3. Appendix

3.1 The ROVCDN2VCD Data Table Function (ROVCDN2VCDDTF).

3.1.1 Required Input to the Derivation.

RI1356ILBH2 — The ratio of 1356 and LBH2 (1650-1800 A) intensities (dimensionless).

VRI1356ILBH2 — The variance associated with RI1356ILBH2 (dimensionless).

SZA — The solar zenith angle at the pixel (radians).

3.1.2 Calculated Output of the Derivation.

ROVCDN2VCD — The ratio of O and N_2 vertical column densities (dimensionless).

VROVCDN2VCD — The variance associated with ROVCDN2VCD dimensionless).

3.1.3 Contents of the ROVCDN2VCD Data Table:

The contents of the ROVCDN2VCD Data Table described below were generated with the optical backgrounds models developed by CPI [Strickland and Meier, 1982; Strickland and Anderson, 1983; Strickland et al., 1995]. Plots of a sample of the data table contents are provided in Figure 3.1

DTSZA — The one-dimensional vector of solar zenith angles (radians).

DTRI1356ILBH2GRID — The one-dimensional vector of ratios of 1356 and LBH2 (1650-1800 A) intensities (dimensionless). The values of the vector DTRI1356ILBH2 are abscissa values for the one-dimensional vector DTVRI1356ILBH2.

DTVRI1356ILBH2 — The one-dimensional vector of variances associated with DTRI1356ILBH2GRID which are not explicitly characterized by the input values (dimensionless). (See Figure 3.1). The sources of uncertainty in DTRI1356ILBH2GRID arise from uncertainties in the cross sections of OI 1356 and N_2 LBH. The assumed uncertainty in the cross sections of OI 1356 and N_2 LBH is 20% [Meier, 1991]. Each element of the vector DTVRI1356ILBH2 was calculated from

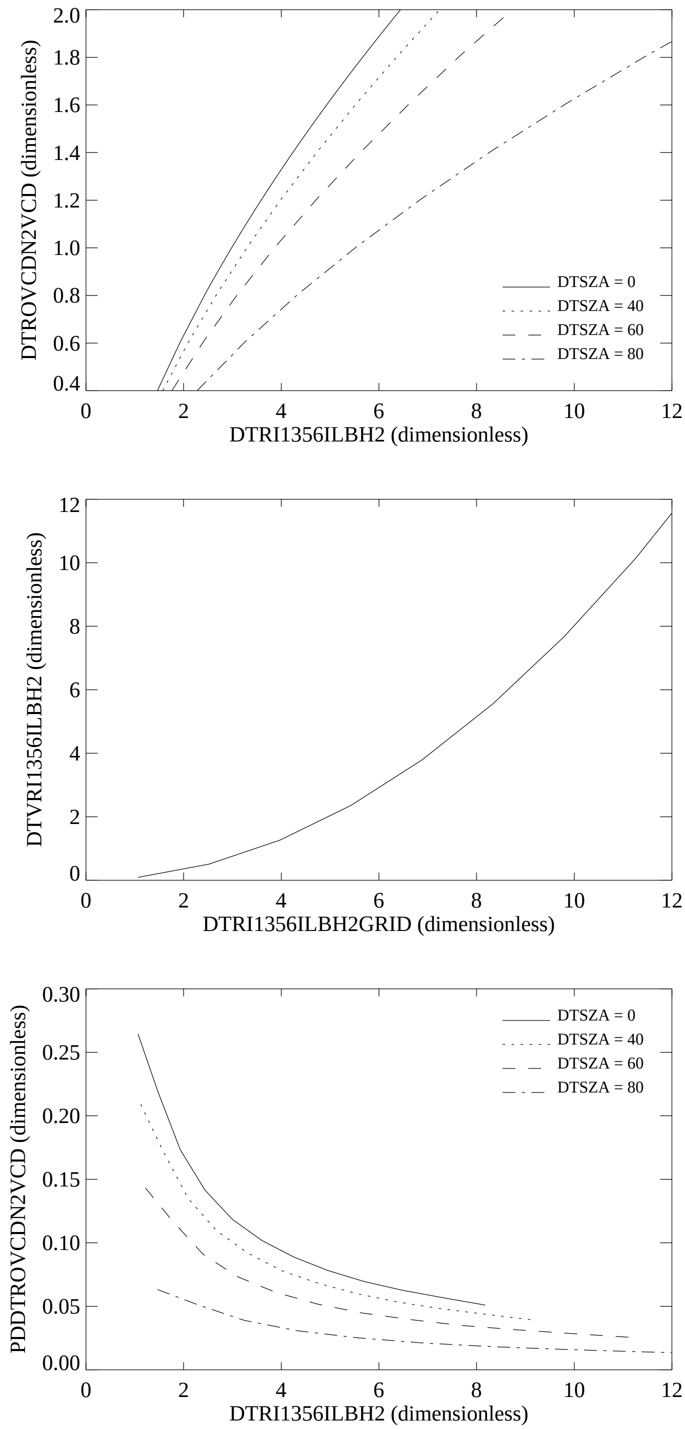

Figure 3.1 Top Panel: Plots of DTROVCDN2VCD versus DTRI1356ILBH2 for solar zenith angles (DTSZA) of 0^{o}, 40^{o}, 60^{o}, and 80^{o}. Middle Panel: Plot of DTVRI1356ILBH2 versus DTRI1356ILBH2GRID for DTSZA values of 0^{o}, 40^{o}, 60^{o}, and 80^{o}. Bottom Panel: Plots of the square of the partial derivatives of DTROVCDN2VCD with respect to DTRI1356ILBH2 (PDDTROVCDN2VCD) for DTSZA values 0^{o}, 40^{o}, 60^{o}, and 80^{o}.

$$\sigma^2_{RI1356ILBH2GRID} = \left(\frac{1}{ILBH2}\right)^2 * (0.2 * I1356)^2 + \left(\frac{I1356}{ILBH2^2}\right)^2 * (0.2 * ILBH2)^2$$

$= 2*\text{DTRI1356ILBH2GRID}^2*(0.2)^2$

DTROVCDN2VCD The one-dimensional vector of ratios of O and N_2 vertical column densities (dimensionless).

DTRI1356ILBH2 The two-dimensional vector of ratios of model 1356 A and LBH2 (1650-1800 A) intensities for the corresponding values of DTROVCDN2VCD and DTSZA (dimensionless). (See Figure 3.1).

PDDTROVCDN2VCD The two-dimensional vector of the square of the partial derivatives of DTROVCDN2VCD with respect to DTRI1356ILBH2 for the corresponding values of DTRI1356ILBH2 and DTSZA (dimensionless). (See Figure 3.1).

3.1.4 The Derivation

3.1.4.1 Begin

3.1.4.2 Interpolate on DTRI1356ILBH2 to obtain a one-dimensional vector of DTRI1356ILBH2 values as a function of DTROVCDN2VCD at input SZA value (INTRPDTRI1356ILBH2).

Note: Each element of the vector INTRPDTRI1356ILBH2 is calculated in the same manner. For the ith element, the value of INTRPDTRI1356ILBH2 is calculated by creating a temporary one-dimensional array (TempA) which holds all values of DTRI1356ILBH2 (corresponding to DTSZA) for the ith DTROVCDN2VCD value. Then interpolate on the vector TempA to obtain the value of TempA which corresponds to the input SZA value.

Note: Each element of the array TempA is calculated in the same manner. For the jth element, the value of TempA is calculated as:

TempA[j] = DTRI1356ILBH2[i,j]

INTRPDTRI1356ILBH2[i] = The interpolated value of the one-dimensional vector TempA which corresponds to the input SZA value. The value INTRPDTRI1356ILBH2 is calculated by the Interpolate Function (INTERPOLATE). The following values should be used as input to the Interpolate Function:

$$\textit{For INTERPOLATE } Y \xrightarrow{\text{Use}} TempA$$

For INTERPOLATE X $\xrightarrow{\text{Use}}$ *DTSZA*
For INTERPOLATE U $\xrightarrow{\text{Use}}$ *SZA*

3.1.4.3 Interpolate on PDDTROVCDN2VCD to obtain the value of PDDTROVCDN2VCD which corresponds to the input RI1356ILBH2 and SZA values (INTRPPDDTROVCDN2VCD).

Note: Each element of the vector TempB is calculated in the same manner. For the ith element, the value of TempB is calculated by creating a temporary one-dimensional array (TempA) which holds all values of PDDTROVCDN2VCD (corresponding to DTSZA) for the ith value of INTRPDTRI1356ILBH2. Interpolate on the vector TempA to obtain the value of TempA which corresponds to the input SZA value.

Note: Each element of the array TempA is calculated in the same manner. For the jth element, the value of TempA is calculated as:

TempA[j] = PDDTROVCDN2VCD[i,j]

TempB[i] = The interpolated value of the one-dimensional vector TempA which corresponds to the input SZA value. The value TempB[i] is calculated by the Interpolate Function (INTERPOLATE). The following values should be used as input to the Interpolate Function:

For INTERPOLATE Y $\xrightarrow{\text{Use}}$ *TempA*
For INTERPOLATE X $\xrightarrow{\text{Use}}$ *DTSZA*
For INTERPOLATE U $\xrightarrow{\text{Use}}$ *SZA*

INTRPPDDTROVCDN2VCD = The interpolated value of the one-dimensional vector TempB which corresponds to the input RI1356ILBH2 value. The value INTRPPDDTROVCDN2VCD is calculated by the Interpolate Function (INTERPOLATE). The following values should be used as input to the Interpolate Function:

For INTERPOLATE Y $\xrightarrow{\text{Use}}$ *TempB*
For INTERPOLATE X $\xrightarrow{\text{Use}}$ *INTRPDTRI1356ILBH2*
For INTERPOLATE U $\xrightarrow{\text{Use}}$ *RI1356ILBH2*

3.1.4.4 Interpolate on DTVRI1356ILBH2 to obtain the value of DTVRI1356ILBH2 which corresponds to the input RI1356ILBH2 value (INTRPDTVRI1356ILBH2)

INTRPDTVRI1356ILBH2 = The interpolated value of the one-dimensional vector DTVRI1356ILBH2 which corresponds to the input RI1356ILBH2 value. The value INTRPDTVRI1356ILBH2 is calculated by the Interpolate Function (INTERPOLATE). The following values should be used as input to the Interpolate Function:

For INTERPOLATE Y $\xrightarrow{\text{Use}}$ *DTVRI1356ILBH2*
For INTERPOLATE X $\xrightarrow{\text{Use}}$ *DTRI1356ILBH2GRID*
For INTERPOLATE U $\xrightarrow{\text{Use}}$ *RI1356ILBH2*

3.1.4.5 Interpolate on the vector DTROVCDN2VCD to obtain the value of DTROVCDN2VCD which corresponds to the input RI1356ILBH2 value (ROVCDN2VCD).

ROVCDN2VCD = The interpolated value of the one-dimensional vector DTROVCDN2VCD which corresponds to the input RI1356ILBH2 value. The value ROVCDN2VCD is calculated by the Interpolate Function (INTERPOLATE). The following values should be used as input to the Interpolate Function:

For INTERPOLATE Y $\xrightarrow{\text{Use}}$ *DTROVCDN2VCD*
For INTERPOLATE X $\xrightarrow{\text{Use}}$ *INTRPDTRI1356ILBH2*
For INTERPOLATE U $\xrightarrow{\text{Use}}$ *RI1356ILBH2*

Calculate the variance associated with the ratio of O and N_2 vertical column densities (VROVCDN2VCD)

Note: The sources of uncertainty in the derived ROVCDN2VCD value arise from uncertainty in the theoretical model used to generate the values in the ROVCDN2VCD Data Table (i.e. PDDTROVCDN2VCD∗ DTVRI1356ILBH2GRID) and from uncertainty in the input RI1356LBH2 value (i.e. PDDTROVCDN2VCD∗VRI1356ILBH2).

VROVCDN2VCD = INTRPPDDTROVCDN2VCD∗ (INTRPDTVRI1356ILBH2 + VRI1356ILBH2)

3.1.4.6 End

3.2 The QEUV Data Table Function (QEUVDTF).

3.2.1 Required Input to the Derivation.

I1356	The 1356 intensities (R).
VI1356	The variance associated with I1356 $(R)^2$.

ROVCDN2VCD	The ratio of O and N_2 vertical column densities (dimensionless).
VROVCDN2VCD	The variance associated with ROVCDN2VCD dimensionless).
SZA	The solar zenith angle at the pixel (radians).

3.2.2 Calculated Output of the Derivation.

QEUV	The solar EUV flux below 450 A (erg cm^{-2} s^{-1}).
VQEUV	The variance associated with QEUV (erg cm^{-2} $s^{-1})^2$.

3.2.3 Contents of the QEUV Data Table:

The contents of the QEUV Data Table described below were generated with the optical backgrounds models developed by CPI [Strickland and Meier, 1982; Strickland and Anderson, 1983; Strickland et al., 1995]. Plots of a sample of the data table contents are provided in Figure 3.2.

DTQEUVREF	The reference QEUV value (erg cm^{-2} s^{-1}).
DTSZA	The one-dimensional vector of solar zenith angles (radians).
DTROVCDN2VCD	The one-dimensional vector ratios of O and N_2 vertical column densities(dimensionless).
DTI1356	The two-dimensional vector of 1356 intensities for the corresponding values of DTROVCDN2VCD and DTSZA (R). (See Figure 3.2).
DTVI1356	The two-dimensional vector of variances associated with DTI1356 which are not explicitly characterized by the input values $(R)^2$. (See Figure 3.2). The sources of uncertainty in DTVI1356 arise from uncertainties in the OI 1356 cross sections. A 20% uncertainty in the cross section of OI 1356 is assumed [Meier, 1991]. Each element of the vector DTVI1356 was calculated from Each element of the vector DTVI1356 was calculated from $DTVI1356 = (0.2*I1356)^2$
PDDTI1356	The two-dimensional vector of the square of the partial derivatives of DTI1356 with respect to DTROVCDN2VCD for the corresponding values of DTROVCDN2VCD and DTSZA $(Rayleighs)^2$. (See Figure 3.2).

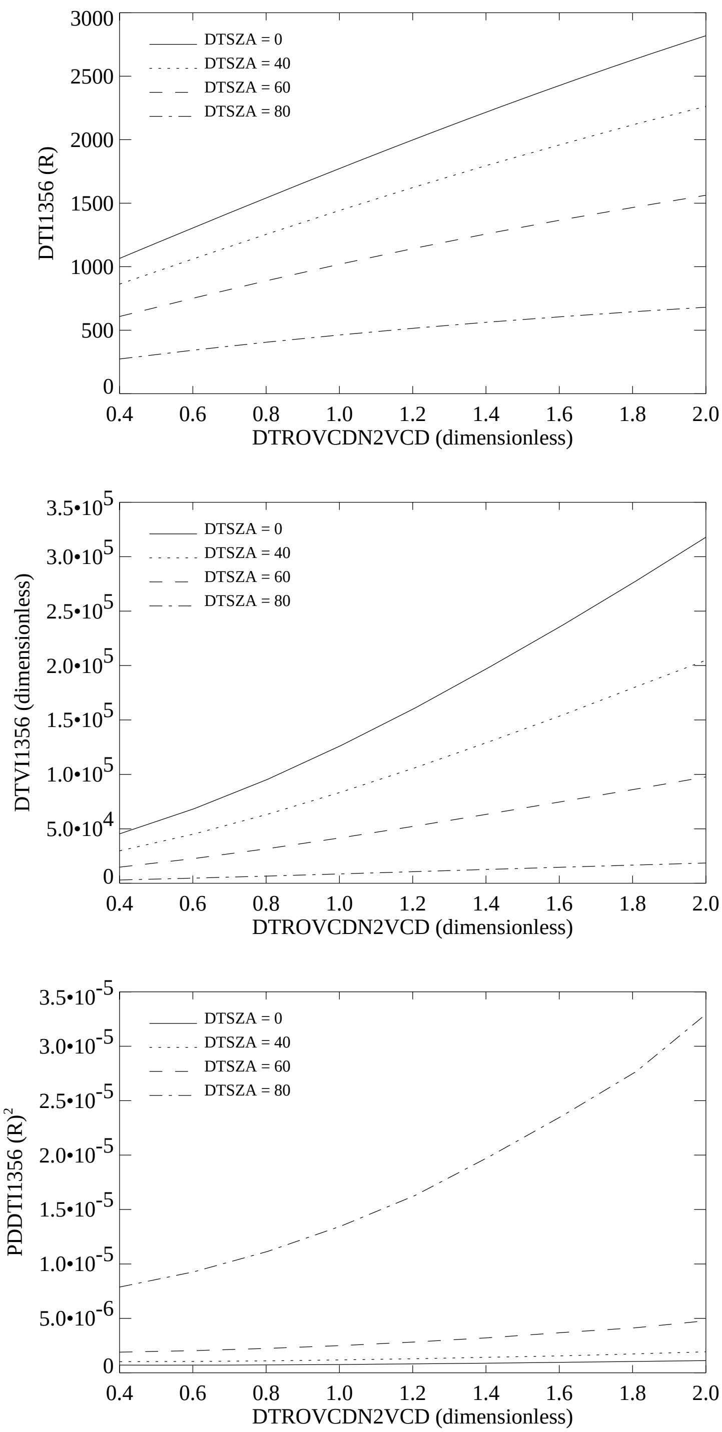

Figure 3.2 Top Panel: Plots of DTI1356 versus DTROVCDN2VCD for solar zenith angles (DTSZA) of 0^o, 40^o, 60^o, and 80^o. Middle Panel: Plots of DTVI1356 versus DTROVCDN2VCD for DTSZA values of 0^o, 40^o, 60^o, and 80^o. Bottom Panel: Plots of the square of the partial derivatives of DTI1356 with respect to DTROVCDN2VCD (PDDTI1356) for DTSZA values 0^o, 40^o, 60^o, and 80^o.

3.2.4 The Derivation

3.2.4.1 Begin

3.2.4.2 Interpolate on DTI1356 to obtain the value of DTI1356 which corresponds to the input ROVCDN2VCD and SZA values (INTRPDTI1356).

Note: Each element of the vector TempB is calculated in the same manner. For the ith element, the value of TempB is calculated by creating a temporary one-dimensional array (TempA) which holds all values of DTI1356 (corresponding to DTSZA) for the ith value of DTROVCDN2VCD. Interpolate on the vector TempA to obtain the value of TempA which corresponds to the input SZA value.

Note: Each element of the array TempA is calculated in the same manner. For the jth element, the value of TempA is calculated as:

TempA[j] = DTI1356I[i,j]

TempB[i] = The interpolated value of the one-dimensional vector TempA which corresponds to the input SZA value. The value TempB[i] is calculated by the Interpolate Function (INTERPOLATE). The following values should be used as input to the Interpolate Function:

For INTERPOLATE Y $\xrightarrow{\text{Use}}$ *TempA*
For INTERPOLATE X $\xrightarrow{\text{Use}}$ *DTSZA*
For INTERPOLATE U $\xrightarrow{\text{Use}}$ *SZA*

INTRPDTI1356 = The interpolated value of the one-dimensional vector TempB which corresponds to the input ROVCDN2VCD value. The value INTRPDTI1356 is calculated by the Interpolate Function (INTERPOLATE). The following values should be used as input to the Interpolate Function:

For INTERPOLATE Y $\xrightarrow{\text{Use}}$ *TempB*
For INTERPOLATE X $\xrightarrow{\text{Use}}$ *DTROVCDN2VCD*
For INTERPOLATE U $\xrightarrow{\text{Use}}$ *ROVCDN2VCD*

3.2.4.3 Interpolate on DTVI1356 to obtain the value of DTVI1356 which corresponds to the input ROVCDN2VCD and SZA values (INTRPDTVI1356).

Note: Each element of the vector TempB is calculated in the same manner. For the ith element, the value of TempB is calculated by creating a temporary one-dimensional array (TempA) which holds all values of DTVI1356 (corresponding to DTSZA) for the ith value of DTROVCDN2VCD.

Interpolate on the vector TempA to obtain the value of TempA which corresponds to the input SZA value.

Note: Each element of the array TempA is calculated in the same manner. For the jth element, the value of TempA is calculated as:

TempA[j] = DTVI1356I[i,j]

TempB[i] = The interpolated value of the one-dimensional vector TempA which corresponds to the input SZA value. The value TempB[i] is calculated by the Interpolate Function (INTERPOLATE). The following values should be used as input to the Interpolate Function:

$$\textit{For INTERPOLATE Y} \xrightarrow{\text{Use}} \textit{TempA}$$
$$\textit{For INTERPOLATE X} \xrightarrow{\text{Use}} \textit{DTSZA}$$
$$\textit{For INTERPOLATE U} \xrightarrow{\text{Use}} \textit{SZA}$$

INTRPDTVI1356 = The interpolated value of the one-dimensional vector TempBwhich corresponds to the input ROVCDN2VCD value. The value INTRPDTVI1356 is calculated by the Interpolate Function (INTERPOLATE). The following values should be used as input to the Interpolate Function:

$$\textit{For INTERPOLATE Y} \xrightarrow{\text{Use}} \textit{TempB}$$
$$\textit{For INTERPOLATE X} \xrightarrow{\text{Use}} \textit{DTROVCDN2VCD}$$
$$\textit{For INTERPOLATE U} \xrightarrow{\text{Use}} \textit{ROVCDN2VCD}$$

3.2.4.4 Interpolate on PDDTI1356 to obtain the value of PDDTI1356 which corresponds to the input ROVCDN2VCD and SZA values (INTRPPDDTI1356).

Note: Each element of the vector TempB is calculated in the same manner. For the ith element, the value of TempB is calculated by creating a temporary one-dimensional array (TempA) which holds all values of PDDTI1356 (corresponding to DTSZA) for the ith value of DTROVCDN2VCD. Interpolate on the vector TempA to obtain the value of TempA which corresponds to the input SZA value.

Note: Each element of the array TempA is calculated in the same manner. For the jth element, the value of TempA is calculated as:

TempA[j] = PDDTI1356I[i,j]

TempB[i] = The interpolated value of the one-dimensional vector TempA which corresponds to the input SZA value. The value TempB[i] is calculated by the Interpolate Function (INTERPOLATE). The following values should be used as input to the Interpolate Function:

$$\text{For INTERPOLATE } Y \xrightarrow{\text{Use}} TempA$$
$$\text{For INTERPOLATE } X \xrightarrow{\text{Use}} DTSZA$$
$$\text{For INTERPOLATE } U \xrightarrow{\text{Use}} SZA$$

INTRPPDDTI1356 = The interpolated value of the one-dimensional vector TempB which corresponds to the input ROVCDN2VCD value. The value INTRPPDDTI1356 is calculated by the Interpolate Function (INTERPOLATE). The following values should be used as input to the Interpolate Function:

$$\text{For INTERPOLATE } Y \xrightarrow{\text{Use}} TempB$$
$$\text{For INTERPOLATE } X \xrightarrow{\text{Use}} DTROVCDN2VCD$$
$$\text{For INTERPOLATE } U \xrightarrow{\text{Use}} ROVCDN2VCD$$

3.2.4.5 Calculate the solar EUV flux below 450 A (QEUV).

$$\text{QEUV} = \left(\frac{I1356}{INTRPDTI1356}\right) * DTQEUVREF$$

Calculate the variance associated with the solar EUV flux (VQEUV).

Note: The variance of the derived QEUV value is obtained by applying the error propagation formula to the expression for QEUV above. The sources of uncertainty in the derived QEUV value arise from uncertainty in the theoretical model used to generate the values in the QEUV Data Table (i.e. DTVI1356) and uncertainty in the input ROVCDN2VCD and I1356 values (i.e. PDDTI1356*VROVCDN2VCD and VI1356). (Uncertainty in QEUV due to uncertainty in DTQEUVREF is assumed to be relatively insignificant). VTempA below gives the total variance of the model 1356 intensity.

VTempA = INTRPPDDTI1356∗VROVCDN2VCD + INTRPDTVI1356

$$\text{VQEUV} = \left(\frac{VI1356}{I1356^2} + \frac{VTempA}{INTRPDTI1356^2}\right) * QEUV^2$$

3.2.4.6 End

3.3 The EDPP Data Table Function (EDPPDTF).

3.3.1 Required Input to the Derivation.

ROVCDN2VCD	The ratio of O and N_2 vertical column densities (dimensionless).
VROVCDN2VCD	The variance associated with ROVCDN2VCD (dimensionless).
QEUV	The solar EUV flux below 450 A (erg cm^{-2} s^{-1}).
VQEUV	The variance associated with QEUV (erg cm^{-2} $s^{-1})^2$.
Ap	The magnetic index (dimensionless).
MONTH	The month of the year (dimensionless).
GMLT	The geomagnetic local time (hours).
GMLAT	The geomagnetic latitude (radians).
GMLON	The geomagnetic longitude (radians).

3.3.2 Calculated Output of the Derivation.

NmF2	The F_2-Region peak density (cm^{-3}).
VNmF2	The variance associated with NmF2 $(cm^{-3})^2$.
hmF2	The height of the F_2-Region peak density (km).
VhmF2	The variance associated with hmF2 $(km)^2$.
TEC	The F_2-Region Total Electron Content (10^{16} e^- m^{-2}).
VTEC	The variance associated with TEC (10^{16} e^- m^{-2}).

3.3.3 Contents of the EDPP Data Table:

The contents of the EDPP Data Table described below were generated with an F_2-Region Ionospheric Model [Anderson, 1973; Anderson, 1973; Anderson, 1981]. Plots of a sample of the data table contents are provided in Figures 3.3.1 through 3.3.9.

DTROVCDN2VCD	The one-dimensional vector of ratios of O and N_2 vertical column densities (dimensionless).
DTQEUV	The one-dimensional vector of solar EUV fluxes below 450 A (erg cm^{-2} s^{-1}).

DTGMLT — The one-dimensional vector of geomagnetic local times (hours).

DTGMLAT — The one-dimensional vector of geomagnetic latitudes (radians).

DTGMLON — The one-dimensional vector of geomagnetic longitudes (radians).

DTNmF2 — The seven-dimensional vector of F_2-Region peak density values for the corresponding values of DTROVCDN2VCD, DTQEUV, DTAp, DTSEASON, DTGMLT, DTGMLAT, and DTGMLON (cm^{-3}). (See Figures 3.3.1-3.3.6)

DTVNmF2 — The seven-dimensional vector of variances associated with the F_2-Region Peak Density values for the corresponding values of DTROVCDN2VCD, DTQEUV, DAp, DTSEASON, DTGMLT, DTGMLAT, and DTGMLON which are not explicitly characterized by the input values $(cm^{-3})^2$. The sources of uncertainties included in DTVNmF2 are uncertainties in the ExB drift and uncertainties in the meridional wind. (See Figures 3.3.9)

DThmF2 — The seven-dimensional vector of F_2-Region peak density height values for the corresponding values of DTROVCDN2VCD, DTQEUV, DTAp, DTSEASON, DTGMLT, DTGMLAT, and DTGMLON (km). (See Figures 3.3.1-3.3.6)

DTVhmF2 — The seven-dimensional vector of variances associated with the F_2-Region Peak Density Height values for the corresponding values of DTROVCDN2VCD, DTQEUV, DTAp, DTSEASON, DTGMLT, DTGMLAT, and DTGMLON which are not explicitly characterized by the input values $(km)^2$. The sources of uncertainties included in DTVhmF2 are uncertainties in the ExB drift and uncertainties in the meridional wind. (See Figure 3.3.9)

DTTEC — The seven-dimensional vector of F_2-Region Total Electron Content values for the corresponding values of DTROVCDN2VCD, DTQEUV, DTAp, DTSEASON, DTGMLT, DTGMLAT, and DTGMLON (10^{16} e^- m^{-2}). (See Figures 3.3.1-3.3.6)

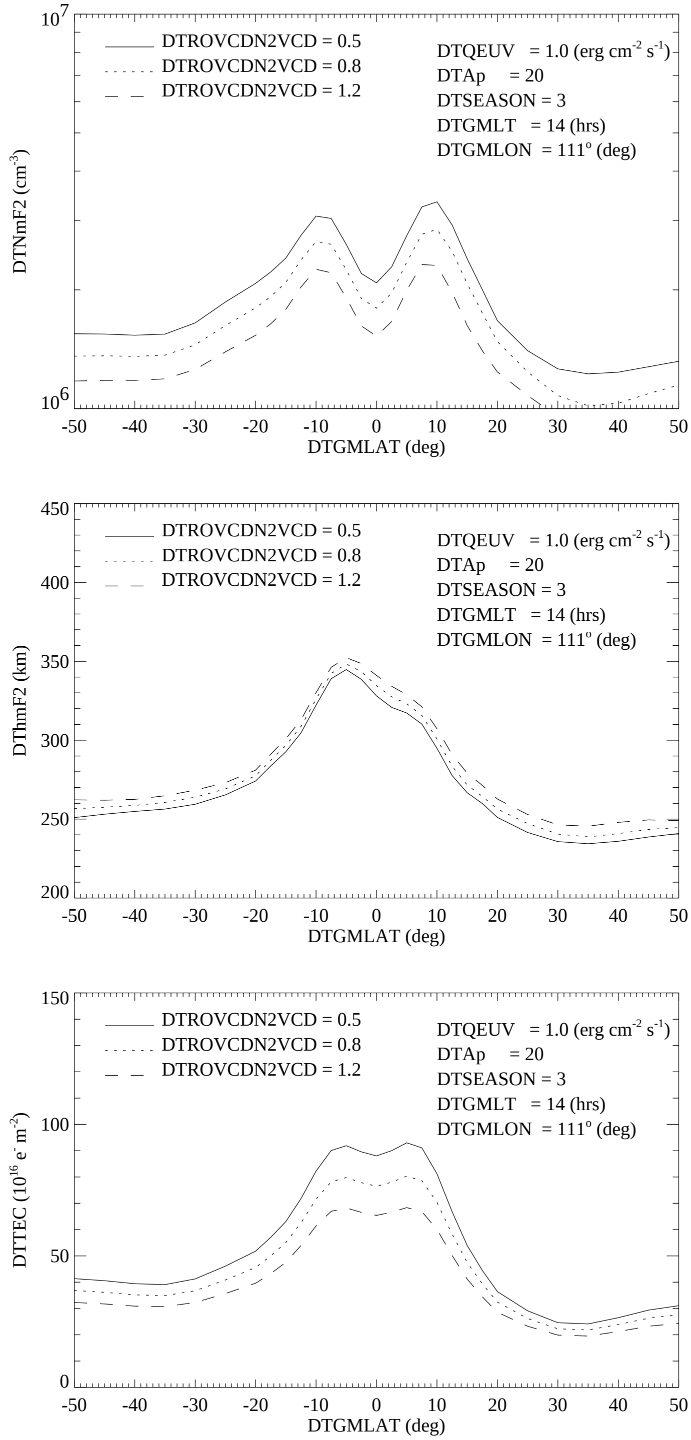

Figure 3.3.1 Plots of DTNmF2 (top panel), DThmF2 (middle panel), and DTTEC (bottom panel) versus DTGMLAT for DTROVCDN2VCD values of 0.5, 0.8, and 1.2.

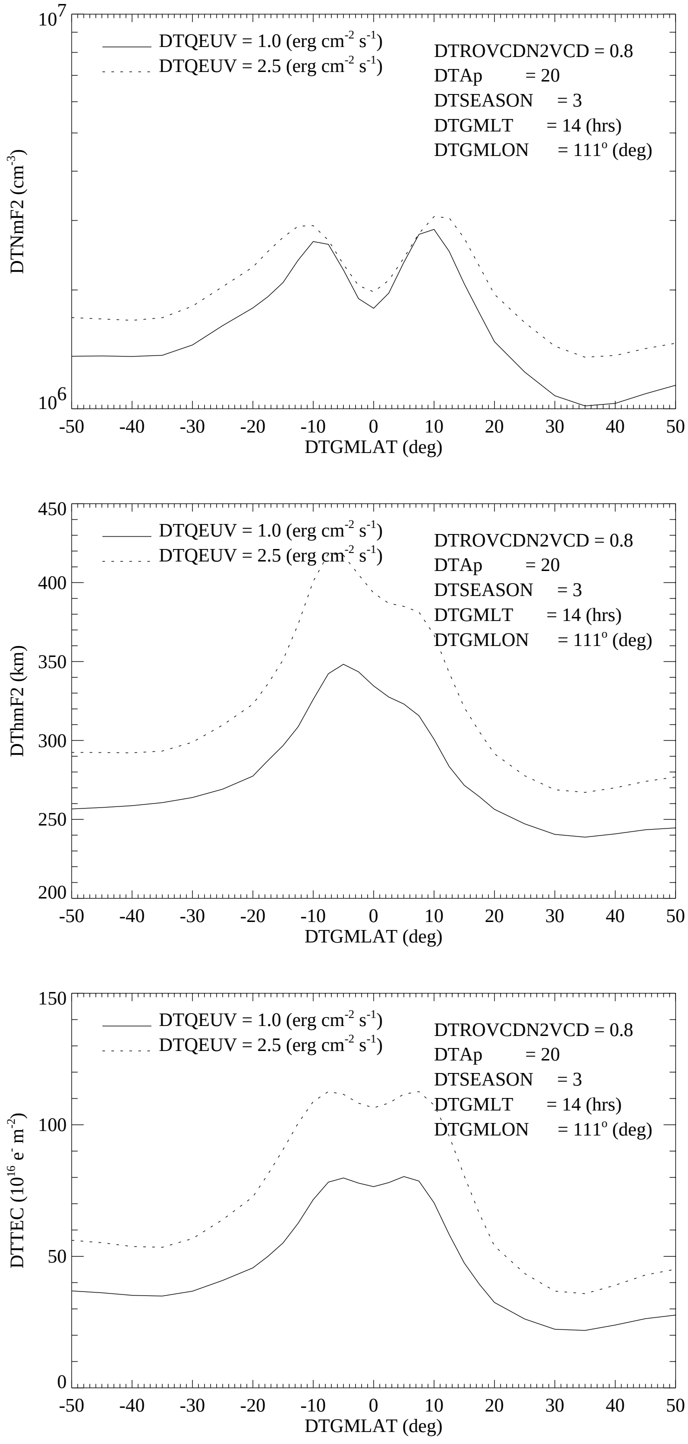

Figure 3.3.2 Plots of DTNmF2 (top panel), DThmF2 (middle panel), and DTTEC (bottom panel) versus DTGMLAT for DTQEUV values of 1.0 and 2.5 (erg cm^{-2} s^{-1}).

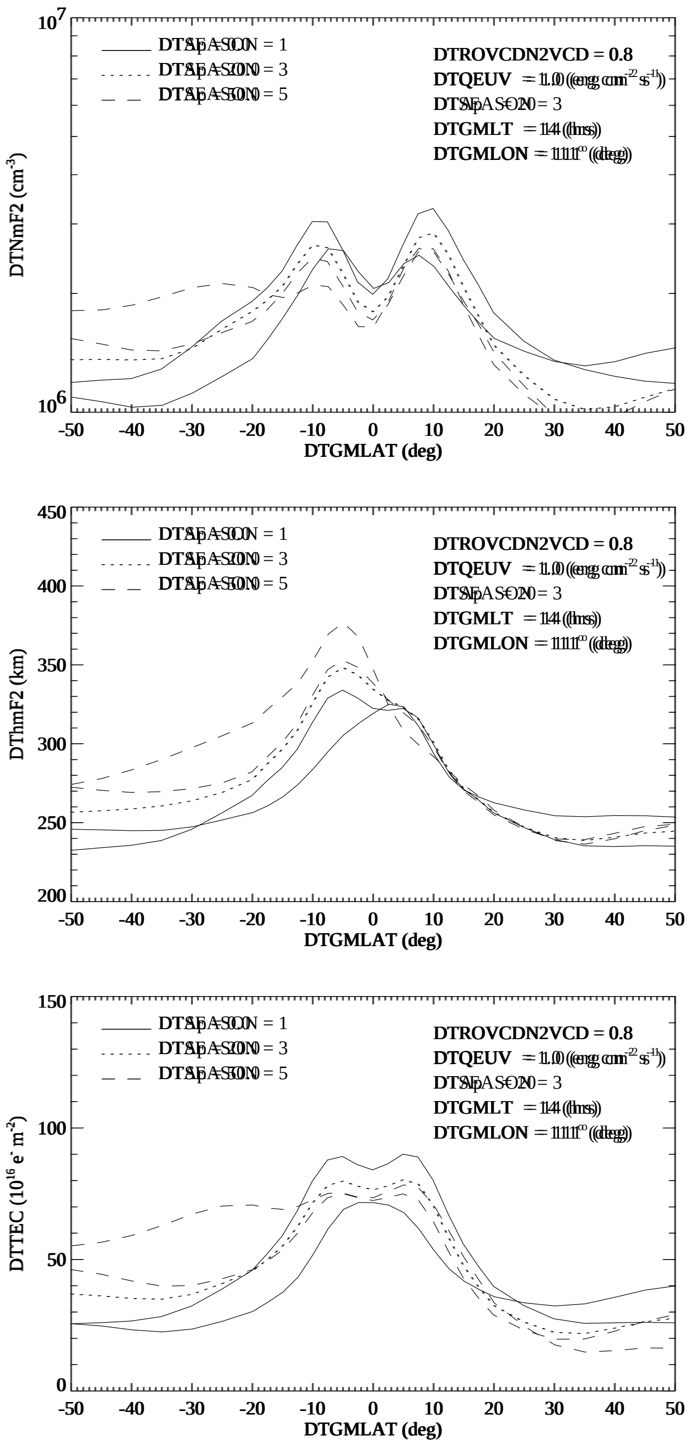

Figure 3.3.3 Plots of DTNmF2 (top panel), DThmF2 (middle panel), and DTTEC (bottom panel) versus DTGMLAT for DTAp values of 0, 20, and 50.

Figure 3.3.4 Plots of DTNmF2 (top panel), DThmF2 (middle panel), and DTTEC (bottom panel) versus DTGMLAT for DTSEASON values of 1 (June), 3 (March or September), and 5 (December).

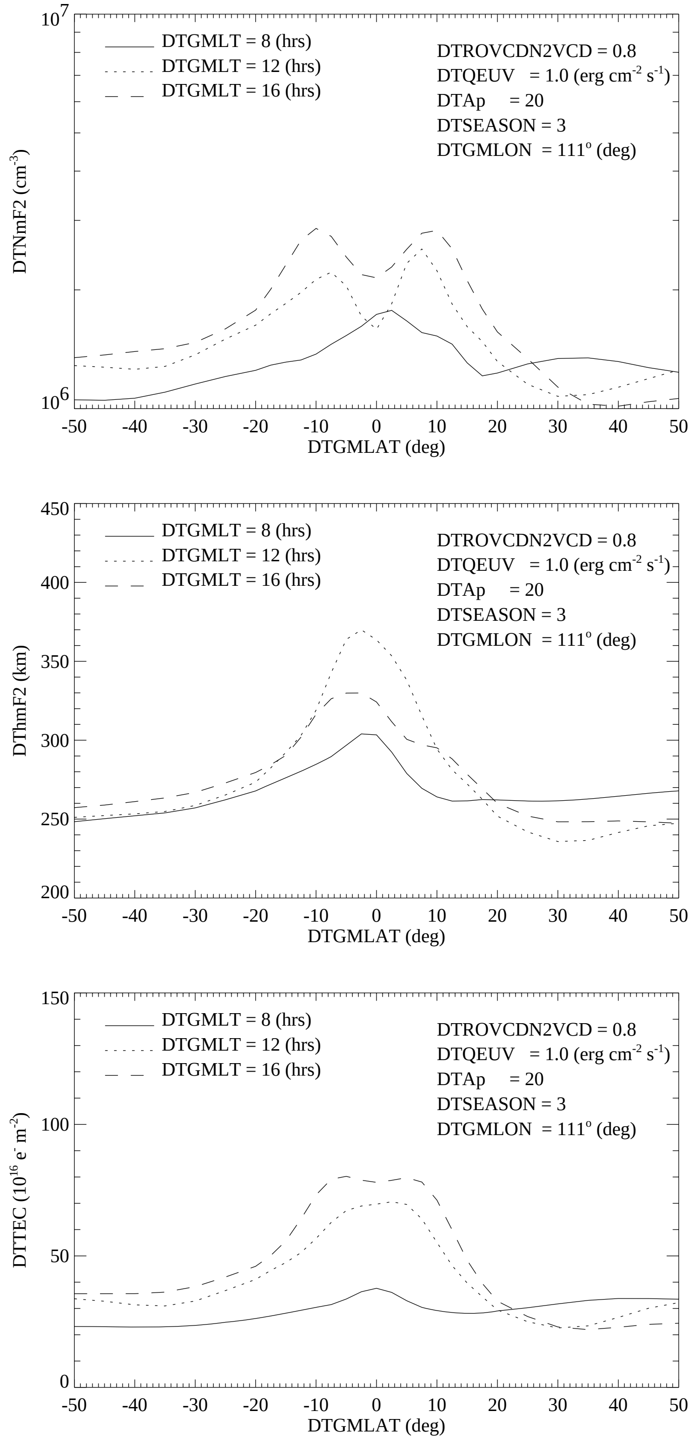

Figure 3.3.5 Plots of DTNmF2 (top panel), DThmF2 (middle panel), and DTTEC (bottom panel) versus DTGMLAT for DTGMLT values of 8, 12, and 16 hrs.

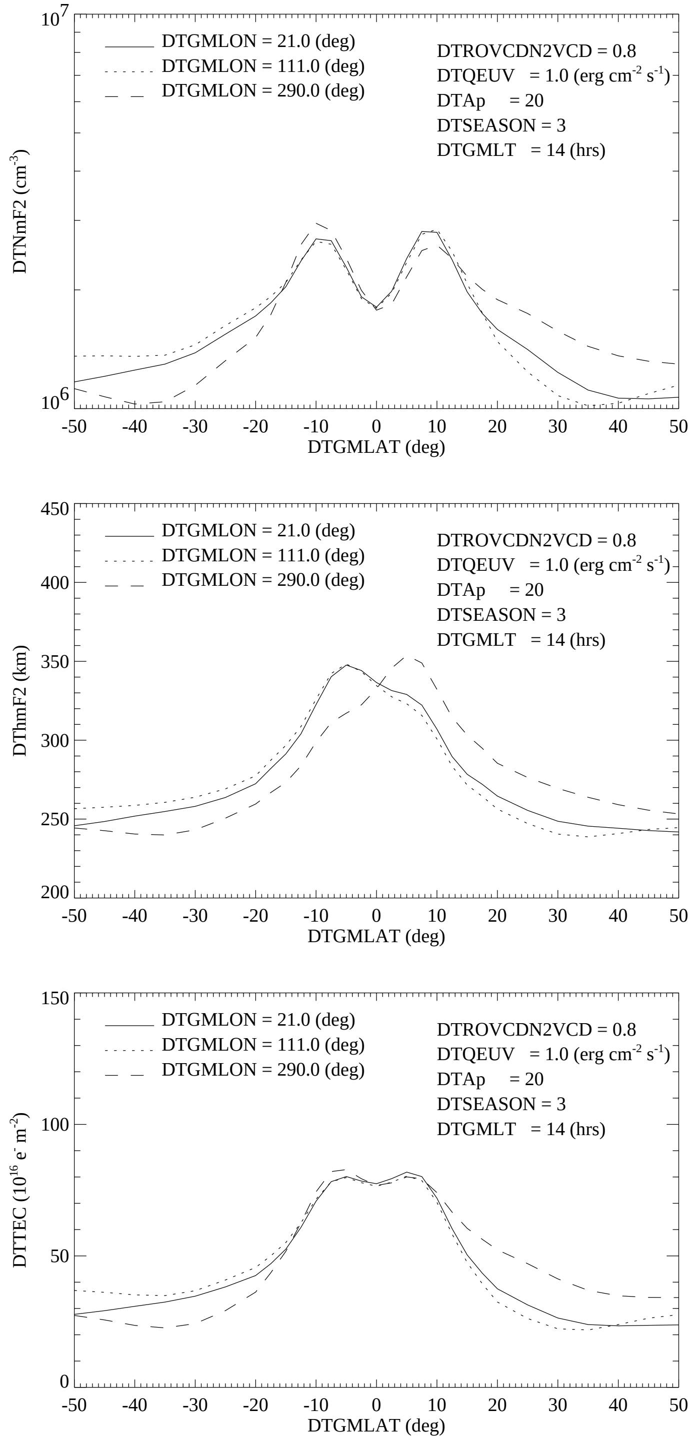

Figure 3.3.6 Plots of DTNmF2 (top panel), DThmF2 (middle panel), and DTTEC (bottom panel) versus DTGMLAT for DTGMLON values of 21.0, 111.0, and 290.0 degrees.

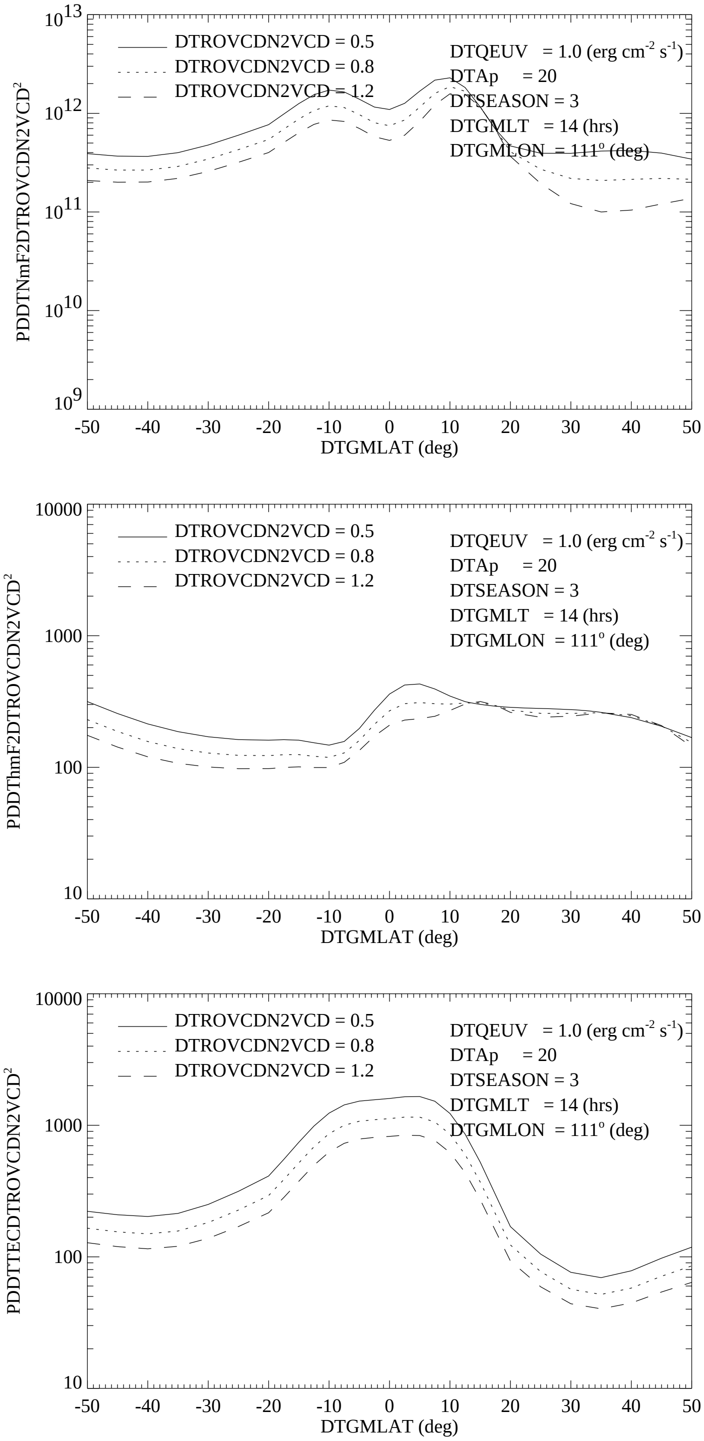

Figure 3.3.7 Plots of the square of PDDTNmF2DTROVCDN2VCD (top panel), PDDThmF2DTROVCDN2VCD (middle panel), and PDDTTECDTROVCDN2VCD (bottom panel) versus DTGMLAT for DTROVCDN2VCD values of 0.5, 0.8, and 1.2.

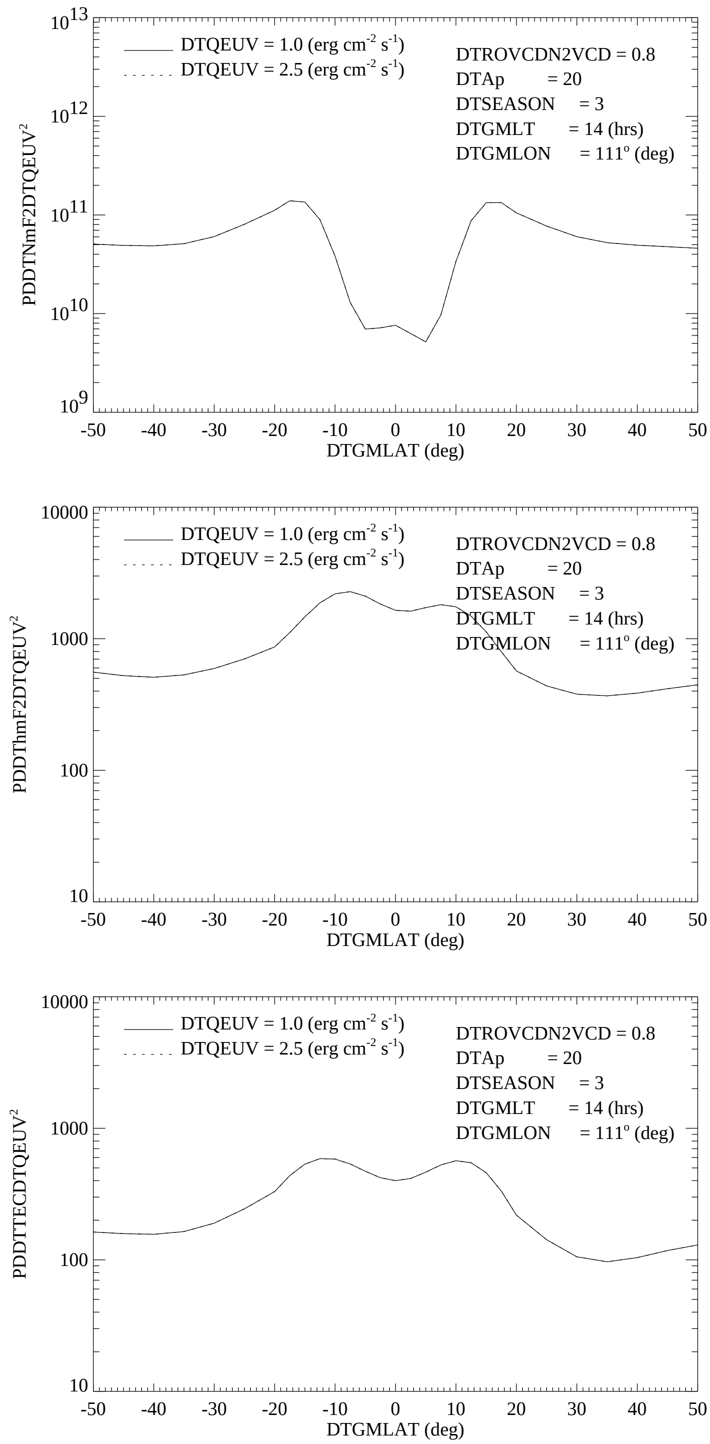

Figure 3.3.8 Plots of the square of PDDTNmF2DTQEUV (top panel), PDDThmF2DTQEUV (middle panel), and PDDTTECDTQEUV (bottom panel) versus DTGMLAT for DTQEUV values of 1.0 and 2.5 (erg cm^{-2} s^{-1}). The results are identical for both DTQEUV values due to numerical one-sided difference.

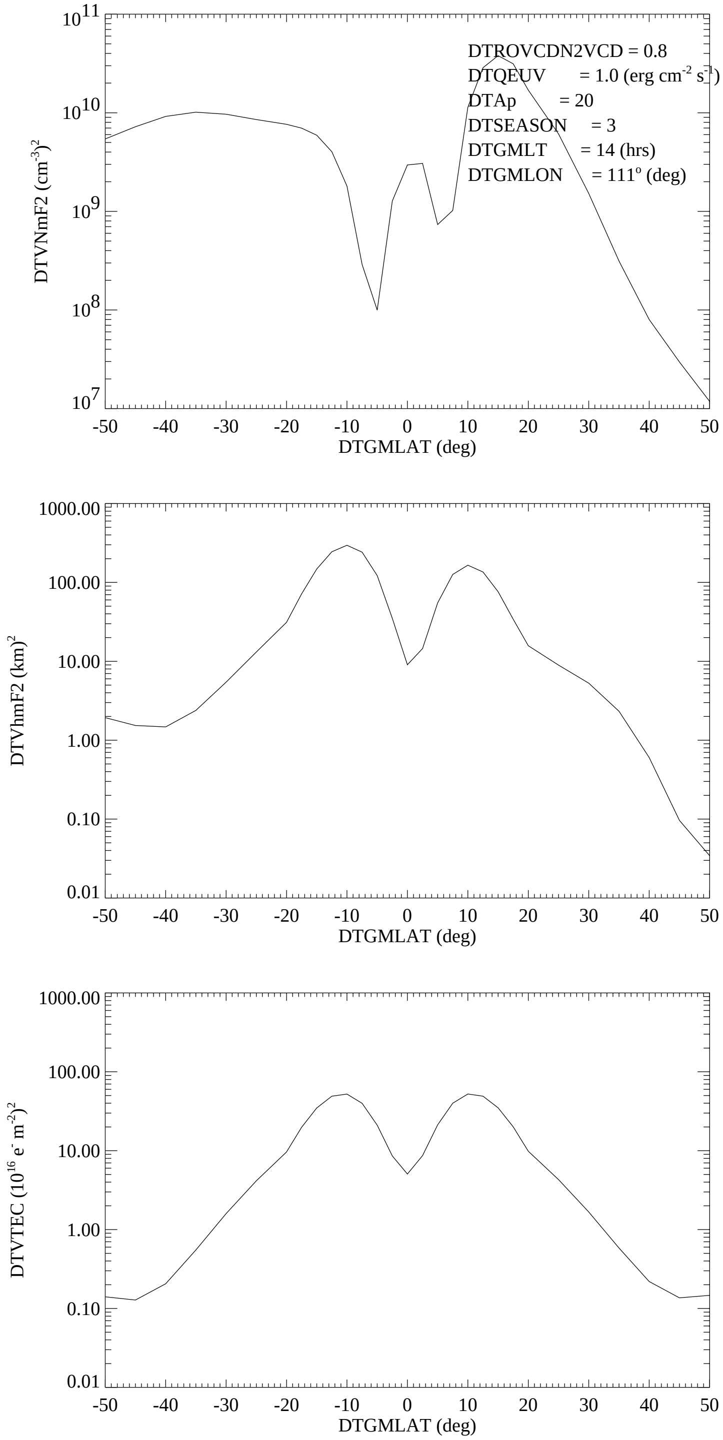

Figure 3.3.9 Plots of VNmF2 (top panel), VhmF2 (middle panel), and VTEC (bottom panel) versus DTGMLAT.

DTVTEC — The seven-dimensional vector of variances associated with the F_2-Region Total Electron Content values for the corresponding values of DTROVCDN2VCD, DTQEUV, DTAP, DTSEASON, DTGMLT, DTGMLAT, and DTGMLON which are not explicitly characterized by the input values $(10^{16}\ e^{-}\ m^{-2})^2$. The sources of uncertainties included in DTVNmF2 are uncertainties in the ExB drift and uncertainties in the meridional wind. (See Figures 3.3.9)

PDDTNmF2DTROVCDN2VCD — The seven-dimensional vector of the square of the partial derivatives of F_2-Region Peak Density values with respect to DTROVCDN2VCD for the corresponding values of DTROVCDN2VCD, DTQEUV, DTAP, DTSEASON, DTGMLT, DTGMLAT, and DTGMLON $(cm^{-3})^2$. (See Figure 3.3.7)

PDDTNmF2DTQEUV — The seven-dimensional vector of the square of the partial derivatives of F_2-Region Peak Density values with respect to DTQEUV for the corresponding values of DTROVCDN2VCD, DTQEUV, DTAP, DTSEASON, DTGMLT, DTGMLAT, and DTGMLON $(cm^{-3})^2$. (See Figure 3.3.8)

PDDThmF2DTROVCDN2VCD — The seven-dimensional vector of the square of the partial derivatives of F_2-Region Peak Density Height values with respect to DTROVCDN2VCD for the corresponding values of DTROVCDN2VCD, DTQEUV, DTSEASON, DTGMLT, DTGMLAT, and DTGMLON $(km)^2$. (See Figure 3.3.7)

PDDThmF2DTQEUV — The seven-dimensional vector of the square of the partial derivatives of F_2-Region Peak Density Height values with respect to DTQEUV for the corresponding values of DTROVCDN2VCD, DTQEUV, DTAP, DTSEASON, DTGMLT, DTGMLAT, and DTGMLON $(km)^2$. (See Figure 3.3.8)

PDDTTECDTROVCDN2VCD — The seven-dimensional vector of the square of the partial derivatives of F_2-Region Total Electron Content values with respect to DTROVCDN2VCD for the corresponding

	values of DTROVCDN2VCD, DTQEUV, DTAP, DTSEASON, DTGMLT, DTGMLAT, and DTGMLON (10^{16} e^{-} $cm^{-2})^2$. (See Figure 3.3.7)
PDDTTECDTQEUV	The seven-dimensional vector of the square of the partial derivatives of F_2-Region Total Electron Content values with respect to DTQEUV for the corresponding values of DTROVCDN2VCD, DTQEUV, DTAP, DTSEASON, DTGMLT, DTGMLAT, and DTGMLON (10^{16} e^{-} $cm^{-2})^2$. (See Figure 3.3.8)

3.3.4 The Derivation

3.3.4.1 Begin

3.3.4.2 Calculate the index corresponding to the element of the vector DTROVCDN2VCD which is closest to the input value ROVCDN2VCD (INDEXDTROVCDN2VCD).

INDEXDTROVCDN2VCD = The index corresponding to the element of the vector DTROVCDN2VCD which is closest to the input value ROVCDN2VCD. The value INDEXDTROVCDN2VCD is calculated by the Search Function (SEARCH). The following values should be used as inputs to the Search Function:

$$\textit{For SEARCH X} \xrightarrow{\text{Use}} \textit{DTROVCDN2VCD}$$
$$\textit{For SEARCH U} \xrightarrow{\text{Use}} \textit{ROVCDN2VCD}$$

3.3.4.3 Calculate the index corresponding to the element of the vector DTQEUV which is closest to the input value QEUV (INDEXDTQEUV).

INDEXDTQEUV = The index corresponding to the element of the vector DTQEUV which is closest to the input value QEUV. The value INDEXDTQEUV is calculated by the Search Function (SEARCH). The following values should be used as inputs to the Search Function:

$$\textit{For SEARCH X} \xrightarrow{\text{Use}} \textit{DTQEUV}$$
$$\textit{For SEARCH U} \xrightarrow{\text{Use}} \textit{QEUV}$$

3.3.4.4 Calculate the index corresponding to the element of the vector DTSEASON which is closest to the input value MONTH (INDEXDTSEASON).

Note: The identifier DTSEASON represents five "seasons" of the year when the declination of the Sun is approximately $+23^{o}$, $+11.5^{o}$, 0^{o}, -11.5^{o}, and -23^{o}. The five seasons can be categorized as: summer solstice, the two months before and after summer solstice, spring and fall equinox, the two months before and after winter solstice, and winter solstice respectively.

$$\text{INDEXDTSEASON} = \begin{cases} 1 & when \quad MONTH = 6 \\ 2 & when \quad MONTH = 4,5,7, or\, 8 \\ 3 & when \quad MONTH = 3\, or\, 9 \\ 4 & when \quad MONTH = 1,2,10, or\, 11 \\ 5 & when \quad MONTH = 12 \end{cases}$$

3.3.4.5 Calculate the index corresponding to the element of the vector DTGMLT which is closest to the input value GMLT (INDEXDTGMLT).

INDEXDTGMLT = The index corresponding to the element of the vector DTGMLT which is closest to the input value GMLT. The value INDEXDTGMLT is calculated by the Search Function (SEARCH). The following values should be used as inputs to the Search Function:

$$For\ SEARCH\ X \xrightarrow{\text{Use}} DTGMLT$$
$$For\ SEARCH\ U \xrightarrow{\text{Use}} GMLT$$

3.3.4.6 Calculate the index corresponding to the element of the vector DTGMLAT which is closest to the input value GMLAT (INDEXDTGMLAT).

INDEXDTGMLAT = The index corresponding to the element of the vector DTGMLAT which is closest to the input value GMLAT. The value INDEXDTGMLAT is calculated by the Search Function (SEARCH). The following values should be used as inputs to the Search Function:

$$For\ SEARCH\ X \xrightarrow{\text{Use}} DTGMLAT$$
$$For\ SEARCH\ U \xrightarrow{\text{Use}} GMLAT$$

3.3.4.7 Calculate the index corresponding to the element of the vector DTGMLON which is closest to the input value GMLON (INDEXDTGMLON).

INDEXDTGMLON = The index corresponding to the element of the vector DTGMLON which is closest to the input value GMLON. The value INDEXDTGMLON is calculated by the Search Function (SEARCH). The following values should be used as inputs to the Search Function:

$$\textit{For SEARCH X} \xrightarrow{\text{Use}} \textit{DTGMLON}$$
$$\textit{For SEARCH U} \xrightarrow{\text{Use}} \textit{GMLON}$$

3.3.4.8 Calculate the F_2-region peak density (NmF2).

NmF2 =DTNmF2 [INDEXDTROVCDN2VCD,
INDEXDTQEUV,
INDEXDTAP,
INDEXDTSEASON,
INDEXDTGMLT,
INDEXDTGMLAT,
INDEXDTGMLON]

Calculate the variance associated with the F_2-region peak density (VNmF2).

Note: The sources of uncertainty in the derived NmF2 value arise from uncertainty in the theoretical model used to generate the values in the EDPP Data Table (i.e. DTVNmF2) and from uncertainties in the input ROVCDN2VCD and QEUV values (i.e. PDDTNmF2DTROVCDN2VCD∗VROVCDN2VCD+ PDDTNmF2DTQEUV∗VQEUV).

TempA = PDDTNmF2DTROVCDN2VCD [INDEXDTROVCDN2VCD,
INDEXDTQEUV,
INDEXDTAP,
INDEXDTSEASON,
INDEXDTGMLT,
INDEXDTGMLAT,
INDEXDTGMLON] ∗
VROVCDN2VCD

TempB = PDDTNmF2DTQEUV [INDEXDTROVCDN2VCD,
INDEXDTQEUV,
INDEXDTAP,
INDEXDTSEASON,
INDEXDTGMLT,
INDEXDTGMLAT,
INDEXDGMLON] ∗VQEUV

TempC = DTVNmF2 [INDEXDTROVCDN2VCD,
INDEXDTQEUV,
INDEXDTAP,
INDEXDTSEASON,

INDEXDTGMLT,
INDEXDTGMLAT,
INDEXDGMLON]

VNmF2 = TempA + TempB + TempC

3.3.4.9 Calculate the height of the F_2-region peak density (hmF2).

hmF2 = DThmF2 [INDEXDTROVCDN2VCD,
INDEXDTQEUV,
INDEXDTAP,
INDEXDTSEASON,
INDEXDTGMLT,
INDEXDTGMLAT,
INDEXDTGMLON]

Calculate the variance associated with the height of the F_2-region peak density (VhmF2).

Note: The sources of uncertainty in the derived hmF2 value arise from uncertainty in the theoretical model used to generate the values in the EDPP Data Table (i.e. DTVhmF2) and from uncertainties in the input ROVCDN2VCD and QEUV values (i.e. PDDThmF2DTROVCDN2VCD∗VROVCDN2VCD+ PDDThmF2DTQEUV∗VQEUV).

TempA = PDDThmF2DTROVCDN2VCD [INDEXDTROVCDN2VCD,
INDEXDTQEUV,
INDEXDTAP,
INDEXDTSEASON,
INDEXDTGMLT,
INDEXDTGMLAT,
INDEXDTGMLON] ∗
VROVCDN2VCD

TempB = PDDThmF2DTQEUV [INDEXDTROVCDN2VCD,
INDEXDTQEUV,
INDEXDTAP,
INDEXDTSEASON,
INDEXDTGMLT,
INDEXDTGMLAT,
INDEXDGMLON] ∗ VQEUV

TempC = DTVhmF2 [INDEXDTROVCDN2VCD,
INDEXDTQEUV,
INDEXDTAP,

INDEXDTSEASON,
INDEXDTGMLT,
INDEXDTGMLAT,
INDEXDGMLON]

VhmF2 = TempA + TempB + TempC

3.3.4.10 Calculate the F_2-region total electron content (TEC).

TEC = DTTEC [INDEXDTROVCDN2VCD,
INDEXDTQEUV,
INDEXDTAP,
INDEXDTSEASON,
INDEXDTGMLT,
INDEXDTGMLAT,
INDEXDTGMLON]

Calculate the variance associated with the height of the F_2-region total electron content (TEC).

Note: The sources of uncertainty in the derived TEC value arise from uncertainty in the theoretical model used to generate the values in the EDPP Data Table (i.e. DTVTEC) and from uncertainties in the input ROVCDN2VCD and QEUV values (i.e. PDDTTECDTROVCDN2VCD∗VROVCDN2VCD+ PDDTTECDTQEUV ∗ VQEUV).

TempA = PDDTTECDTROVCDN2VCD [INDEXDTROVCDN2VCD,
INDEXDTQEUV,
INDEXDTAP,
INDEXDTSEASON,
INDEXDTGMLT,
INDEXDTGMLAT,
INDEXDTGMLON] ∗
VROVCDN2VCD

TempB = PDDTTECDTQEUV [INDEXDTROVCDN2VCD,
INDEXDTQEUV,
INDEXDTAP,
INDEXDTSEASON,
INDEXDTGMLT,
INDEXDTGMLAT,
INDEXDGMLON] ∗ VQEUV

TempC = DTVTEC [INDEXDTROVCDN2VCD,
INDEXDTQEUV,

INDEXDTAP,
INDEXDTSEASON,
INDEXDTGMLT,
INDEXDTGMLAT,
INDEXDGMLON]

VTEC = TempA + TempB + TempC

3.3.4.11 End

3.4 The Discrete Inverse Theory Data Table Function (DITDTF).

3.4.1 Required Input to the Derivation.

Texo	The exospheric temperature (K).
VTexo	The variance associated with Texo $(K)^2$.
QEUV	The solar EUV flux below 450 A (erg cm^{-2} s^{-1}).
VQEUV	The variance associated with QEUV (erg cm^{-2} $s^{-1})^2$.
SZA	The solar zenith angle (radians).
SCLN2	The N_2 density scale factor (dimensionless).
VSCLN2	The variance associated with SCLN2 (dimensionless).
SCLO2	The O_2 density scale factor (dimensionless).
VSCLO2	The variance associated with SCLO2 (dimensionless).
SCLO	The O density scale factor (dimensionless).
VSCLO	The variance associated with SCLO (dimensionless).
ALTGRID	The tangent altitude grid for the output data-items (km).
VALTGRID	The variance associated with ALTGRID $(km)^2$.

3.4.2 Calculated Output of the Derivation.

I1356P	The vector of 1356 A intensities (Rayleighs).
VI1356P	The variance associated with I1356P $(Rayleighs)^2$.
ILBH1P	The vector of LBH1 (1400-1500 A) intensities (Rayleighs).
VILBH1P	The variance associated with ILBH1P $(Rayleighs)^2$.
ILBH2P	The vector of LBH2 (1650-1800 A) intensities (Rayleighs).
VILBH2P	The variance associated with ILBH2P $(Rayleighs)^2$.
N2DP	The vector of N_2 volume densities (cm^{-3}).

VN2DP	The variance associated with N2DP $(cm^{-3})^2$.
O2DP	The vector of O_2 volume densities (cm^{-3}).
VO2DP	The variance associated with O2DP $(cm^{-3})^2$.
ODP	The vector of O volume densities (cm^{-3}).
VODP	The variance associated with ODP $(cm^{-3})^2$.

3.4.3 Contents of the Discrete Inverse Theory Data Table:

The contents of the Discrete Inverse Theory Data Table described below were generated with the optical backgrounds models developed by CPI [Strickland and Meier, 1982; Strickland and Anderson, 1983]. Plots of a sample of the data table contents are provided in Figures 3.4.1 through 3.4.3.

DTQEUVREF	The value of the reference solar EUV flux below 450 A (erg cm^{-2} s^{-1}).
DTUNCIP	The percent uncertainty of DTI1356P, DTILBH1P, and DTILBH2P due to uncertainty in the models used to generate the Discrete Inverse Theory Data Table. The uncertainty DTUNCIP accounts for uncertainty in I1356P, ILBH1P, and ILBH2P due to a 20% uncertainty in the OI 1356 and N_2 LBH cross sections. [Meier, 1991; Meier, 1993].
DTTexo	The one-dimensional vector of exospheric temperatures (K).
DTSZA	The one-dimensional vector of solar zenith angles (radians).
DTSCLN2	The one-dimensional vector of density profile scale factors. The vector DTSCLN2 represents the scale factors for N_2 density profiles (dimensionless).
DTSCLO2	The one-dimensional vector of density profile scale factors. The vector DTSCLO2 represents the scale factors for O_2 density profiles (dimensionless).
DTSCLO	The one-dimensional vector of density profile scale factors. The vector DTSCLO represents the scale factors for O density profiles (dimensionless).

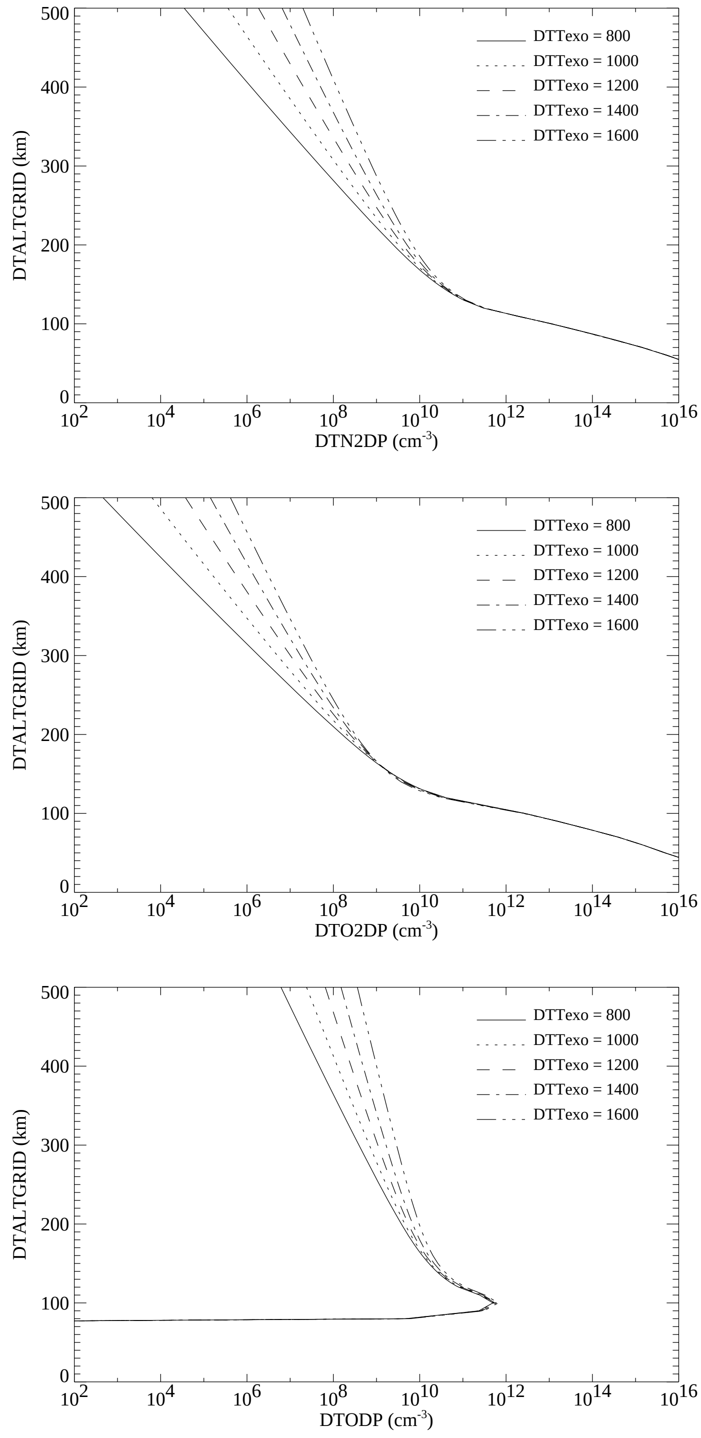

Figure 3.4.1 Top Panel: Plots of DTN2DP versus DTALTGRID for exospheric temperature (DTTexo) values 800 K, 1000 K, 1200 K, 1400 K, and 1600 K. Middle Panel: Plots of DTO2DP versus DTALTGRID for DTTexo values 800 K, 1000 K, 1200 K, 1400 K, and 1600 K. Bottom Panel: Plots of DTODP versus DTALTGRID for DTTexo values 800 K, 1000 K, 1200 K, 1400 K, and 1600 K.

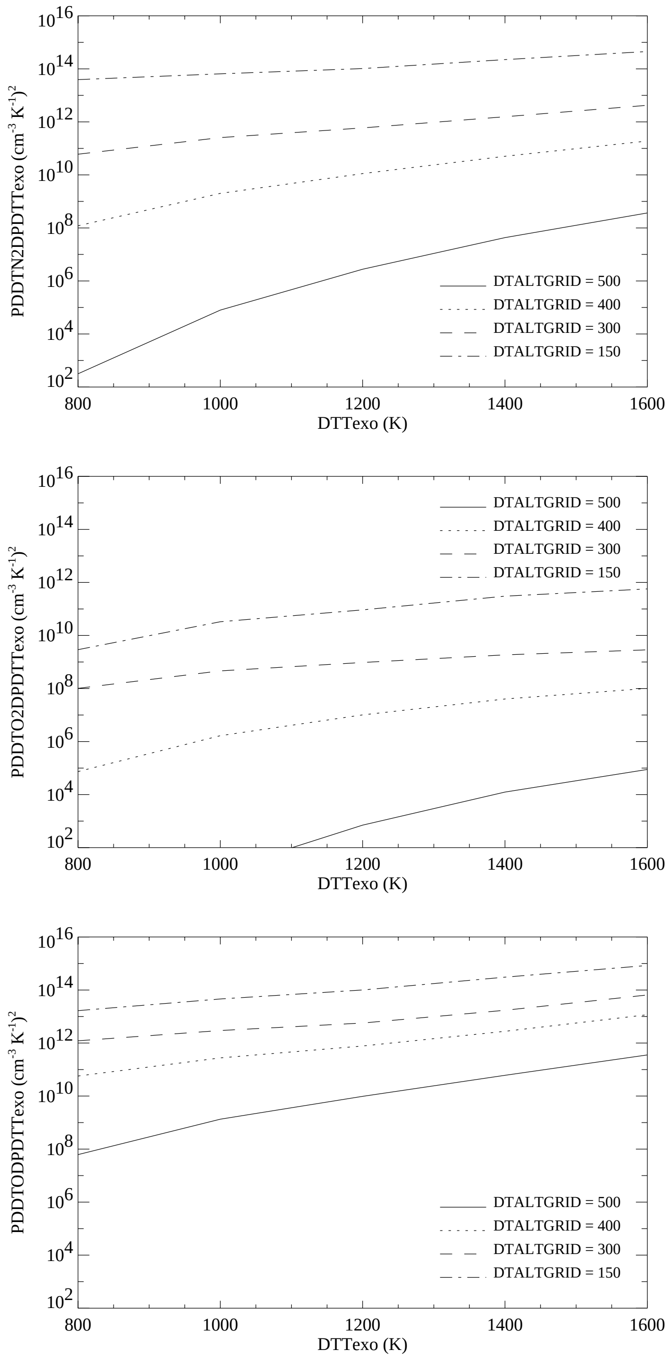

Figure 3.4.2 Top Panel: Plots of PDDTN2DPDTTexo versus DTTexo for DTALTGRID values 500 km, 400 km, 300 km, and 150 km. Middle Panel: Plots of PDDTO2DPDTTexo versus DTTexo for DTALTGRID values 500 km, 400 km, 300 km, and 150 km. Bottom Panel: Plots of PDDTODPDTTexo versus DTTexo for DTALTGRID values 500 km, 400 km, 300 km, and 150 km.

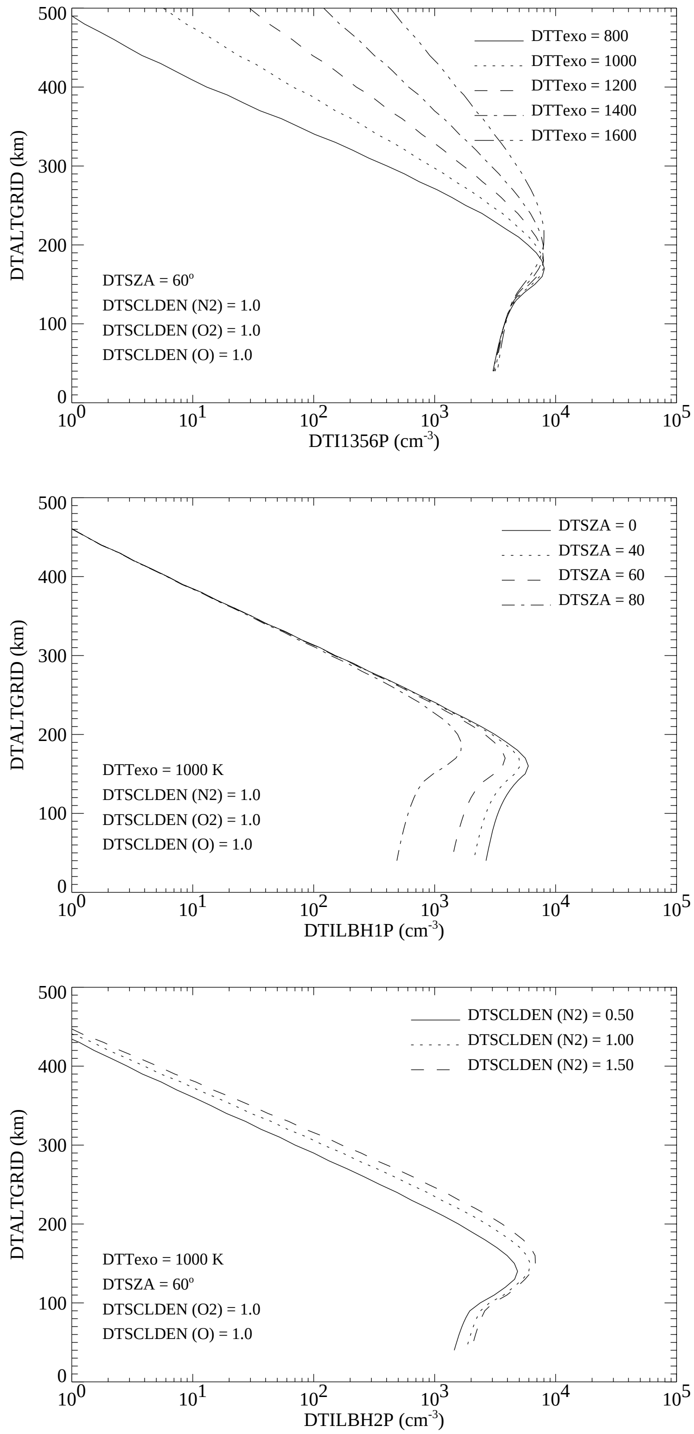

Figure 3.4.3 Top Panel: Plots of DTI1356P versus DTALTGRID for DTTexo values 800 K, 1000 K, 1200 K, 1400 K, and 1600 K. Middle Panel: Plots of DTILBH1P versus DTALTGRID for DTSZA values 0^o, 40^o, 60^o, and 80^o. Bottom Panel: Plots DTILBH2P versus DTALTGRID for N_2 density scale factor (DTSCLDEN) values 0.5, 1.0, and 1.5

DTALTGRID — The one-dimensional vector of tangent altitudes (km).

DTN2DP — The two-dimensional vector of N_2 density values for the corresponding values of DTTexo and DTALTGRID (cm^{-3}). (See Figure 3.4.1).

DTO2DP — The two-dimensional vector of O_2 density values for the corresponding values of DTTexo and DTALTGRID (cm^{-3}). (See Figure 3.4.1).

DTODP — The two-dimensional vector of O density values for the corresponding values of DTTexo and DTALTGRID (cm^{-3}). (See Figure 3.4.1).

PDDTN2DPDTTexo — The two-dimensional vector of the square of the partial derivatives of DTN2DP with respect to DTTexo for the corresponding values of DTTexo and DTALTGRID (cm^{-3} $K^{-1})^2$. (See Figure 3.4.2).

PDDTO2DPDTTexo — The two-dimensional vector of the square of the partial derivatives of DTO2DP with respect to DTTexo for the corresponding values of DTTexo and DTALTGRID (cm^{-3} $K^{-1})^2$. (See Figure 3.4.2).

PDDTODPDTTexo — The two-dimensional vector of the square of the partial derivatives of DTODP with respect to DTTexo for the corresponding values of DTTexo and DTALTGRID (cm^{-3} $K^{-1})^2$. (See Figure 3.4.2).

DTI1356P — The six-dimensional vector of 1356 A column emission rate values for the corresponding values of DTTexo, DTSZA, DTSCLN2, DTSCLO2, DTSCLO, and DTALTGRID (Rayleighs). (See Figure 3.4.3).

DTILBH1P — The six-dimensional vector of LBH1 (1400-1500 A) column emission rate values for the corresponding values of DTTexo, DTSZA, DTSCLN2, DTSCLO2, DTSCLO, and DTALTGRID (Rayleighs). (See Figure 3.4.3).

DTILBH2P — The six-dimensional vector of LBH2 (1650-1800 A) column emission rate values for the corresponding values of DTTexo, DTSZA, DTSCLN2, DTSCLO2, DTSCLO, and DTALTGRID (Rayleighs). (See Figure 3.4.3).

3.4.4 The Derivation

3.4.4.1 Begin

3.4.4.2 Calculate the index corresponding to the element of the vector DTTexo which is closest to the input value Texo (INDEXDTTexo).

INDEXDTTexo = The index corresponding to the element of the vector DTTexo which is closest to the input value Texo. The value INDEXDTTexo is calculated by the Search Function (SEARCH) The following values should be used as inputs to the Search Function:

$$\textit{For SEARCH X} \xrightarrow{\text{Use}} \textit{DTTexo}$$
$$\textit{For SEARCH U} \xrightarrow{\text{Use}} \textit{Texo}$$

3.4.4.3 Calculate the index corresponding to the element of the vector DTSCLN2 which is closest to the input value SCLN2 (INDEXDTSCLN2).

INDEXDTSCLN2 = The index corresponding to the element of the vector DTSCLN2 which is closest to the input value SCLN2. The value INDEXDTSCLN2 is calculated by the Search Function (SEARCH). The following values should be used as inputs to the Search Function:

$$\textit{For SEARCH X} \xrightarrow{\text{Use}} \textit{DTSCLN2}$$
$$\textit{For SEARCH U} \xrightarrow{\text{Use}} \textit{SCLN2}$$

3.4.4.4 Calculate the index corresponding to the element of the vector DTSCLO2 which is closest to the input value SCLO2 (INDEXDTSCLO2).

INDEXDTSCLO2 = The index corresponding to the element of the vector DTSCLO2 which is closest to the input value SCLO2. The value INDEXDTSCLO2 is calculated by the Search Function (SEARCH). The following values should be used as inputs to the Search Function:

$$\textit{For SEARCH X} \xrightarrow{\text{Use}} \textit{DTSCLO2}$$
$$\textit{For SEARCH U} \xrightarrow{\text{Use}} \textit{SCLO2}$$

3.4.4.5 Calculate the index corresponding to the element of the vector DTSCLO which is closest to the input value SCLO (INDEXDTSCLO).

INDEXDTSCLO = The index corresponding to the element of the vector DTSCLO which is closest to the input value SCLO. The value INDEXDTSCLO is calculated by the Search

Function (SEARCH). The following values should be used as inputs to the Search Function:

$$For\ SEARCH\ X \xrightarrow{Use} DTSCLO$$
$$For\ SEARCH\ U \xrightarrow{Use} SCLO$$

3.4.4.6 Calculate the model 1356 A intensity profile (I1356P).

$$\text{TempA} = \left(\frac{QEUV}{DTQEUVREF} \right)$$

Repeat the following calculations for each index i (corresponding to the ith element of DTALTGRID) of the one-dimensional vector TempC.

Note: Each element of the one-dimensional vector TempB is calculated in the same manner. For the jth element (corresponding to the jth element of DTSZA), the value of TempB is calculated as:

TempB [j] = TempA* DTI1356P [INDEXDTTexo,
j,
INDEXDTSCLN2,
INDEXDTSCLO2,
INDEXDTSCLO,
i]

Note: Each element of the one-dimensional vector TempC is calculated in the same manner. For the ith element (corresponding to the ith element of DTALTGRID), the value of TempC is calculated as:

TempC [i] = The interpolated value of TempB corresponding to the input value SZA for the ith element of DTALTGRID. The value TempC[i] is calculated by the Interpolate Function (INTERPOLATE). The following values should be used as input to the Interpolate Function:

$$For\ INTERPOLATE\ Y \xrightarrow{Use} TempB$$
$$For\ INTERPOLATE\ X \xrightarrow{Use} DTSZA$$
$$For\ INTERPOLATE\ U \xrightarrow{Use} SZA$$

End repeat calculations (index i)

Note: Each element of the one-dimensional vector I1356P is calculated in the same manner. For the ith element (corresponding to the ith element of ALTGRID), the value of I1356P is calculated as:

I1356P [i] = The interpolated value of TempC for the ith element of the input vector ALTGRID. The value I1356P[i] is calculated by the Interpolate Function (INTERPOLATE). The following values should be used as input to the Interpolate Function:

For INTERPOLATE Y $\xrightarrow{\text{Use}}$ *TempC*
For INTERPOLATE X $\xrightarrow{\text{Use}}$ *DTALTGRID*
For INTERPOLATE U $\xrightarrow{\text{Use}}$ *ALTGRID [i]*

Calculate the variance associated with the model 1356 A intensity profile (VI1356P)

Note: The sources of uncertainty in the derived I1356P values arise from uncertainty in the theoretical model used to generate the values in the Discrete Inverse Theory Data Table (i.e. DTUNCIP∗I1356P) and from uncertainties in the input QEUV and ALTGRID values (i.e. VQEUV and VALTGRID multiplied by the square of the appropriate partial derivatives).

Repeat the following calculations for each index i (corresponding to the ith element of DTALTGRID) of the one-dimensional vector VI1356P.

Note: Each element of the one-dimensional vector VI1356P is calculated in the same manner. For the ith element (corresponding to the ith element of ALTGRID), the value of VI1356P is calculated as:

TempD = The partial derivative of I1356P with respect to ALTGRID at the altitude point ALTGRID[i]. The value TempD is calculated by the Derivative Function (DERIVATIVE). The following values should be used as input to the Derivative Function:

For DERIVATIVE Y $\xrightarrow{\text{Use}}$ *I1356P*
For DERIVATIVE X $\xrightarrow{\text{Use}}$ *ALTGRID*
For DERIVATIVE INDEX $\xrightarrow{\text{Use}}$ *i*

$$\text{TempE} = \left(\frac{\text{I1356P}[i]}{\text{QEUV}}\right)^2 * \text{VQEUV}$$

$$\text{TempF} = (\text{DTUNCIP} * \text{I1356P}[i])^2$$

$$\text{TempG} = \text{TempD}^2 * \text{VALTGRID}[i]$$

VI1356P [i] = TempE + TempF + TempG

End repeat calculations (index i)

3.4.4.7 Calculate the model LBH1 (1400-1500 A) intensity profiles (ILBH1P).

$$\text{TempA} = \left(\frac{QEUV}{DTQEUVREF}\right)$$

Repeat the following calculations for each index i (corresponding to the ith element of DTALTGRID) of the one-dimensional vector TempC.

Note: Each element of the one-dimensional vector TempB is calculated in the same manner. For the jth element (corresponding to the jth element of DTSZA), the value of TempB is calculated as:

TempB [j] = TempA* DTILBH1P [INDEXDTTexo,
j,
INDEXDTSCLN2,
INDEXDTSCLO2,
INDEXDTSCLO,
i]

Note: Each element of the one-dimensional vector TempC is calculated in the same manner. For the ith element (corresponding to the ith element of DTALTGRID), the value of TempC is calculated as:

TempC [i] = The interpolated value of TempB corresponding to the input value SZA for the ith element of DTALTGRID. The value TempC[i] is calculated by the Interpolate Function (INTERPOLATE). The following values should be used as input to the Interpolate Function:

$$\textit{For INTERPOLATE Y} \xrightarrow{\text{Use}} \textit{TempB}$$
$$\textit{For INTERPOLATE X} \xrightarrow{\text{Use}} \textit{DTSZA}$$
$$\textit{For INTERPOLATE U} \xrightarrow{\text{Use}} \textit{SZA}$$

End repeat calculations (index i)

Note: Each element of the one-dimensional vector ILBH1P is calculated in the same manner. For the ith element (corresponding to the ith element of ALTGRID), the value of ILBH1P is calculated as:

ILBH1P [i] = The interpolated value of TempC for the ith element of the input vector ALTGRID. The value ILBH1P[i] is calculated by the Interpolate Function (INTERPOLATE). The following values should be used as input to the Interpolate Function:

$$\textit{For INTERPOLATE Y} \xrightarrow{\text{Use}} \textit{TempC}$$

For INTERPOLATE X $\xrightarrow{\text{Use}}$ *DTALTGRID*
For INTERPOLATE U $\xrightarrow{\text{Use}}$ *ALTGRID [i]*

Calculate the variance associated with the model LBH1 (1400 - 1500 A) intensity profile (VILBH1P)

Note: The sources of uncertainty in the derived ILBH1P values arise from uncertainty in the theoretical model used to generate the values in the Discrete Inverse Theory Data Table (i.e. DTUNCIP∗ILBH1P) and from uncertainties in the input QEUV and ALTGRID values (i.e. VQEUV and VALTGRID multiplied by the square of the appropriate partial derivatives).

Repeat the following calculations for each index i (corresponding to the ith element of DTALTGRID) of the one-dimensional vector VILBH1P.

Note: Each element of the one-dimensional vector VILBH1P is calculated in the same manner. For the ith element (corresponding to the ith element of ALTGRID), the value of VILBH1P is calculated as:

TempD = The partial derivative of ILBH1P with respect to ALTGRID at the altitude point ALTGRID[i]. The value TempD is calculated by the Derivative Function (DERIVATIVE). The following values should be used as input to the Derivative Function:

For DERIVATIVE Y $\xrightarrow{\text{Use}}$ *ILBH1P*
For DERIVATIVE X $\xrightarrow{\text{Use}}$ *ALTGRID*
For DERIVATIVE INDEX $\xrightarrow{\text{Use}}$ *i*

$$\text{TempE} = \left(\frac{\text{ILBH1P[i]}}{\text{QEUV}}\right)^2 * \text{VQEUV}$$

$$\text{TempF} = (\text{DTUNCIP} * \text{ILBH1P[i]})^2$$

$$\text{TempG} = \text{TempD}^2 * \text{VALTGRID[i]}$$

VILBH1P [i] = TempE + TempF + TempG

End repeat calculations (index i)

3.4.4.8 Calculate the model LBH2 (1650-1800 A) intensity profiles (ILBH2P).

$$\text{TempA} = \left(\frac{QEUV}{DTQEUVREF}\right)$$

Repeat the following calculations for each index i (corresponding to the ith element of DTALTGRID) of the one-dimensional vector TempC.

Note: Each element of the one-dimensional vector TempB is calculated in the same manner. For the jth element (corresponding to the jth element of DTSZA), the value of TempB is calculated as:

TempB [j] = TempA* DTILBH2P [INDEXDTTexo,
j,
INDEXDTSCLN2,
INDEXDTSCLO2,
INDEXDTSCLO,
i]

Note: Each element of the one-dimensional vector TempC is calculated in the same manner. For the ith element (corresponding to the ith element of DTALTGRID), the value of TempC is calculated as:

TempC [i] = The interpolated value of TempB corresponding to the input value SZA for the ith element of DTALTGRID. The value TempC[i] is calculated by the Interpolate Function (INTERPOLATE). The following values should be used as input to the Interpolate Function:

$$\textit{For INTERPOLATE Y} \xrightarrow{\text{Use}} \textit{TempB}$$
$$\textit{For INTERPOLATE X} \xrightarrow{\text{Use}} \textit{DTSZA}$$
$$\textit{For INTERPOLATE U} \xrightarrow{\text{Use}} \textit{SZA}$$

End repeat calculations (index i)

Note: Each element of the one-dimensional vector ILBH2P is calculated in the same manner. For the ith element (corresponding to the ith element of ALTGRID), the value of ILBH2P is calculated as:

ILBH2P [i] = The interpolated value of TempC for the ith element of the input vector ALTGRID. The value ILBH2P[i] is calculated by the Interpolate Function (INTERPOLATE). The following values should be used as input to the Interpolate Function:

$$\textit{For INTERPOLATE Y} \xrightarrow{\text{Use}} \textit{TempC}$$
$$\textit{For INTERPOLATE X} \xrightarrow{\text{Use}} \textit{DTALTGRID}$$
$$\textit{For INTERPOLATE U} \xrightarrow{\text{Use}} \textit{ALTGRID [i]}$$

Calculate the variance associated with the model LBH2 (1650 - 1800 A) intensity profile (VILBH2P)

Note: The sources of uncertainty in the derived ILBH2P values arise from uncertainty in the theoretical model used to generate the values in the Discrete Inverse Theory Data Table (i.e. DTUNCIP∗ILBH2P) and from uncertainties in the input QEUV and ALTGRID values (i.e. VQEUV and VALTGRID multiplied by the square of the appropriate partial derivatives).

Repeat the following calculations for each index i (corresponding to the ith element of DTALTGRID) of the one-dimensional vector VILBH2P.

Note: Each element of the one-dimensional vector VILBH2P is calculated in the same manner. For the ith element (corresponding to the ith element of ALTGRID), the value of VILBH2P is calculated as:

TempD = The partial derivative of ILBH2P with respect to ALTGRID at the altitude point ALTGRID[i]. The value TempD is calculated by the Derivative Function (DERIVATIVE). The following values should be used as input to the Derivative Function:

$$\begin{array}{ll} \textit{For DERIVATIVE Y} & \xrightarrow{\text{Use}} \textit{ILBH2P} \\ \textit{For DERIVATIVE X} & \xrightarrow{\text{Use}} \textit{ALTGRID} \\ \textit{For DERIVATIVE INDEX} & \xrightarrow{\text{Use}} \textit{i} \end{array}$$

$$\text{TempE} = \left(\frac{\text{ILBH2P[i]}}{\text{QEUV}}\right)^2 * \text{VQEUV}$$

$$\text{TempF} = (\text{DTUNCIP} * \text{ILBH2P[i]})^2$$

$$\text{TempG} = \text{TempD}^2 * \text{VALTGRID[i]}$$

VILBH2P [i] = TempE + TempF + TempG

End repeat calculations (index i)

3.4.4.9 Calculate the model data intensity profile (MDIP).

Note: Each element of the one-dimensional vector MDIP is calculated in the same manner. For the ith element, the value of MDIP is calculated as:

$$\text{MDIP[i]} = \begin{cases} \text{I1356P[i]} & \text{when} \quad i = 1, N \\ \text{ILBH1P[i} - \text{N]} & \text{when} \quad i = N + 1, 2 * N \\ \text{ILBH2P[i} - 2 * \text{N]} & \text{when} \quad i = 2 * N + 1, 3 * N \end{cases}$$

where

N = The number of elements in each of the vectors I1356P, ILBH1P, and ILBH2P

Calculate the variance associated with the model data intensity profile (VMDIP)

Note: Each element of the one-dimensional vector VMDIP is calculated in the same manner. For the ith element, the value of VMDIP is calculated as:

$$\mathrm{VMDIP}[i] = \begin{cases} \mathrm{VI1356P}[i] & \text{when } i = 1, N \\ \mathrm{VILBH1P}[i - N] & \text{when } i = N + 1, 2 * N \\ \mathrm{VILBH2P}[i - 2 * N] & \text{when } i = 2 * N + 1, 3 * N \end{cases}$$

where

N = The number of elements in each of the vectors VI1356P, VILBH1P, and VILBH2P

3.4.4.10 Calculate the model N_2 density profile (N2DP).

Repeat the following calculations for each index i (referring to the ith index of DTALTGRID) of the one-dimensional vector TempA.

Note: Each element of the vector TempB is calculated in the same manner. For the ith DTALTGRID point and the jth DTTexo point, the value of TempB is calculated as:

TempB[j] = ln (SCLN2∗DTN2DP [j,i])

where

ln = The natural logarithm function.

TempA[i] = The interpolated value of TempB at the input exospheric temperature Texo and altitude point DTALTGRID [i]. The value TempA[i] is calculated by the Interpolate Function (INTERPOLATE). The following values should be used as input to the Interpolate function:

$$\textit{For INTERPOLATE Y} \xrightarrow{\text{Use}} \textit{TempB}$$
$$\textit{For INTERPOLATE X} \xrightarrow{\text{Use}} \textit{DTTexo}$$

For INTERPOLATE U $\xrightarrow{\text{Use}}$ *Texo*

End repeat calculations (index i)

Note: Each element of the vector N2DP is calculated in the same manner. For the ith element, the value of N2DP is calculated as:

N2DP[i] = The interpolated value of TempA at the input exospheric temperature Texo and altitude point ALTGRID [i]. The value N2DP[i] is calculated by the Interpolate Function (INTERPOLATE). The following values should be used as input to the Interpolate function:

For INTERPOLATE Y $\xrightarrow{\text{Use}}$ *TempA*
For INTERPOLATE X $\xrightarrow{\text{Use}}$ *DTALTGRID*
For INTERPOLATE U $\xrightarrow{\text{Use}}$ *ALTGRID [i]*

N2DP[i] = exp (N2DP[i])

where

exp = The exponential function.

Calculate the variance associated with the model N_2 *density profile (VN2DP)*

Note: The sources of uncertainty in the derived N2DP value arise from uncertainties in the input SCLN2, Texo, and ALTGRID values (i.e. VSCLN2, Vtexo, and VALTGRID multiplied by the square of the appropriate partial derivatives).

Repeat the following calculations for each index i (referring to the ith index of DTALTGRID) of the one-dimensional vector TempE.

Note: Each element of the vector TempD is calculated in the same manner. For the ith DTALTGRID point and the jth DTTexo point, the value of TempD is calculated as:

TempD[j] = ln ($SCLN2^2$ ∗PDDTN2DPDTTexo [j,i])

where

ln = The natural logarithm function.

TempE[i] = The interpolated value of TempD at the input exospheric temperature Texo and altitude point DTALTGRID [i]. The value TempE[i] is calculated by the Interpolate Function

(INTERPOLATE). The following values should be used as input to the Interpolate function:

$$\textit{For INTERPOLATE Y} \xrightarrow{\text{Use}} \textit{TempD}$$
$$\textit{For INTERPOLATE X} \xrightarrow{\text{Use}} \textit{DTTexo}$$
$$\textit{For INTERPOLATE U} \xrightarrow{\text{Use}} \textit{Texo}$$

End repeat calculations (index i)

Note: Each element of the vector TempF is calculated in the same manner. For the ith element, the value of TempF is calculated as:

TempF[i] = The interpolated value of TempE at the input exospheric temperature Texo and altitude point ALTGRID [i]. The value TempE[i] is calculated by the Interpolate Function (INTERPOLATE). The following values should be used as input to the Interpolate function:

$$\textit{For INTERPOLATE Y} \xrightarrow{\text{Use}} \textit{TempE}$$
$$\textit{For INTERPOLATE X} \xrightarrow{\text{Use}} \textit{DTALTGRID}$$
$$\textit{For INTERPOLATE U} \xrightarrow{\text{Use}} \textit{ALTGRID [i]}$$

TempF[i] = exp (TempF[i])

where

exp = The exponential function.

Note: Each element of the vector TempG is calculated in the same manner. For the ith element, the value of TempG is calculated as:

TempG [i] = The partial derivative of N2DP with respect to ALTGRID at the altitude point ALTGRID[i]. The value TempG [i] is calculated by the Derivative Function (DERIVATIVE). The following values should be used as input to the Derivative Function:

$$\textit{For DERIVATIVE Y} \xrightarrow{\text{Use}} \textit{N2DP}$$
$$\textit{For DERIVATIVE X} \xrightarrow{\text{Use}} \textit{ALTGRID}$$
$$\textit{For DERIVATIVE INDEX} \xrightarrow{\text{Use}} i$$

Note: Each element of the vector VN2DP is calculated in the same manner. For the ith element, the value of VN2DP is calculated as:

$$\text{VN2DP [i]} = \left(\frac{N2DP[i]}{SCLN2}\right)^2 * VSCLN2 + \text{TempF[i]}*\text{VTexo} +$$

$TempG[i]^2 * VALTGRID[i]$

3.4.4.11 Calculate the model O_2 density profile (O2DP).

Repeat the following calculations for each index i (referring to the ith index of DTALTGRID) of the one-dimensional vector TempA.

Note: Each element of the vector TempB is calculated in the same manner. For the ith DTALTGRID point and the jth DTTexo point, the value of TempB is calculated as:

$TempB[j] = \ln(SCLO2 * DTO2DP[j,i])$

where

ln = The natural logarithm function.

TempA[i] = The interpolated value of TempB at the input exospheric temperature Texo and altitude point DTALTGRID [i]. The value TempA[i] is calculated by the Interpolate Function (INTERPOLATE). The following values should be used as input to the Interpolate function:

$$\text{For INTERPOLATE } Y \xrightarrow{\text{Use}} TempB$$
$$\text{For INTERPOLATE } X \xrightarrow{\text{Use}} DTTexo$$
$$\text{For INTERPOLATE } U \xrightarrow{\text{Use}} Texo$$

End repeat calculations (index i)

Note: Each element of the vector O2DP is calculated in the same manner. For the ith element, the value of O2DP is calculated as:

O2DP[i] = The interpolated value of TempA at the input exospheric temperature Texo and altitude point ALTGRID [i]. The value O2DP[i] is calculated by the Interpolate Function (INTERPOLATE). The following values should be used as input to the Interpolate function:

$$\text{For INTERPOLATE } Y \xrightarrow{\text{Use}} TempA$$
$$\text{For INTERPOLATE } X \xrightarrow{\text{Use}} DTALTGRID$$
$$\text{For INTERPOLATE } U \xrightarrow{\text{Use}} ALTGRID[i]$$

$O2DP[i] = \exp(O2DP[i])$

where

exp = The exponential function.

Calculate the variance associated with the model O_2 density profile (VO2DP)

Note: The sources of uncertainty in the derived O2DP value arise from uncertainties in the input SCLO2, Texo, and ALTGRID values (i.e. VSCLO2, Vtexo, and VALTGRID multiplied by the square of the appropriate partial derivatives).

Repeat the following calculations for each index i (referring to the ith index of DTALTGRID) of the one-dimensional vector TempE.

Note: Each element of the vector TempD is calculated in the same manner. For the ith DTALTGRID point and the jth DTTexo point, the value of TempD is calculated as:

$$TempD[j] = \ln (SCLO2^2 * PDDTO2DPDTTexo\ [j,i])$$

where

ln = The natural logarithm function.

TempE[i] = The interpolated value of TempD at the input exospheric temperature Texo and altitude point DTALTGRID [i]. The value TempE[i] is calculated by the Interpolate Function (INTERPOLATE). The following values should be used as input to the Interpolate function:

$$\textit{For INTERPOLATE Y} \xrightarrow{\text{Use}} \textit{TempD}$$
$$\textit{For INTERPOLATE X} \xrightarrow{\text{Use}} \textit{DTTexo}$$
$$\textit{For INTERPOLATE U} \xrightarrow{\text{Use}} \textit{Texo}$$

End repeat calculations (index i)

Note: Each element of the vector TempF is calculated in the same manner. For the ith element, the value of TempF is calculated as:

TempF[i] = The interpolated value of TempE at the input exospheric temperature Texo and altitude point ALTGRID [i]. The value TempE[i] is calculated by the Interpolate Function (INTERPOLATE). The following values should be used as input to the Interpolate function:

$$\textit{For INTERPOLATE Y} \xrightarrow{\text{Use}} \textit{TempA}$$
$$\textit{For INTERPOLATE X} \xrightarrow{\text{Use}} \textit{DTALTGRID}$$
$$\textit{For INTERPOLATE U} \xrightarrow{\text{Use}} \textit{ALTGRID [i]}$$

TempF[i] = exp (TempF[i])

where

exp = The exponential function.

Note: Each element of the vector TempG is calculated in the same manner. For the ith element, the value of TempG is calculated as:

TempG [i] = The partial derivative of O2DP with respect to ALTGRID at the altitude point ALTGRID[i]. The value TempG [i] is calculated by the Derivative Function (DERIVATIVE). The following values should be used as input to the Derivative Function:

$$\begin{array}{ll} \textit{For DERIVATIVE Y} & \xrightarrow{\text{Use}} O2DP \\ \textit{For DERIVATIVE X} & \xrightarrow{\text{Use}} ALTGRID \\ \textit{For DERIVATIVE INDEX} & \xrightarrow{\text{Use}} i \end{array}$$

Note: Each element of the vector VO2DP is calculated in the same manner. For the ith element, the value of VO2DP is calculated as:

$$\text{VO2DP [i]} = \left(\frac{O2DP[i]}{SCLO2}\right)^2 * VSCLO2 + \text{TempF[i]} * \text{VTexo} + \text{TempG[i]}^2 * \text{VALTGRID[i]}$$

3.4.4.12 Calculate the model O density profile (ODP).

Repeat the following calculations for each index i (referring to the ith index of DTALTGRID) of the one-dimensional vector TempA.

Note: Each element of the vector TempB is calculated in the same manner. For the ith DTALTGRID point and the jth DTTexo point, the value of TempB is calculated as:

TempB[j] = ln (SCLO∗DTN2DP [j,i])

where

ln = The natural logarithm function.

TempA[i] = The interpolated value of TempB at the input exospheric temperature Texo and altitude point DTALTGRID [i]. The value TempA[i] is calculated by the Interpolate Function (INTERPOLATE). The following values should be used as input to the Interpolate function:

For INTERPOLATE Y $\xrightarrow{\text{Use}}$ *TempB*
For INTERPOLATE X $\xrightarrow{\text{Use}}$ *DTTexo*
For INTERPOLATE U $\xrightarrow{\text{Use}}$ *Texo*

End repeat calculations (index i)

Note: Each element of the vector ODP is calculated in the same manner. For the ith element, the value of ODP is calculated as:

ODP[i] = The interpolated value of TempA at the input exospheric temperature Texo and altitude point ALTGRID [i]. The value ODP[i] is calculated by the Interpolate Function (INTERPOLATE). The following values should be used as input to the Interpolate function:

For INTERPOLATE Y $\xrightarrow{\text{Use}}$ *TempA*
For INTERPOLATE X $\xrightarrow{\text{Use}}$ *DTALTGRID*
For INTERPOLATE U $\xrightarrow{\text{Use}}$ *ALTGRID [i]*

ODP[i] = exp (ODP[i])

where

exp = The exponential function.

Calculate the variance associated with the model O density profile (VODP)

Note: The sources of uncertainty in the derived ODP value arise from uncertainties in the input SCLO, Texo, and ALTGRID values (i.e. VSCLO, Vtexo, and VALTGRID multiplied by the square of the appropriate partial derivatives).

Repeat the following calculations for each index i (referring to the ith index of DTALTGRID) of the one-dimensional vector TempE.

Note: Each element of the vector TempD is calculated in the same manner. For the ith DTALTGRID point and the jth DTTexo point, the value of TempD is calculated as:

TempD[j] = ln ($SCLO^2 *$PDDTODPDTTexo [j,i])

where

ln = The natural logarithm function.

TempE[i] = The interpolated value of TempD at the input exospheric temperature Texo and altitude point DTALTGRID [i]. The value TempE[i] is calculated by the Interpolate Function (INTERPOLATE). The following values should be used as input to the Interpolate function:

For INTERPOLATE Y $\xrightarrow{\text{Use}}$ *TempD*
For INTERPOLATE X $\xrightarrow{\text{Use}}$ *DTTexo*
For INTERPOLATE U $\xrightarrow{\text{Use}}$ *Texo*

End repeat calculations (index i)

Note: Each element of the vector TempF is calculated in the same manner. For the ith element, the value of TempF is calculated as:

TempF[i] = The interpolated value of TempE at the input exospheric temperature Texo and altitude point ALTGRID [i]. The value TempE[i] is calculated by the Interpolate Function (INTERPOLATE). The following values should be used as input to the Interpolate function:

For INTERPOLATE Y $\xrightarrow{\text{Use}}$ *TempE*
For INTERPOLATE X $\xrightarrow{\text{Use}}$ *DTALTGRID*
For INTERPOLATE U $\xrightarrow{\text{Use}}$ *ALTGRID [i]*

TempF[i] = exp (TempF[i])

where

exp = The exponential function.

Note: Each element of the vector TempG is calculated in the same manner. For the ith element, the value of TempG is calculated as:

TempG [i] = The partial derivative of ODP with respect to ALTGRID at the altitude point ALTGRID[i]. The value TempG [i] is calculated by the Derivative Function (DERIVATIVE). The following values should be used as input to the Derivative Function:

For DERIVATIVE Y $\xrightarrow{\text{Use}}$ *ODP*
For DERIVATIVE X $\xrightarrow{\text{Use}}$ *ALTGRID*
For DERIVATIVE INDEX $\xrightarrow{\text{Use}}$ *i*