7.4. Ushuaia, Argentina

According to the World Meteorological Organisation[+], the Antarctic "ozone hole" in the austral fall of 2008 reached a maximum 27 million km^2. This is only slightly smaller than the all-time record of 29 million km^2
that was observed in 2006. The ozone hole is typically closed by mid-December but lasted exceptionally long in 2008: areas with total ozone below 220 DU were observed until the end of December 2008, according to measurements of NOAA's SBUV/2 satellites[1]. The minimum ozone column in 2008 was 100 DU and was reached on 4-October, according to measurements by the Ozone Monitoring Instrument (OMI) onboard NASA's AURA satellite. The value of 100 DU is similar to the average "minimum total ozone" observed between 1990 and 2001[2].

The ozone hole occasionally extends to South America. During these events, total ozone at Ushuaia can drop below 200 DU, which may lead to large spikes in UV intensities. Such episodes also occurred during the reporting period, specifically on 6-October, 21-October, 28-October, and 28-November.

Figure 7.4.1 shows total column ozone at Ushuaia measured by the Total Ozone Mapping Spectrometer (TOMS) and the Ozone Monitoring Instrument (OMI). Data from 2008 and 2009 are contrasted with measurements from prior years. Total ozone spiked when the ozone hole passed over the city. The lowest ozone column of 181 DU was measured on 21-October 2008.

Figure 7.4.2 shows noon-time (i.e. 17:00 UT) irradiance of the 298.51 - 303.03 nm integral. Large spikes in UV were observed on 21 and 28 October, which exceeded the long-term average by about a factor of 5.

Figure 7.4.3 contrasts the maximum daily UV Index measured in 2008 and 2009 with corresponding values observed between 1991 and 2007. As SUV-100 measurements are only available up to 14-November 2008, we also plotted UV Indices from the collocated GUV-511 instrument. Both datasets are consistent to within a few percent. The UV Index are less affected by ozone than the 298.51 - 303.03 nm integral. The variability due to ozone is less obvious and often masked by changes in cloud cover. However, the low ozone value on 5, 21, and 28 October also led to a distinct peak in the UV Index of up to 10.9 This value is comparable to the typical summer-time UV Index at San Diego.

Daily doses in the 400-600 nm range are shown in Figure 7.4.4. Since radiation in the visible is only marginally affected by atmospheric ozone concentrations, Volume 18 measurements have a similar pattern than measurements from previous years. There is a large day-to-day variability caused by rapid changes in cloudiness.

[+] See http://www.wmo.ch/pages/prog/arep/gawozobull06_en.html
[1] See http://www.cpc.ncep.noaa.gov/products/stratosphere/polar/gif_files/ozone_hole_plot.png
[2] See ftp://jwocky.gsfc.nasa.gov/pub/eptoms/images/qcplots/zmqchl_v8.png

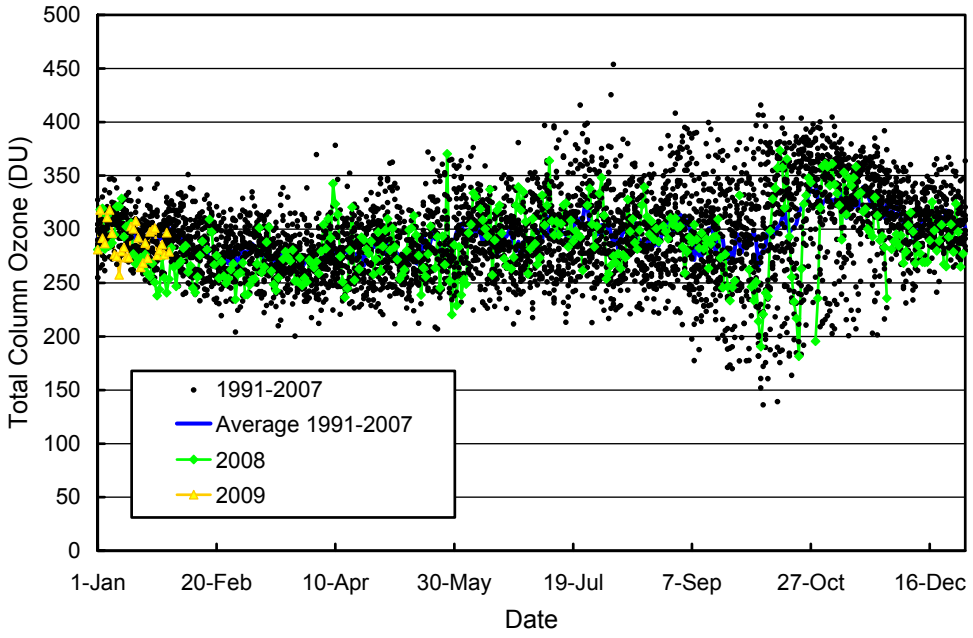

Figure 7.4.1. *Total column ozone in Ushuaia. OMI measurements from 2008 and 2009 are contrasted with ozone data from the years 1991-2001 recorded by TOMS /Nimbus-7(1991-1993),TOMS/ Meteor-3 (1993-1994), NOAA/TOVS (1995-1996), TOMS/Earth Probe (1997-2003), and OMI (2004-2007) satellites.*

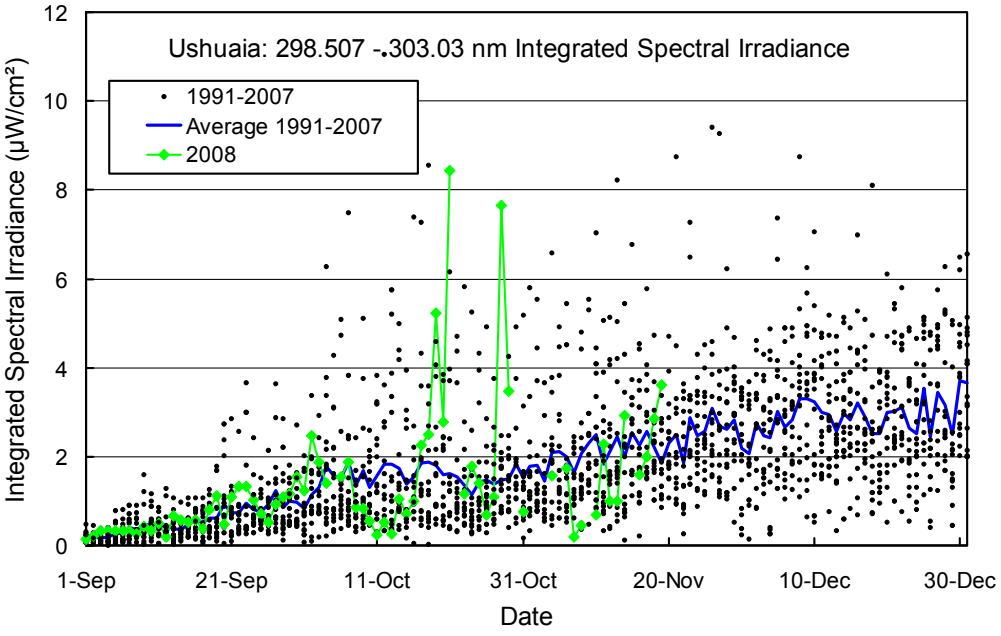

Figure 7.4.2. *Noontime integrated spectral UV irradiance (298.51 - 303.03 nm) at Ushuaia. Measurements from 2008 are contrasted with individual data points and the average of measurements taken between 1991 and 2007.*

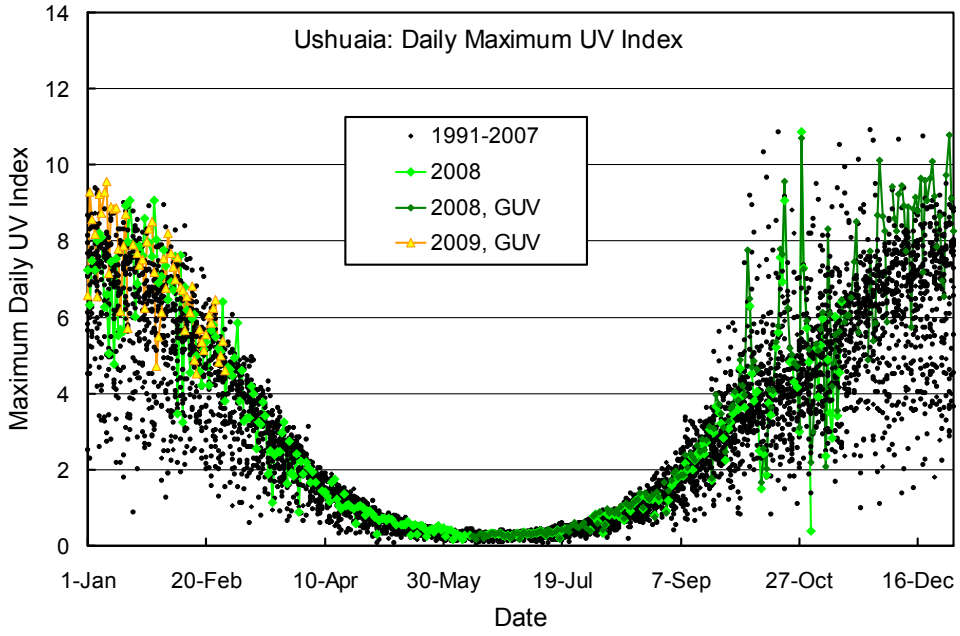

Figure 7.4.3. *Maximum daily UV Index at Ushuaia. Measurements from 2008 and 2009 are contrasted with data of the years 1991 through 2007.*

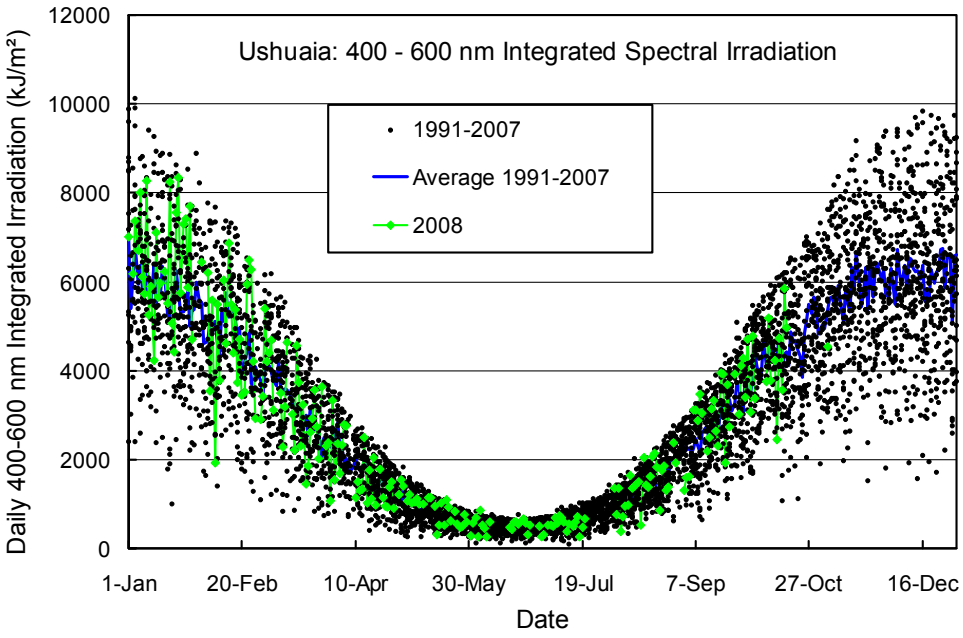

Figure 7.4.4. *Daily irradiation of the 400-600 nm band for Ushuaia. Measurements from 2008 and 2009 are contrasted with individual data points and the average of measurements taken between 1991 and 2007.*