

## 7.7. Summit, Greenland

The instrument at Summit was installed in August 2004. UV measurements from the years 2004-2012 are compared in this Section.

In Figure 7.7.1, column ozone data from the Ozone Monitoring Instrument (OMI) onboard NASA's AURA satellite measured in 2011 and 2012 are compared with ozone records from the years 1991-2010. There is a strong seasonal dependence: ozone columns are generally higher and have a larger variability in spring than autumn.

Measurements in 2011 were particularly low in March when unprecedented Arctic ozone loss was observed (Manney et al., 2011). Ozone levels in March of 2012 were within the typically range, however, an episode of reduced ozone was observed during the first week of April. Other periods with ozone significantly below the long-term mean (blue line in Figure 7.7.1) were: 5/29/12 - 6/4/12 and 7/11/12 - 7/20/12.

The low ozone values of March 2011 and April 2012 led to enhancements of the UV Index (Figure 7.7.2). UV Indices on 6/2/12 and 7/13/12 are also slightly increased due to the relatively low atmospheric ozone concentrations during this period. Spectral irradiance integrated over 298.51 - 303.03 nm (Figure 7.7.3) shows enhancements during the same periods, however, the low-ozone events of March 2011 and April 2012 occurred at a time when the Sun was still low in the sky. Because UV levels depend strongly on the height of the Sun above the horizon, absolute UV levels of this short-wavelength interval remained small despite the very low ozone columns during these periods.

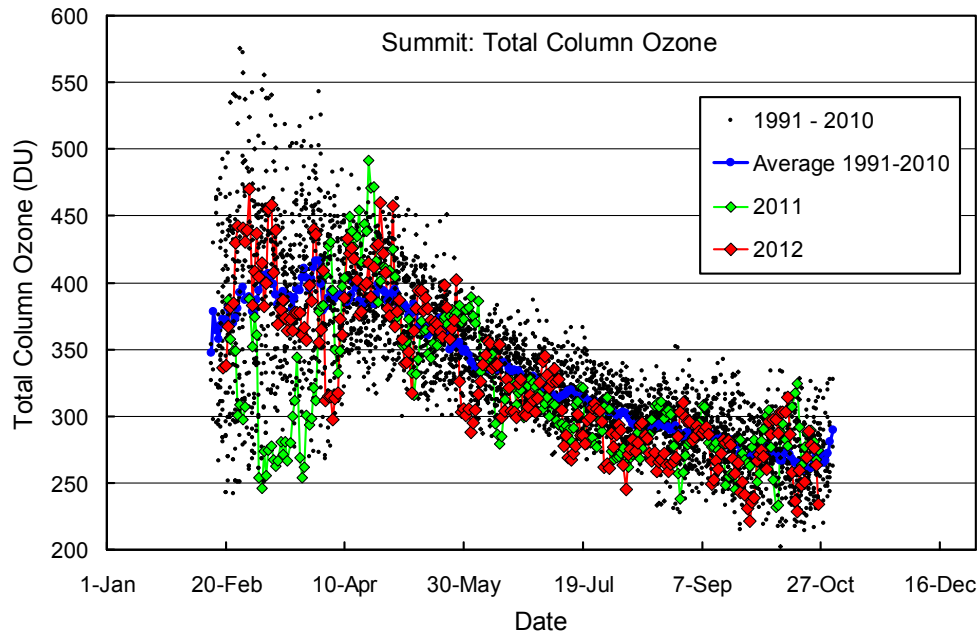
Figure 7.7.4 shows measurements in the 337.5-342.5 nm band, integrated over 24 hours. This band is not affected by the atmospheric ozone content. Data show remarkable little day-to-day variation and change from one year to the next. On one hand, this is a confirmation of the consistency of calibrations applied during the eight years of operation. On the other hand, the low level of variability is also a consequence of constant, high surface albedo at Summit, which mitigates attenuation of UV radiation by clouds.

Figure 7.7.5 shows measurements in the 400 - 600 nm band, integrated over 24 hours. These data look very similar to those shown in Figure 7.7.4 because this band is also very little affected by variations in total ozone. The somewhat larger variability in the 400 - 600 nm band compared to the 337.5-342.5 nm band is caused by the fact that clouds have a larger effect on radiation in the visible than the UV.

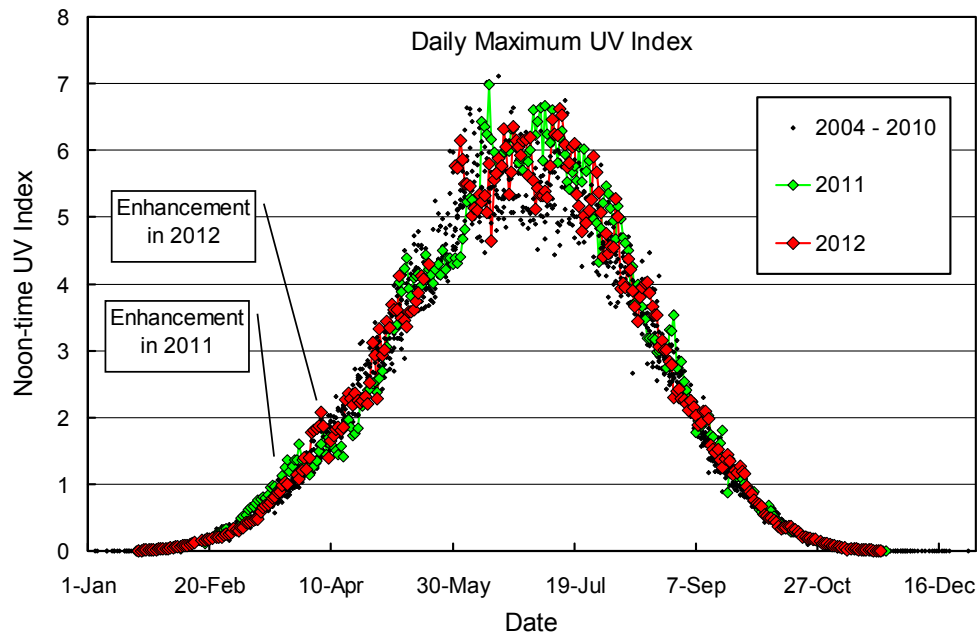
Lastly, Figure 7.7.6 compares the daily maximum UV Index with daily irradiation in the 400-600 nm spectral range. The latter quantity is symmetrical about the solstice. The UV Index on the other hand is suppressed during the spring due to the annual cycle in total ozone (Figure 7.7.1).

### References

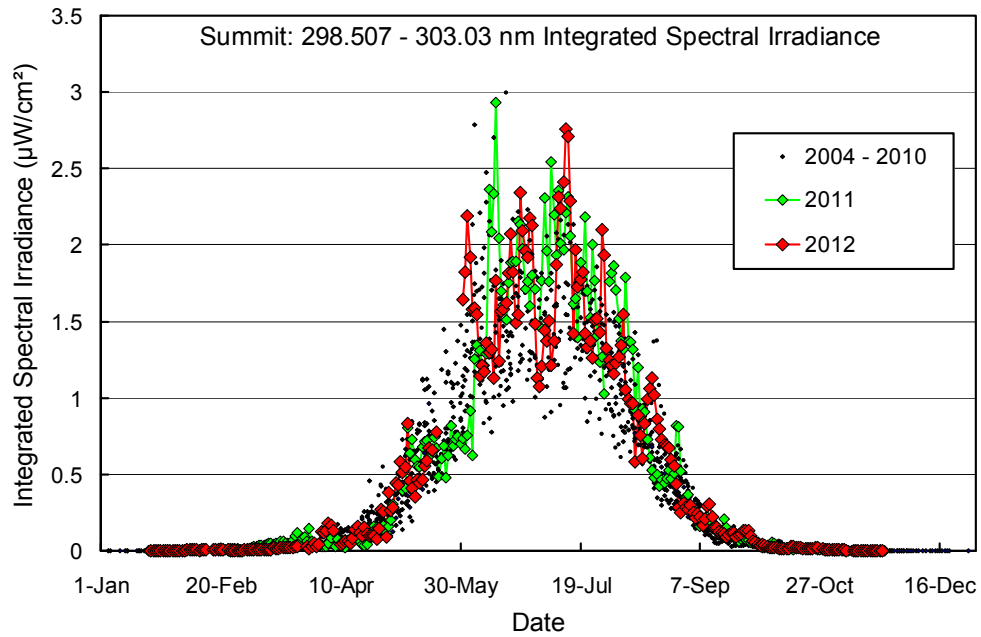
Manney, G. L., M. L. Santee, M. Rex., N. J. Livesey, M. C. Pitts, P. Veefkind, E. R. Nash, I. Wohltmann, R. Lehmann, L. Froidevaux, L. R. Poole, M. R. Schoeberl, D. P. Haffner, J. Davies, V. Dorokhov, H. Gernandt, B. Johnson, R. Kivi, E. Kyrö, N. Larsen, P. F. Levelt, A. Makshtas, C. T. McElroy, H. Nakajima, M. C. Parrondo, D. W. Tarasick, P. von der Gathen, K. A. Walker, and N. S. Zinoviev (2011): Unprecedented Arctic ozone loss in 2011, *Nature*, 478, 469-475. Available at: <http://www.nature.com/nature/journal/v478/n7370/full/nature10556.html>.



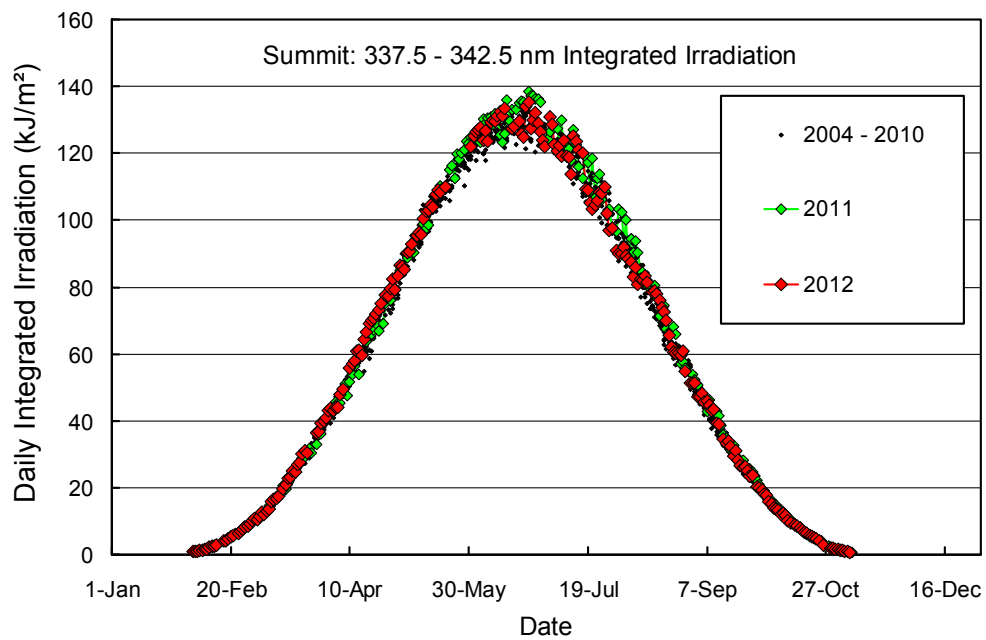
**Figure 7.7.1.** Total column ozone at Summit. OMI measurements from 2011 and 2012 are contrasted with ozone data from prior years recorded by TOMS on Nimbus-7 (1991-1993), Earth Probe (1996-2004), and OMI (2005-2012) satellites. TOMS data are from the Version 8 data set.



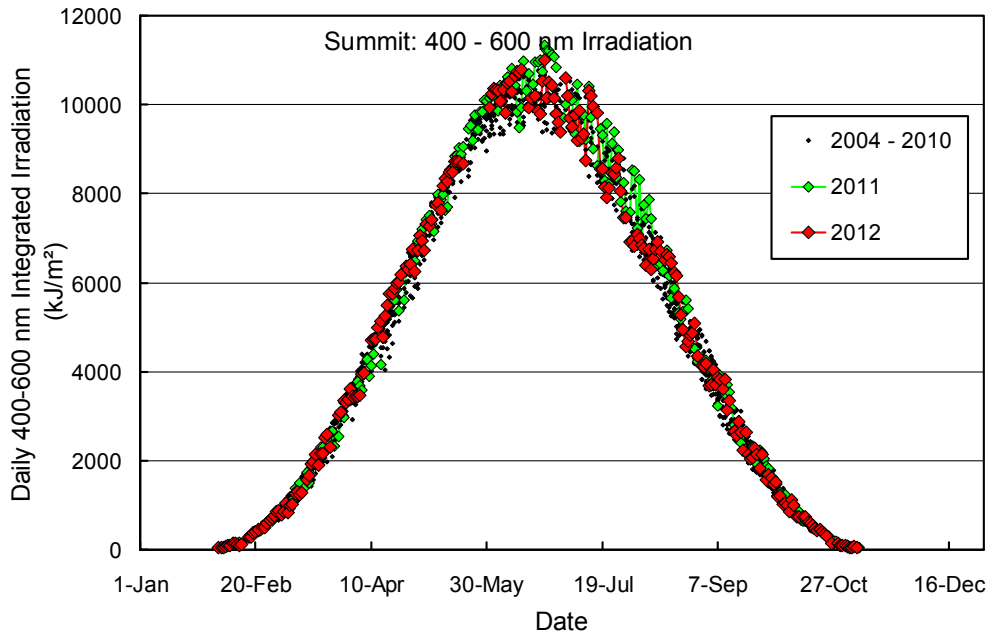
**Figure 7.7.2.** Daily maximum UV Index at Summit. Measurements from 2011 and 2012 are contrasted with measurements taken between 2004 and 2010.



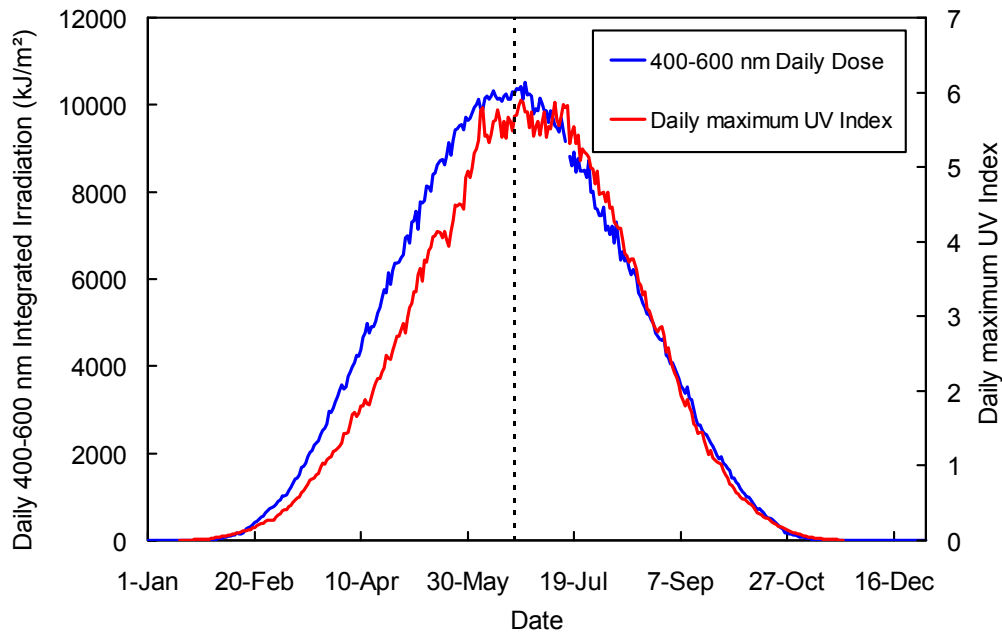
**Figure 7.7.3.** Noontime integrated spectral UV irradiance (298.51 - 303.03 nm) at Summit. Measurements from 2011 and 2012 are contrasted with measurements taken between 2004 and 2010.



**Figure 7.7.4.** Daily irradiation of the 337.5 - 342.5 nm band at Summit. Volume 22 measurements from 2011 and 2012 are contrasted with measurements taken between 2004 and 2010.



**Figure 7.7.5.** Daily irradiation of the 400-600 nm band at Summit. Volume 22 measurements from 2011 and 2012 are contrasted with measurements taken between 2004 and 2010.



**Figure 7.7.6.** Comparison of the daily maximum UV Index (right axis) with daily irradiation in the 400-600 nm spectral range (left axis) at Summit. Both curves are average values for the period 2004-2012. The broken vertical line indicates solstice.