

6. Description of Published Data

6.1. Overview

Published data from the NSF network include:

- Tables in ASCII comma separated value (CSV) format, denoted “Databases”, and described in detail in Section 6.2. There are five different types of Databases with the following contents:
 - **Database 1** includes system parameters and is maintained for quality control purposes. It does not include solar irradiance data.
 - **Database 2** includes measurements at specific wavelengths, which were extracted from the full-resolution spectra. These databases provide an easy way to analyze time series over extended periods.
 - **Database 3** includes spectral integrals (e.g., UV-B and UV-A) and weighted spectral irradiances (“dose-rates”). A total of six biological action spectra have been implemented, including the CIE action spectrum for erythema and Setlow’s action spectrum for DNA damage.
 - **Database 4** combines the most important quantities of Databases 2 and 3.
 - **Database 5** includes information from response scans and can be used for monitoring system stability

Ancillary solar measurements with Eppley PSP and TUVR radiometers are part of Databases 1– 3.

- **Solar spectra in full resolution** between 280 and 605 nm. Each spectrum is stored in a separate file. File formats are described in detail in Section 6.3.
- **NASA TOMS ozone data** for all network sites, see Section 6.4.
- **Weather data** for network sites, obtained from the National Climatic Data Center (NCDC), see Section 6.5.

The quality reviewed and published data set currently encompasses the years 1988 – 1999. The data set is broken into different volumes, shown in Figure 6.1. Network data is primarily distributed via CD-ROM. Format and contents of published data have evolved over the year. See Section 6.6 for a detailed description of the CD-ROM contents of each volume. Volume 7 and 8 data, including corresponding network operations reports in PDF-format, are additionally available by download from our website, www.biospherical.com. (In future, we intend to make also volumes prior to Volume 7 available via the Internet).

A subset of most current data, which has not yet undergone complete quality review (i.e. data measured after 1999), is posted on the website www.biospherical.com, and is updated frequently. These data have to be regarded as preliminary, and investigators are cautioned that they are subject to revision.

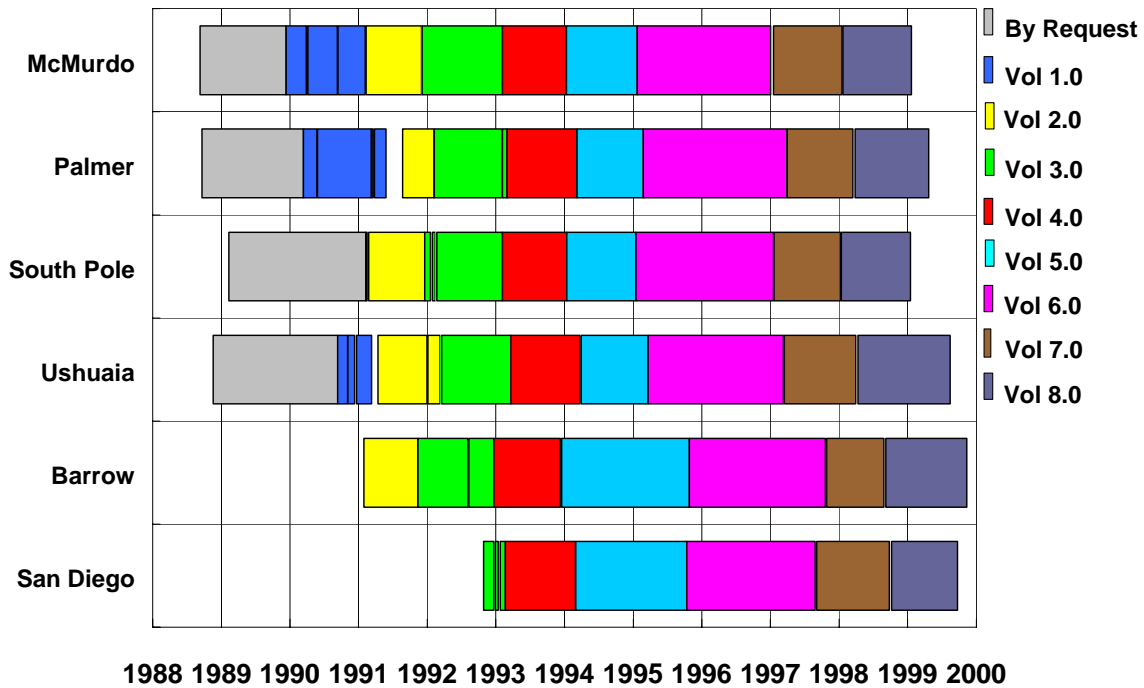


Figure 6.1. Availability of NSF network data, Volumes 1.0 through 8.0. CD-ROMs of Volumes 1.0 through 3.0 are no longer available, except by research-specific request.

6.2. Contents of Databases

The contents of Databases 1 – 5 is described in detail below. The following is specific to Volume 8; differences from previous volumes are briefly explained. Please see previous network operation reports for additional information on the database structure of earlier volumes.

6.2.1. Database 1: Instrument Parameters during Solar Scans

Database 1 is a “housekeeping” database to monitor system performance, and does not include solar irradiance data. It records various system parameters measured during data scans such as system temperatures, the wavelength offset correction, system noise levels, and offsets. Table 6.1 shows the Volume 8 structure of Database 1. The structure is very similar to the format of previous volumes, with exceptions explained below.

The fields “Volume”, “AcqVersion”, and “AnalVersion”, which were not available in the Volume 6 format, were added to Volume 7. Also, some field names were changed to increase compatibility on different computer platforms. The structures of Volume 7 and Volume 8 are identical.

Table 6.1 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 accommodates both old (Volumes 1 – 5) and new (Volumes 6 – 8) data scan formats. New-type data scans are performed at two different high voltages, and all variables can be related to either HV setting: **A** (high setting) or **C** (low setting). The format for Volumes 1 – 5 used three different high voltages. The assignment of the labels **A**, **B**, and **C** to the different items of a data scan is shown in Table 6.2 for both formats.

Table 6.1. Database 1 structure of Volume 8.

| Col. | Field Name | Units | Comment |
|------|-------------|----------------------|---|
| 1 | DataScan | | See Section 6.2.6. <i>Glossary of Database Notation</i> |
| 2 | Volume | | “8” for Volume 8 |
| 3 | ErrorCode | | All should be 0 (otherwise error condition) |
| 4 | RespScan | | See Section 6.2.6. <i>Glossary of Database Notation</i> |
| 5 | WIScan | | See Section 6.2.6. <i>Glossary of Database Notation</i> |
| 6 | WICorr | | Identifies wavelength calibration source |
| 7 | LampCal | | Identifies responsivity calibration source |
| 8 | AXSSCorr | | Identifies AXSS calibration source |
| 9 | TimeA | | Start time of Item 1 data scan. See Section 6.2.6. <i>Glossary of Database Notation</i> |
| 10 | Site | | Site identifier. See Section 6.2.6. <i>Glossary of Database Notation</i> |
| 11 | WIOffset | nm | Wavelength offset before correction was applied |
| 12 | Bandwidth | nm | Bandwidth of 296.728 nm mercury peak |
| 13 | HV_A | V | High voltage settings. HV_A > HV_C. See Table 6.2. |
| 14 | HV_C | V | |
| 15 | DC_A | nA | Dark PMT current at each high voltage. See Table 6.2. |
| 16 | DC_C | nA | |
| 17 | maxC_A | nA | |
| 18 | maxC_C | nA | Maximum PMT current at each high voltage. See Table 6.2. |
| 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 | WIPot_A | nm | Averaged wavelength analog potentiometer reading at the beginning of data scan |
| 24 | WIPot_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 / cm ² | Averaged Eppley PSP reading at the beginning of data scan |
| 28 | PSP_C | mW / cm ² | Averaged Eppley PSP reading at the end of data scan |
| 29 | TUVR_A | mW / cm ² | Averaged Eppley TUV reading at the beginning of data scan |
| 30 | TUVR_C | mW / cm ² | Averaged Eppley TUV 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. See Table 6.2. |
| 37 | DCstdevC | | |
| 38 | AcqVersion | | Version of data acquisition software |
| 39 | AnalVersion | | Version of data analysis software |

Table 6.2. Data scan item identification.

| Label in Database 1 | Volume 1-5 Format | Current Format |
|---------------------|-------------------|------------------|
| A | Item 1 | Item 1 |
| B | Item 2 | Not available |
| C | Item 3 | Items 2, 3 and 4 |

6.2.2. Database 2: Solar Spectral Irradiance at Selected Wavelengths

Database 2 contains a variety of selected spectral irradiance values 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. Irradiance is 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 PSP and TUV data are the averages of the readings taken over the second item.

Table 6.3. Database 2 structure of Volume 8.

| Col. | Field Name | Units | Comment |
|------|------------|----------------------------------|---|
| 1 | DataScan | | See Section 6.2.6. <i>Glossary of Database Notation</i> |
| 2 | Volume | | “8” for Volume 8 |
| 3 | TimeB | | Start time of Item 2 data scan. See Section 6.2.6. <i>Glossary of Database Notation</i> |
| 4 | Site | | Site identifier. See Section 6.2.6. <i>Glossary of Database Notation</i> |
| 5 | Abnormal | | Identifies data with reduced accuracy |
| 6 | ZenithB | degrees | Sun position at the beginning of Item 2 data scan. See Section 6.2.6. |
| 7 | AzimuthB | degrees | Sun position at the beginning of Item 2 data scan. See Section 6.2.6. |
| 8 | E285_A | $\mu\text{W} / (\text{nm cm}^2)$ | Solar spectral irradiance at 285 nm from Item 1 data scan |
| 9 | E285_C | $\mu\text{W} / (\text{nm cm}^2)$ | Solar spectral irradiance at 285 nm from Item 3 data scan |
| 10 | E290 | $\mu\text{W} / (\text{nm cm}^2)$ | Solar spectral irradiance at 290 nm |
| 11 | E295 | $\mu\text{W} / (\text{nm cm}^2)$ | Solar spectral irradiance at 295 nm |
| 12 | E297 | $\mu\text{W} / (\text{nm cm}^2)$ | Solar spectral irradiance at 297 nm |
| 13 | E298 | $\mu\text{W} / (\text{nm cm}^2)$ | Solar spectral irradiance at 298 nm |
| 14 | E299 | $\mu\text{W} / (\text{nm cm}^2)$ | Solar spectral irradiance at 299 nm |
| 15 | E300 | $\mu\text{W} / (\text{nm cm}^2)$ | Solar spectral irradiance at 300 nm |
| 16 | E302_5 | $\mu\text{W} / (\text{nm cm}^2)$ | Solar spectral irradiance at 302.5 nm |
| 17 | E305 | $\mu\text{W} / (\text{nm cm}^2)$ | Solar spectral irradiance at 305 nm |
| 18 | E306_5 | $\mu\text{W} / (\text{nm cm}^2)$ | Solar spectral irradiance at 306.5 nm |
| 19 | E307_5 | $\mu\text{W} / (\text{nm cm}^2)$ | Solar spectral irradiance at 307.5 nm |
| 20 | E308_26 | $\mu\text{W} / (\text{nm cm}^2)$ | Solar spectral irradiance at 308.26 nm |
| 21 | E310_1 | $\mu\text{W} / (\text{nm cm}^2)$ | Solar spectral irradiance at 310.1 nm |
| 22 | E313 | $\mu\text{W} / (\text{nm cm}^2)$ | Solar spectral irradiance at 313 nm |
| 23 | E313_5 | $\mu\text{W} / (\text{nm cm}^2)$ | Solar spectral irradiance at 313.5 nm |
| 24 | E316_8 | $\mu\text{W} / (\text{nm cm}^2)$ | Solar spectral irradiance at 316.8 nm |
| 25 | E320 | $\mu\text{W} / (\text{nm cm}^2)$ | Solar spectral irradiance at 320 nm |
| 26 | E325 | $\mu\text{W} / (\text{nm cm}^2)$ | Solar spectral irradiance at 325 nm |
| 27 | E332_01 | $\mu\text{W} / (\text{nm cm}^2)$ | Solar spectral irradiance at 332.01 nm |
| 28 | E337_28 | $\mu\text{W} / (\text{nm cm}^2)$ | Solar spectral irradiance at 337.28 nm |
| 29 | E340 | $\mu\text{W} / (\text{nm cm}^2)$ | Solar spectral irradiance at 340 nm |
| 30 | E349 | $\mu\text{W} / (\text{nm cm}^2)$ | Solar spectral irradiance at 349 nm |
| 31 | E350 | $\mu\text{W} / (\text{nm cm}^2)$ | Solar spectral irradiance at 350 nm |
| 32 | E380 | $\mu\text{W} / (\text{nm cm}^2)$ | Solar spectral irradiance at 380 nm |
| 33 | E400 | $\mu\text{W} / (\text{nm cm}^2)$ | Solar spectral irradiance at 400 nm |
| 34 | E500 | $\mu\text{W} / (\text{nm cm}^2)$ | Solar spectral irradiance at 500 nm |
| 35 | E600 | $\mu\text{W} / (\text{nm cm}^2)$ | 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 / cm^2 | Averaged Eppley PSP reading from Item 2 data scan |
| 40 | TUVR_B | mW / cm^2 | Averaged Eppley TUVR reading from Item 2 data scan |

Spectral irradiances in Table 6.3 are extracted from various items depending on what data scan format was employed at the time, i.e. for Volumes 1 – 5 format of data scans:

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

while for the new type data scans

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

The fields “Volume”, “Abnormal”, “E313”, and “E380”, which were not available in the Volume 6 format, were added to Volume 7. Some field names were changed (e.g., decimal points were replaced by underscores to increase compatibility on different computer platforms).

6.2.3. Database 3: Spectral Integrals and Dose Weightings

Database 3 contains a variety of spectral and dose-weighted integrals, for example erythemally weighted irradiance (column 27 of database 3). Table 6.4 shows the header of Database 3, while Tables 6.5 and 6.6 include the database structure for spectral, and dose-weighted integrals, respectively.

Table 6.4. Database 3 structure of Volume 8 (Columns 1-7).

| Col. | Field Name | Units | Comment |
|------|------------|---------|---|
| 1 | DataScan | | See Section 6.2.6. <i>Glossary of Database Notation</i> |
| 2 | Volume | | “8” for Volume 8 |
| 3 | TimeB | | Start time of Item 2 data scan. See Section 6.2.6. <i>Glossary of Database Notation</i> |
| 4 | Abnormal | | Identifies data with reduced accuracy |
| 5 | Site | | Site identifier. See Section 6.2.6. <i>Glossary of Database Notation</i> |
| 6 | ZenithB | Degrees | Sun position at the beginning of Item 2 data scan. See Section 6.2.6. |
| 7 | AzimuthB | Degrees | Sun position at the beginning of Item 2 data scan. See Section 6.2.6. |

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 in Table 6.5. In some cases, the mean values of the TSI sensor and Eppley PSP and TUVB radiometers during the particular spectral integration are also available.

Table 6.5. Database 3 structure of Volume 8. Spectral integrals and supporting measurements (Columns 8-24 and 31-44).

| λ_1 | λ_2 | Comment | Spectral Integral | | TSI | | Eppley PSP | | Eppley TUVB | |
|-------------|-------------|-------------------|-------------------|-----------------------------|------|-------|------------|---------------------|-------------|---------------------|
| | | | Col. | Units | Col. | Units | Col. | Units | Col. | Units |
| 290.0 nm | 315.0 nm | UV-B ₁ | 8 | $\mu\text{W} / \text{cm}^2$ | 31 | V | | | | |
| 290.0 nm | 320.0 nm | UV-B ₂ | 9 | $\mu\text{W} / \text{cm}^2$ | 32 | V | 41 | mW /cm ² | 43 | MW /cm ² |
| 320.0 nm | 360.0 nm | UV-A ₁ | 10 | $\mu\text{W} / \text{cm}^2$ | 33 | V | | | | |
| 360.0 nm | 400.0 nm | UV-A ₂ | 11 | $\mu\text{W} / \text{cm}^2$ | 34 | V | | | | |
| 400.0 nm | 600.0 nm | Visible | 12 | $\mu\text{W} / \text{cm}^2$ | 35 | V | 42 | mW /cm ² | 44 | MW /cm ² |
| 289.855 nm | 294.118 nm | | 13 | $\mu\text{W} / \text{cm}^2$ | | | | | | |
| 294.118 nm | 298.507 nm | | 14 | $\mu\text{W} / \text{cm}^2$ | | | | | | |
| 298.507 nm | 303.03 nm | | 15 | $\mu\text{W} / \text{cm}^2$ | 36 | V | | | | |
| 303.03 nm | 307.692 nm | | 16 | $\mu\text{W} / \text{cm}^2$ | 37 | V | | | | |
| 307.692 nm | 312.5 nm | | 17 | $\mu\text{W} / \text{cm}^2$ | 38 | V | | | | |
| 312.5 nm | 317.5 nm | | 18 | $\mu\text{W} / \text{cm}^2$ | | | | | | |
| 317.5 nm | 322.5 nm | | 19 | $\mu\text{W} / \text{cm}^2$ | | | | | | |
| 322.5 nm | 327.5 nm | | 20 | $\mu\text{W} / \text{cm}^2$ | 39 | V | | | | |
| 327.5 nm | 332.5 nm | | 21 | $\mu\text{W} / \text{cm}^2$ | | | | | | |
| 332.5 nm | 337.5 nm | | 22 | $\mu\text{W} / \text{cm}^2$ | | | | | | |
| 337.5 nm | 342.5 nm | | 23 | $\mu\text{W} / \text{cm}^2$ | 40 | V | | | | |
| 342.5 nm | 347.5 nm | | 24 | $\mu\text{W} / \text{cm}^2$ | | | | | | |

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 TUVB in column 43.

The six columns 25-30 are weighted spectral integrals $\int_{290}^{400} E(\lambda)W(\lambda)d\lambda$, also called “dose-rates”, see Table 6.6. Note that the units of weighted and non-weighted integral units are identical, since dose weighting functions, $W(\lambda)$, are dimensionless (see Section 4.2.3).

Spectral and dose-weighted integrals are numerically calculated by using the extended Trapezoidal Rule, utilizing solar data from various items. Interpolated irradiance values are involved in calculations around integral limits λ_1 and λ_2 , while measured irradiances are sufficient inside the integration interval.

Table 6.6. Database 3 structure of Volume 8. Dose weightings (Columns 25-30 and 45).

| Col. | Field Name | Units |
|------|--------------------|-----------------------------|
| 25 | Dose1 | $\mu\text{W} / \text{cm}^2$ |
| 26 | Dose2 | $\mu\text{W} / \text{cm}^2$ |
| 27 | Dose3_CIE_Erythema | $\mu\text{W} / \text{cm}^2$ |
| 28 | Setlow | $\mu\text{W} / \text{cm}^2$ |
| 29 | Hunter | $\mu\text{W} / \text{cm}^2$ |
| 30 | Caldwell | $\mu\text{W} / \text{cm}^2$ |
| 45 | W_TSI | $\mu\text{W} / \text{cm}^2$ |

Note: W_TSI is an abbreviation of Weighted TSI.

Items used for calculation of spectral integrals:

With the Volume 1 – 5 data scan format, columns 13 through 17 from Table 6.5 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. For the data scan format of Volume 6 through 8, 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-A₁ (parameter 10) is calculated from Items 1 (320 – 340 nm) and 2 (340 – 360 nm). For all other calculations, the high resolution Item 1 is sufficient.

Items used for calculation of dose-rates:

To calculate dose-rates from Volume 1 – 5 data scans, data between 290 and 310 nm is from Item 1; data between 310 and 345 nm data is from Item 2; and data between 345 and 400 nm data is from Item 3. For Volumes 6 – 8, low-resolution Item 3 is no longer needed in dose-rate calculations, data between 290 and 340 nm is available from Item 1, and data between 340 and 400 nm from Item 2.

6.2.4. Database 4: General Interest (Short Form)

Database 4 is a compact database combining several quantities from the other databases. The format of Database 4 was revised for Volume 7. This database now includes the most common UV integrals and dose-rates, including the UV Index according to *WMO* (1994). Table 6.7 shows the format used in Volumes 1 – 6; Table 6.8 shows the format introduced in Volume 7.

Table 6.7. Database 4 format of Volume 1 – 6.

| Col. | Field Name | Units | Comment |
|------|------------|----------------------------------|---|
| 1 | DataScan | | See Section 6.2.6. <i>Glossary of Database Notation</i> |
| 2 | TimeDateB | | Start time of data scan Item 2. See Section 6.2.6. <i>Glossary of Database Notation</i> |
| 3 | Site | | Site identifier. See Section 6.2.6. <i>Glossary of Database Notation</i> |
| 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 | $\mu\text{W} / \text{cm}^2$ | 280-315 nm spectral integral |
| 9 | UVB_320 | $\mu\text{W} / \text{cm}^2$ | 280-320 nm spectral integral |
| 10 | UVA | $\mu\text{W} / \text{cm}^2$ | 320-400 nm spectral integral |
| 11 | E@300 | $\mu\text{W} / (\text{nm cm}^2)$ | Solar irradiance at 300 nm |
| 12 | E@313.5 | $\mu\text{W} / (\text{nm cm}^2)$ | 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) |

Table 6.8. Database 4 structure of Volume 7 and 8.

| Col. | Field Name | Units | Comment |
|------|--------------------|-----------------------------|---|
| 1 | DataScan | | See Section 6.2.6. <i>Glossary of Database Notation</i> |
| 2 | Volume | | “8” for Volume 8 |
| 3 | TimeB | | Start time of data scan Item 2. See Section 6.2.6. <i>Glossary of Database Notation</i> |
| 4 | Site | | Site identifier. See Section 6.2.6. <i>Glossary of Database Notation</i> |
| 5 | ZenithB | Degrees (DDD.DD) | |
| 6 | E290to315 | $\mu\text{W} / \text{cm}^2$ | 290-315 nm spectral integral |
| 7 | E290to320 | $\mu\text{W} / \text{cm}^2$ | 290-320 nm spectral integral |
| 8 | E315to400 | $\mu\text{W} / \text{cm}^2$ | 315-400 nm spectral integral |
| 9 | E320to400 | $\mu\text{W} / \text{cm}^2$ | 320-400 nm spectral integral |
| 10 | Dose3_CIE_Erythema | $\mu\text{W} / \text{cm}^2$ | Erythemally weighted irradiance (CIE action spectrum) |
| 11 | Setlow | $\mu\text{W} / \text{cm}^2$ | DNA (Setlow) dose-rate, see Section 4.2.3. |
| 12 | Hunter | $\mu\text{W} / \text{cm}^2$ | Hunter dose-rate, see Section 4.2.3. |
| 13 | Caldwell | $\mu\text{W} / \text{cm}^2$ | Caldwell dose-rate, see Section 4.2.3. |
| 14 | Uvindex | | UV index, (equals column 10 multiplied with 0.4) |

6.2.5. Database 5: Instrument Parameters during Response Scans

Database 5, contains information sampled during response scans that can be used to assess the calibration stability of the instrument. The format of this database has evolved over the years. Table 6.9 shows the Database 5 structure of Volumes 7 and 8. See previous reports for earlier formats.

Table 6.9. Database 5 structure Volume 7 and 8.

| Col. | Field Name | Units | Comment |
|------------------------|--------------|-------|---|
| 1 | RespScan | | See Section 6.2.6. <i>Glossary of Database Notation</i> |
| 2 | Volume | | “7” for Volume 7 |
| 3 | ErrorCode | | Should be 0 (otherwise error condition) |
| 4 | WIScan | | See Section 6.2.6. <i>Glossary of Database Notation</i> |
| 5 | WICorr | | Identifies wavelength calibration source |
| 6 | AXSSCorr | | Identifies AXSS calibration source |
| 7 | Time | | Start time Item 1 of response scan. See Section 6.2.6. <i>Glossary of Database Notation</i> |
| 8 | Site | | Site identifier. See Section 6.2.6. <i>Glossary of Database Notation</i> |
| 9 | WIOffset | 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 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 | WIPot_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 | WIPeakHeight | nA | Height of 296.728 nm Hg peak (assessed from wavelength scan) |
| 79 | WIPeakWidth | 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.

Entries in Database 5 correspond to the time/date of response scans performed with the internal irradiance reference 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 up to six different high voltages.

6.2.6. Glossary of Database Notation

- **Scan File Name:**

SFYYHHMM.DDD,

Where

- *S* is a site code letter from Table 6.10.
- *F* specifies the type of the scan (D stands for the data scan, R - for the response, M - for a multiple segment wavelength scan, W - for a two segment 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 6.10. 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 |

For Volume 7 data, the Site ID Number was mistakenly set in front of the scan file name, i.e. File Name is of the form NSFYYHHMM.DDD, where N is Site ID Number.

- **Time and Date:**

The time/date recorded in the data files refers to Greenwich Mean Time (GMT) time. Time encoded in the filename is the time at the start of the scan. Time/date given in the fields "TimeA" (Database 1), TimeB (Databases 2 – 4), and "Time" (Database 5) 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. (For example, the fractional part multiplied with 24 gives the hour of the measurement). "TimeA" gives time at the start of Item 1 of a data scan; "TimeB" reflects time at start of Item 2 of a data scan. On some occasions, the time of the system control computer was set incorrectly. Unless otherwise noted, data were time-corrected during data analysis. In this case the times given in the Databases are correct but the time encoded in the filename is not changed and will still be in error.

- **Solar Angles:**

Solar angles are calculated using a modification of the "Solar Ephemeris Program," adapted from solar Ephemeris algorithms published in Wilson (1980). The zenith angle is 0 if the sun is directly overhead. For all sites except the South Pole, an azimuth angle of 0 refers to geographic north. At the South Pole an azimuth angle of 0 refers to the prime meridian, often denoted "Grid North."

- **-999 / Missing or Defective data:**

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

- Units of measure are compiled in Table 6.11.

Table 6.11. Units of measure.

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

Note: * TSI (UV-A region sensor) - see Section 2.1.2.

** Eppley Sensors - see Section 2.1.2.

*** A Dobson unit (DU) is defined as a milli-atmosphere-centimeter of ozone at standard pressure. A value of 292 DU would correspond to all the ozone in the atmosphere compressed into a layer 2.92 mm.

6.3. Format of Solar Irradiance Spectra Files

There are four types of spectral irradiance files: files containing 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. The fourth file type contains “composite spectra”, which are assembled from high-, medium-, and low-resolution data. Wavelength increments correspond to the wavelength-steps of data scan items (see Section 4.1.1 for further explanation). All files contain calibrated data, not the original “raw” data. Spectral irradiance files have the following naming convention

STYYHHMM.DDD,

Where

- *S* is the site code letter from the Table 6.10
- *T* represents the type of data scan: **L**ow resolution, **M**edium resolution, **H**igh resolution, or **C**omposite scan
- *HH* - hour (two digits)
- *MM* - minute (two digits)
- *DDD* - Julian Day (three digits)

The contents and format of spectral irradiance files have evolved over the years. The exact contents of these files is given below separately for each Volume. Despite differences, there are also common features. All published spectral irradiance file are in CSV format. They all have 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 $\mu\text{W} / (\text{cm}^2 \text{nm})$. From Format 1C onwards, there is also a third column with TSI measurements. Note that, although the original data were recorded on even wavelength increments (280.0, 280.2, 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 4.2.2. 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.

Format 1A (Volume 1, except Barrow):

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.
```

Format 1B (Volume 1, Barrow):

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 format of the remaining lines is identical to Format 1A.

```
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.
```

Format 1C (Volumes 2 and 3):

Format 1C 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, solar zenith and azimuth angles (see Section 6.2.6) recorded at the start of the scan is added. In addition to wavelength and spectral irradiance columns there is a third column with TSI sensor measurements. The TSI reading normally appears with every fifth wavelength-irradiance pair. This reading can be helpful in determining cloud cover changes during the spectral scan.

```
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.
```

Format 1D (Volumes 4, 5, and part of Volume 6):

Format 1D expresses time/date as an ASCII string. The first line contains not only the start and end time of a segment, but also the duration. The format of the remaining lines is identical to Format 1C.

```
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 2A (Part of Volume 6, and Volume 7 and 8)

A part of the CD-ROM Volume 6 spectra and all spectra of Volume 7 and 8 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-, medium-, and low-resolution – combined together at 344 nm and 404 nm, respectively. As shown 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.

```
8/28/98 0:01:12,8/28/98 0:12:02,0:10:50
641,63.09,205.76
.....
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.
```

6.4. Ozone Data

Ozone data provided on the Volume 8 CD-ROMs, were collected by satellite – NASA Earth Probe TOMS. These data cover NSF instrument sites from July 1996 to end of 1999, and were downloaded from the website toms.gsfc.nasa.gov. Data are courtesy of G.J. Labow, R.D. McPeters, and the TOMS Ozone Processing Team at NASA's Goddard Space Flight Center. Please see the TOMS website for more information on TOMS ozone observations.

Data format of Earth Probe / TOMS ozone data (excerpt of the TOMS website)

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.

Contacts for TOMS data:

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6.5. Weather Data

Weather data provide on the Volume 8.0 CD-ROMs, was 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. WMO Identification Numbers for each site can be found in Table 6.12.

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 published files are in CSV format, and are labeled by site. For example, San Diego data will be labeled *SANDIEGO.CSV*. 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.

Table 6.12: 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 |

6.6. CD-ROM Contents

In the following, the contents and directory structure of files published on CD-Rom are described for each Volume. Please see previous network operations reports for a more detailed file description of published data preceding Volume 7.

Volume 1.0 CD-ROM: 1990 Season

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

- Files with solar irradiance spectra in high, medium- and low resolution
- Databases with spectral integrals and biological dose-rates, presented in both ASCII CSV format and in Microsoft Excel Version 3.0 spreadsheet format.

Volume 2.0 and Volume 3.0 CD-ROM: 1991 and 1992 Season

Four basic types of data appear on the Volumes 2.0 and 3.0 UV Radiation Monitoring Network CD-ROM:

- Files with solar irradiance spectra in high, medium- and low resolution, including solar zenith and azimuth angles at the start of the scan and TSI voltages during the scan.
- Databases similar to those described in Section 6.2, presented in both ASCII CSV format and in Microsoft Excel-PC, Version 4.0 spreadsheet format.
- NASA TOMS Release 6.0 Ozone Data for network sites in ASCII CSV format and Microsoft Excel Version 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.

Volume 4.0 CD-ROM: 1993 Season

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

- Files with solar irradiance spectra in high, medium- and low resolution, including solar zenith and azimuth angles at the start of the scan and TSI voltages during the scan.
- Databases similar to those described in Section 6.2 in ASCII CSV format and in Microsoft Excel-PC, Version 4.0 spreadsheet format.
- NASA TOMS Ozone data for network 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 network sites and six additional sites of interest.

Volume 5.0 CD-ROM: 1994-1995 Season

Four basic types of appear on the Volume 5.0 UV Radiation Monitoring Network CD-ROM:

- Files with solar irradiance spectra in high, medium- and low resolution, including solar zenith and azimuth angles at the start of the scan and TSI voltages during the scan.

- Databases similar to those described in Section 6.2 in ASCII CSV format
- 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.

Volume 6.0.a and 6.0.b CD-ROMs: 1995-1997 Season

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

- Files with solar irradiance spectra in high, medium- and low resolution, as well as composite spectra, including solar zenith and azimuth angles at the start of the scan and TSI voltage during the scan.
- Databases similar to those described in Section 6.2 in ASCII CSV format
- Ozone data for network 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)

Volume 7.0.a and 7.0.b CD-ROMs: 1997-1998 Season

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

- Files with solar irradiance spectra (composite spectra), including solar zenith and azimuth angles at the start of the scan and TSI voltage during the scan.
- Databases as described in Section 6.2 in ASCII CSV format
- NASA TOMS Earth Probe ozone data for network 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)
Ushuaia (4/2/97 - 4/10/98)

Dates and Sites covered on Volume 7.0.b:

Barrow (10/26/97 - 8/18/98)
San Diego (9/9/97 - 9/20/98)
South Pole (2/1/97 - 1/3/98)

Volume 8.0.a-c CD-ROMs: 1998-1999 Season

Four basic types of data appear on the Volumes 8.0.a-c UV Radiation Monitoring Network CD-ROMs:

- Files with solar irradiance spectra (composite spectra), including solar zenith and azimuth angles at the start of the scan and TSI voltage during the scan.
- Databases as described in Section 6.2 in ASCII CSV format
- NASA TOMS Earth Probe ozone data for network sites.
- Weather data of the network sites for the periods of interest, obtained from National Climatic Data Center.

Dates and Sites covered on Volume 8.0.a:

McMurdo (1/19/98 – 1/19/99)

South Pole (1/10/98 – 1/11/99)

Dates and Sites covered on Volume 8.0.b:

Palmer (4/6/98 – 5/2/99)

Ushuaia (4/20/98 – 8/24/99)

Dates and Sites covered on Volume 8.0.c:

San Diego (10/2/98 – 9/19/99)

Barrow (8/28/98 - 11/4/99)

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 6.2). 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.

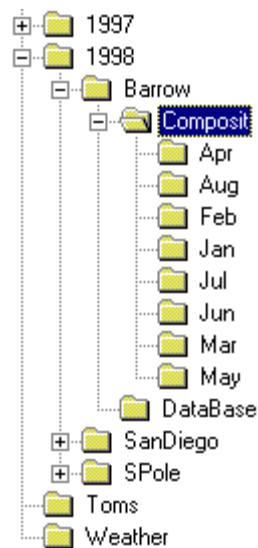


Figure 6.2. Example Directory structure of CD-ROMs Volume 7 and 8.

