Appendices

A1. References

Note: * References that utilize NSF UV Spectroradiometer Network data

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Note: * References that utilize NSF UV Spectroradiometer Network data

A2. CD-ROM Format

Data from the NSF network is distributed via CD-ROM. Figure A.1 shows the time periods for which data are available. Volume 7 data will also be available by download (2000) from our website, www.biospherical.com.

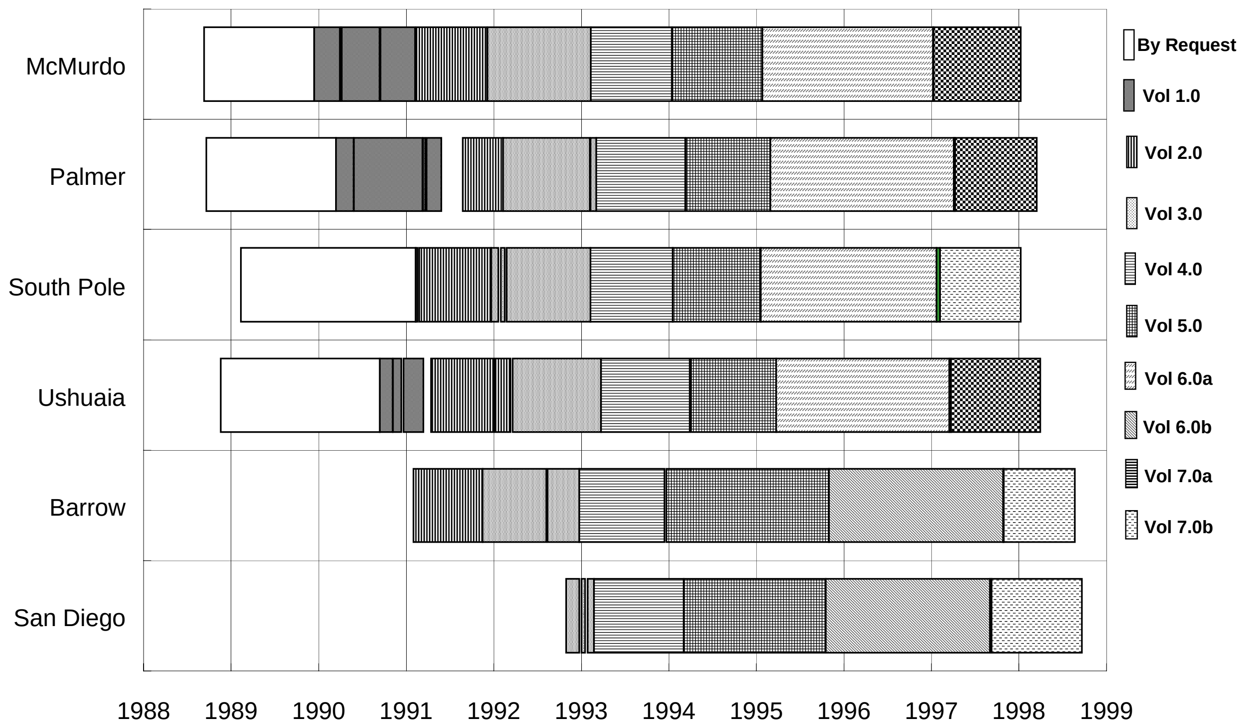

Figure A.1 *Data published on CD-ROM, Volumes 1.0 through 7.0. CD-ROMs of Volumes 1.0 through 3.0 are no longer available, except by research-specific request.*

Data published on the CD-ROM include irradiance spectra and "databases" in ASCII (text) format that contain:

- System parameters (Database 1),
- Spectral irradiance at selected wavelengths (Database 2),
- Spectral integrals and dose rates (Database 3),
- A summary of most important quantities (Database 4), and
- Information from response scans (Database 5).

Data from the network is also accompanied by external ozone and weather information. The CD-ROM contents and the format of data provided have evolved over the years. The following sections give an overview of the data structure of different volumes.

A2.1. Volume 1.0 CD-ROM: 1990 Season

Two basic types of data appear on the Volume 1.0 UV Radiation Monitoring Network CD-ROM:

- Full resolution data in each of the spectral resolutions (scan Items 1, 2, and 3)
- Extracted data in "Database" format with spectral integrals (UV-B) and biological dose rates. These data appear in both ".CSV" format and in Microsoft Excel (PC, Version 3.0) spreadsheet format.

A2.2. Volume 2.0 CD-ROM: 1991 Season

Four basic types of data appear on the Volume 2.0 UV Radiation Monitoring Network CD-ROM:

- Full resolution data in each of the spectral resolutions, including solar zenith and azimuth angles at the start of the scan and TSI voltages during the scan.
- Extracted data in "database" format with spectral integrals (UV-B) and biological dose rates. Presented in both ASCII CSV format and in Microsoft Excel-PC, Ver. 4.0 spreadsheet format.
- NASA TOMS Release 6.0 Ozone Data for Spectroradiometer Sites in ASCII CSV format and Microsoft Excel-PC Ver. 4.0 spreadsheet format. Data date from 1978.
- Weather data from several sources including WBAN, airport observations, and site operators' observations. Some of the data start from 1973.

A2.3. Volume 3.0 CD-ROM: 1992 Season

Four basic types of data appear on the Volume 3.0 UV Radiation Monitoring Network CD-ROM:

- Full resolution data in each of the spectral resolutions, including solar zenith and azimuth angles at the start of the scan and TSI voltages during the scan.
- Extracted data in "database" format with spectral integrals (UV-B) and biological dose rates. Presented in both ASCII CSV format and in Microsoft Excel-PC Ver. 4.0 spreadsheet format.
- NASA TOMS Release 6.0 Ozone Data for Spectroradiometer Sites in ASCII CSV format and Microsoft Excel-PC v 4.0 spreadsheet format. Data date from 1978.
- Weather data from several sources including WBAN, airport observations and site operators' observations. Some of the data start from 1973.

A2.4. Volume 4.0 CD-ROM: 1993 Season

Four basic types of data appear on the Volume 4.0 UV Radiation Monitoring Network CD-ROM:

- Full resolution data in each of the spectral resolutions, including solar zenith and azimuth angles at the start of the scan, and TSI voltage during the scan.
- Extracted data in "Database" format with spectral integrals (UV-B) and biological dose rates. Presented in both ASCII CSV format and in Excel-PC v 4.0 spreadsheet format.
- NASA TOMS Ozone data for Spectroradiometer sites and three additional sites of interest in ASCII CSV format. Data dates from September 1991.
- Weather data obtained from NCAR starting February 1993. Data available for the six spectroradiometer sites and six additional sites of interest.

A2.5. Volume 5.0 CD-ROM: 1994-1995 Season

Four basic types of data in ASCII CSV format appear on the Volume 5.0 UV Radiation Monitoring Network CD-ROM:

- Full resolution data in each of the spectral resolutions, including solar zenith and azimuth angles at the start of the scan and TSI voltage during the scan.
- Extracted data in "database" format with spectral integrals (UV-B) and biological dose rates.
- Ozone data for Spectroradiometer sites and three additional sites of interest. NASA TOMS data available from 9/28/91 through 12/1/94. TOVS data presented by months of interest for 1994 and 1995.
- Weather data obtained from NCAR for time period 12/12/93 - 10/28/95. Data available for the six spectroradiometer sites and six additional sites of interest.

A2.6. Volume 6.0.a and 6.0.b CD-ROM: 1995-1997 Season

Four basic types of data in ASCII CSV format appear on the Volumes 6.0.a-b UV Radiation Monitoring Network CD-ROMs:

- Full resolution data in each of the spectral resolutions as well as composite spectra, including solar zenith and azimuth angles at the start of the scan and TSI voltage during the scan.
- Extracted data in "database" format with spectral integrals (UV-B) and biological dose rates.
- Ozone data for spectroradiometer sites and several additional sites of interest. NASA TOMS data and TOVS data are available from mid-1996 through mid -1997 (actual dates vary by sites).
- Weather data of the spectroradiometer sites for the periods of interest, purchased from National Climatic Data Center.

Dates and Sites covered on Volume 6.0.a:

McMurdo (2/3/95 - 1/12/97)
Palmer (3/12/95 - 4/12/97)
South Pole (1/17/95 - 1/17/97)
Ushuaia (4/11/95 - 3/25/97)

Dates and Sites covered on Volume 6.0.b:

Barrow (10/28/95 - 10/20/97)
San Diego (10/18/95 - 9/2/97)

A2.7. Volume 7.0.a and 7.0.b CD-ROM: 1997-1998 Season

Four basic types of data in ASCII CSV format appear on the Volumes 7.0.a-b UV Radiation Monitoring Network CD-ROMs:

- Full resolution composite spectra, including solar zenith and azimuth angles at the start of the scan and TSI voltage during the scan.
- Extracted data in "database" format with spectral integrals (e.g., UV-B) and biological dose rates (see Appendix A3).
- NASA TOMS Earth Probe Ozone data for spectroradiometer sites.
- Weather data of the spectroradiometer sites for the periods of interest, purchased from National Climatic Data Center.

Dates and Sites covered on Volume 7.0.a:

McMurdo (1/16/97 - 1/13/98)
Palmer (4/19/97 - 3/25/98)
South Pole (2/1/97 - 1/3/98)

Dates and Sites covered on Volume 7.0.b:

Ushuaia (4/2/97 - 4/10/98)
Barrow (10/26/97 - 8/18/98)
San Diego (9/9/97 - 9/20/98)

A2.8. Directory Structure

The number of network sites and the volume of data from each site dictate that the files be organized hierarchically in a nested-tree directory Figure A.2). All data, individual files and databases, are grouped by year and then by site. Databases and composite spectra are stored separately in appropriate directories. Directories containing individual spectra are subdivided by month to avoid keeping a large number of files in a single directory (as computer time required to find an individual file increases significantly for directories with a large number of files). TOMS ozone data, as well as weather data, are located in separate directories and are accompanied by information text files.

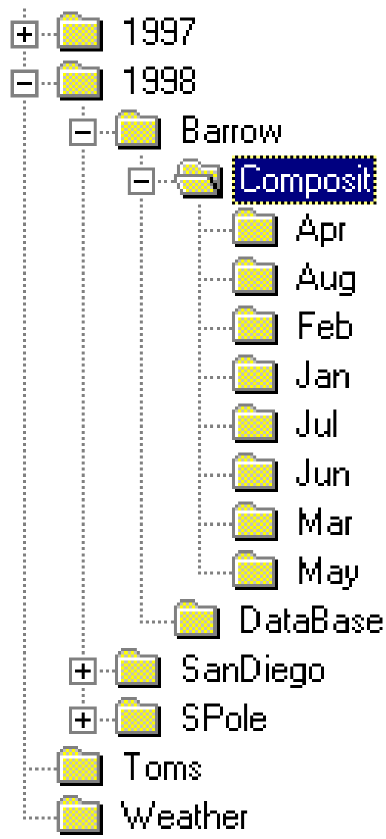

Figure A.2. *Example Directory structure of the CD-ROM Volume 7.0.b*

A3. Database Organization

Appendix A3 gives a detailed overview of the contents and structure of Databases 1-5. In order to maintain compatibility with as many platforms as possible, the database tables on the CD-ROMs are ASCII (text) Comma Separated Value (*.CSV) files.

A3.1. Database 1: Detailed Scan Parameters with AXSS Observations

Database 1 is a "housekeeping" database, which does not included irradiance data. It records various parameters such as system temperature, lamp output, the wavelength offset correction, exact start and stop wavelengths of data scans, and system noise levels and offsets. Table A.1 shows the Volume 7.0 format of Database 1. The structure is very similar to the format of previous volumes, with exceptions explained below.

Table A. 1: Database 1 format Volume 7.0

Col.	Field Name	Units	Comment
1	DataScan		See A3.6. *Glossary of Database Notation*
2	Volume		"7" for Volume 7
3	ErrorCode		All should be 0 (otherwise error condition)
4	RespScan		See A3.6. *Glossary of Database Notation*
5	WlScan		See A3.6. *Glossary of Database Notation*
6	WlCorr		Identifies wavelength calibration source
7	LampCal		Identifies responsivity calibration source
8	AXSSCorr		Identifies AXSS calibration source
9	TimeA		Start time of data scan. See A3.6. *Glossary of Database Notation*
10	Site		Site identifier. See A3.6. *Glossary of Database Notation*
11	WlOffset	nm	Wavelength offset before correction was applied
12	Bandwidth	nm	Bandwidth of 296.728 nm Hg peak
13	HV_A	V	High voltage settings. HV_A > HV_C. See Table A.2
14	HV_C	V	
15	DC_A	nA	Dark PMT current at each high voltage. See Table A.2
16	DC_C	nA	
17	maxC_A	nA	Maximum PMT current at each high voltage. See Table A.2
18	maxC_C	nA	
19	MonoT_A	°C	Averaged monochromator temperature at the beginning of data scan
20	MonoT_C	°C	Averaged monochromator temperature at the end of data scan
21	TSI_A	V	Averaged TSI reading at the beginning of data scan
22	TSI_C	V	Averaged TSI reading at the end of data scan
23	WlPot_A	nm	Averaged wavelength analog potentiometer reading at the beginning of data scan
24	WlPot_C	nm	Averaged wavelength analog potentiometer reading at the end of data scan
25	UpBoxT_A	°C	Averaged upper enclosure temperature at the beginning of data scan
26	UpBoxT_C	°C	Averaged upper enclosure temperature at the end of data scan
27	PSP_A	mW / cm²	Averaged Eppley PSP reading at the beginning of data scan
28	PSP_C	mW / cm²	Averaged Eppley PSP reading at the end of data scan
29	TUVR_A	mW / cm²	Averaged Eppley TUVR reading at the beginning of data scan
30	TUVR_C	mW / cm²	Averaged Eppley TUVR reading at the end of data scan
31	Ground_A	V	AXSS ground reference at the beginning of data scan
32	Ground_C	V	AXSS ground reference at the end of data scan
33	LoBoxT_A	°C	Averaged lower enclosure temperature at the beginning of data scan
34	LoBoxT_C	°C	Averaged lower enclosure temperature at the end of data scan
35	TSIcv		TSI coefficient of variation. (cloud change indicator)
36	DcstdevA		Dark current standard deviation at each high voltage (noise indicator). See Table A.2
37	DcstdevC		
38	AcqVersion		Version of data acquisition software
39	AnalVersion		Version of data analysis software

Table A. 1 refers to data scan items as **A**, **B,** and **C** rather than 1, 2, and 3. This notation was first introduced in Volume 6 and differs from the format of previously published CD-ROMs. It allows the accommodation of both old (pre-Volume 6) and new (Volume 6 and 7) data scan formats. New-type data scans are performed at two different high voltages, and, in this case, all variables can be related to either HV setting: **A** (high setting) or **C** (low setting). Since the format before Volume 6 utilized three different high voltages, existence of **A**, **B,** and **C** indexed magnitudes is pre-defined. More specifically, variables with index **A** are always calculated from the first item while **C** variables in the old data context mean Item 3, but for new-type data, this is a combination of Items 2, 3, and 4.

Table A.2: Data scan item identification.

	Pre-Volume 6 Format	Current Format
A	Item 1	Item 1
B	Item 2	Not available
C	Item 3	Items 2, 3 and 4

Notation **A** and **C** is also used to emphasize that certain variables are calculated at the beginning or end of data scan. Comparing these values allows an assessment of instrument environmental stability.

The fields “Volume”, “AcqVersion”, and “AnalVersion”, which were not available in the Volume 6 format, were added to Volume 7.0. In addition, some field names were changed to increase compatibility on different computer platforms.

A3.2. Database 2: Extracted Wavelength Data

Database 2 contains a variety of selected spectral irradiances at specific wavelengths. These wavelengths were chosen to either mark “round numbers” (i.e. 300 nm) or meet the requests of various investigators who have expressed a particular interest in certain wavelengths. Data are fully calibrated and processed. Irradiances are calculated based on linear interpolation from the two nearest data points. The TSI data are the averages of all readings during each data scan segment. The Eppley data are the averages of the readings taken over the second item.

Table A.3: Database Two format.

Col.	Field Name	Units	Comment
1	DataScan		See A3.6. *Glossary of Database Notation*
2	Volume		“7” for Volume 7
3	TimeDateB		Start time of data scan Item 2. See A3.6. *Glossary of Database Notation*
4	Site		Site identifier. See A3.6. *Glossary of Database Notation*
5	Abnormal		Identifies data with reduced accuracy
6	ZenithB	degrees	Sun position at the beginning of Item 2 data scan
7	AzimuthB	degrees	Sun position at the beginning of Item 2 data scan
8	E285_A	μW / (nm cm²)	Solar spectral irradiance at 285 nm from Item 1 data scan
9	E285_C	μW / (nm cm²)	Solar spectral irradiance at 285 nm from Item 3 (or Item 4) data scan
10	E290	μW / (nm cm²)	Solar spectral irradiance at 290 nm
11	E295	μW / (nm cm²)	Solar spectral irradiance at 295 nm
12	E297	μW / (nm cm²)	Solar spectral irradiance at 297 nm
13	E298	μW / (nm cm²)	Solar spectral irradiance at 298 nm
14	E299	μW / (nm cm²)	Solar spectral irradiance at 299 nm
15	E300	μW / (nm cm²)	Solar spectral irradiance at 300 nm
16	E302_5	μW / (nm cm²)	Solar spectral irradiance at 302.5 nm
17	E305	μW / (nm cm²)	Solar spectral irradiance at 305 nm
18	E306_5	μW / (nm cm²)	Solar spectral irradiance at 306.5 nm
19	E307_5	μW / (nm cm²)	Solar spectral irradiance at 307.5 nm
20	E308_26	μW / (nm cm²)	Solar spectral irradiance at 308.26 nm
21	E310_1	μW / (nm cm²)	Solar spectral irradiance at 310.1 nm
22	E313	μW / (nm cm²)	Solar spectral irradiance at 313 nm
23	E313_5	μW / (nm cm²)	Solar spectral irradiance at 313.5 nm
24	E316_8	μW / (nm cm²)	Solar spectral irradiance at 316.8 nm
25	E320	μW / (nm cm²)	Solar spectral irradiance at 320 nm
26	E325	μW / (nm cm²)	Solar spectral irradiance at 325 nm
27	E332_01	μW / (nm cm²)	Solar spectral irradiance at 3332.01 nm
28	E337_28	μW / (nm cm²)	Solar spectral irradiance at 337.28 nm
29	E340	μW / (nm cm²)	Solar spectral irradiance at 340 nm

30	E349	µW / (nm cm²)	Solar spectral irradiance at 349 nm
31	E350	µW / (nm cm²)	Solar spectral irradiance at 350 nm
32	E380	µW / (nm cm²)	Solar spectral irradiance at 380 nm
33	E400	µW / (nm cm²)	Solar spectral irradiance at 400 nm
34	E500	µW / (nm cm²)	Solar spectral irradiance at 500 nm
35	E600	µW / (nm cm²)	Solar spectral irradiance at 600 nm
36	TSI_A	V	Averaged TSI reading from Item 1 data scan
37	TSI_B	V	Averaged TSI reading from Item 2 data scan
38	TSI_C	V	Averaged TSI reading from Item 3 data scan
39	PSP_B	mW / cm²	Averaged Eppley PSP reading from Item 2 data scan
40	TUVR_B	mW / cm²	Averaged Eppley TUVR reading from Item 2 data scan

Spectral irradiances in Table A.3 are extracted from various items depending on what data scan format was employed at the time, i.e. for the pre-Volume 6 format of data scans:

- Parameters 10 through 23 are calculated from Item 1
- Parameters 24 trough 31 – from Item 2
- Parameters E300, 34 and 35 – from Item 3

while for the new type data scans

- Parameters 10 through 29 are determined from Item 1
- Parameters 30 trough 33 – from Item 2
- Parameters 34 and 35 – from Item 3

The fields “Volume”, “Abnormal”, “E313”, and “E380”, which were not available in the Volume 6.0 format, were added to Volume 7.0. Some field names were changed (e.g., decimal points were replaced by underscores to increase compatibility on different computer platforms.

A3.3. Database 3: Spectral Integrals and Dose Weightings

Database 3 contains a variety of popular spectral integrals and dose-weighted integrals, for example erythemally weighted irradiance (column 27 of database 3). Table A. 4 shows the header of Database 3, while Table A.5 and Table A.6 include the database structure for spectral integrals and dose weighted integrals, respectively.

Table A. 4: Database 3 format. Header (Columns 1-5).

Col.	Field Name	Units	Comment
1	DataScan		See A3.6. *Glossary of Database Notation*
2	Volume		“7” for Volume 7
3	TimeB		Start time of data scan Item 2. See A3.6. *Glossary of Database Notation*
4	Abnormal		Identifies data with reduced accuracy
5	Site		Site identifier. See A3.6. *Glossary of Database Notation*
6	ZenithB	Degrees	Sun position at the beginning of Item 2 data scan
7	AzimuthB	Degrees	Sun position at the beginning of Item 2 data scan

Spectral integrals such as UV-B (Columns 8 and 9) are widely used in summarizing UV irradiances. Columns 10 and 11 describe UV-A radiation over the 320-400 nm region. Spectral 400-600 nm integral in column 12 characterizes the visible part of spectrum. In addition, the World Meteorological Organization (WMO) has defined certain spectral integrals in the UV and other spectral regions. All of the above mentioned spectral integrals can be specified as $\int_{\lambda_1}^{\lambda_2} E(\lambda)d\lambda$, where λ_1 and λ_2 are defined Table A.5. Interpolated irradiance values are involved in calculations around integral limits λ_1 and λ_2, while measured irradiances are sufficient inside the integration interval. In some cases, the mean values of the

TSI sensor (see Section 2.4.1) and Eppley sensors (see Section 2.4.2) during the particular spectral integration are also available.

Table A.5: Database 3 format. Spectral integrals and supporting measurements (Columns 8-24 and 31-44).

			Spectral Integral		TSI		Eppley PSP		Eppley TUVR	
λ_1	λ_2	**Comment**	**Col.**	**Units**	**Col.**	**Units**	**Col.**	**Units**	**Col.**	**Units**
290.0 nm	315.0 nm	UV-B_1	8	µW / cm²	31	V				
290.0 nm	320.0 nm	UV-B_2	9	µW / cm²	32	V	41	mW /cm²	43	MW /cm²
320.0 nm	360.0 nm	UV-A_1	10	µW / cm²	33	V				
360.0 nm	400.0 nm	UV-A_2	11	µW / cm²	34	V				
400.0 nm	600.0 nm	Visible	12	µW / cm²	35	V	42	mW /cm²	44	MW /cm²
289.855 nm	294.118 nm		13	µW / cm²						
294.118 nm	298.507 nm		14	µW / cm²						
298.507 nm	303.03 nm		15	µW / cm²	36	V				
303.03 nm	307.692 nm		16	µW / cm²	37	V				
307.692 nm	312.5 nm		17	µW / cm²	38	V				
312.5 nm	317.5 nm		18	µW / cm²						
317.5 nm	322.5 nm		19	µW / cm²						
322.5 nm	327.5 nm		20	µW / cm²	39	V				
327.5 nm	332.5 nm		21	µW / cm²						
332.5 nm	337.5 nm		22	µW / cm²						
337.5 nm	342.5 nm		23	µW / cm²	40	V				
342.5 nm	347.5 nm		24	µW / cm²						

Note: This means, for example, that the UV-B (290-320 nm) irradiance is in column 9 and the TSI reading averaged over this interval is in column 32. The PSP value for the same time can be found in column 41, and TUVR in column 43.

With the pre-Volume 6 data scan format, Parameters 13 through 17 from the table above were calculated from Item 1 of the data scan. Parameters 8, 9, and 18 through 24 were calculated from Item 2, and the rest (parameters 10, 11, 12) from Item 3. With the data scan format of Volume 6 and 7, Item 3 is used only to evaluate the visible integral 400-600 nm, and Item 2 is employed in determination of the UV-A and 342.5-347.5 nm integrals. UV-A_1 (parameter 10) is calculated from Items 1 (320 – 340 nm) and 2 (340 – 360 nm). For all other calculations, high resolution Item 1 is sufficient.

The six columns 25-30 are weighted spectral integrals $\int_{290}^{400} E(\lambda)W(\lambda)d\lambda$, frequently called “doses”, see Table A.6. Note that weighted and non-weighted integral units are identical, since dose weighting functions, $W(\lambda)$, are dimensionless (See Section 3.3.3 *Biological Dose Weightings* and A.1 *References* for details and the original presentations).

Table A.6: Database 3 format. Dose weightings (Columns 25-30 and 45).

Col.	Field Name	Units
25	Dose1	µW / cm²
26	Dose2	µW / cm²
27	Dose3_CIE_Erythema	µW / cm²
28	Setlow	µW / cm²
29	Hunter	µW / cm²
30	Caldwell	µW / cm²
45	W_TSI	µW / cm²

Note: W_TSI is an abbreviation of Weighted TSI (Dose 4).

All spectral integrals and dose weightings are approximated based on the extended trapezoidal rule, utilizing data from various items depending on what type of data scans were available at the time. More specifically, with pre-Volume 6 data scans, data between 290 and 310 nm is extracted from Item 1, (310, 345) nm data is from Item 2 and (345, 400) nm data is from Item 3. Wavelength resolution varies from 0.2 nm (corresponding to Item 1 data) to 0.5 nm (Item 2) and 1 nm (Item 3). Since the data collection routine was switched to the new type schedule, low-resolution Item 3 is no longer involved in dose calculations, data between 290 and 340 nm is available from Item 1, and data between 340 and 400 nm from Item 2.

A3.4. Database 4: General Interest (short form)

Database 4 is a compact database combining several functions from the other databases. Its smaller size may facilitate loading onto computer systems with restricted memory. The format of Database 4 was completely revised for Volume 7.0. The database now includes the most common UV integrals and doses, including the UV Index according to *WMO* (1994). Table A.7 shows the format used in Volume 1-6, Table A.8 shows the new format introduced in Volume 7.

Table A.7: Database 4 format Volume 1-6.

Col.	Field Name	Units	Comment
1	DataScan		See A3.6. *Glossary of Database Notation*
2	TimeDateB		Start time of data scan Item 2. See A3.6. *Glossary of Database Notation*
3	Site		Site identifier. See A3.6. *Glossary of Database Notation*
4	ZenithA	Degrees (DDD.DD)	Sun position at the beginning of data scan
5	ZenithC	Degrees (DDD.DD)	Sun position at the end of data scan
6	AzimuthA	Degrees (DDD.DD)	Sun position at the beginning data scan
7	AzimuthC	Degrees (DDD.DD)	Sun position at the end of data scan
8	UVB_315	$\mu W / cm^2$	280-315 nm spectral integral
9	UVB_320	$\mu W / cm^2$	280-320 nm spectral integral
10	UVA	$\mu W / cm^2$	320-400 nm spectral integral
11	E@300	$\mu W / (nm\ cm^2)$	Solar irradiance at 300 nm
12	E@313.5	$\mu W / (nm\ cm^2)$	Solar irradiance at 313.5nm
13	TSI	V	Averaged TSI reading
14	PSP	mW / cm^2	Averaged Eppley PSP reading
15	TUVR	mW / cm^2	Averaged Eppley TUVR reading
16	TSIcv		TSI coefficient of variation (cloud change indicator)

Note: Comparison of solar zenith angles at the beginning and at the end of data scans shows how much the sun changed position during the scan. 300 nm and 313.5 nm are ozone sensitive wavelength. TSI and Eppley averages are scan averages.

Table A.8: Database 4 format Volume 7.

Col.	Field Name	Units	Comment
1	DataScan		See A3.6. *Glossary of Database Notation*
2	Volume		"7" for Volume 7
3	TimeB		Start time of data scan Item 2. See A3.6. *Glossary of Database Notation*
4	Site		Site identifier. See A3.6. *Glossary of Database Notation*
5	ZenithB	Degrees (DDD.DD)	
6	E290to315	$\mu W / cm^2$	290-315 nm spectral integral
7	E290to320	$\mu W / cm^2$	290-320 nm spectral integral
8	E315to400	$\mu W / cm^2$	315-400 nm spectral integral
9	E320to400	$\mu W / cm^2$	320-400 nm spectral integral
10	Dose3_CIE_Erythema	$\mu W / cm^2$	Erythemally weighted irradiance (CIE action spectrum)
11	Setlow	$\mu W / cm^2$	DNA (Setlow) dose, see Section 3.3.3.
12	Hunter	$\mu W / cm^2$	Hunter dose, see Section 3.3.3.
13	Caldwell	$\mu W / cm^2$	Caldwell dose, see Section 3.3.3.
14	Uvindex		UV index, (equals column 10 multiplied with 0.4)

A3.5. Database 5: Quality Control

Database 5, unlike the previous four databases, contains information that can be used to assess the calibration stability of the instrument at the time of a particular data scan. The format of this database has evolved over the years. Table A.9 shows the Database 5 format of Volume 7. See previous reports for old formats.

Entries in Database 5 correspond to the time/date of calibration scans of the internal irradiance lamp, as opposed to the time/date of the data scans (as in the other four databases). The current format of Database 5 contains information about system environmental stability as well as 45-Watt lamp irradiances for six possible high voltages.

Table A.9: Database 5 formats Volume 7.

Col.	Field Name	Units	Comment
1	RespScan		See A3.6. *Glossary of Database Notation*
2	Volume		“7” for Volume 7
3	ErrorCode		Should be 0 (otherwise error condition)
4	WlScan		See A3.6. *Glossary of Database Notation*
5	WlCorr		Identifies wavelength calibration source
6	AXSSCorr		Identifies AXSS calibration source
7	Time		Start time of response scan. See A3.6. *Glossary of Database Notation*
8	Site		Site identifier. See A3.6. *Glossary of Database Notation*
9	WlOffset	nm	Wavelength offset before correction was applied
10, 21, 32, 43, 54, 65	HV_I	V	High voltage setting during Item i, where i = 1 –6.
11, 22, 33, 44, 55, 66	MaxPMT_I	nA	Maximum PMT current from 45 W lamp (should be less than 1000 nA) during Item i
12, 23, 34, 45, 56, 67	PMT300_I	nA	PMT current from 45 W lamp at 300 nm during Item i
13, 24, 35, 46, 57, 68	PMT340_i	nA	PMT current from 45 W lamp at 340 nm during Item i
14, 25, 36, 47, 58, 69	PMT370_I	nA	PMT current from 45 W lamp at 370 nm during Item i
15, 26, 37, 48, 59, 70	PMT400_i	nA	PMT current from 45 W lamp at 400 nm during Item i
16, 27, 38, 49, 60, 71	PMT600_i	nA	PMT current from 45 W lamp at 600 nm during Item i
17, 28, 39, 50, 61, 72	MonoT_I	°C	Averaged monochromator temperature during Item i
18, 29, 40, 51, 62, 73	TSI_I	V	Averaged TSI reading during Item i
19, 30, 41, 52, 63, 74	WlPot_I	V	Averaged wavelength analog potentiometer reading during Item i
20, 31, 42, 53, 64, 75	LoBoxT_I	°C	Averaged lower enclosure temperature during Item i
76	UpBoxT	°C	Averaged upper enclosure temperature
77	Ground	V	AXSS ground reference
78	WlPeakHeight	nA	Height of 296.728 nm Hg peak (assessed from wavelength scan)
79	WlPeakWidth	nA	Width of 296.728 nm Hg peak (assessed from wavelength scan)
80, 81, 82, 83, 84, 85	DMM_I	V	45W lamp current monitor during Item i =1-6
86, 87, 88, 89, 90, 91	DMM2_I	V	Reference DMM reading during Item i=1-6 (site visit only)

Note: Items with smaller consecutive numbers are represented first, e.g., PMT current from the 45-Watt lamp during Item 1 is represented in Columns 12-16, PMT current during Item 2 is in Columns 23-27, etc.

A3.6. Glossary of Database Notation

Scan File Name:

SFYYHHMM.DDD,

Where

- ***S*** is a site code letter from Table A.10
- ***F*** specifies the type of the scan (D stands for the data scan, R - for the response, M - for the multiple peak wavelength scan, W - for the single peak wavelength scan)

The remaining nine digits specify the scheduled time/date for the beginning of the scan

- ***YY*** - year (two digits)
- ***HH*** - hour (two digits)
- ***MM*** - minute (two digits)
- ***DDD*** - Julian Day (three digits)

Table A.10: Site identifiers

Site Code Letter	Site ID Number	Site
A	1	McMurdo, Antarctica
B	2	Palmer, Antarctica
C	3	South Pole, Antarctica
D	4	Ushuaia, Argentina
E	5	San Diego, California
F	6	Barrow, Alaska

Time and Date:

The time/date recorded in the data files is the GMT time of the start of the scan. The time and date recorded in the first line of the data file are encoded into a single number where the integer part is the day number relative to January 1, 1900 (day 1 corresponds to 1/1/1900). The fractional part is the time of day. The nominal scheduled time of the scan (in the filename) may be in error by as much as 1 hour.

Solar Angles:

Solar angles are calculated using a modification of the "Solar Ephemeris Program," adapted from solar Ephemeris algorithms and published in Wilson (1980).

-999 / Missing or Overloaded data:

"-999" were used historically to mark data that are missing, obtained during an instrument overload, or defective for some other reason. In Volume 7, such fields are just empty.

Table A.11: Units of measure.

Magnitude	Units
Wavelength	nm
Voltage	V
PMT Current	nA
Spectral irradiance	$\mu W / (nm\ cm^2)$
Spectral integral *	$\mu W / cm^2$
Auxiliary sensors non-calibrated (TSI) **	V
Auxiliary sensors calibrated (Eppley sensors) ***	mW / cm^2
Ozone	DU (Dobson Units) ****

Note: ***** Spectral integrals are in the same units as spectral irradiances except that the "nm" term has been integrated out.
****** TSI (UV-A region sensor) - see Section 2.4.1.
******* Eppley Sensors - see Section 2.4.2.
**** A Dobson unit (DU) is defined as a milli-atmosphere-centimeter of ozone at STP. A value of 292DU would correspond to all the ozone in the atmosphere compressed into a layer 2.92 mm.

A4. Full Resolution Data Format

There are three types of spectral irradiance files: high-resolution (wavelength increment = 0.2 nm), medium-resolution (wavelength increment = 0.5 nm), and low-resolution (wavelength increment = 1, 2.5 or 5 nm, depending on the time and site) spectral irradiance. These correspond to the three scan items. Each data file is processed with all calibration values applied. Therefore, only calibrated data appear on the CD-ROM, not original or “raw” data. In addition, no background data are included with these files. High-, medium- and low-resolution data files are acquired chronologically at each site. The data files are encoded reflecting the site and chronology of this acquisition scheme:

STYYHHMM.DDD,

Where

- ***S*** is a site code letter from the Table A.10
- ***T*** represents the type of data scan: **L**ow resolution, **M**edium resolution, **H**igh resolution, or **C**omposite scan (resolution varies through the scan from 0.2 nm in UV-B to 0.5 nm in UV-A and 1 nm in visible part of the spectrum)

The remaining nine digits represent the sample chronology from the scheduled start of the scan sequence (see also Section A3.6.).

In all of the full resolution data file formats described below, the data are recorded as comma separated values (CSV). All formats provide two lines of header, followed by two or three columns, which include the spectrum. The first column is wavelength in nm, the second column is irradiance in µW / (nm cm²). From Format 1C onwards, there is also a third column with TSI measurements (see below). Note that, although the original data were recorded on even wavelength increments (280.0, 200.2, etc.), the data here occur over somewhat irregular increments. This is due to corrections for monochromator drive offsets and non-linearities in the drive system, as described in Section 3.3.1. Negative irradiances are due to system noise. Entries showing "-999" should not be included in calculations because they are used to indicate missing data or data that occurred during overload conditions.

A4.1. Format 1A

This file structure occurs at all sites of the Volume 1.0 CD-ROM except Barrow. The time and date are expressed as ASCII strings as shown in the following example. The second line contains a single entry describing the number of points following. The following is an example of the first few lines of one of the files.

```
10/25/1990, 17:01:21
176
279.91 , 0.162E-03
280.10 , -.190E-03
280.30 , -.192E-03
280.50 , -.343E-03
280.70 , 0.198E-02
```
etc.

A4.2. Format 1B

This file structure occurs only in the Barrow data of the Volume 1.0 CD-ROM. The time and date are expressed in the native Microsoft format, in which the fractional part of the date is the fractional part of the day and the integer part is the number of days since 1/1/1990. The second line contains a single entry describing the number of points following. The remaining lines contain wavelength and irradiance [μW/(nm cm²)] pairs. The following is an example of the first few lines of one of the files.

```
33416.8801
176
280.04 , -.165E-03
280.24 , -.290E-03
280.44 , 0.847E-04
280.64 , -.422E-03
280.84 , -.406E-04
etc.
```

A4.3. Format 1C (Volumes 2 and 3 CD-ROM)

Format 1C (on Volumes 2 and 3 CD-ROMs) combines the Excel-style time/date long precision real number format (as in format 1B) with the more common text strings for date and time in the first line. In line two, in addition to listing the number of points in the remaining lines of data, we have added the solar zenith and azimuth angles (in degrees) recorded at the start of the scan. Data are recorded with wavelengths in [nm], irradiance in [μW/(nm cm²)], and the TSI sensor output in [V].

```
04/01/91,00:01:06, 33329.0007638889
 176 , 68.53796 , 204.1531
280.64 , -.456E-03,0.150E+01
280.84 , -.357E-03,
281.04 , -.271E-03,
281.24 , -.498E-03,
281.44 , -.264E-03,
281.64 , -.443E-03,0.150E+01
etc.
```

A4.4. Format 1D (Volumes 4, 5, and 6 CD-ROMS)

Format 1D expresses time/date as an ASCII string. The first line contains not only the start time and end time of the segment, but also the duration. The second row is unchanged; it describes the number of lines following, and the solar zenith and azimuth angles (in degrees) at the start of the scan. The zenith angle will be 0 if the sun was directly overhead, and the azimuth angle will be 0 if the sun was inclined due north (or at the prime meridian at the South Pole).

Data recorded include wavelength [nm], irradiance [µW/(nm cm²)] and the TSI sensor output [Volts]. The TSI reading normally appears with every fifth wavelength-irradiance pair, as the third entry on the line. This reading can be helpful in determining cloud cover changes during the spectral scan. The part of the spectrum that the TSI is sampling is constant, and if a significant change in this reading occurs during the scan, the user should expect a distortion of the spectra.

1/1/95 0:01, 1/1/95 0:04, 0:02:42
176, 66.95, 180.48
279.91, -0.00002, 3.50513
280.11, -0.00022,
280.31, -0.00048,
280.51, 0.00043,
280.71, -0.00047,
280.91, -0.00022, 3.50024
etc.

Format 1D displays irradiances and TSI values with five digits after the point, while format C uses numbers with floating point precision. This change reduces the size of each individual high-/medium-resolution file by approximately 800 bytes, and each low-resolution file by more than 1000 bytes. The size of a typical high/medium resolution file does not exceed 4 KB, and low-resolution file is smaller than 7 KB.

A4.5. Format 2A (Part of Volume 6, and Volume 7 CD-ROMS)

A part of the CD-ROM Volume 6 spectra and all spectra of Volume 7 are published in the “composite” Format 2A. Composite irradiance spectra include the high-, medium-, and low-resolution parts of a data scan, in a single file. Unlike Format 1D, Format 2A does not have equal steps in the wavelength domain. Composite scans consist of three sections – high-resolution, medium-resolution and low-resolution – affixed together at 344 nm and 404 nm, respectively. As illustrated below, there are irregularities in TSI reading frequencies around these points, normally every tenth wavelength-irradiance pair. The size of a typical composite scan does not exceed 12 KB. The header lines of Format 2A are the same as in Format 1D.

…………………..
342.33, 48.8242, 5.6923
342.53, 49.05429,
342.73, 49.48007,
342.93, 49.87489,
343.14, 50.15921,
343.34, 49.77986,
343.54, 48.30101,
343.74, 45.59745,
343.94, 42.40682,
344.14, 39.48264,
344.34, 37.98429, 5.68741
344.84, 41.22701,
345.34, 46.85482, 5.69718
345.84, 46.79203,
346.34, 45.38802,
346.85, 47.7859,
347.35, 46.38398,
347.85, 44.48513,
348.35, 46.15034,
348.85, 46.09332,
349.35, 44.22007,
349.86, 46.90749,
350.36, 52.92419, 5.70206
etc.

A5. Code Fragments for Dose Weightings and Integrations

To show how the dose weighting and spectral integrals were calculated, the following code fragments were reproduced. The new software was written in Visual Basic 5.0 for 32-bit Windows development.

All functions designed to calculate different spectral integrals use three major arrays: *Irradiance(),* calculated irradiances (or weighted irradiances) at certain wavelengths; *Wavelength()*, where corrected wavelengths from all items are stored; and *Points()*, which references the location of the data from a particular item. To be more specific, Points*()* is a two-dimensional array, where the first index is 1 for item start or 2 for item stop, and the second index is item. For example,

Points(1,1) - beginning of Item 1 (= *1*),
Points(2,1) - end of Item 1,
…
Points(1,item) - beginning of item *item (= Points(2,item-1) + 1*),
Points(2,item) - end of item *item*,
…
Points(1,last_item) - beginning of item *last_item (= Points(2,last_item-1) + 1*),
Points(2,last_item) - end of item *last_item* (and total number of points in the scan).

Also *(Points(2,item) - Points(1,item) + 1)* is the number of points in a particular item. Generally speaking, ***CalculateIntegral*** is the main function, while other functions derive weighted irradiance from *Irradiance()* and the given weight function, and reference to ***CalculateIntegral***.

A5.1. Spectral (Non-weighted) Integrals

The function ***CalculateIntegral*** uses the three arrays mentioned above as well as three other input parameters - *wStart, wStop and Item* - as a definition of integration limits and source of data (Item 1, 2 or 3). If, for some reason, data from a requested item are not available, this function returns -999 (indicating missing data).

```
Function CalculateIntegral (wStart, wStop, Item, Points() As Integer, Wavelength() As Single, Irradiance() As Single) As Single

        Dim i As Integer, iStart As Integer, iStop As Integer
        Dim Wav As Single, Irr As Single, Integr As Single

        If UBound(Points, 2) < Item Then CalculateIntegral = -999: Exit Function
        iStart = Points(1, Item): iStop = Points(2, Item)

        While (Wavelength(iStart) <= wStart) And (iStart < iStop): iStart = iStart + 1 :Wend
        If (iStart = Points(1, Item)) Or (iStart = Points(2, Item)) Then CalculateIntegral = -999: Exit Function

        While (Wavelength(iStop) >= wStop) And (iStop > iStart): iStop = iStop - 1: Wend
        If (iStop = Points(2, Item)) Or (iStart = iStop) Then CalculateIntegral = -999: Exit Function

        i = iStop
        Irr = InterpolateIrradiance(i, wStop, Item, Points(), Wavelength(), Irradiance())
        If Irr < -998 Then CalculateIntegral = -999: Exit Function
        Integr = (Irradiance(iStop) + Irr) / 2 * (wStop - Wavelength(iStop))

        i = iStart
        Irr = InterpolateIrradiance(i, wStart, Item, Points(), Wavelength(), Irradiance())
        If Irr < -998 Then CalculateIntegral = -999: Exit Function

        Wav = wStart
        For i = iStart To iStop
                If Irradiance(i) < -998 Then CalculateIntegral = -999: Exit Function
                Integr = Integr + (Irradiance(i) + Irr) / 2 * (Wavelength(i) - Wav)
                Wav = Wavelength(i): Irr = Irradiance(i)
```

```
        Next i
        CalculateIntegral = Integr
End Function
```

A5.2. Dose Weightings

Several alterations to the code were performed to accommodate changes in the data and response scans. In previous software releases, the highest resolution scan (Item 1) was used for calculations below 310 nm, the medium resolution scan (Item 2) – between 310 and 340 nm, and the lowest resolution scan (Item 3) – above 340 nm. No data beyond 400 nm was utilized. With the new version, these limits have changed: interval (285, 340) nm is covered by Item 1 and interval (340, 400) nm is covered by Item 2. If data are not available (or only partially available), doses are not determined and the corresponding functions return "-999." Keeping in mind that there are 1-minute pauses between the items and that items with smaller subsequent numbers are performed at higher resolution, the new calculation appears to be more precise.

In order to generalize the determination of wavelength segments and simplify accommodation of any future changes, two new functions were added to the code. One of them – ***DoseItem*** – defines what scan item can be used for dose calculation and the other one **–** ***DoseBreak*** **–** determines what wavelength segment might be utilized from this particular item. If a certain wavelength segment is available from various items, higher resolution data are preferred. Assuming that a few beginning points of each item might be compromised by monochromator backlash, and because items overlap by at least 10 nm, it is possible to improve data quality by engaging only "middle" points. Variable *OverlapWavelength* determines the size of the segment that will be sacrificed.

The two-dimensional structure *Header(item, scan)* contains information about scan parameters, such as start wavelength, stop wavelength, etc., and variable *scan = 3* for data scan. Array *Items (scan)* defines the numbers of items in the scan, e.g., *Items(3)* is the number of items in a particular data scan.

```
Function DoseItem (Wav As Single, Points() As Integer, Wavelength() As Single) As Integer
        Dim i As Integer, item As Integer

        item = 0
        For i = 1 To UBound(Points, 2)
                If (Wavelength(Points(1, i)) <= Wav) And (Wav < Wavelength(Points(2, i)) - OverlapWavelength) Then
                        If item = 0 Then
                                item = i
                        ElseIf Header(i, 3).Conditions.StepWl < Header(item, 3).Conditions.StepWl Then
                                item = i
                        End If
                End If
        Next i
        DoseItem = item
        End Function
```

```
Function DoseBreak (Wav As Single, item As Integer, Points() As Integer, Wavelength() As Single) As Single
        Dim i As Integer

        If Wav < Wavelength(Points(2, item)) Then
                DoseBreak = Wav
        Else
                i = Points(2, item) - Int(OverlapWavelength / Header(item, 3).Conditions.StepWl)
                While (Wavelength(i) < Wavelength(Points(2, item)) - OverlapWavelength)
                        i = i + 1
                        If i = Points(2, item) Then
                                DoseBreak = Wavelength(Points(2, item)) – OverlapWavelength: Exit Function
                        End If
                Wend
                DoseBreak = Wavelength(i)
        End If
End Function
```

A5.2.1. Erythema Dose1

Unfortunately, in previous software versions ***Dose1*** was calculated incorrectly. Thanks to Sari Kalliskota, this problem was noticed and fixed in the latest software revision. Precisely, weighted function

$$W(\lambda) = \frac{0.4485}{1 + \frac{\exp\{\lambda - 311.4\}}{3.13}} + \frac{4 \cdot 0.9949 \cdot \exp\{\frac{\lambda - 296.5}{2.692}\}}{1 + \exp\{\frac{\lambda - 296.5}{2.692}\}^2}$$ was coded instead of $$W(\lambda) = \frac{0.4485}{1 + \frac{\exp\{\lambda - 311.4\}}{3.13}} + \frac{4 \cdot 0.9949 \cdot \exp\{\frac{\lambda - 296.5}{2.692}\}}{\left\{1 + \exp\{\frac{\lambda - 296.5}{2.692}\}\right\}^2}.$$

```
Function Dose1 (Points() As Integer, Wavelength() As Single, Irradiance() As Single) As Single

    Dim i As Integer, item As Integer
    Dim Wav As Single, Wav1 As Single, Wav2 As Single
    Dim integrI As Single, integr As Single
    Dim WeightedIrr() As Single: ReDim WeightedIrr(Points(2, Items(3)))

    Wav2 = 286: integr = 0
    While Wav2 < 400
        Wav1 = Wav2: item = DoseItem(Wav1, Points(), Wavelength()): If item = 0 Then Dose1 = -999: Exit Function
        Wav2 = DoseBreak(400, item, Points(), Wavelength())
        For i = Points(1, item) To Points(2, item)
            Wav = Wavelength(i)
            If (Wav1 - 1 <= Wav) And (Wav <= Wav2 + 1) Then
                WeightedIrr(i) = Irradiance(i) * (0.04485 / (1 + Exp((Wav - 311.4) / 3.13)) + 4 * 0.9949
                                        * Exp((Wav - 296.5) / 2.692) / (1 + Exp((Wav - 296.5) / 2.692)) ^ 2)
            End If
        Next i
        integrI = CalculateIntegral(Wav1, Wav2, item, Points(), Wavelength(), WeightedIrr())
        If integrI < -998 Then Dose1 = -999: Exit Function
        integr = integr + integrI
    Wend
    Erase WeightedIrr
    Dose1 = integr
End Function
```

A5.2.2. Erythema Dose2

```
Function Dose2 (Points() As Integer, Wavelength() As Single, Irradiance() As Single) As Single

    Dim i As Integer, item As Integer
    Dim Wav As Single, Wav1 As Single, Wav2 As Single
    Dim integrI As Single, integr As Single, Weight As Single
    Dim WeightedIrr() As Single: ReDim WeightedIrr(Points(2, Items(3)))

    Wav2 = 286: integr = 0
    While Wav2 < 400
        Wav1 = Wav2: item = DoseItem(Wav1, Points(), Wavelength()): If item = 0 Then Dose2 = -999: Exit Function
        Wav2 = DoseBreak(400, item, Points(), Wavelength())
        For i = Points(1, item) To Points(2, item)
            Wav = Wavelength(i)
            If (Wav1 - 1 <= Wav) And (Wav <= Wav2 + 1) Then
                Select Case Wav
                    Case Is < 295: Weight = 10 ^ (-1.215837 + (Wav * 0.004728))
                    Case 295 To 300: Weight = 10 ^ (10.73862 + (Wav * -0.035795))
                    Case 300 To 305: Weight = 10 ^ (17.54579 + (Wav * -0.058486))
                    Case 305 To 310: Weight = 10 ^ (50.49061 + (Wav * -0.166502))
                    Case 310 To 320: Weight = 10 ^ (27.87686 + (Wav * -0.093554))
                    Case 320 To 335: Weight = 10 ^ (15.3893 + (Wav * -0.054531))
                    Case 335 To 365: Weight = 10 ^ (1.703584 + (Wav * -0.013555))
                    Case 365 To 380: Weight = 10 ^ (8.365825 + (Wav * -0.031808))
                    Case Is > 380: Weight = 10 ^ (-1.705338 + (Wav * -0.005305))
                End Select
                WeightedIrr(i) = Irradiance(i) * Weight
            End If
        Next i
        integrI = CalculateIntegral(Wav1, Wav2, item, Points(), Wavelength(), WeightedIrr()):
        If integrI < -998 Then Dose2 = -999: Exit Function
        integr = integr + integrI
```

```
        Wend
        Erase WeightedIrr
        Dose2 = integr
End Function
```

A5.2.3. Erythema Dose3

Function **Dose3** (Points() As Integer, Wavelength() As Single, Irradiance() As Single) As Single

```
        Dim i As Integer, item As Integer
        Dim Wav As Single, Wav1 As Single, Wav2 As Single
        Dim integrI As Single, integr As Single, Weight As Single
        Dim WeightedIrr() As Single: ReDim WeightedIrr(Points(2, Items(3)))

        Wav2 = 286: integr = 0
        While Wav2 < 400
                Wav1 = Wav2: item = DoseItem(Wav1, Points(), Wavelength()): If item = 0 Then Dose3 = -999: Exit Function
                Wav2 = DoseBreak(400, item, Points(), Wavelength())
                For i = Points(1, item) To Points(2, item)
                        Wav = Wavelength(i)
                        If (Wav1 - 1 <= Wav) And (Wav <= Wav2 + 1) Then
                                Select Case Wav
                                        Case Is < 298: Weight = 1
                                        Case 298 To 328: Weight = 10 ^ (0.094 * (298 - Wav))
                                        Case Is > 328: Weight = 10 ^ (0.015 * (139 - Wav))
                                End Select
                                WeightedIrr(i) = Irradiance(i) * Weight
                        End If
                Next i
                integrI = CalculateIntegral(Wav1, Wav2, item, Points(), Wavelength(), WeightedIrr())
                If integrI < -998 Then Dose3 = -999: Exit Function
                integr = integr + integrI
        Wend
        Erase WeightedIrr
        Dose3 = integr
End Function
```

A5.2.4. Setlow Dose

Function **Setlow** (Points() As Integer, Wavelength() As Single, Irradiance() As Single) As Single

```
        Dim i As Integer, item As Integer
        Dim Wav As Single, Wav1 As Single, Wav2 As Single
        Dim integrI As Single, integr As Single, Weight as Single
        Dim WeightedIrr() As Single: ReDim WeightedIrr(Points(2, Items(3)))

        Wav2 = 286: integr = 0
        While Wav2 < 340
                Wav1 = Wav2: item = DoseItem(Wav1, Points(), Wavelength()): If item = 0 Then Setlow = -999: Exit
        Function
                Wav2 = DoseBreak(340, item, Points(), Wavelength())
                For i = Points(1, item) To Points(2, item)
                        Wav = Wavelength(i)
                        If (Wav1 - 1 <= Wav) And (Wav <= Wav2 + 1) Then
                                Select Case Wav
                                        Case Is < 290: Weight = 10 ^ (13.04679 + (Wav * -0.047012))
                                        Case 290 To 295: Weight = 10 ^ (20.75595 + (Wav * -0.073595))
                                        Case 295 To 300: Weight = 10 ^ (30.12706 + (Wav * -0.105362))
                                        Case 300 To 305: Weight = 10 ^ (42.94028 + (Wav * -0.148073))
                                        Case Is > 305: Weight = 10 ^ (45.24538 + (Wav * -0.15563))
                                End Select
                                WeightedIrr(i) = Irradiance(i) * Weight
                        End If
                Next i
                integrI = CalculateIntegral(Wav1, Wav2, item, Points(), Wavelength(), WeightedIrr())
                If integrI < -998 Then Setlow = -999: Exit Function
```

```
        integr = integr + integrI
    Wend
    Erase WeightedIrr
    Setlow = integr
End Function
```

A5.2.5. Hunter Dose

```
Function Hunter (Points() As Integer, Wavelength() As Single, Irradiance() As Single) As Single
    Dim i As Integer, item As Integer
    Dim Wav As Single, Wav1 As Single, Wav2 As Single
    Dim integrI As Single, integr As Single
    Dim WeightedIrr() As Single: ReDim WeightedIrr(Points(2, Items(3)))

    Wav2 = 290: integr = 0
    While Wav2 < 340
        Wav1 = Wav2: item = DoseItem(Wav1, Points(), Wavelength()): If item = 0 Then Hunter = -999: Exit
    Function
        Wav2 = DoseBreak(340, item, Points(), Wavelength())
        For i = Points(1, item) To Points(2, item)
            Wav = Wavelength(i)
            If (Wav1 - 1 <= Wav) And (Wav <= Wav2 + 1) Then
                WeightedIrr(i) = Irradiance(i) * Exp(61.1381 - 0.21551 * Wav)
            End If
        Next i
        integrI = CalculateIntegral(Wav1, Wav2, item, Points(), Wavelength(), WeightedIrr())
        If integrI < -998 Then Hunter = -999: Exit Function
        integr = integr + integrI
    Wend
    Erase WeightedIrr
    Hunter = integr
End Function
```

A5.2.6. Caldwell Dose

```
Function Caldwell (Points() As Integer, Wavelength() As Single, Irradiance() As Single) As Single
    Dim i As Integer, item As Integer
    Dim Wav As Single, Wav1 As Single, Wav2 As Single
    Dim integrI As Single, integr As Single
    Dim WeightedIrr() As Single: ReDim WeightedIrr(Points(2, Items(3)))

    Wav2 = 286: integr = 0
    While Wav2 < 313
        Wav1 = Wav2: item = DoseItem(Wav1, Points(), Wavelength()): If item = 0 Then Caldwell = -999: Exit Function
        Wav2 = DoseBreak(313, item, Points(), Wavelength())
        For i = Points(1, item) To Points(2, item)
            Wav = Wavelength(i)
            If (Wav1 - 1 <= Wav) And (Wav <= Wav2 + 1) Then
                WeightedIrr(i) = Irradiance(i) * 2.618 * (1 - (Wav / 313.3) ^ 2) * Exp((300 - Wav) / 31.08)
            End If
        Next i
        integrI = CalculateIntegral(Wav1, Wav2, item, Points(), Wavelength(), WeightedIrr())
        If integrI < -998 Then Caldwell = -999: Exit Function
        integr = integr + integrI
    Wend
    Erase WeightedIrr
    Caldwell = integr
End Function
```

A5.2.7. Weighted TSI (Dose4)

```
Function WeightedTSI (Points() As Integer, Wavelength() As Single, Irradiance() As Single) As Single
	Dim i As Integer, item As Integer
	Dim Wav As Single, Wav1 As Single, Wav2 As Single
	Dim integrI As Single, integr As Single
	Dim WeightedIrr() As Single: ReDim WeightedIrr(Points(2, Items(3)))

	Wav2 = 320: integr = 0
	While Wav2 < 392
		Wav1 = Wav2: item = DoseItem(Wav1, Points(), Wavelength()): If item = 0 Then WeightedTSI = -999: Exit Function
		Wav2 = DoseBreak(392, item, Points(), Wavelength())
		For i = Points(1, item) To Points(2, item)
			Wav = Wavelength(i)
			If (Wav1 - 1 <= Wav) And (Wav <= Wav2 + 1) Then
				If Wav < 367 Then
					WeightedIrr(i) = Irradiance(i) * (0.005598382 + Wav * -0.00004901834
					    + Wav * Wav * 0.0000001420638 + Wav * Wav * Wav * -1.361036E-10)
				Else
					WeightedIrr(i) = Irradiance(i) * (-0.08228739 + Wav * 0.0006492523 + Wav
					    * Wav * -0.00000170513 + Wav * Wav * Wav * 0.000000001490757)
				End If
			End If
		Next i
		integrI = CalculateIntegral(Wav1, Wav2, item, Points(), Wavelength(), WeightedIrr())
		If integrI < -998 Then WeightedTSI = -999: Exit Function
		integr = integr + integrI
	Wend
	Erase WeightedIrr
	WeightedTSI = integr
End Function
```

A6. Ozone Data

Ozone data provide on the Volume 7.0 CD-ROMs, was collected by satellite – NASA Earth Probe TOMS. These data cover NSF instrument sites and periods of operation. Sample observations were used earlier in this report to illustrate global trends in ozone and to emphasize correlation with spectroradiometer network data.

Daily total column ozone maps are also available from NOAA and can be found on the World Wide Web at www.cpc.ncep.noaa.gov/products/stratosphere/sbuv2to/. Original data are produced by the Solar Backscatter Ultraviolet (SBUV-2) instrument onboard the NOAA-11 satellite. Several caveats are associated with the use of these maps. The first is that the data come from an operational data set and, therefore are subject to future reprocessing to yield a more consistent and accurate data set. The second caveat is the statement on the maps indicating the latitude above which there are no data. Links to these and other UV-related World Wide Web sites are listed on the Biospherical Instruments web site at www.biospherical.com.

Researchers interested in ozone maps might also want to consider visiting the World Meteorological Organization (WMO) site at www.wmo.ch, to obtain data from http://lap.physics.auth.gr/ozonemaps/. Since 1990, WMO has arranged for the preparation of daily maps of total ozone distribution over the Northern Hemisphere during the period 1 November to 31 March. The basis for these maps are ozone data obtained from about 90 monitoring stations of the WMO Global Ozone Observing System, which is now part of the WMO Global Atmosphere Watch (GAW), that are submitted in near-real time. Over the ocean regions these data are complemented by satellite data (TOMS historically, and currently SBUV-2). The preparation and distribution of the maps are performed by the WMO Northern Hemisphere Daily Ozone Mapping Center, which is operated by the Laboratory of Atmospheric Physics at the University of Thessaloniki (Greece).

A.6.1. TOMS Data

TOMS (Total Ozone Mapping Spectrometer) data have been included on the NSF CD-ROMs since Version 2.0. NASA Goddard Space Flight Center (GSFC) publishes data online at http://jwocky.gsfc.nasa.gov/, which include data for the UV Spectroradiometer installation sites.

A6.1.1. The TOMS Ozone Measurement (Excerpt from NASA Web Site)

Global measurements of total column ozone are provided daily by NASA's TOMS instruments. Nimbus-7 TOMS and Meteor-3 TOMS provided daily ozone data from November 1978 through December 1994. One and a half years followed without data collection until August 17,1996 when ADEOS TOMS was launched. Data were collected until June 29,1997 when the ADEOS satellite ceased to function properly. The launch of Earth Probe TOMS, which was supposed to provide data to complement that of ADEOS TOMS, has been providing data since July 2, 1996.

Through the courtesy of G.J. Labow, R.D. McPeters and The TOMS Ozone Processing Team at NASA's Goddard Space Flight Center we include data from the Earth Probe TOMS satellite. The NSF UV Monitoring Program Volume 7.0 CD-ROMs contain Earth Probe TOMS data from July 1996 to the most recent data available at the time of the CD-ROM pressing, for the six NSF UV Network stations. Each site has a unique identification number. When possible, the Dobson (or M83) number from the satellite data sets is used.

Table A.12. ADEOS and Earth Probe TOMS data availability.

File Name	Site/City Location	Identification Number
Barrow_OVP199.ept.txt	Barrow, Alaska	199
McM_OVP689.ept.txt	McMurdo Station, Antarctica	689
Palmer_OVP698.ept.txt	Palmer Station, Antarctica	698
SanDiego_OVP239.ept.txt	San Diego, California	239
Spo_OVP111.ept.txt	Amundsen-Scott Station, South Pole, Antarctica	111
Ushuaia_OVP339.ept.txt	Ushuaia, Argentina	339

A6.1.2. TOMS Data Format

Each data set is recorded in a space separated values ASCII (*.TXT) file, which includes the main data and header information. The contents of Overpass Data Files contain the data derived from the best-matched TOMS field-of-view (FOV) to a site for every day the TOMS instrument was operational. Each overpass file contains four (4) header records: 1).Site name, ID, and location.; 2) Overpass program run information, 3) Column headings;.4) Marker record; followed by the data records, as in the example below.

MJD	Year	Day	sec-UT	SCN	LAT	LON	DIS	PT	SZA	OZONE	REF	A.I.	SOI
50280.8	1996	198	72911	19	71.4	-156.7	8	100	53.96	308.5	46.5	-0.6	2
50281.8	1996	199	66190	1	71.96	-155.5	80	100	61.27	288.2	50.6	0.3	0
50284.9	1996	202	74070	25	71.26	-156.1	19	100	53.52	312.2	18.1	-0.7	-5
50285.8	1996	203	72950	19	71.32	-156.7	3	100	54.78	312.1	39.6	-0.8	2
50289.9	1996	207	74081	25	71.17	-156.1	26	100	54.45	302.4	67.9	-0.7	1
50290.8	1996	208	72953	19	71.4	-156.8	11	100	55.9	323.4	16.3	-0.3	1
50291.8	1996	209	71818	14	71.21	-156.1	24	100	56.85	332.2	28.8	-0.3	4
50292.8	1996	210	70690	9	71.29	-156.5	6	100	58.33	337.1	36.1	0.3	11
50293.8	1996	211	69562	6	71.45	-156.1	22	100	59.75	319.1	4.9	-0.2	0
50294.9	1996	212	74059	24	71.47	-157.2	27	100	56.07	341	45.2	-0.2	4
50295.8	1996	213	72924	19	71.4	-156.7	8	100	57.06	319.5	8.3	-1.2	0
50296.8	1996	214	71788	13	71.14	-156.7	21	100	58.13	311.5	47	-0.7	-3

More specifically, the TOMS measurement Data Records contain fourteen (14) values. They are as follows:

MJD Modified Julian Day. Astronomical Julian Day number*, less 2,400,000.5 The number is given to the nearest 1/10 day.
Year The four-digit Gregorian year number of the TOMS measurement.
Day The day number (day 1 through 366) of the TOMS measurement.
sec-UT The number of seconds from midnight Universal Time, on the day specified by Year and Day.
SCN TOMS instrument scan position (1--35 for N7 and EP; 1--37 for Adeos)
LAT Latitude of the center of the IFOV.
LON Longitude of the same.
DIS Distance from site and IFOV center position, in km.
PT Terrain pressure at IFOV center, in (atm x 100)
SZA Solar zenith angle, in degrees, at time and location of IFOV
OZONE TOMS Version-7 best total ozone, in Dobson Units (DU)
REF TOMS Version-7 reflectivity at 380 nm (N7, M3) or 360 nm (EP, Adeos).
A.I. TOMS Version-7 aerosol index.
SOI TOMS Version-7 Sulfur dioxide index.

(*) The astronomical Julian day number (JD) is the number of Greenwich mean noons that have occurred since Greenwich noon on 1 January 4713 B.C.E., on the Julian proleptic calendar. This provides an unambiguous time index. The Modified Julian Date (MJD) is defined as MJD = JD - 2,400,000.5 . Using the MJD saves having to store the leading two digits, which, for the purpose of this data set are always `24', and makes integral values of MJD begin at Greenwich mean midnight. Additional information about these may be found in the Explanatory Supplement to the Astronomical Almanac.

A6.1.3. Contacts for NASA TOMS Data

Contacts for TOMS data:

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A7. Weather Data

Data describing cloud conditions, temperature, pressure, wind speed and direction, and other weather phenomena are available on CD-ROMs Volume7.0. The five-digit WMO standard station identification numbers for the sites are listed in Table A.13.

Table A.13: WMO identification numbers.

Station	Location	Identification Number
BARROW	Barrow, Alaska	70026
MCMURDO	McMurdo Station, Antarctica	89664
PALMER	Palmer Station, Antarctica	89061
SANDIEGO	San Diego, California	72290
SPOLE	Amundsen-Scott Station, South Pole, Antarctica	89009
USHUAIA	Ushuaia, Argentina	87938

Weather observations were purchased from the National Climatic Data Center (NCDC). Data frequency for the different sites varies from hourly to ten-day increments. The files for each site are found in the \WEATHER subdirectory on the CD-ROMs.

Data were originally provided in the DATSAV2 Surface Abbreviated format. A subset of this data is provided, to match the needs of the project. All files are comma separated value (*.CSV) format, and are labeled by site. For example, San Diego data will be labeled ***SANDIEGO.CSV***. The header is self-explanatory. The contents of the weather data files are discussed in the ***read.me*** ASCII text file found in the weather subdirectory. Reference is made to WMO codes within the weather data sets. It is recommended that a copy of the World Meteorological Organization (WMO) Handbook #306 be used as a guide to decode the data.