Factors Affecting UV Radiation at Barrow, Alaska

G. Bernhard[1], C.R. Booth[1], J.C. Ehramjian[1], R. Stone[2], and E.G. Dutton[2]

[1]Biospherical Instruments Inc., 5340 Riley Street, San Diego, CA 92110; 619-686-1888 (x175), Fax: 619-686-1887, E-mail: bernhard@biospherical.com
[2]NOAA Earth System Research Laboratory, 325 Broadway, Boulder, CO 80305

The National Science Foundation's Ultraviolet Spectral Irradiance Monitoring Network includes seven mostly high-latitude sites where high-resolution UV-visible spectroradiometers are deployed. A new data version has recently been produced for the network instrument located at Barrow, Alaska (71°N, 157°W). Based on the new data set and complementing calculations with a radiative transfer model, we quantify the effects of total ozone, albedo, aerosols, and clouds on UV and visible irradiance. Total ozone is the dominant parameter modifying spectral irradiance at 305 nm. Large transient increases in spring-time UV were observed in several years during episodes of abnormally low ozone. High surface albedo from snow cover can enhance UV irradiance by up to 57%. Aerosols typically lead to reductions of 5%, but larger decreases were observed during Arctic haze events. Stratospheric aerosols from the Pinatubo eruption in 1991 enhanced spectral irradiance at short wavelengths and large solar zenith angles. UV-A irradiance is considerably higher in spring than in autumn due to larger albedo and lower cloudiness earlier in the year. Year-to-year variations are mostly caused by variations in total ozone and cloudiness. Anticipated long-term changes in surface albedo could have a marked impact on UV levels from May through July. Results have been published in: Bernhard G., C. R. Booth, J. C. Ehramjian, R. Stone, and E. G. Dutton (2007), Ultraviolet and Visible Radiation at Barrow, Alaska: Climatology and Influencing Factors on the Basis of Version 2 NSF Network Data, *J. Geophys. Res.*, doi:10.1029/2006JD007865.

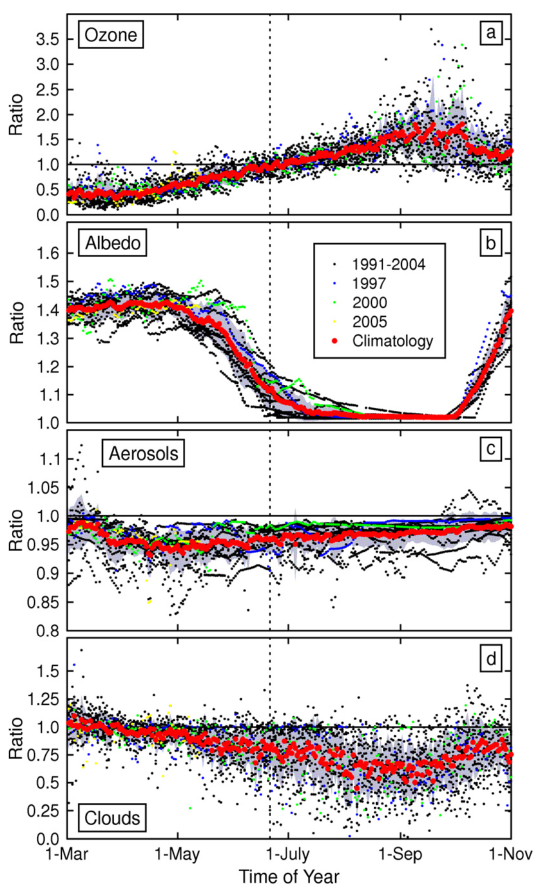

Figure 1, a – d.

The effects of total ozone, albedo, and aerosols on UV irradiance were determined with model calculations. Two sets of model spectra were compared. Model input parameters of the first set reflect the best estimate of the conditions at the time of the measurement. The second set uses identical input parameters with the exception of the parameter whose effect on UV is to be analyzed. This parameter was set to a constant value. The figure shows ratios of the two model runs for spectral irradiance at 305 nm. To study the effect of clouds, measurements were compared with clear-sky model calculations.

(a): Effect of total ozone. *Reference ozone column is 343 DU, i.e. the climatological value at the solstice.* Due to the seasonal ozone cycle, spectral irradiance at 305 nm is half as large in spring than at the solstice (dashed line), and twice as large in autumn.

(b): Effect of surface albedo. *Surface albedo was estimated by comparing measurements and model during clear sky conditions. Reference surface albedo is 0%.* Snow covered ground during winter and spring leads to surface albedo in excess of 0.8 and enhances UV irradiance by up to 50%.

(c): Effect of aerosols. *Aerosol optical depths were determined by sunphotometers. Reference optical depth is zero.* Aerosols typically reduce UV by 5% with maximum reductions of up to 20%.

(d): Effect of clouds. *Reference is clear sky.* Reduction of UV radiation by clouds is small during spring when clouds are optically thin and radiation is trapped by high surface albedo. Cloud reductions are typically 20-40% during summer and fall.