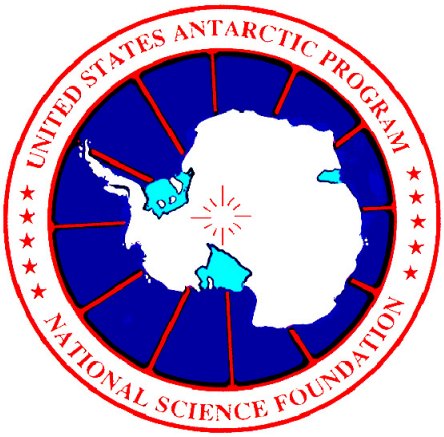
Appendices


NSF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A1. Errata

There are no known errors in data of Volumes 7-16, which have not been reported in the Operations Reports complementing these volumes. For known errors in data of Volumes 1-6, please refer to the Operations Reports of Volumes 7-12.

A2. References

Note: References marked with an asterisk (*) use 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

$$W(\lambda) = \frac{0.04485}{1 + \frac{\exp\{\lambda - 311.4\}}{3.13}} + \frac{4 \cdot 0.9949 \cdot \exp\{\frac{\lambda - 296.5}{2.692}\}}{1 + \exp\{\frac{\lambda - 296.5}{2.692}\}^2}$$ was coded instead of $$W(\lambda) = \frac{0.04485}{1 + \exp\{\frac{\lambda - 311.4}{3.13}\}} + \frac{4 \cdot 0.9949 \cdot \exp\{\frac{\lambda - 296.5}{2.692}\}}{\left\{1 + \exp\{\frac{\lambda - 296.5}{2.692}\}\right\}^2}.$$

```
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
```