two peaks in September. They mark the highest UV-levels on record observed during this month at McMurdo. On the other hand, UV levels in October were almost insignificant and short-wave UV irradiance in November was below average. In December, UV levels returned to values typical for this month. Erythemal noon-time irradiance values (Figure 7.1.3) show two peaks in September, similar as the short-wave integral, and remain significantly below average until the end of November

A pattern similar to that observed for noon-time values can also be seen in daily doses, i.e., irradiance integrated over one day. DNA-weighted daily dose (Figure 7.1.4) and erythemally weighted daily dose (Figure 7.1.5) are relatively high during September, and below the average that is calculated from the observations during the last decade of the 20th century. Note that the variability of both doses is much lower between January and March than it is between September and November, the period affected by the ozone hole.

Radiation in the visible is only marginally affected by total ozone. Daily doses in the visible measured during the Volume 10 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 several percent lower in 2000 compared to doses from previous years. Further analysis revealed that this is caused by the instrument's collector upgrade performed during the site visit in January 2000 (see Chapter 5). 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 values were therefore significantly overestimated. This also affected daily doses due to the large contribution of measurements around noon to the daily integral. Measurements in the visible are much more affected by this error than measurements in the UV as the ratio of direct/global irradiance increases with increasing wavelength. This can be demonstrated by plotting daily doses calculated from measurements in the 337.5 – 342.5 nm wavelength band. This spectral region is not affected by atmospheric ozone concentrations and also less prone to azimuth errors. Figure 7.1.7 shows that daily doses for this wavelength band are indeed very similar in 2000 and years prior to the collector modification. It can therefore be expected that the upgrade introduced only a small step-change in time-series of biologically weighted daily doses.

[1] The summary of the year 2000 ozone hole was compiled from Pablo O. Canziani, "The Evolution of the Antarctic zone hole in 2000", http://www.aero.jussieu.fr/~sparc/News16/16_Canziani.html, and the WMO Antarctic ozone bulletins, http://www.wmo.ch/web/arep/00/

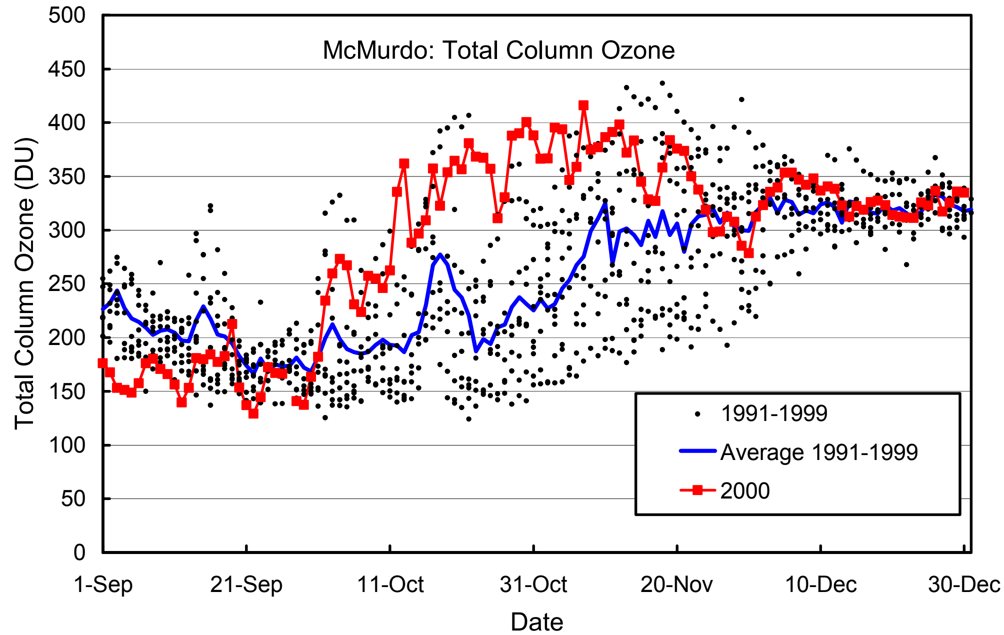

Figure 7.1.1. *Total column ozone in McMurdo. TOMS/Earth Probe measurements from 2000 are contrasted with ozone data from the years 1991-1999 recorded by TOMS /Nimbus-7(1991-1993),TOMS/ Meteor-3 (1993-1994), NOAA/TOVS (1995-1996), and TOMS/Earth Probe (1997-1998) satellites.*

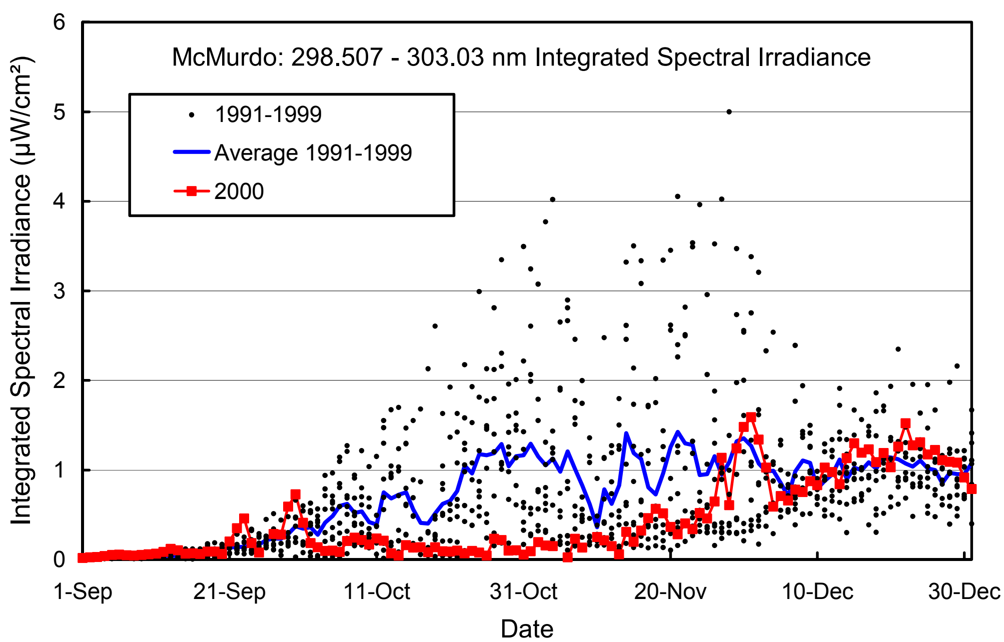

Figure 7.1.2. *Noontime integrated spectral UV irradiance (298.51 - 303.03 nm) at McMurdo. Measurements from 2000 (squares) are contrasted with individual data points and the average of measurements taken between 1991 and 1999.*

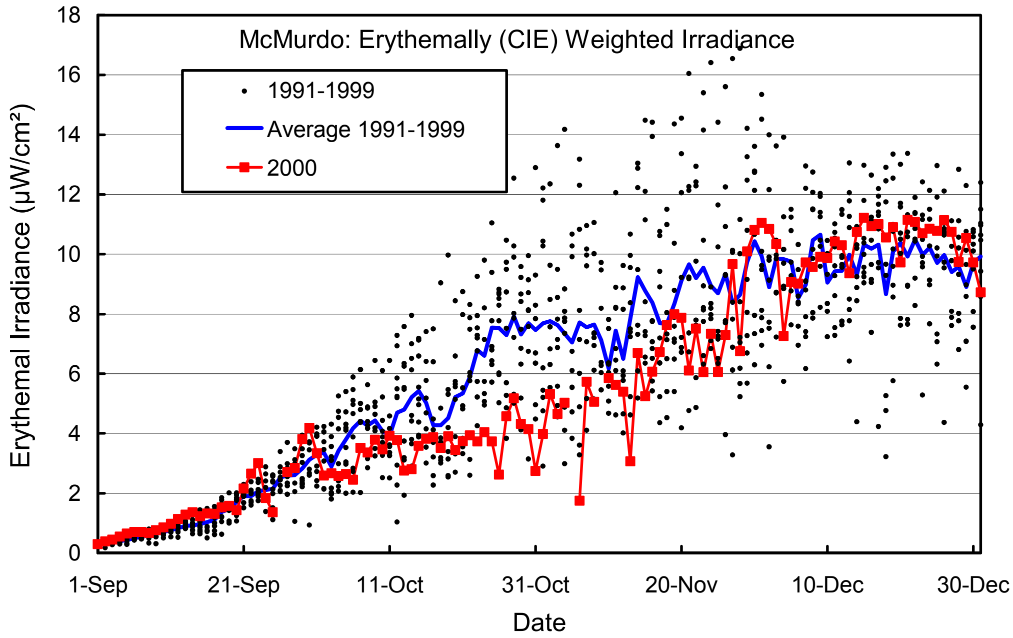

Figure 7.1.3. *Erythemally (CIE) weighted irradiance at McMurdo. Measurements from 2000 (squares) are contrasted with individual data points and the average of measurements taken between 1991 and 1999.*

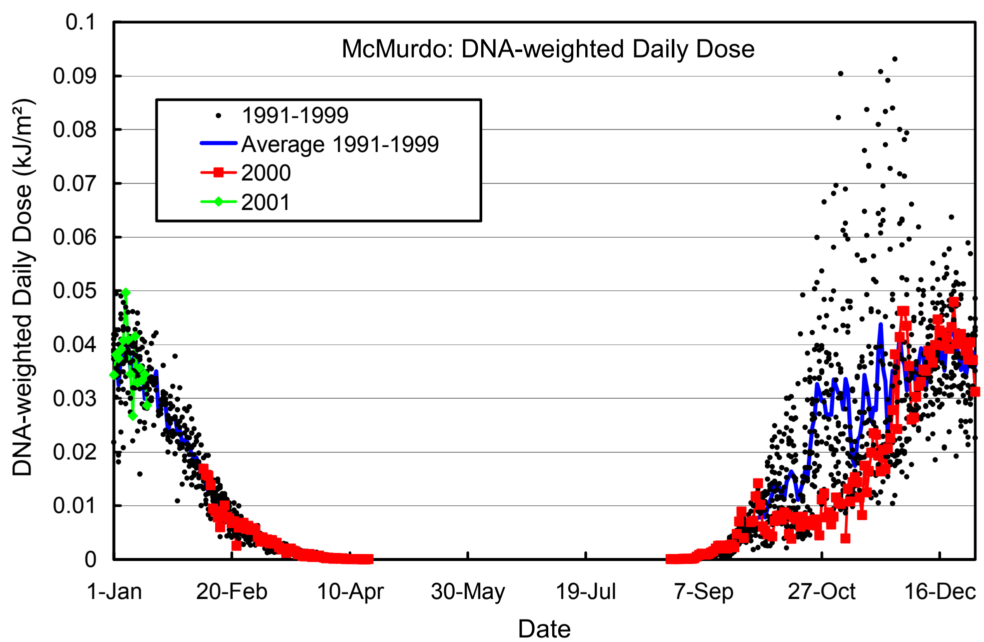

Figure 7.1.4. *Daily DNA-weighted dose for McMurdo. Volume 10 measurements from 2000 and 2001 are contrasted with individual data points and the average of measurements taken between 1991 and 1999.*

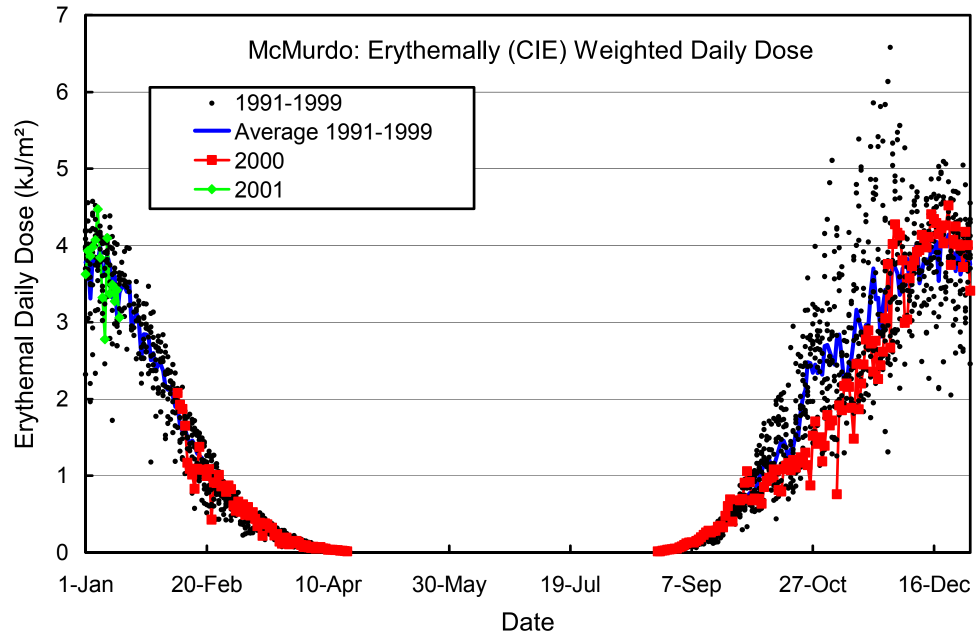

Figure 7.1.5. *Daily erythemal dose for McMurdo. Volume 10 measurements from 2000 and 2001 are contrasted with individual data points and the average of measurements taken between 1991 and 1999.*

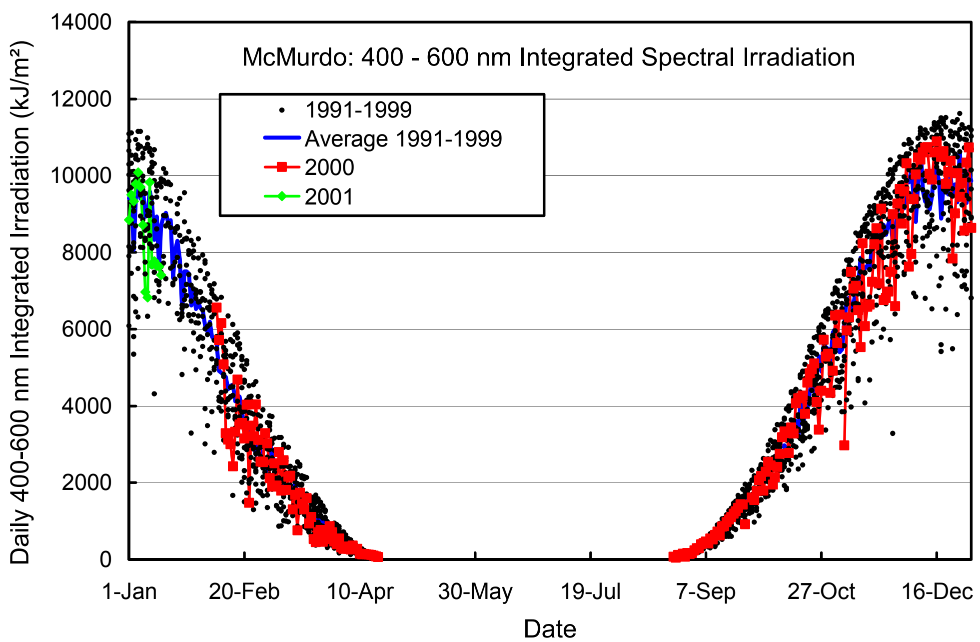

Figure 7.1.6. *Daily irradiation of the 400-600 nm band for McMurdo. Volume 10 measurements from 2000 and 2001 are contrasted with individual data points and the average of measurements taken between 1991 and 1999.*

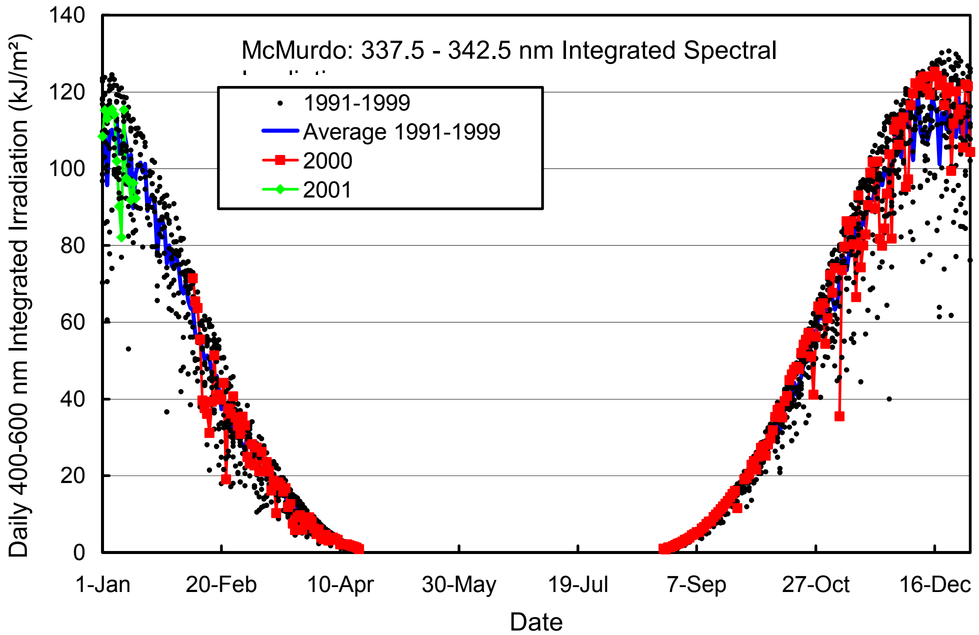

Figure 7.1.7 *Daily irradiation of the 337.5 – 342.5 nm nm band for McMurdo. Volume 10 measurements from 2000 and 2001 are contrasted with individual data points and the average of measurements taken between 1991 and 1999.*