Appendices

A1. Errata

Over the past few years we have enhanced our data processing techniques and quality assurance measures. In doing so, we have discovered errors and inconsistencies in earlier volumes of the NSF UV Network CD-ROMs. This section describes all known flaws in previously published data and documentation.

On the CD-ROM Volumes 1-5 erythema dose 1 was calculated incorrectly. 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

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

As a result, the dose was overestimated by approximately 5%-10%. Figure A.1.1 illustrates the effect of this error on Palmer dataset April 1995 - April 1997 (11,000 observations). This error does not appear in the other more popular erythemal doses.

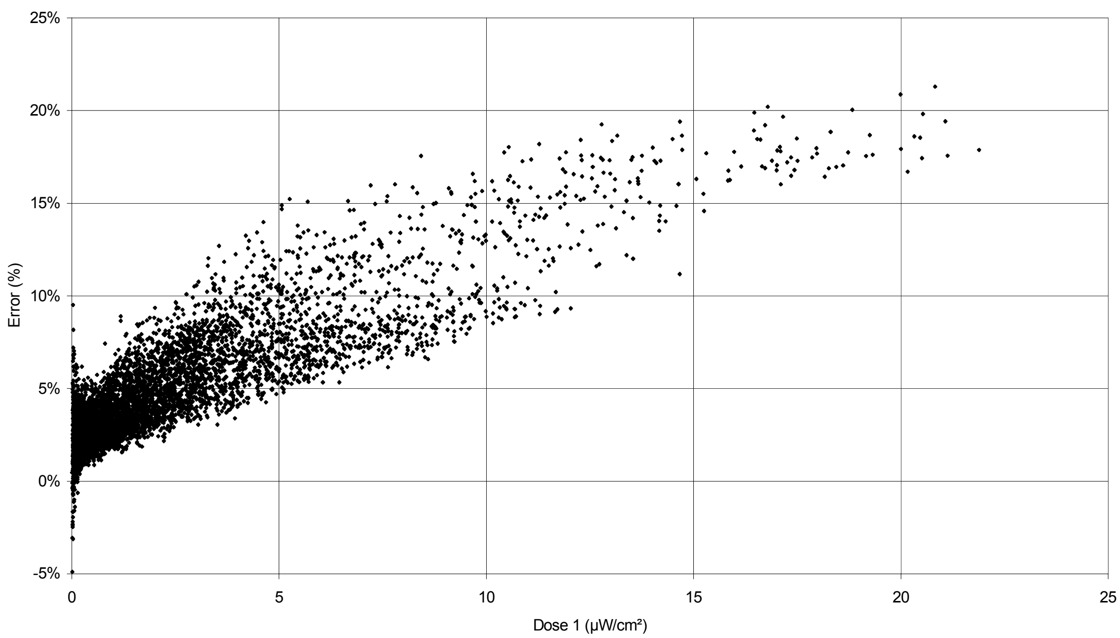

Figure A.1.1 *Inaccuracy in Palmer 1995 – 1997 data caused by error in dose 1 calculation.*

Due to an error in the early versions of the decoding software, the spectral integral 303.507-307.693 nm was calculated instead of the integral 303.03-307.692 nm. This error affected Column 14 of Database Three on the first three volumes of the CD-ROM. Also, on the same CD-ROMs, Column 21 of Database Two was incorrectly reported as being calculated from Item 2. In actuality, 313.5 nm irradiance is obtained from Item 1.

On CD-ROM Volumes 2 and 3 the time/date stamps in the databases (in both *.csv and *.xls files), are truncated after the hundredths value of the Microsoft Excel time/date format. This means that only the date and hour of the data record are accurate. In order to obtain the correct time, users are encouraged to add four minutes to the beginning of the data scan as identified by the scan name. This error did not affect the recorded solar angles since they were calculated using the correct time.

Starting with CD-ROM Volume 4, there were several improvements in the data processing that resulted in minor inconsistencies with the earlier volumes. These changes are listed in Table A.1.1.

Table A.1.1. Changes in data processing.

Parameter	Location		Change
	Database	**Col.**	
Error Code	1	2	Reports errors encountered by each item of the data scan and corresponding response and wavelength scans, e.g. “0 0 0(R: 0 0 0 0 0 W: 0 0 0 0 0 0 0 0)” means no error condition.
	5	2	Reports errors encountered by each item of the response and corresponding wavelength scans, e.g. “0 0 0 0 0(W: 0 0 0 0 0 0 0 0)” means no error condition.
Time / Date	1	8	Extracted from Item 1 and not from Item 3, as before.
	2,3, and 4	2	Identifies the beginning of the second item of the data scan in order to be consistent with calculations of the solar angles and major integrals (previously extracted from Item 3).
TSI coefficient	1	37	Measured as *StDev / |Mean|* based on data from all items. Formerly was obtained from
of variation	4	16	the first item as *StDev / (n Mean)*, where *n* was the number of AXSS readings in Item 1.
Dark current standard deviation	1	38-40	Calculated as variance and used instead of the parameter reported earlier as “*Dark current coefficient of variation.*”
TSI		13	An average of all readings taken during data scan, while before it was defined as
Eppley PSP	4	14	$(Mean_1 + Mean_2 + Mean_3) / 3$, where *Mean* was an averaged value from the
Eppley TUVR		15	Corresponding item.
	1	41-49	These columns were sacrificed to reduce the database size.

Barrow and Ushuaia data presented on CD-ROM Volume 1 were inaccurate. Barrow data were revised and published on the next CD-ROM. As shown in Figure A.1.2, data from Ushuaia were underestimated by up to 8%. The corrected data are now available upon request from Biospherical Instruments Inc. Also, minor gaps in the data reported on Volume 1 have been restored and are available.

In Volume 6 data on CD-ROM, several scans were published, when the instrument was saturated. Primarily data from Ushuaia and San Diego were affected. These scans should not be used. Scan names are compiled in Table A.1.2.

There has also been a revision of the documentation. In the *Weather* section of the Appendix of Operations Reports 1991-1993 and 1993-1994, the precipitation amounts (in mm) for codes 991-998 in Table 3590 (the last table in the report) were inadvertently omitted.

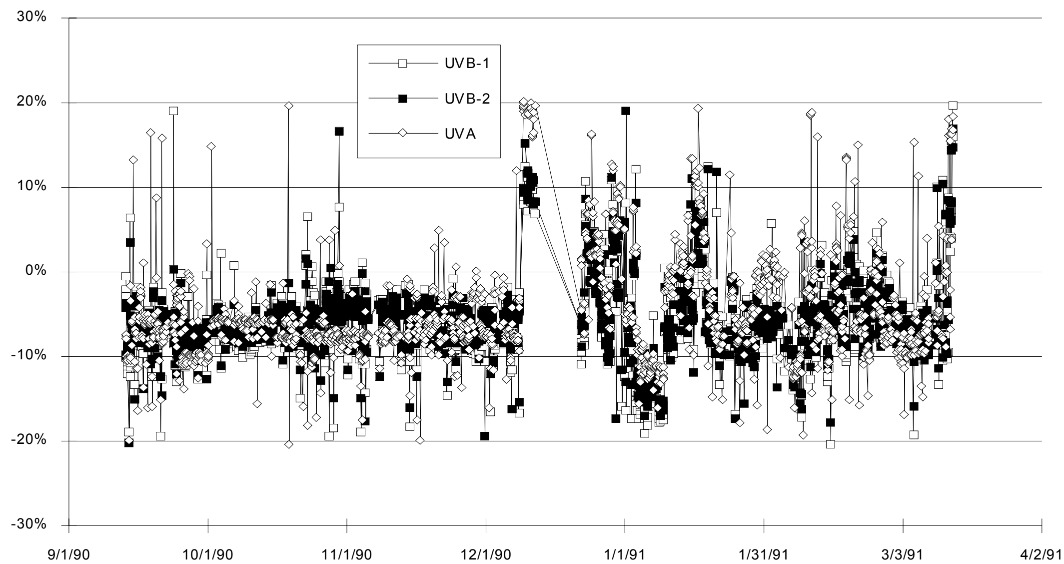

Figure A.1.2. *Inaccuracy in Ushuaia 1990 data measured as* $\frac{\text{CDROMvalue} - \text{RevisedValue}}{\text{RevisedValue}}$ *for three major variables.*

Table A.1.2 Saturated scans of Volume 6

McMurdo	DD971200.063	DD972100.078	ED971615.016	ED972030.025
AD960700.039	DD972000.063	DD971200.079	ED971600.017	ED972045.025
AD961000.356	DD972100.063	DD971200.079	ED971615.017	ED972100.025
Palmer	DD972100.063	DD971200.079	ED972345.017	ED972115.025
BD971000.024	DD972100.063	DD971300.079	ED971600.018	ED972130.025
BD971000.030	DD972200.063	DD971300.079	ED971615.018	ED972145.025
BD971100.030	DD972200.063	DD971300.079	ED972345.018	ED972200.025
BD972300.034	DD971300.064	DD971400.079	ED971600.019	ED972215.025
Ushuaia	DD971100.065	DD971300.082	ED971615.019	ED972230.025
DD971100.036	DD971200.065	DD971300.082	ED971545.020	ED972245.025
DD972100.037	DD972100.065	DD971300.082	ED972345.021	ED972300.025
DD972300.037	DD971100.066	DD971300.089	ED971600.022	ED972315.025
DD972200.038	DD971300.066	DD971200.090	ED972000.024	ED972330.025
DD971100.039	DD972000.068	DD971300.090	ED972015.024	ED972345.025
DD971200.039	DD972100.069	DD971500.090	ED972030.024	ED970000.026
DD971100.041	DD971200.070	DD971800.090	ED972045.024	ED970015.026
DD971200.041	DD971200.070	DD972000.090	ED972100.024	ED970030.026
DD971000.042	DD971200.070	DD972030.090	ED972115.024	ED970045.026
DD971100.043	DD971400.070	San Diego	ED972130.024	ED970100.026
DD971100.045	DD971400.070	ED961430.238	ED972145.024	ED971500.026
DD971100.046	DD971400.070	ED961530.315	ED972200.024	ED971515.026
DD972200.046	DD972000.070	ED961545.333	ED972215.024	ED971530.026
DD971100.047	DD972100.070	ED961600.334	ED972230.024	ED971545.026
DD971300.047	DD971100.071	ED962315.334	ED972245.024	ED971600.026
DD971200.049	DD971200.071	ED961545.335	ED972300.024	ED971615.026
DD971300.049	DD971200.071	ED961600.335	ED972315.024	ED971630.026
DD971100.050	DD971200.071	ED962315.335	ED972330.024	ED971645.026
DD971200.050	DD971400.071	ED961545.336	ED972345.024	ED971700.026
DD971100.051	DD971400.071	ED961600.336	ED970000.025	ED971715.026
DD971100.052	DD971400.071	ED962315.336	ED970015.025	ED971730.026
DD972100.052	DD971200.072	ED961545.337	ED970030.025	ED971745.026
DD971100.053	DD971200.072	ED961600.337	ED970045.025	ED971800.026
DD971200.053	DD971200.072	ED962315.337	ED970100.025	ED971815.026
DD972200.054	DD971400.072	ED961600.338	ED970115.025	ED971830.026
DD971100.055	DD972100.072	ED961600.339	ED971445.025	ED971845.026
DD971200.055	DD971100.073	ED961600.340	ED971500.025	ED971900.026
DD971300.055	DD971100.073	ED961600.342	ED971515.025	ED971915.026
DD971200.056	DD971200.073	ED961600.343	ED971530.025	ED971930.026
DD972200.056	DD971200.073	ED961600.350	ED971545.025	ED971945.026
DD971200.057	DD971200.073	ED961600.351	ED971600.025	ED972000.026
DD972200.057	DD971400.073	ED961600.354	ED971615.025	ED972015.026
DD972000.058	DD971400.073	ED961600.357	ED971630.025	ED972030.026
DD972000.059	DD971400.073	ED961600.358	ED971645.025	ED972045.026
DD972000.059	DD972000.073	ED961615.359	ED971700.025	ED972100.026
DD971100.060	DD972100.073	ED961600.360	ED971715.025	ED972115.026
DD971200.060	DD972100.074	ED961615.360	ED971730.025	ED972130.026
DD971300.060	DD971200.076	ED961545.364	ED971745.025	ED972145.026
DD972000.060	DD971200.077	ED961600.364	ED971800.025	ED972200.026
DD972200.060	DD971400.077	ED971600.004	ED971815.025	ED972215.026
DD972000.061	DD971400.077	ED971615.004	ED971830.025	ED972230.026
DD972200.061	DD971200.078	ED971615.006	ED971845.025	ED972245.026
DD971100.062	DD971200.078	ED972330.006	ED971900.025	ED972300.026
DD971200.062	DD971200.078	ED971615.007	ED971915.025	ED972315.026
DD971300.062	DD971300.078	ED971615.008	ED971930.025	ED972330.026
DD972200.062	DD971900.078	ED971615.009	ED971945.025	ED972345.026
DD972200.062	DD972100.078	ED971615.010	ED972000.025	ED971330.148
DD971100.063	DD972100.078	ED971600.015	ED972015.025	

A2. References

Note: * References that utilize NSF UV Spectroradiometer Network data

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A3. 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***.

A3.1. 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
```

A3.2. 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
```

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
```

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
```

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
```

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
```

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
```

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
```

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
```