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REMOTE SENSING OF THE STRATOSPHERE Vol. III: Supporting Material

The Mitre Corporation/Metrek Division

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The Capability of Satellite Borne Remote Sensors to Measure Stratospheric Trace Constituents Volume III: Supporting Material

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ABSTRACT

This document is Volume III of a three volume report issued as MITRE/METREK Technical Report, MTR-7519. The three volumes cover the following principal subjects:

Volume I contains a synthesis of the results of two previous MITRE/METREK studies {1,2} and an update of the information contained in them. The update was made during the Summer and Fall of 1977. These studies deal with a comprehensive review of stratospheric trace constituent measurement requirements. The scope of the study was restricted to those constituents which fall into the general category of "air pollutants."

Volume II separates stratospheric trace constituent measurement requirements into two somewhat overlapping areas. In the first area, it is assumed that the only problem of interest is ozone; its chemistry chain, environmental effects and measurement requirements. In like manner, in the second area it is assumed that the only problem of interest is stratospheric aerosols; their chemistry, effects and measurement requirements.

Volume III contains material of a supportive nature not considered to be of sufficient importance to be included in the other two volumes. This material is of two types:

- Information and numerical evaluations used in the development of mission evaluations for stratospheric trace constituent measurement.
- Various spatial and temporal distributions for those stratospheric trace species having sufficient measurements available to warrant their presentation.

The reader is advised to note that the results and conclusions presented here are based on the specific combination of remote sensors, Shuttle orbits and analysis values selected to exemplify the technique presented. Although these sensors and orbits are typical, extension of the study to include all available sensors and many orbits, or to another specific small combination could result in different results and conclusions.

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LIST OF CHEMICAL SYMBOLS*

<u>Symbol</u>	<u>Name</u>
A	Argon
Al ⁺⁺⁺⁺	Aluminum ion
nAl ₂ O ₃	Aluminum oxide aerosol
Br	Atomic bromine
Br ⁻	Bromide ion aerosol
BrO	Bromine oxide
Ca ⁺⁺	Calcium ion aerosol
CBr ₄	Tetrabromomethane (carbon tetrabromide)
CCl ₂ =CHCl	Trichloroethylene
CCl ₄	Tetrachloromethane (carbon tetrachloride)
CFC1 ₂ ⁺	Dichlorofluoromethane radical
CFC1 ₃	Trichlorofluomethane (F-11)
CF ₂ Cl ⁺	Chlorodifluoromethane radical
CF ₂ ClCFC1 ₂	Trichlorotrifluoroethane (F-113)
CF ₂ Cl ₂	Dichlorodifluoromethane (F-12)
CHClF ₂	Chlorodifluoromethane (F-22)
CHCl ₂ F	Dichlorofluoromethane
CHCl ₃	Trichloromethane (chloroform)
CH ₂ :CHCl	Vinyl chloride
CH ₂ Cl ₂	Dichloromethane (methyl dichloride)

* Common name given in parentheses where appropriate. Unless specifically stated, species is assumed to be in gaseous state.

LIST OF CHEMICAL SYMBOLS (Continued)

<u>Symbol</u>	<u>Name</u>
CH_2O	Methanal (formaldehyde)
CH_3	Methyl radical
CH_3Br	Bromomethane (methyl bromide)
CH_3CCl_3	Trichloroethane (methyl chloroform)
CH_3Cl	Chloromethane (methyl chloride)
CH_3O	Methyl oxy radical
CH_3O_2	Methyl peroxy radical
$(\text{CH}_3)_2\text{S}$	Methyl sulfide
CH_4	Methane
CO	Carbon monoxide
COCl	Carbonyl monochloride
COS	Carbonyl sulfide
CO_2	Carbon dioxide
$n\text{CO}_2$	Carbon dioxide in cluster formation; quasi aerosol
CS_2	Carbon disulfide
$\text{C}_2\text{H}_4\text{Cl}_2$	Dichloroethane
$\text{C}_2\text{H}_5\text{Cl}$	Chloroethane (ethyl chloride)
C_xH_y	Non-methane hydrocarbons (NMHC)
Cl	Atomic chlorine
Cl^-	Chloride ion aerosol
$\text{Cl}_2\text{C:CCl}_2$	Tetrachloroethene (perchloroethylene)
ClFCO	Fluoroformyl chloride

LIST OF CHEMICAL SYMBOLS (Continued)

<u>Symbol</u>	<u>Name</u>
ClO	Chlorine monoxide
ClONO ₂	Chlorine nitrate
ClO ₂	Chlorine dioxide
ClO _x	"Odd" chlorine
Cu ⁺⁺	Copper ion aerosol
F ₂ CO	Carbonyl fluoride
Fe ⁺⁺ or Fe ⁺⁺⁺	Iron ion aerosol
H	Atomic hydrogen
HBr	Hydrogen bromide
HCl	Hydrogen chloride
HF	Hydrogen fluoride
HNO ₂	Nitrous acid
HNO ₃	Nitric acid
nHNO ₃	Nitric acid aerosol
HO or OH	Hydroxyl
HO ₂	Hydroperoxyl
HSO ₃ ⁻	Bisulfite radical
H ₂	Molecular hydrogen
H ₂ O	Water vapor
nH ₂ O	Liquid water or ice (as aerosol or in cluster formation)
H ₂ O ₂	Hydrogen peroxide

LIST OF CHEMICAL SYMBOLS (Continued)

<u>Symbol</u>	<u>Name</u>
H_2S	Hydrogen sulfide
H_2SO_4	Sulfuric acid
$H_2SO_4 \cdot nH_2O$	Sulfuric acid aerosol
$\begin{matrix} H & C & O \\ x & y & z \end{matrix}$	Unspecified organic compound
I^-	Iodide ion aerosol
K^+	Potassium ion aerosol
M	Unspecified third body
Mg	Magnesium aerosol
Mn^{++} or Mn^{+++}	Manganese ion aerosol
N	Atomic nitrogen
N_2	Molecular nitrogen
nN_2	Molecular nitrogen in cluster formation; quasi aerosol
NH_3	Ammonia
NH_4^+	Ammonium ion
nNH_4^+	Ammonium ion aerosol
$NH_4HSO_4 \cdot nH_2O$	Ammonium bisulfate aerosol
$(NH_4)_2SO_4$	Ammonium sulfate aerosol
$(NH_4)_2S_2O_8$	Ammonium peroxydisulfate aerosol
NO	Nitric oxide
nNO	Nitric oxide in cluster formation; quasi aerosol
NO_2	Nitrogen dioxide

LIST OF CHEMICAL SYMBOLS (Continued)

<u>Symbol</u>	<u>Name</u>
NO_2^-	Nitrite ion aerosol
NO_3	Nitrogen trioxide
NO_3^-	Nitrate ion aerosol
NO_x	"Odd" nitrogen (nitrogen oxides)
N_2O	Nitrous oxide
N_2O_5	Nitrogen pentoxide
Na^+	Sodium ion aerosol
O	Atomic oxygen, unspecified
$\text{O}(^1\text{D})$	Atomic oxygen, excited state ^1D
$\text{O}(^3\text{P})$	Atomic oxygen, normal state
$\text{O}(^1\text{S})$	Atomic oxygen, excited state ^1S
O_2	Molecular oxygen
$\text{O}_2(^1\Delta)$	Molecular oxygen, excited state $^1\Delta$
O_3	Ozone
SF_6	Sulfur hexafluoride
SO_2	Sulfur dioxide
nSO_2	Sulfur dioxide in cluster formation; quasi aerosol
SO_3	Sulfur trioxide
$\text{SO}_4^{=}$	Sulfate ion aerosol
Si^{++++}	Silicon ion aerosol

1.0 INTRODUCTION

This volume presents several appendices of supporting material used in preparation of Volumes I and II. Brief descriptions of these appendices are given below.

1.1 Appendix A

This appendix presents the two basic information sets used in the evaluation of the individual stratospheric constituents. The first set consists of the value matrices for all species contained in groups 1 and 2 of the prioritized list of constituents contained in Volume I plus the matrices for all those other constituents for which evaluations were planned or completed.

The second information set gives the evaluations of the various species for present knowledge and required knowledge. Also shown are the weighting functions for the various performance parameters along with the rationale for selecting these weightings.

1.2 Appendix B

The twenty-nine figures presented show various distributions for those species having sufficient measurements to warrant their presentation. References to the principal sources of the information are shown in the caption for each figure. Table 1-1 presents a compilation of the distributions given in this appendix.

In all cases, the information is intended to show typical rather than precise data. These figures are presented for purposes of mission planning and not necessarily for precise scientific study.

TABLE 1-I
 SPECIFIC DISTRIBUTIONS INCLUDED IN APPENDIX B

	Vertical	Latitude	Global	Seasonal
H ₂ O Vapor	x			
O ₃	x	x	x	x
Aerosols	x	x		
CO ₂	x			
NO	x	x		x
NO ₂	x			
H ₂	x			
N ₂ O	x			
HNO ₃	x	x		x
CO	x			
CH ₄	x			
HCl	x			
Freon 11	x	x		x
Sulfates	x	x		
Bromides	x	x		

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All vertical profiles for gases are presented on identical base charts for interspecies comparisons at a glance. The profiles show both the number density and the volume mixing ratio of each gas. The other distributions shown are presented in the units used in the original references.

1.3 Appendix C

This appendix presents the references used in all three volumes. For the convenience of the user, the same set of reference numbers was used in all volumes. Therefore, the text of any one volume does not cite all the references.

APPENDIX A

INFORMATION SETS USED IN THE EVALUATIONS

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APPENDIX A: INFORMATION SETS USED IN THE EVALUATIONS

A.1 INTRODUCTION

This appendix presents the evaluation matrices used during the mission evaluations discussed in Volumes I and II. The use of these matrices and of the evaluation method has been discussed in Appendix A of both Volumes I and II.

For each species evaluated six matrices and a summary table are presented. The matrices for the seventh parameter, launch time, are not presented since in the present evaluations no case occurred where the time of launch was of any significance. Therefore every species was given equal value for this parameter. This common matrix is shown as Table A-I.

The summary table gives the total value for present knowledge and required knowledge for each species. Also included are the parameter weighting functions and the rationale for assignment of these.

TABLE A-1

EVALUATION MATRIX, TIME OF LAUNCH, ALL SPECIES

DATA STATUS	Good				DNA 10
	Med				
	Sparse				
	None				
		270°	180°	90°	None or DNA

SEASONAL PHASE DEVIATION*

- 90° - Launch is one season prior to desired season.
- 180° - Launch is two seasons prior to desired season.
- 270° - Launch is three seasons prior to desired season.
- DNA - Launch time is not important.

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A.2 INFORMATION SETS

The following pages present the evaluation matrices (left side of page) and the summary table (right side of page) for each of the eighteen species in the study.

TABLE A-II

EVALUATION MATRICES, WATER VAPOR, H₂O

Latitude Coverage

DATA STATUS	Good		6	8	10
	Med		5	7	R ₉
	Sparse		2	P ₆	7
	None	0			
		None	60°	120°	180°

LATITUDE BAND COVERED

Duration of Measurement Program

DATA STATUS	Good		3	9	10
	Med		2	7	R ₉
	Sparse		1	P ₅	7
	None	0			
		None	Short	>One Decades	Survey Year

DURATION OF MEASUREMENT PROGRAM

Diurnal Coverage

DATA STATUS	Good		3	5	7	9	10
	Med		2	4	6	8	9
	Sparse		1	2	3	P ₇	R ₈
	None	0					
		None	Fixed	Partial	Full	Part	Full
			Time	Day	Day	Day/	Diurnal
						Night	

DIURNAL COVERAGE

Vertical Coverage

DATA STATUS	Good		3	7	R ₁₀
	Med		2	6	9
	Sparse		1	P ₅	7
	None	0			
		None	<10%	50%	100%

STRATOSPHERIC VERTICAL COVERAGE

Vertical Resolution

DATA STATUS	Good		0	3	5	R ₁₀
	Med		0	2	4	9
	Sparse		0	1	3	P ₇
	None	0				
		None	<1	1	10	>40

NUMBER OF DATA POINTS OBTAINED

Longitude Coverage

DATA STATUS	Good		8	9	10
	Med		7	8	9
	Sparse		6	7	R ₈
	None	P ₀			
		None	0-90°	90°-180°	180°-360°

LONGITUDE BAND COVERED

TABLE A-III
EVALUATION SUMMATION, WATER VAPOR, H₂O

Parameter	WF 0-1	Present Knowledge		Required Knowledge	
		V	VXWF	V	VXWF
Latitude	.3	6	1.8	9	2.7
Duration of Program	.2	5	1.0	9	1.8
Diurnal Coverage	.1	7	0.7	8	0.8
Launch Time	0	10	0	10	0
Vertical Profile Coverage	.15	5	0.75	10	1.5
Vertical Profile Resolution	.15	7	1.05	10	1.5
Longitude	.1	0	0	8	0.8
	1.0	5.3		9.1	
Rounded Off Total		5		9	

Rationale for weighting functions:

All parameters known to some extent. Increased knowledge of Latitudinal and Vertical profiles desirable. Diurnal change considered to be negligible.

Legend: WF = Weighting Function
V = Value to user taken from value matrices
VXWF = Product of V and WF

TABLE A-IV

EVALUATION MATRICES, OZONE, O₃

Latitude Coverage

DATA STATUS	Good		4	6	P ₁₀ ^R
	Med		3	5	9
	Sparse		2	4	8
	None	0			
		None	60°	120°	180°

LATITUDE BAND COVERED

Duration of Measurement Program

DATA STATUS	Good		2	6	R ₁₀
	Med		2	5	P ₇
	Sparse		1	4	6
	None	0			
		None	Short	>One Decades	Survey Year

DURATION OF MEASUREMENT PROGRAM

Diurnal Coverage

DATA STATUS	Good			5	6	9	10
	Med			4	5	R ₈	9
	Sparse			P ₂	3	6	7
	None	0					
		None	Fixed Time	Partial Day	Full Day	Part Day/ Night	Full Diurnal

DIURNAL COVERAGE

Vertical Coverage

DATA STATUS	Good		2	7	R ₁₀
	Med		1	6	8
	Sparse		0	5	P ₇
	None				
		None	<10%	50%	100%

STRATOSPHERIC VERTICAL COVERAGE

Vertical Resolution

DATA STATUS	Good		0	3	7	R ₁₀
	Med		0	2	5	7
	Sparse		0	1	3	P ₅
	None					
		None	<1	1	10	>40

NUMBER OF DATA POINTS OBTAINED

Longitude Coverage

DATA STATUS	Good		3	5	P ₁₀ ^R
	Med		2	4	9
	Sparse		1	3	6
	None				
		None	0-90°	90°-180°	180°-360°

LONGITUDE BAND COVERED

TABLE A-V
EVALUATION SUMMATION, OZONE, O₃

Parameter	WF 0-1	Present Knowledge		Required Knowledge	
		V	VXWF	V	VXWF
Latitude	.25	10	2.5	10	2.5
Duration of Program	.25	7	1.75	10	2.5
Diurnal Coverage	.15	2	.3	8	1.2
Launch Time	0	10	0	10	0
Vertical Profile Coverage	.1	7	.7	10	1
Vertical Profile Resolution	.15	5	.75	10	1.5
Longitude	.1	10	1	10	1
	1.0		7.0		9.7
Rounded Off Total			7		10

Rationale for weighting functions:

Latitude coverage very important due to desirability of polar zone measurements.

Total ozone has to be measured for several decades.

Diurnal coverage: Ozone shows little diurnal change extensive measurement not warranted.

Vertical profiles rather well understood some improvement desirable.

Longitudinal distribution of total ozone reasonably well measured.

Legend: WF = Weighting Function
V = Value to user taken from value matrices
VXWF = Product of V and WF

TABLE A-VI

EVALUATION MATRICES, AEROSOLS

Latitude Coverage

DATA STATUS	Good		4	6	R ₁₀
	Med		3	5	P ₉
	Sparse		2	4	5
	None				
		None	60°	120°	180°

LATITUDE BAND COVERED

Duration of Measurement Program

DATA STATUS	Good		5	R ₉	10
	Med		3	P ₈	9
	Sparse		1	5	7
	None				
		None	Short	>One Decades	Survey Year

DURATION OF MEASUREMENT PROGRAM

Diurnal Coverage

DATA STATUS	Good		8	8	8	9	10
	Med		7	7	7	P ₉ R	9
	Sparse		6	6	6	8	8
	None						
		None	Fixed	Partial	Full	Part	Full
			Time	Day	Day	Day/	Diurnal
						Night	

DIURNAL COVERAGE

Vertical Coverage

DATA STATUS	Good		2	7	R ₁₀
	Med		1	6	P ₈
	Sparse		0	5	7
	None				
		None	<10%	50%	100%

STRATOSPHERIC VERTICAL COVERAGE

Vertical Resolution

DATA STATUS	Good		0	2	7	R ₁₀
	Med		0	1	5	P ₇
	Sparse		0	0	2	4
	None					
		None	<1	1	10	>40

NUMBER OF DATA POINTS OBTAINED

Longitude Coverage

DATA STATUS	Good		8	9	R ₁₀
	Med		7	8	9
	Sparse		P ₆	7	8
	None				
		None	0-90°	90°-180°	180°-360°

LONGITUDE BAND COVERED

TABLE A-VII

EVALUATION SUMMATION, AEROSOLS

Parameter	WF 0-1	Present Knowledge		Required Knowledge	
		V	VXWF	V	VXWF
Latitude	.15	9	1.35	10	1.5
Duration of Program	.15	8	1.2	9	1.35
Diurnal Coverage	.05	9	0.45	9	0.45
Launch Time	0	10	0	10	0
Vertical Profile Coverage	.25	8	2.0	10	2.5
Vertical Profile Resolution	.15	7	1.05	10	1.5
Longitude	.25	6	1.5	10	2.5
	<u>1.0</u>		<u>7.55</u>		<u>9.8</u>
Rounded Off Total		8		10	

Rationale for weighting functions:

Latitude already well covered

Measurements taken over many year period.

Diurnal change small and negligible.

Launch time unimportant except for volcanic activity.

Vertical coverage: More data needed in upper stratosphere current data resolution acceptable.

Longitudinal coverage needs improvement.

Note: SAM II is scheduled for NIMBUS-G, 1 Km resolution, polar orbit (aerosols)

Legend: WF = Weighting Function

V = Value to user taken from value matrices

VXWF = Product of V and WF

TABLE A-VIII

EVALUATION MATRICES, CARBON DIOXIDE, CO₂

Latitude Coverage

DATA STATUS	Good		3	7	10
	Med		2	5	9
	Sparse		1	2	P ₈ ^R
	None	0			

None 60° 120° 180°

LATITUDE BAND COVERED

Duration of Measurement Program

DATA STATUS	Good		3	7	10
	Med		2	5	9
	Sparse		1	3	P ₈ ^R
	None	0			

None Short >One Decades
Survey Year

DURATION OF MEASUREMENT PROGRAM

Diurnal Coverage

DATA STATUS	Good		2	3	4	9	10
	Med		1	2	3	8	9
	Sparse		0	1	2	P ₈ ^R	8
	None	0					

None Fixed Partial Full Part Full
Time Day Day Day/ Diurnal
Night

DIURNAL COVERAGE

Vertical Coverage

DATA STATUS	Good		2	5	P ₁₀ ^R
	Med		1	3	9
	Sparse		0	1	8
	None	0			

None <10% 50% 100%
STRATOSPHERIC VERTICAL COVERAGE

Vertical Resolution

DATA STATUS	Good		0	6	R ₉	10
	Med		0	4	8	9
	Sparse		0	2	7	P ₈
	None	0				

None <1 1 10 >40
NUMBER OF DATA POINTS OBTAINED

Longitude Coverage

DATA STATUS	Good		3	7	10
	Med		2	5	9
	Sparse		1	2	P ₈ ^R
	None	0			

None 0-° 90°- 180°-
90° 180° 360°
LONGITUDE BAND COVERED

TABLE A-IX

EVALUATION SUMMATION, CARBON DIOXIDE, CO₂.

Parameter	WF 0-1	Present Knowledge		Required Knowledge	
		V	VXWF	V	VXWF
Latitude	0.1	8	0.8	8	0.8
Duration of Program	0.3	8	2.4	8	2.4
Diurnal Coverage	0.1	8	0.8	8	0.8
Launch Time	0	10	0	10	0
Vertical Profile Coverage	0.2	10	2.0	10	2.0
Vertical Profile Resolution	0.2	8	1.6	9	1.8
Longitude	0.1	8	0.8	8	0.8
	<u>1.0</u>		<u>8.4</u>		<u>8.6</u>
Rounded Off Total		8		9	

Rationale for weighting functions:

CO₂ distributions are nearly constant except for long-term buildup. Vertical profile needs some additional verification particularly at higher altitudes.

Legend: WF = Weighting Function

V = Value to user taken from value matrices

VXWF = Product of V and WF

TABLE A-X

EVALUATION MATRICES, HYDROXYL, HO

Latitude Coverage

DATA STATUS	Good		8	9	10
	Med		7	R ₈	9
	Sparse		6	7	8
	None	P ₀			
		None	60°	120°	180°

LATITUDE BAND COVERED

Duration of Measurement Program

DATA STATUS	Good		8	9	10
	Med		R ₇	8	9
	Sparse		5	7	8
	None	P ₀			
		None	Short	>One Decades	Survey Year

DURATION OF MEASUREMENT PROGRAM

Diurnal Coverage

DATA STATUS	Good		1	4	5	9	10
	Med		1	4	5	R ₈	9
	Sparse		1	3	4	7	8
	None	P ₀					
		None	Fixed Time	Partial Day	Full Day	Part Day/ Night	Full Diurnal

DIURNAL COVERAGE

Vertical Coverage

DATA STATUS	Good		4	8	10
	Med		3	R ₇	9
	Sparse		2	6	7
	None	P ₀			
		None	<10%	50%	100%

STRATOSPHERIC VERTICAL COVERAGE

Vertical Resolution

DATA STATUS	Good		2	3	8	10
	Med		1	2	R ₇	9
	Sparse		1	2	5	7
	None	P ₀				
		None	<1	1	10	>40

NUMBER OF DATA POINTS OBTAINED

Longitude Coverage

DATA STATUS	Good		8	9	10
	Med		7	8	9
	Sparse		6	7	R ₈
	None	P ₀			
		None	0°-90°	90°-180°	180°-360°

LONGITUDE BAND COVERED

TABLE A-XI

EVALUATION SUMMATION, HYDROXYL, HO

Parameter	WF 0-1	Present Knowledge		Required Knowledge	
		V	VXWF	V	VXWF
Latitude	.15	0	0	8	1.2
Duration of Program	.1	0	0	7	.7
Diurnal Coverage	.3	0	0	8	2.4
Launch Time	0	10	0	10	0
Vertical Profile Coverage	.2	0	0	7	1.4
Vertical Profile Resolution	.2	0	0	7	1.4
Longitude	.05	0	0	8	0.4
	<u>1.0</u>	<u>0</u>		<u>7.5</u>	
Rounded Off Total		0		8	

Rationale for weighting functions:

Primary requirements at present are for initial measurements of hydroxyl stressing vertical profile and diurnal change. Theoretical models indicate a strong diurnal change.

Legend: WF = Weighting Function

V = Value to user taken from value matrices

VXWF = Product of V and WF

TABLE A-XII

EVALUATION MATRICES, ATOMIC OXYGEN, O(³P)

Latitude Coverage

DATA STATUS	Good		8	9	10
	Med		7	8	R ₉
	Sparse		6	7	8
	None	P ₀			
		None	60°	120°	180°

LATITUDE BAND COVERED

Duration of Measurement Program

DATA STATUS	Good		8	9	10
	Med		R ₇	8	9
	Sparse		5	7	8
	None	P ₀			
		None	Short	>One Decades	Survey Year

DURATION OF MEASUREMENT PROGRAM

Diurnal Coverage

DATA STATUS	Good		1	4	5	9	10
	Med		1	4	5	8	R ₉
	Sparse		1	3	4	7	8
	None	P ₀					
		None	Fixed Time	Partial Day	Full Day	Part Day/ Night	Full Diurnal

DIURNAL COVERAGE

Vertical Coverage

DATA STATUS	Good		4	5	10
	Med		3	4	R ₉
	Sparse		P ₂	3	7
	None	0			
		None	<10%	50%	100%

STRATOSPHERIC VERTICAL COVERAGE

Vertical Resolution

DATA STATUS	Good		2	3	6	10
	Med		1	2	5	R ₉
	Sparse		1	2	P ₄	6
	None	0				
		None	<1	1	10	>40

NUMBER OF DATA POINTS OBTAINED

Longitude Coverage

DATA STATUS	Good		8	9	10
	Med		7	8	9
	Sparse		6	7	R ₈
	None	P ₀			
		None	0-90°	90°-180°	180°-360°

LONGITUDE BAND COVERED

TABLE A-XIII

EVALUATION SUMMATION, ATOMIC OXYGEN, O(³P)

Parameter	WF 0-1	Present Knowledge		Required Knowledge	
		V	VXWF	V	VXWF
Latitude	.15	0	0	9	1.35
Duration of Program	.1	0	0	7	0.7
Diurnal Coverage	.3	0	0	9	2.7
Launch Time	0	10	0	10	0
Vertical Profile Coverage	.2	0	0	9	1.8
Vertical Profile Resolution	.2	0	0	9	1.8
Longitude	.05	0	0	8	0.4
	<u>1.0</u>	<u>0</u>	<u>0</u>	<u>8.75</u>	
Rounded Off Total		0		9	

Rationale for weighting functions:

Primary requirements at present are for initial measurements of atomic oxygen stressing vertical profile and diurnal change.

Legend: WF = Weighting Function
 V = Value to user taken from value matrices
 VXWF = Product of V and WF

TABLE A-XIV

EVALUATION MATRICES, ATOMIC OXYGEN, O(¹D)

Latitude Coverage

DATA STATUS	Good		8	9	10
	Med		7	8	R ₉
	Sparse		6	7	8
	None	P ₀			
		None	60°	120°	180°

LATITUDE BAND COVERED

Duration of Measurement Program

DATA STATUS	Good		8	9	10
	Med		R ₇	8	9
	Sparse		5	7	8
	None	P ₀			
		None	Short	>One Decades	Survey Year

DURATION OF MEASUREMENT PROGRAM

Diurnal Coverage

DATA STATUS	Good		1	4	5	9	10
	Med		1	4	5	8	R ₉
	Sparse		1	3	4	7	8
	None	P ₀					
		None	Fixed Time	Partial Day	Full Day	Part Day/ Night	Full Diurnal

DIURNAL COVERAGE

Vertical Coverage

DATA STATUS	Good		4	5	10
	Med		3	4	R ₉
	Sparse		2	3	7
	None	P ₀			
		None	<10%	50%	100%

STRATOSPHERIC VERTICAL COVERAGE

Vertical Resolution

DATA STATUS	Good		2	3	6	10
	Med		1	2	5	R ₉
	Sparse		1	2	4	6
	None	P ₀				
		None	<1	1	10	>40

NUMBER OF DATA POINTS OBTAINED

Longitude Coverage

DATA STATUS	Good		8	9	10
	Med		7	8	9
	Sparse		6	7	R ₈
	None	P ₀			
		None	0°-90°	90°-180°	180°-360°

LONGITUDE BAND COVERED

TABLE A-XV

EVALUATION SUMMATION, ATOMIC OXYGEN, O(¹D)

Parameter	WF 0-1	Present Knowledge		Required Knowledge	
		V	VXWF	V	VXWF
Latitude	.15	0	0	9	1.35
Duration of Program	.1	0	0	7	0.7
Diurnal Coverage	.3	0	0	9	2.7
Launch Time	0	10	0	10	0
Vertical Profile Coverage	.2	0	0	9	1.8
Vertical Profile Resolution	.2	0	0	9	1.8
Longitude	.05	0	0	8	0.4
	<u>1.0</u>	<u>0</u>	<u>0</u>	<u>8.75</u>	
Rounded Off Total		0		9	

Rationale for weighting functions:

Primary requirements at present are for initial measurements of atomic oxygen stressing vertical profile and diurnal change.

Legend: WF = Weighting Function

V = Value to user taken from value matrices

VXWF = Product of V and WF

TABLE A-XVI

EVALUATION MATRICES, AMMONIA, NH₃

Latitude Coverage

DATA STATUS	Good		8	9	10
	Med		7	8	9
	Sparse		6	R ₇	8
	None	P ₀			
		None	60°	120°	180°

LATITUDE BAND COVERED

Duration of Measurement Program

DATA STATUS	Good		8	9	10
	Med.		7	8	9
	Sparse		R ₆	7	8
	None	P ₀			
		None	Short	>One Decades	Survey Year

DURATION OF MEASUREMENT PROGRAM

Diurnal Coverage

DATA STATUS	Good		3	7	8	9	10
	Med		2	R ₆	7	8	9
	Sparse		1	4	6	7	8
	None	P ₀					
		None	Fixed Time	Partial Day	Full Day/ Night	Part Day/ Diurnal	Full Diurnal

DIURNAL COVERAGE

Vertical Coverage

DATA STATUS	Good		4	8	10
	Med		3	R ₇	9
	Sparse		2	6	7
	None	P ₀			
		None	<10%	50%	100%

STRATOSPHERIC VERTICAL COVERAGE

Vertical Resolution

DATA STATUS	Good		2	3	8	10
	Med		1	2	R ₇	9
	Sparse		1	2	5	7
	None	P ₀				
		None	<1	1	10	>40

NUMBER OF DATA POINTS OBTAINED

Longitude Coverage

DATA STATUS	Good		8	9	10
	Med		7	8	9
	Sparse		6	7	R ₈
	None	P ₀			
		None	0-90°	90°-180°	180°-360°

LONGITUDE BAND COVERED

TABLE A-XVII

EVALUATION SUMMATION, AMMONIA, NH₃

Parameter	WF 0-1	Present Knowledge		Required Knowledge	
		V	VXWF	V	VXWF
Latitude	.2	0	0	7	1.4
Duration of Program	.1	0	0	6	0.6
Diurnal Coverage	.15	0	0	6	0.9
Launch Time	0	10	0	10	0
Vertical Profile Coverage	.25	0	0	7	1.75
Vertical Profile Resolution	.25	0	0	7	1.75
Longitude	.05	0	0	8	0.4
	<u>1.0</u>	<u>0</u>		<u>6.8</u>	
Rounded Off Total		0		7	

Rationale for weighting functions:

Primary requirements at present are for initial measurements of ammonia stressing vertical profile.

Legend: WF = Weighting Function

V = Value to user taken from value matrices

VXWF = Product of V and WF

TABLE A-XVIII
EVALUATION MATRICES, NITRIC OXIDE, NO

Latitude Coverage

DATA STATUS	Good		6	9	R ₁₀
	Med		5	8	9
	Sparse		P ₄	6	8
	None	0			
		None	60°	120°	180°

LATITUDE BAND COVERED

Duration of Measurement Program

DATA STATUS	Good		5	R ₉	10
	Med		2	P ₈	9
	Sparse		0	2	8
	None				
		None	Short	>One	Decades
			Survey	Year	

DURATION OF MEASUREMENT PROGRAM

Diurnal Coverage

DATA STATUS	Good		2	3	6	9	10
	Med		1	2	5	8	R ₉
	Sparse		0	1	4	P ₅	8
	None						
		None	Fixed	Partial	Full	Part	Full
			Time	Day	Day	Day/	Diurnal
						Night	

DIURNAL COVERAGE

Vertical Coverage

DATA STATUS	Good		2	8	R ₁₀
	Med		1	P ₇	9
	Sparse		0	3	8
	None				
		None	<10%	50%	100%

STRATOSPHERIC VERTICAL COVERAGE

Vertical Resolution

DATA STATUS	Good		0	2	8	R ₁₀
	Med		0	1	P ₇	9
	Sparse		0	0	0	6
	None					
		None	<1	1	10	>40

NUMBER OF DATA POINTS OBTAINED

Longitude Coverage

DATA STATUS	Good		8	9	10
	Med		7	8	9
	Sparse		6	7	R ₈
	None	P ₀			
		None	0°- 90°	90°- 180°	180°- 360°

LONGITUDE BAND COVERED

TABLE A-XIX

EVALUATION SUMMATION, NITRIC OXIDE, NO

Parameter	WF 0-1	Present Knowledge		Required Knowledge	
		V	VXWF	V	VXWF
Latitude	.25	4	1.0	10	2.5
Duration of Program	.2	8	1.6	9	1.8
Diurnal Coverage	.3	5	1.5	9	2.7
Launch Time	0	10	0	10	0
Vertical Profile Coverage	.1	7	0.7	10	1.0
Vertical Profile Resolution	.1	7	0.7	10	1.0
Longitude	.05	0	0	8	0.4
	<u>1.0</u>	<u>5.5</u>		<u>9.4</u>	
Rounded Off Total		6		9	

Rationale for weighting functions:

Vertical profile has been measured to some extent. Most important need lies in understanding diurnal change. Also important are the latitudinal and seasonal changes. Theoretically diurnal and seasonal changes are large.

Legend: WF = Weighting Function

V = Value to user taken from value matrices

VXWF = Product of V and WF

TABLE A-XX

EVALUATION MATRICES, NITROGEN DIOXIDE, NO₂

Latitude Coverage

DATA STATUS	Good		6	9	R ₁₀
	Med		5	8	9
	Sparse		P ₄	6	8
	None				
		None	60°	120°	180°

LATITUDE BAND COVERED

Duration of Measurement Program

DATA STATUS	Good		6	R ₉	10
	Med		6	8	9
	Sparse		P ₅	7	8
	None				
		None	Short	>One Decades	Survey Year

DURATION OF MEASUREMENT PROGRAM

Diurnal Coverage

DATA STATUS	Good		2	3	6	9	10
	Med		1	2	5	8	R ₉
	Sparse		0	1	4	P ₅	8
	None						
		None	Fixed	Partial	Full	Part	Full
			Time	Day	Day	Day/	Diurnal
						Night	

DIURNAL COVERAGE

Vertical Coverage

DATA STATUS	Good		2	8	R ₁₀
	Med		1	7	9
	Sparse		0	P ₆	8
	None				
		None	<10%	50%	100%

STRATOSPHERIC VERTICAL COVERAGE

Vertical Resolution

DATA STATUS	Good		0	2	8	R ₁₀
	Med		0	1	7	9
	Sparse		0	0	P ₄	6
	None					
		None	<1	1	10	>40

NUMBER OF DATA POINTS OBTAINED

Longitude Coverage

DATA STATUS	Good		8	9	10
	Med		7	8	9
	Sparse		6	7	R ₈
	None		P ₀		
		None	0-90°	90°-180°	180°-360°

LONGITUDE BAND COVERED

TABLE A-XXI

EVALUATION SUMMATION, NITROGEN DIOXIDE, NO₂

Parameter	WF 0-1	Present Knowledge		Required Knowledge	
		V	VXWF	V	VXWF
Latitude	.15	4	.6	10	1.5
Duration of Program	.15	5	.75	9	1.35
Diurnal Coverage	.35	5	1.75	9	3.15
Launch Time	0	10	0	10	0
Vertical Profile Coverage	.15	6	0.9	10	1.5
Vertical Profile Resolution	.15	4	0.6	10	1.5
Longitude	.05	0	0	8	0.4
	<u>1.0</u>		<u>4.6</u>		<u>9.4</u>
Rounded Off Total		5		9	

Rationale for weighting functions:

Critical need lies in diurnal measurements to clarify contradiction between theoretical and measured diurnal changes. Also needed are better vertical profiles, latitudinal and seasonal changes.

Legend: WF = Weighting Function
 V = Value to user taken from value matrices
 VXWF = Product of V and WF

TABLE A-XXII
EVALUATION MATRICES, ATOMIC CHLORINE, Cl

Latitude Coverage

DATA STATUS	Good		6	8	10
	Med		5	7	9
	Sparse		4	6	R ₈
	None	P ₀			
		None	60°	120°	180°

LATITUDE BAND COVERED

Duration of Measurement Program

DATA STATUS	Good		7	9	10
	Med		6	R ₈	10
	Sparse		5	7	9
	None	P ₀			
		None	Short	>One Decades	Survey Year

DURATION OF MEASUREMENT PROGRAM

Diurnal Coverage

DATA STATUS	Good		2	5	7	9	10
	Med		1	4	6	8	10
	Sparse		0	3	5	R ₇	9
	None	P ₀					
		None	Fixed	Partial	Full	Part	Full
			Time	Day	Day	Day/	Diurnal
						Night	

DIURNAL COVERAGE

Vertical Coverage

DATA STATUS	Good		5	9	10
	Med		4	R ₈	9
	Sparse		P ₃	7	8
	None	0			
		None	<10%	50%	100%

STRATOSPHERIC VERTICAL COVERAGE

Vertical Resolution

DATA STATUS	Good		0	3	9	10
	Med		0	2	R ₈	9
	Sparse		0	1	P ₂	8
	None	0				
		None	<1	1	10	>40

NUMBER OF DATA POINTS OBTAINED

Longitude Coverage

DATA STATUS	Good		8	9	10
	Med		7	8	9
	Sparse		6	7	R ₈
	None	P ₀			
		None	0- 90°	90°- 180°	180°- 360°

LONGITUDE BAND COVERED

TABLE A-XXIII

EVALUATION SUMMATION, ATOMIC CHLORINE, Cl

Parameter	WF 0-1	Present Knowledge		Required Knowledge	
		V	VXWF	V	VXWF
Latitude	.2	0	0	8	1.6
Duration of Program	.1	0	0	8	.8
Diurnal Coverage	.35	0	0	7	2.45
Launch Time	0	10	0	10	0
Vertical Profile Coverage	.15	0	0	8	1.2
Vertical Profile Resolution	.15	0	0	8	1.2
Longitude	.05	0	0	8	.4
	<u>1.0</u>	<u>0</u>	<u>0</u>	<u>8</u>	<u>7.65</u>
Rounded Off Total		0		8	

Rationale for weighting functions:

No measurements of stratospheric atomic Cl exist. Since atomic Cl is formed by various UV reactions and atomic Cl reacts almost immediately with O₃ diurnal variation is very important. Other important initial measurements are vertical profile and latitudinal distribution.

Legend: WF = Weighting Function

V = Value to user taken from value matrices

VXWF = Product of V and WF

TABLE A-XXIV

EVALUATION MATRICES, CHLORINE MONOXIDE, ClO

Latitude Coverage

DATA STATUS	Good		6	8	10
	Med		5	7	9
	Sparse		4	6	R ₈
	None	P ₀			
		None	60°	120°	180°

LATITUDE BAND COVERED

Duration of Measurement Program

DATA STATUS	Good		7	9	10
	Med		6	R ₈	10
	Sparse		5	7	9
	None	P ₀			
		None	Short	>One Decades	Survey Year

DURATION OF MEASUREMENT PROGRAM

Diurnal Coverage

DATA STATUS	Good		2	5	7	9	10
	Med		1	4	6	8	10
	Sparse		0	3	5	R ₇	9
	None	P ₀					
		None	Fixed	Partial	Full	Part	Full
			Time	Day	Day	Day/	Diurnal
						Night	

DIURNAL COVERAGE

Vertical Coverage

DATA STATUS	Good		5	9	10
	Med		4	R ₈	9
	Sparse		P ₃	7	8
	None	0			
		None	<10%	50%	100%

STRATOSPHERIC VERTICAL COVERAGE

Vertical Resolution

DATA STATUS	Good		0	3	9	10
	Med		0	2	R ₈	9
	Sparse		0	1	P ₂	8
	None	0				
		None	<1	1	10	>40

NUMBER OF DATA POINTS OBTAINED

Longitude Coverage

DATA STATUS	Good		8	9	10
	Med		7	8	9
	Sparse		6	7	R ₈
	None	P ₀			
		None	0°- 90°	90°- 180°	180°- 360°

LONGITUDE BAND COVERED

TABLE A-XXV

EVALUATION SUMMATION, CHLORINE MONOXIDE, ClO

Parameter	WF 0-1	Present Knowledge		Required Knowledge	
		V	VXWF	V	VXWF
Latitude	.2	0	0	8	1.6
Duration of Program	.1	0	0	8	0.8
Diurnal Coverage	.35	0	0	7	2.45
Launch Time	0	10	0	10	0
Vertical Profile Coverage	.15	0	0	8	1.2
Vertical Profile Resolution	.15	0	0	8	1.2
Longitude	.05	0	0	8	0.4
	<u>1.0</u>		<u>4.8</u>		<u>9.35</u>
Rounded Off Total			5		9

Rationale for weighting functions:

No measurements of stratospheric ClO exist. Reactions of ClO are closely linked to atomic Cl reactions. Also ClO photodissociates in presence of UV. Diurnal change important. Therefore, same weighting functions as Atomic Cl are used.

Legend: WF = Weighting Function
 V = Value to user taken from value matrices
 VXWF = Product of V and WF,

TABLE A-XXVI

EVALUATION MATRICES, NITROUS OXIDE, N₂O

Latitude Coverage

DATA STATUS	Good		6	9	R ₁₀
	Med		5	8	9
	Sparse		P ₄	6	8
	None				
		None	60°	120°	180°

LATITUDE BAND COVERED

Duration of Measurement Program

DATA STATUS	Good		6	R ₉	10
	Med		6	8	9
	Sparse		P ₅	7	8
	None				
		None	Short	>One Decades	Survey Year

DURATION OF MEASUREMENT PROGRAM

Diurnal Coverage

DATA STATUS	Good		2	3	6	9	10
	Med		1	2	4	9	10
	Sparse		0	1	4	P ₈ R	9
	None						
		None	Fixed	Partial	Full	Part	Full
			Time	Day	Day	Day/	Diurnal
						Night	

DIURNAL COVERAGE

Vertical Coverage

DATA STATUS	Good		2	8	R ₁₀
	Med		1	7	9
	Sparse		0	P ₆	8
	None				
		None	<10%	50%	100%

STRATOSPHERIC VERTICAL COVERAGE

Vertical Resolution

DATA STATUS	Good		0	2	8	R ₁₀
	Med		0	1	7	9
	Sparse		0	0	P ₄	6
	None					
		None	<1	1	10	>40

NUMBER OF DATA POINTS OBTAINED

Longitude Coverage

DATA STATUS	Good		8	9	10
	Med		7	8	9
	Sparse		6	7	R ₈
	None		P ₀		
		None	0°-90°	90°-180°	180°-360°

LONGITUDE BAND COVERED

TABLE A-XXVII

EVALUATION SUMMATION, NITROUS OXIDE, N₂O

Parameter	WF 0-1	Present Knowledge		Required Knowledge	
		V	VXWF	V	VXWF
Latitude	.25	4	1.0	10	2.5
Duration of Program	.15	5	0.75	9	1.35
Diurnal Coverage	.1	8	0.8	8	0.8
Launch Time	0	10	0	10	0
Vertical Profile Coverage	.15	6	0.9	10	1.5
Vertical Profile Resolution	.15	4	0.6	10	1.5
Longitude	.05	0	0	8	0.4
	<u>1.0</u>	<u>4.05</u>		<u>8.05</u>	
Rounded Off Total		4		8	

Rationale for weighting functions:

Very few measurements exist. Primary need is for increased vertical profile data and latitudinal distributions. Theoretically there is no diurnal change.

Legend: WF = Weighting Function
 V = Value to user taken from value matrices
 VXWF = Product of V and WF

TABLE A-XXVIII

EVALUATION MATRICES, NITRIC ACID VAPOR, HNO₃

Latitude Coverage

DATA STATUS	Good		6	9	R ₁₀
	Med		4	8	9
	Sparse		2	P ₅	7
	None				
		None	60°	120°	180°

LATITUDE BAND COVERED

Duration of Measurement Program

DATA STATUS	Good		5	R ₉	10
	Med		4	7	9
	Sparse		3	P ₃	7
	None	0			
		None	Short	>One	Decades
			Survey	Year	

DURATION OF MEASUREMENT PROGRAM

Diurnal Coverage

DATA STATUS	Good		2	4	7	9	10
	Med		1	3	7	R ₈	9
	Sparse		0	2	4	P ₇	8
	None						
		None	Fixed	Partial	Full	Part	Full
			Time	Day	Day	Day/	Diurnal
						Night	

DIURNAL COVERAGE

Vertical Coverage

DATA STATUS	Good		3	8	R ₁₀
	Med		2	P ₇	9
	Sparse		1	3	5
	None				
		None	<10%	50%	100%

STRATOSPHERIC VERTICAL COVERAGE

Vertical Resolution

DATA STATUS	Good		0	3	9	R ₁₀
	Med		0	1	P ₈	9
	Sparse		0	0	4	7
	None					
		None	<1	1	10	>40

NUMBER OF DATA POINTS OBTAINED

Longitude Coverage

DATA STATUS	Good		6	8	10
	Med		5	7	9
	Sparse		4	6	R ₈
	None	P ₀			
		None	0°-90°	90°-180°	180°-360°

LONGITUDE BAND COVERED

TABLE A-XXIX

EVALUATION SUMMATION, NITRIC ACID VAPOR, HNO₃

Parameter	WF 0-1	Present Knowledge		Required Knowledge	
		V	VXWF	V	VXWF
Latitude	.3	5	1.5	10	3.0
Duration of Program	.25	3	.75	9	2.25
Diurnal Coverage	.1	7	.7	8	.8
Launch Time	0	10	0	10	0
Vertical Profile Coverage	.15	7	1.05	10	1.5
Vertical Profile Resolution	.1	8	.8	10	1.0
Longitude	.1	0	0	8	.8
	<u>1.0</u>	<u>4.8</u>		<u>9.35</u>	
Rounded Off Total		5		9	

Rationale for weighting functions:

Latitudinal variations and seasonal variations are large and require additional measurement. Vertical profile should be extended to top of stratosphere. Diurnal variation appears to be small.

Legend: WF = Weighting Function
 V = Value to user taken from value matrices
 VXWF = Product of V and WF

TABLE A-XXX

EVALUATION MATRICES, CARBON MONOXIDE, CO

Latitude Coverage

DATA STATUS	Good		8	9	10
	Med		7	8	9
	Sparse		6	7	R ₈
	None	P ₀			
		None	60°	120°	180°

LATITUDE BAND COVERED

Duration of Measurement Program

DATA STATUS	Good		8	9	10
	Med		7	8	9
	Sparse		R ₆	7	8
	None	P ₀			
		None	Short	>One Decades	Survey Year

DURATION OF MEASUREMENT PROGRAM

Diurnal Coverage

DATA STATUS	Good		3	7	8	9	10
	Med		2	R ₆	7	8	9
	Sparse		1	4	6	7	8
	None	P ₀					
		None	Fixed	Partial	Full	Part	Full
			Time	Day	Day	Day/	Diurnal
						Night	

DIURNAL COVERAGE

Vertical Coverage

DATA STATUS	Good		4	8	10
	Med		3	7	R ₉
	Sparse		2	P ₅	6
	None	0			
		None	<10%	50%	100%

STRATOSPHERIC VERTICAL COVERAGE

Vertical Resolution

DATA STATUS	Good		2	3	8	10
	Med		1	2	7	R ₉
	Sparse		0	1	P ₃	7
	None					
		None	<1	1	10	>40

NUMBER OF DATA POINTS OBTAINED

Longitude Coverage

DATA STATUS	Good		8	9	10
	Med		7	8	9
	Sparse		6	7	R ₈
	None	P ₀			
		None	0-°	90°-	180°-
			90°	180°	360°

LONGITUDE BAND COVERED

TABLE A-XXXI

EVALUATION SUMMATION, CARBON MONOXIDE, CO

Parameter	WF 0-1	Present Knowledge		Required Knowledge	
		V	VXWF	V	VXWF
Latitude	.4	0	0	8	3.2
Duration of Program	.1	0	0	6	0.6
Diurnal Coverage	.15	0	0	6	0.9
Launch Time	0	10	0	10	0
Vertical Profile Coverage	.15	5	.75	9	1.35
Vertical Profile Resolution	.15	3	.45	9	1.35
Longitude	.05	0	0	8	0.4
	<u>1.0</u>		<u>1.2</u>		<u>7.8</u>
Rounded Off Total			1		8

Rationale for weighting functions:

Distribution mostly unknown except for a few vertical profiles. Additional vertical profiles and latitudinal measurements of first priority.

Legend: WF = Weighting Function

V = Value to user taken from value matrices

VXWF = Product of V and WF

TABLE A-XXXII

EVALUATION MATRICES, METHANE, CH₄

Latitude Coverage

DATA STATUS	Good		8	9	10
	Med		7	8	9
	Sparse		6	7	R ₈
	None	P ₀			
		None	60°	120°	180°

LATITUDE BAND COVERED

Duration of Measurement Program

DATA STATUS	Good		8	9	10
	Med		7	8	9
	Sparse		R ₆	7	8
	None	P ₀			
		None	Short	>One Decades	Survey Year

DURATION OF MEASUREMENT PROGRAM

Diurnal Coverage

DATA STATUS	Good		3	7	8	9	10
	Med		2	R ₆	7	8	9
	Sparse		1	4	6	7	8
	None	P ₀					
		None	Fixed Time	Partial Day	Full Day	Part Day/Night	Full Diurnal

DIURNAL COVERAGE

Vertical Coverage

DATA STATUS	Good		4	8	10
	Med		3	7	R ₈
	Sparse		2	5	P ₆
	None	0			
		None	<10%	50%	100%

STRATOSPHERIC VERTICAL COVERAGE

Vertical Resolution

DATA STATUS	Good		2	3	8	10
	Med		1	2	7	R ₉
	Sparse		0	1	P ₃	7
	None					
		None	<1	1	10	>40

NUMBER OF DATA POINTS OBTAINED

Longitude Coverage

DATA STATUS	Good		8	9	10
	Med		7	8	9
	Sparse		6	7	R ₈
	None	P ₀			
		None	0-90°	90°-180°	180°-360°

LONGITUDE BAND COVERED

TABLE A-XXXIII.

EVALUATION SUMMATION, METHANE, CH₄

Parameter	WF 0-1	Present Knowledge		Required Knowledge	
		V	VXWF	V	VXWF
Latitude	.4	0	0	8	3.2
Duration of Program	.1	0	0	6	0.6
Diurnal Coverage	.15	0	0	6	0.9
Launch Time	0	10	0	10	0
Vertical Profile Coverage	.15	6	0.9	8	1.2
Vertical Profile Resolution	.15	3	0.45	9	1.35
Longitude	.05	0	0	8	0.4
	<u>1.0</u>		<u>1.35</u>		<u>7.65</u>
Rounded Off Total			1		8

Rationale for weighting functions:

Distribution mostly unknown except for a few vertical profiles. Additional vertical profiles and latitudinal measurements of first priority.

Legend: WF = Weighting Function

V = Value to user taken from value matrices

VXWF = Product of V and WF

TABLE A-XXXIV

EVALUATION MATRICES, HYDROGEN CHLORIDE, HCl

Latitude Coverage

DATA STATUS	Good		6	8	10
	Med		5	7	R ₉
	Sparse		P ₄	6	8
	None				
		None	60°	120°	180°

LATITUDE BAND COVERED

Duration of Measurement Program

DATA STATUS	Good		7	9	10
	Med		6	R ₈	10
	Sparse		P ₅	7	9
	None				
		None	Short	>One Decades	Survey Year

DURATION OF MEASUREMENT PROGRAM

Diurnal Coverage

DATA STATUS	Good		2	5	7	9	10
	Med		1	4	6	8	10
	Sparse		0	3	5	R ₇	9
	None	P ₀					
		None	Fixed	Partial	Full	Part	Full
			Time	Day	Day	Day/	Diurnal
						Night	

DIURNAL COVERAGE

Vertical Coverage

DATA STATUS	Good		5	8	10
	Med		4	7	R ₉
	Sparse		3	P ₆	8
	None	0			
		None	<10%	50%	100%

STRATOSPHERIC VERTICAL COVERAGE

Vertical Resolution

DATA STATUS	Good		0	3	9	10
	Med		0	2	8	R ₉
	Sparse		0	1	P ₇	8
	None					
		None	<1	1	10	>40

NUMBER OF DATA POINTS OBTAINED

Longitude Coverage

DATA STATUS	Good		8	9	10
	Med		7	8	9
	Sparse		6	7	R ₈
	None	P ₀			
		None	0-90°	90°-180°	180°-360°

LONGITUDE BAND COVERED

TABLE A-XXXV

EVALUATION SUMMATION, HYDROGEN CHLORIDE, HCl

Parameter	WF 0-1	Present Knowledge		Required Knowledge	
		V	VXWF	V	VXWF
Latitude	.35	4	1.4	9	3.15
Duration of Program	.1	5	.5	8	.8
Diurnal Coverage	.1	0	0	7	.7
Launch Time	0	10	0	10	0
Vertical Profile Coverage	.2	6	1.2	9	1.8
Vertical Profile Resolution	.2	7	1.4	9	1.8
Longitude	.05	0	0	8	.4
	<u>1.0</u>		<u>4.5</u>		<u>8.65</u>
Rounded Off Total			5		9

Rationale for weighting functions:

Very few measurements of stratospheric HCl exist. Basic need is for better and more extensive measurements of the vertical and latitudinal profiles. Since the reaction rates for the basic HCl formation and decomposition reactions are at least an order of magnitude slower than the rates for the principal Cl and ClO reactions, diurnal changes in HCl should be small.

Legend: WF = Weighting Function

V = Value to user taken from value matrices

VXWF = Product of V and WF

TABLE A-XXXVI

EVALUATION MATRICES, HYDROGEN FLUORIDE, HF

Latitude Coverage

DATA STATUS	Good		8	9	10
	Med		7	8	9
	Sparse		6	R ₇	8
	None	P ₀			
		None	60°	120°	180°

LATITUDE BAND COVERED

Duration of Measurement Program

DATA STATUS	Good		8	9	10
	Med		7	8	9
	Sparse		R ₆	7	8
	None	P ₀			
		None	Short	>One Decades	Survey Year

DURATION OF MEASUREMENT PROGRAM

Diurnal Coverage

DATA STATUS	Good		3	7	8	9	10
	Med		2	R ₆	7	8	9
	Sparse		1	4	6	7	8
	None	P ₀					
		None	Fixed Time	Partial Day	Full Day	Part Day/Night	Full Diurnal

DIURNAL COVERAGE

Vertical Coverage

DATA STATUS	Good		4	8	10
	Med		3	R ₇	9
	Sparse		2	6	7
	None	P ₀			
		None	<10%	50%	100%

STRATOSPHERIC VERTICAL COVERAGE

Vertical Resolution

DATA STATUS	Good		2	3	8	10
	Med		1	2	R ₇	9
	Sparse		1	2	5	7
	None	P ₀				
		None	<1	1	10	>40

NUMBER OF DATA POINTS OBTAINED

Longitude Coverage

DATA STATUS	Good		8	9	10
	Med		7	8	9
	Sparse		6	7	R ₈
	None	P ₀			
		None	0-90°	90°-180°	180°-360°

LONGITUDE BAND COVERED

TABLE A-XXXVII

EVALUATION SUMMATION, HYDROGEN FLUORIDE, HF

Parameter	WF 0-1	Present Knowledge		Required Knowledge	
		V	VXWF	V	VXWF
Latitude	.2	0	0	7	1.4
Duration of Program	.1	0	0	6	0.6
Diurnal Coverage	.15	0	0	6	0.9
Launch Time	0	10	0	10	0
Vertical Profile Coverage	.25	0	0	7	1.75
Vertical Profile Resolution	.25	0	0	7	1.75
Longitude	<u>.05</u>	<u>0</u>	<u>0</u>	<u>8</u>	<u>0.4</u>
	1.0		0		6.8
Rounded Off Total		0		7	

Rationale For Weighting Functions:

Primary requirements at present are for initial measurements of hydrogen fluoride stressing vertical profile.

Legend: WF = Weighting Function
V = Value to user taken from value matrices
VXWF = Product of V and WF

APPENDIX B

SPECIFIC SPECIES DISTRIBUTIONS

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APPENDIX B: SPECIFIC SPECIES DISTRIBUTIONS

This appendix contains twenty-nine figures presented to show various distributions for those species having sufficient measurements to warrant their presentation. In all cases, the information is intended to show typical rather than precise data. These figures are presented for purposes of mission planning and not necessarily for precise scientific study.

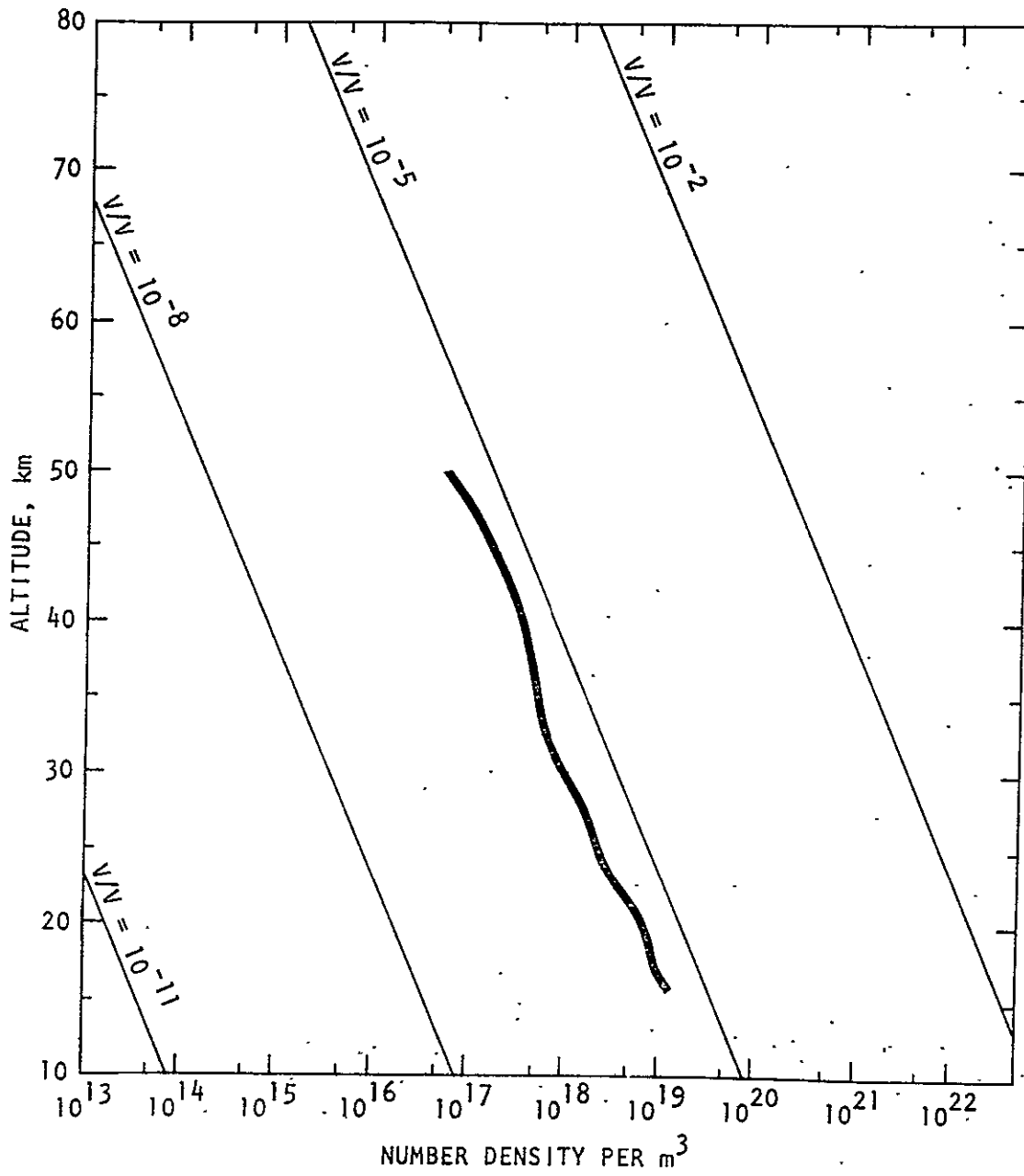


FIGURE B-1
 VERTICAL DISTRIBUTION OF WATER VAPOR,
 H₂O, MID-LATITUDE [84, 85, 86, 87]

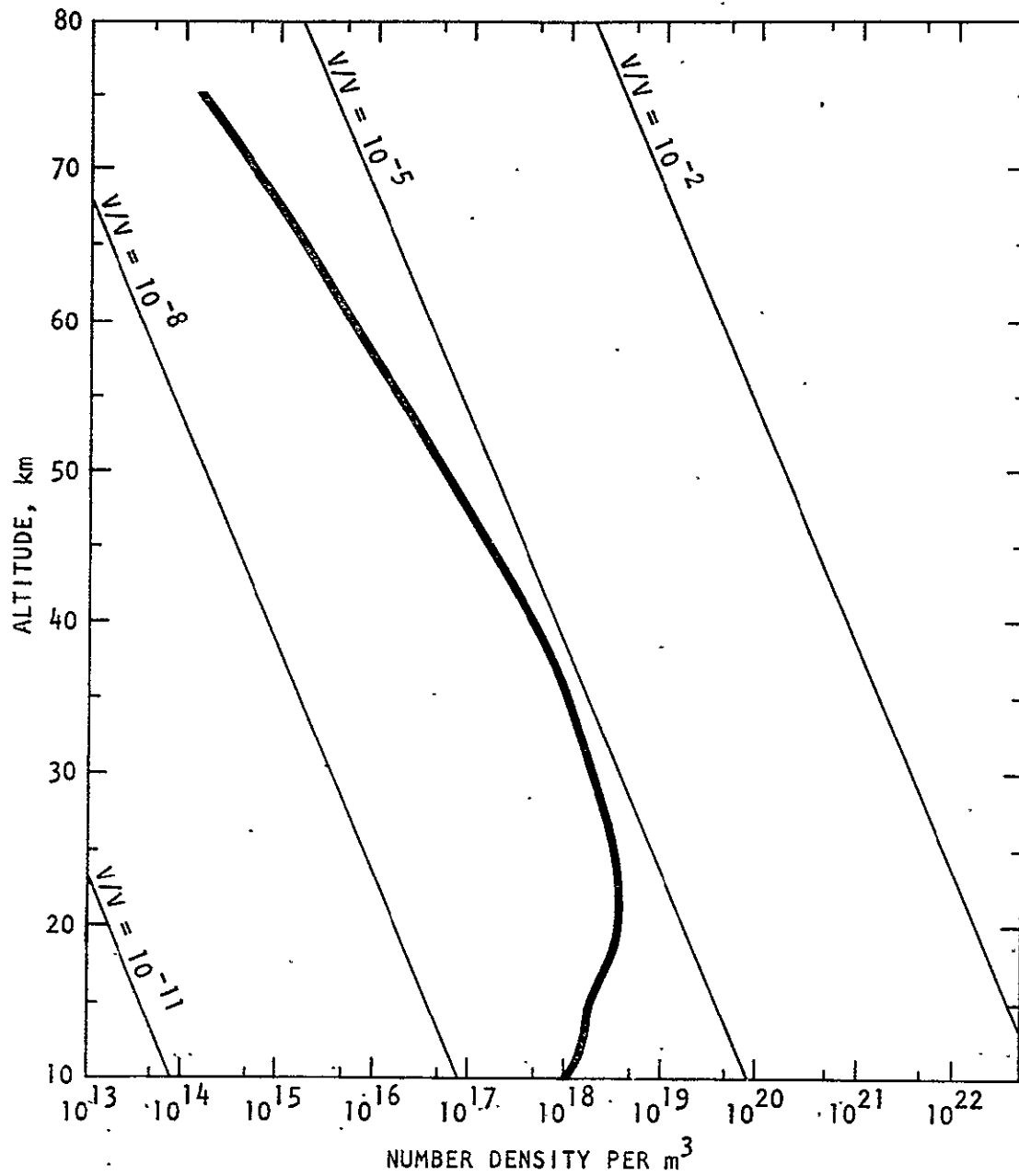
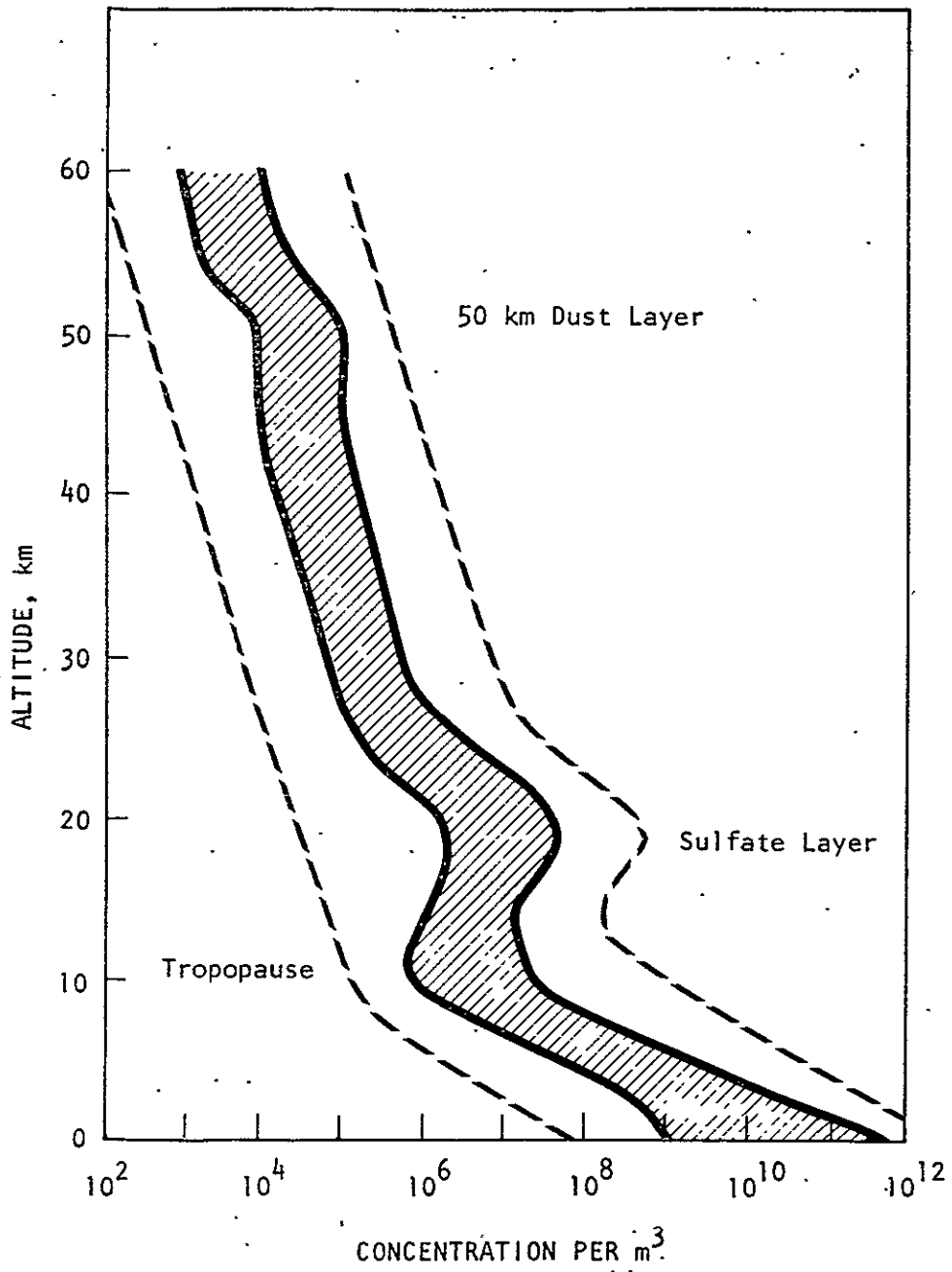


FIGURE B-2
 VERTICAL DISTRIBUTION OF OZONE, O₃
 MID-LATITUDE [88]



MOST FREQUENT CONCENTRATIONS
 EXTREME VALUES

FIGURE B-3
 VERTICAL DISTRIBUTION OF AEROSOLS [66]

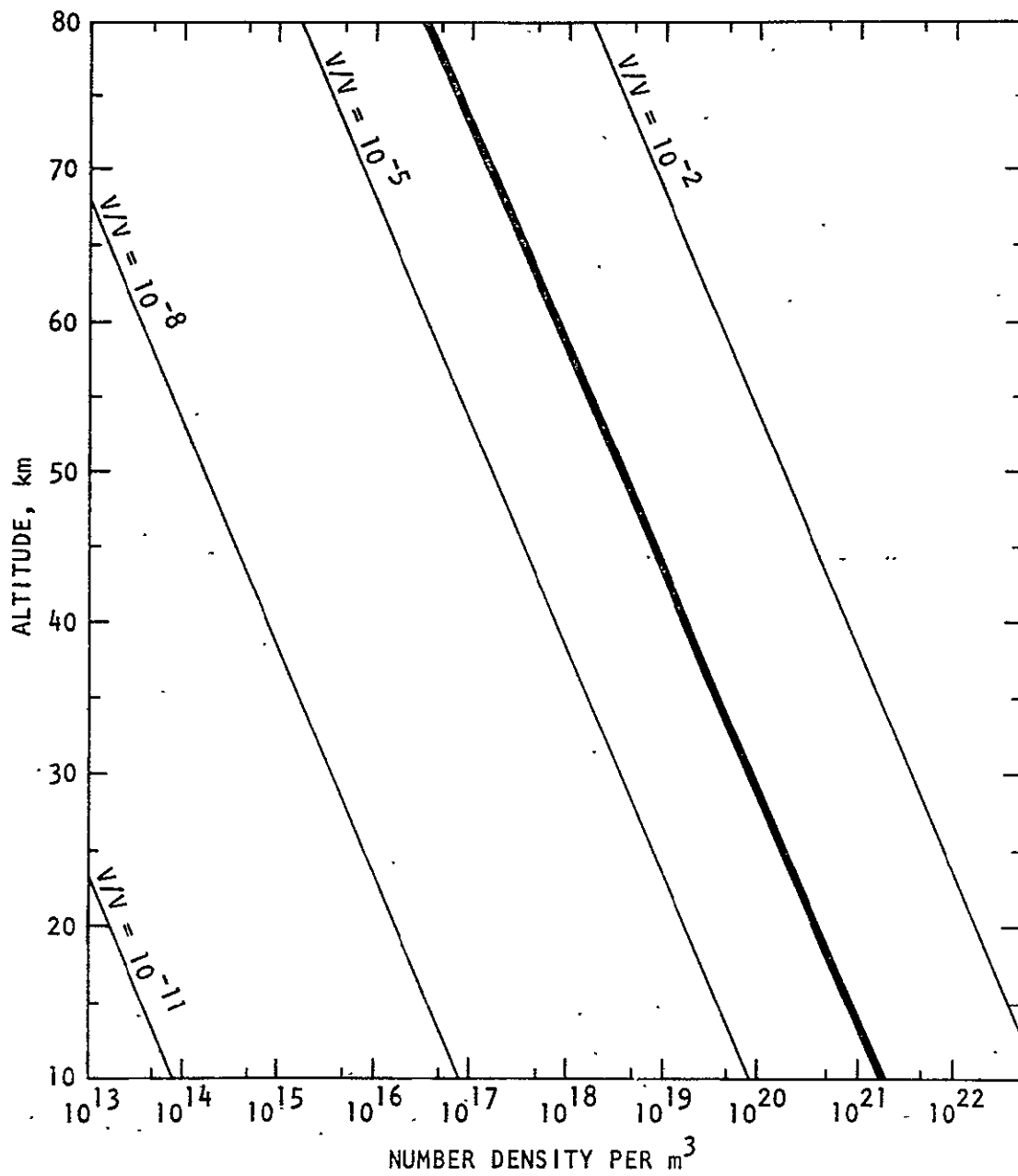


FIGURE B-4
VERTICAL DISTRIBUTION OF CARBON DIOXIDE, CO₂
ALL LATITUDES, ALL SEASONS [89]

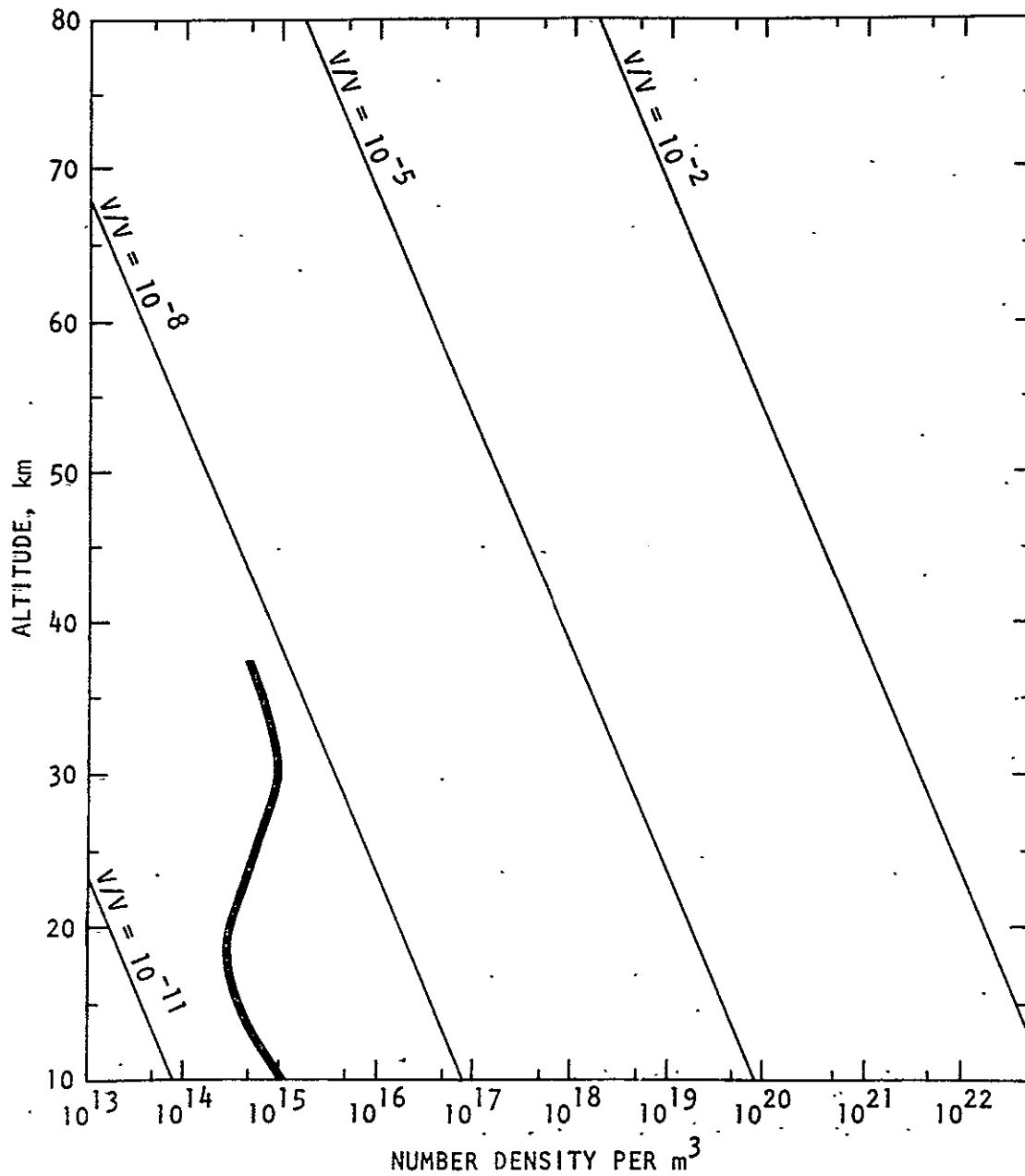


FIGURE B-5
 VERTICAL DISTRIBUTION OF NITRIC OXIDE, NO
 MID-LATITUDE [89]

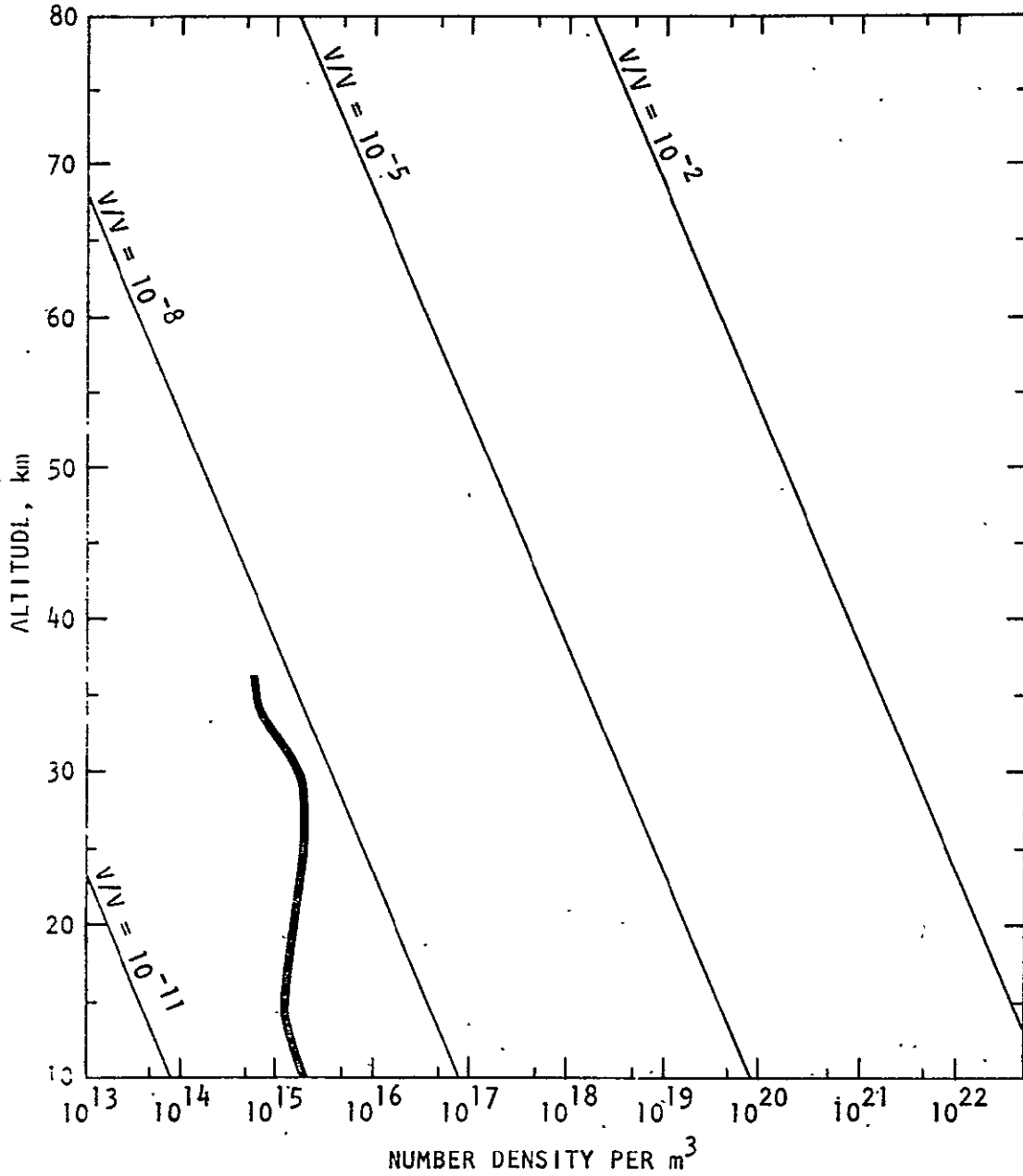


FIGURE B-6
 VERTICAL DISTRIBUTION OF NITROGEN DIOXIDE, NO₂
 MID-LATITUDE [89]

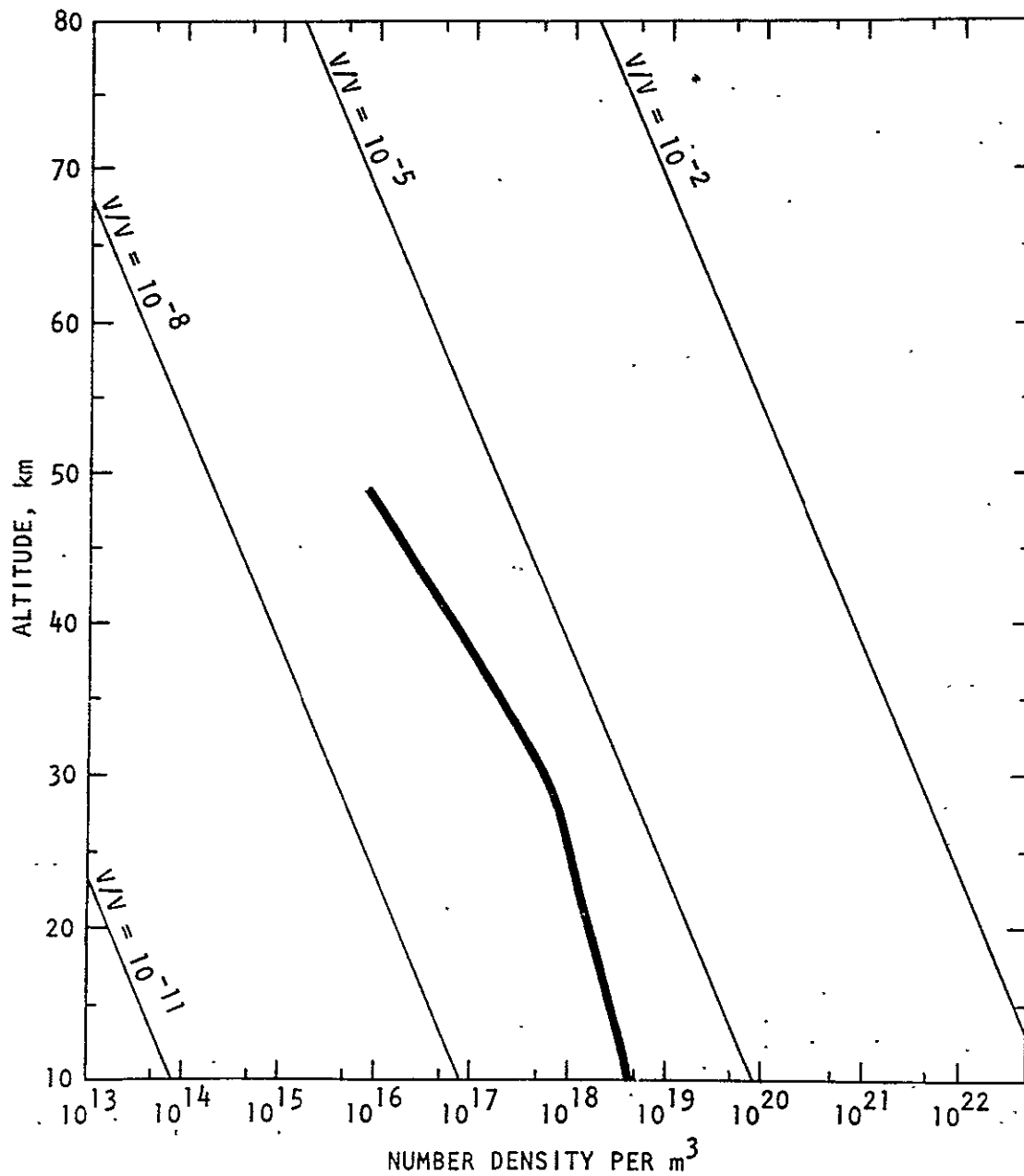


FIGURE B-7
 VERTICAL DISTRIBUTION OF HYDROGEN, H₂
 MID-LATITUDE [63]

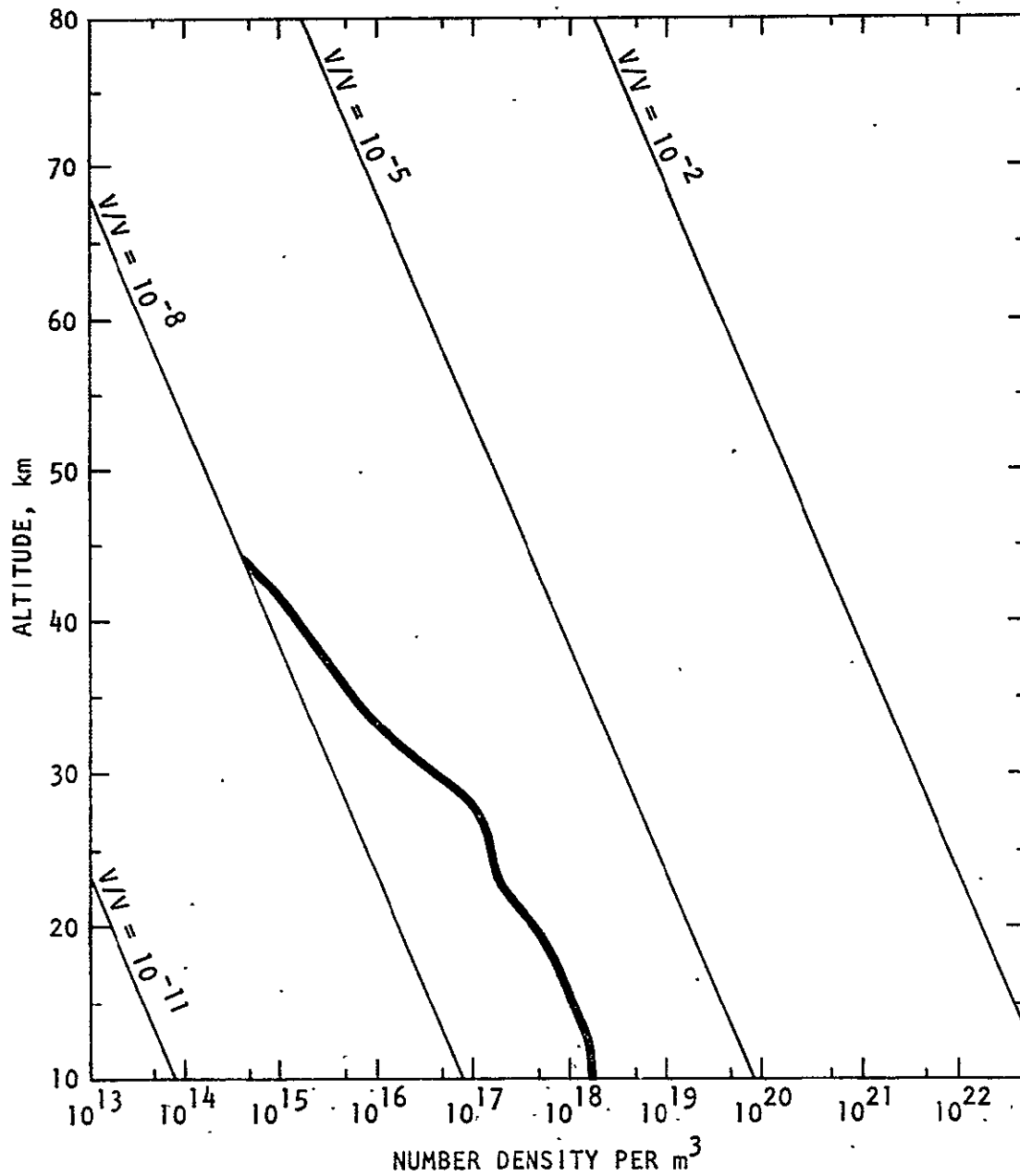


FIGURE B-8
 VERTICAL DISTRIBUTION OF NITROUS OXIDE, N₂O
 MID-LATITUDE [90]

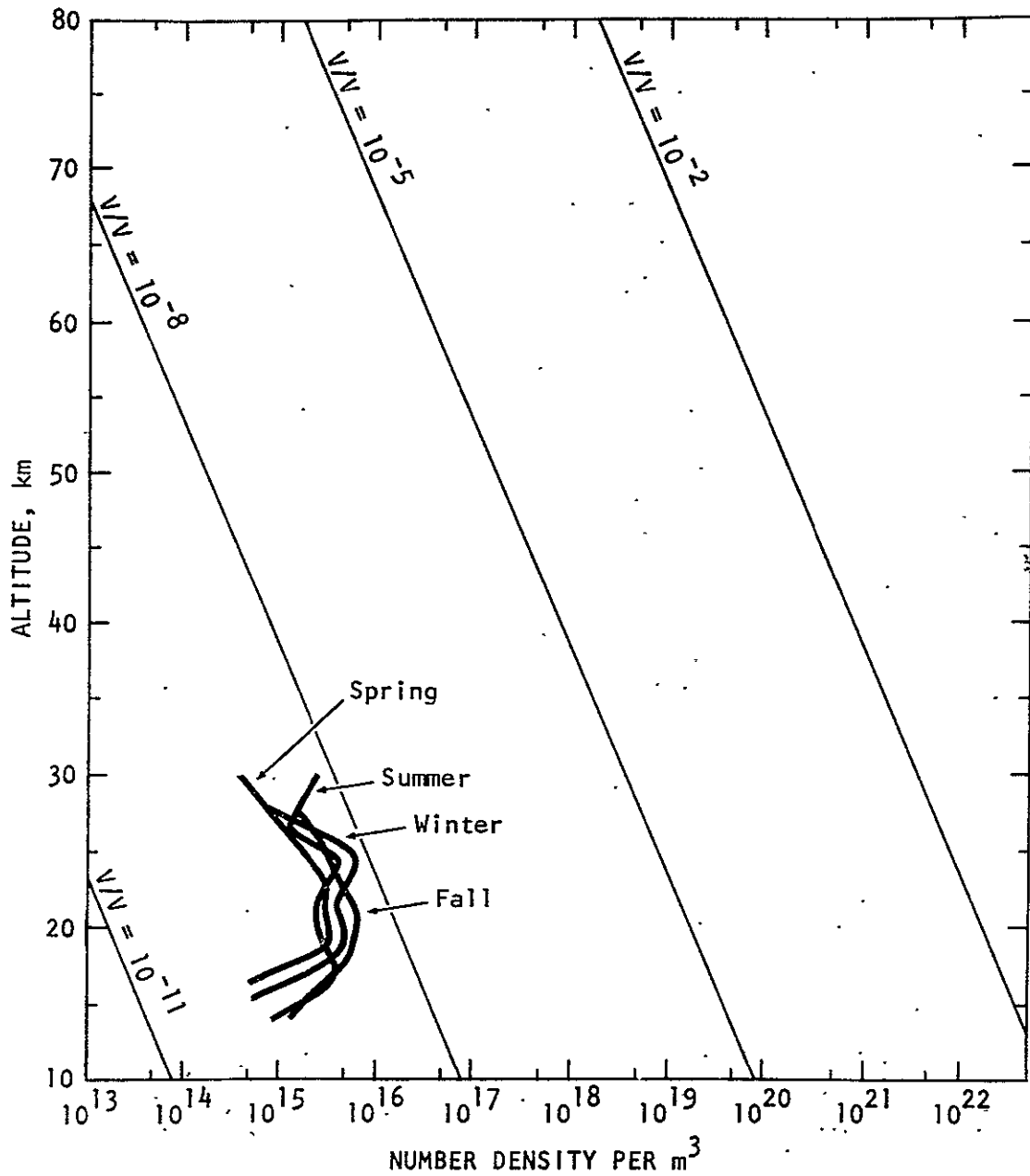


FIGURE B-9
VERTICAL DISTRIBUTION OF NITRIC ACID, HNO_3
MID-LATITUDE [91]

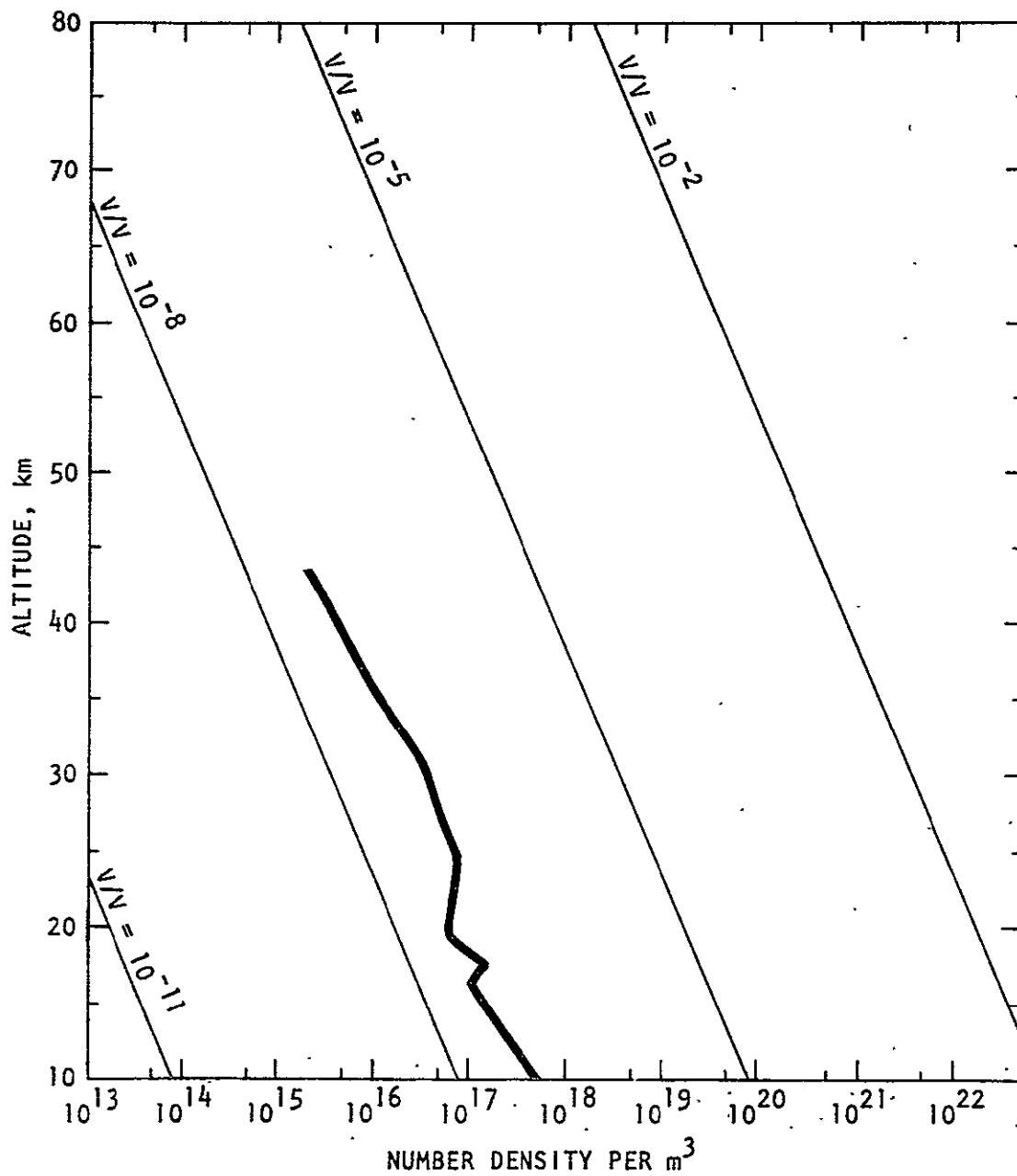


FIGURE B-10
 VERTICAL DISTRIBUTION OF CARBON MONOXIDE, CO
 MID-LATITUDE [90]

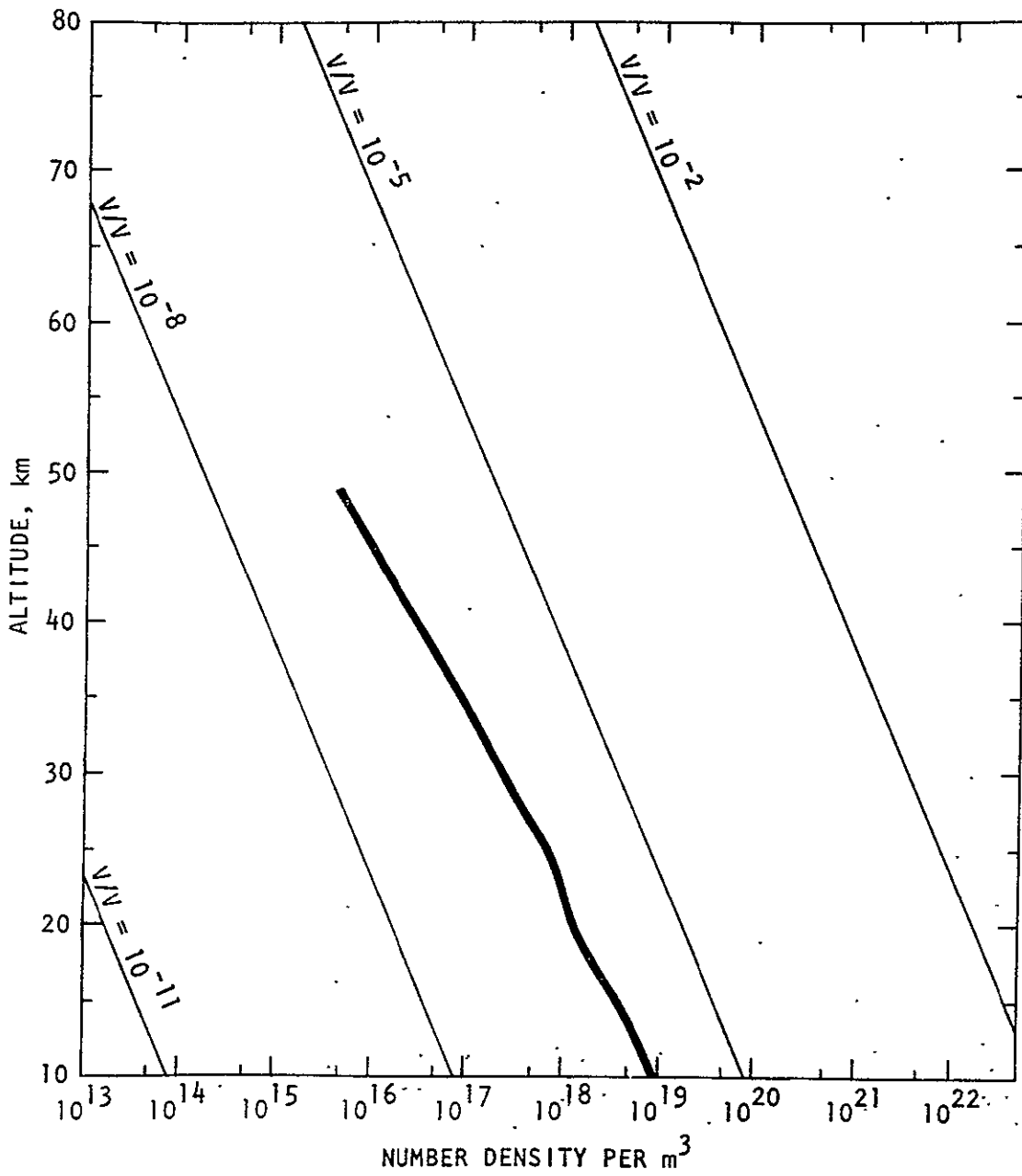


FIGURE B-11
VERTICAL DISTRIBUTION OF METHANE, CH₄
MID-LATITUDE [90]

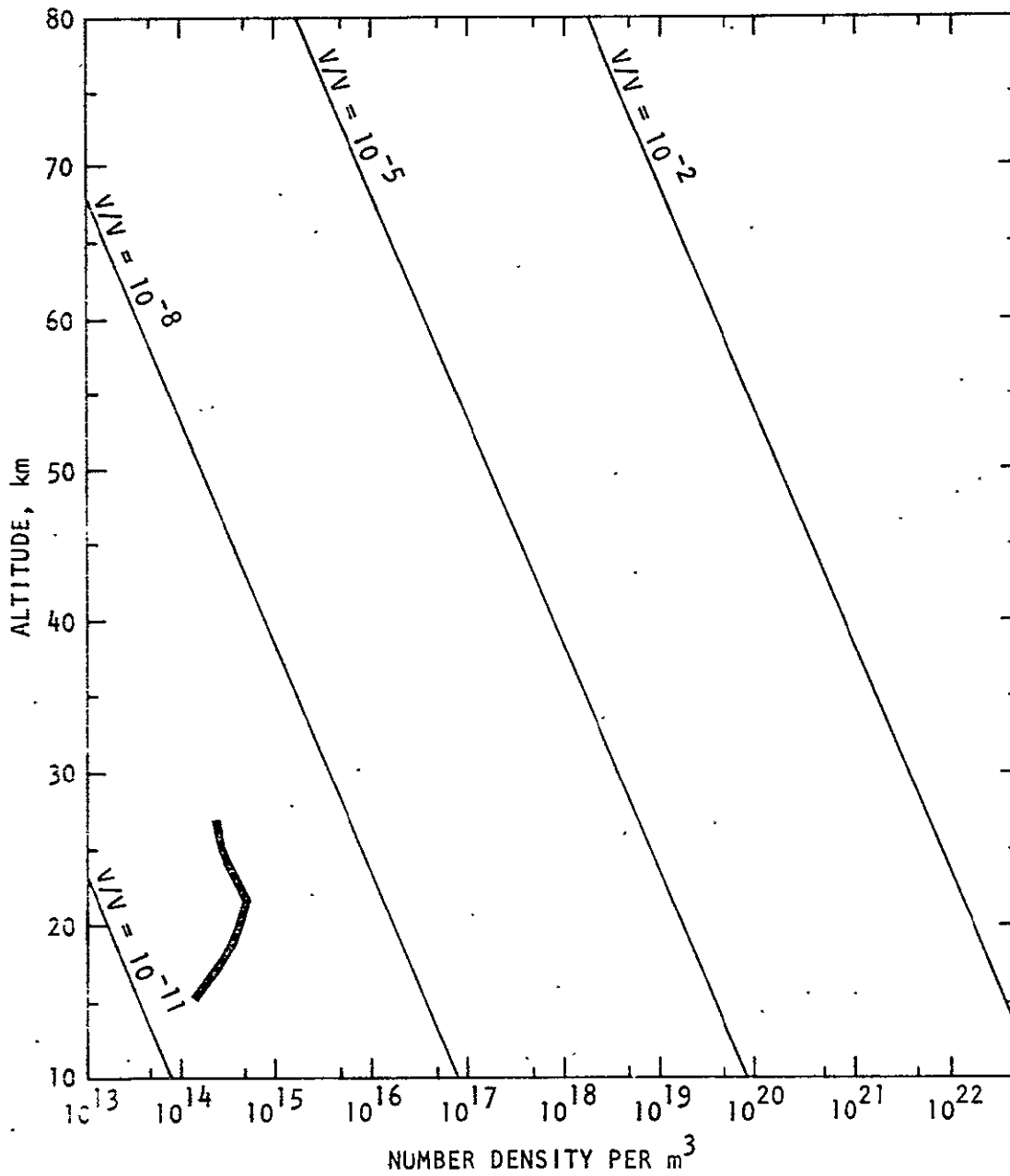


FIGURE B-12
 VERTICAL DISTRIBUTION OF HYDROGEN CHLORIDE, HCL
 MID-LATITUDE [40]

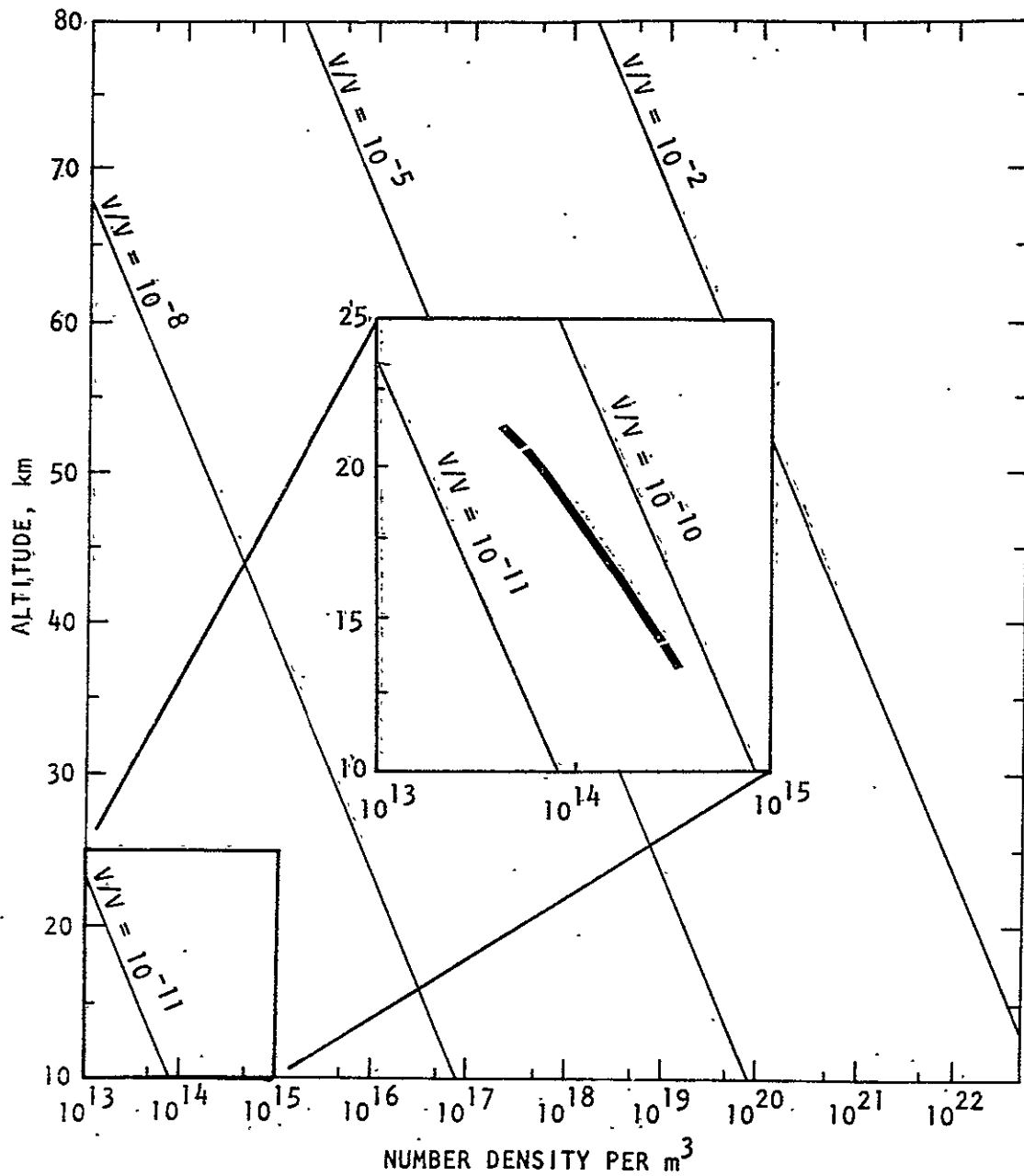


FIGURE B-13
 VERTICAL DISTRIBUTION OF FREON 11, SPRING, EQUATOR [40]

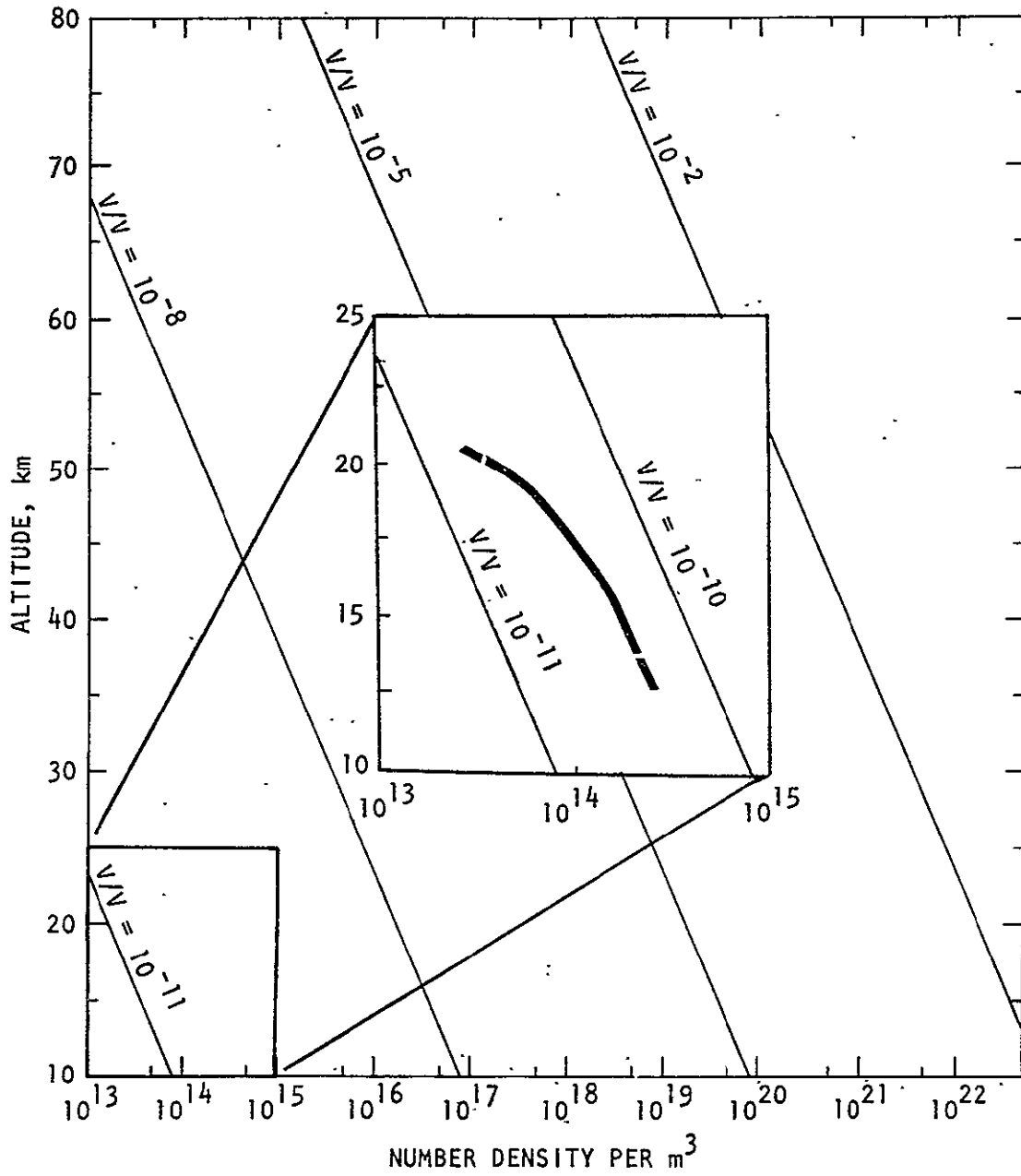


FIGURE B-14
 VERTICAL DISTRIBUTION OF FREON 11, SPRING,
 MID-LATITUDE [40]

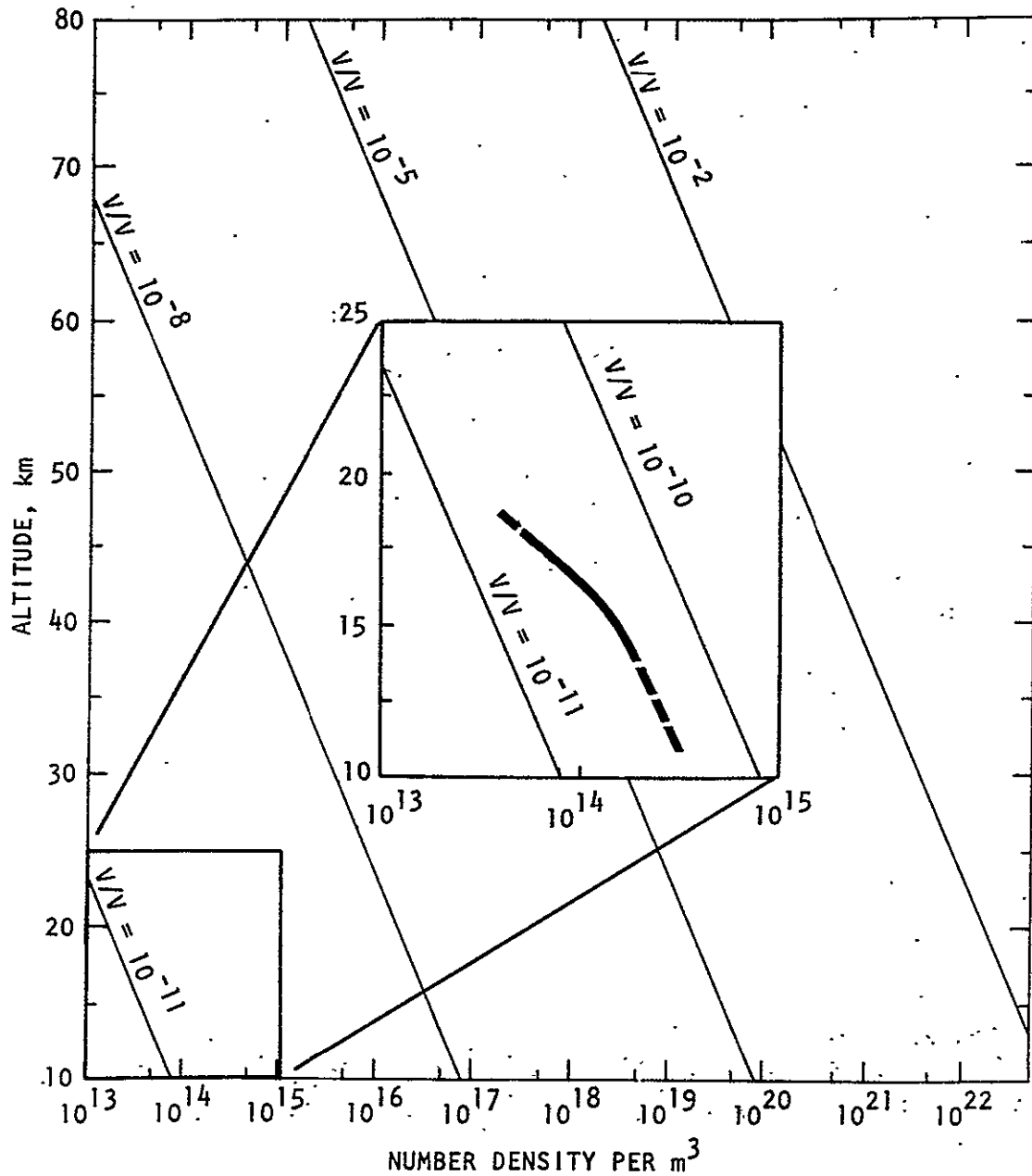


FIGURE B-15
 VERTICAL DISTRIBUTION OF FREON 11, SPRING, 70°N [40]

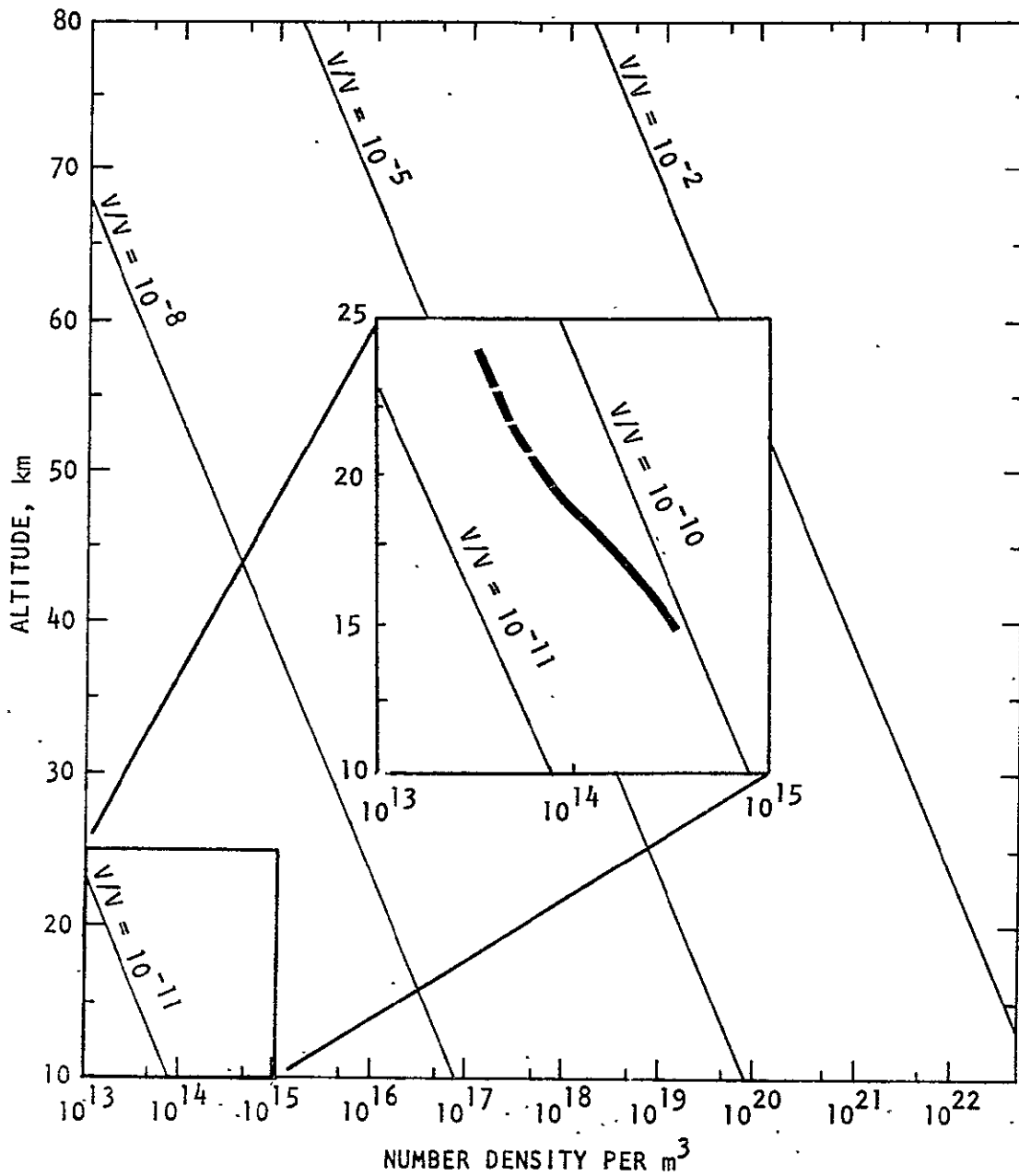


FIGURE B-16
 VERTICAL DISTRIBUTION OF FREON 11, AUTUMN, EQUATOR [40]

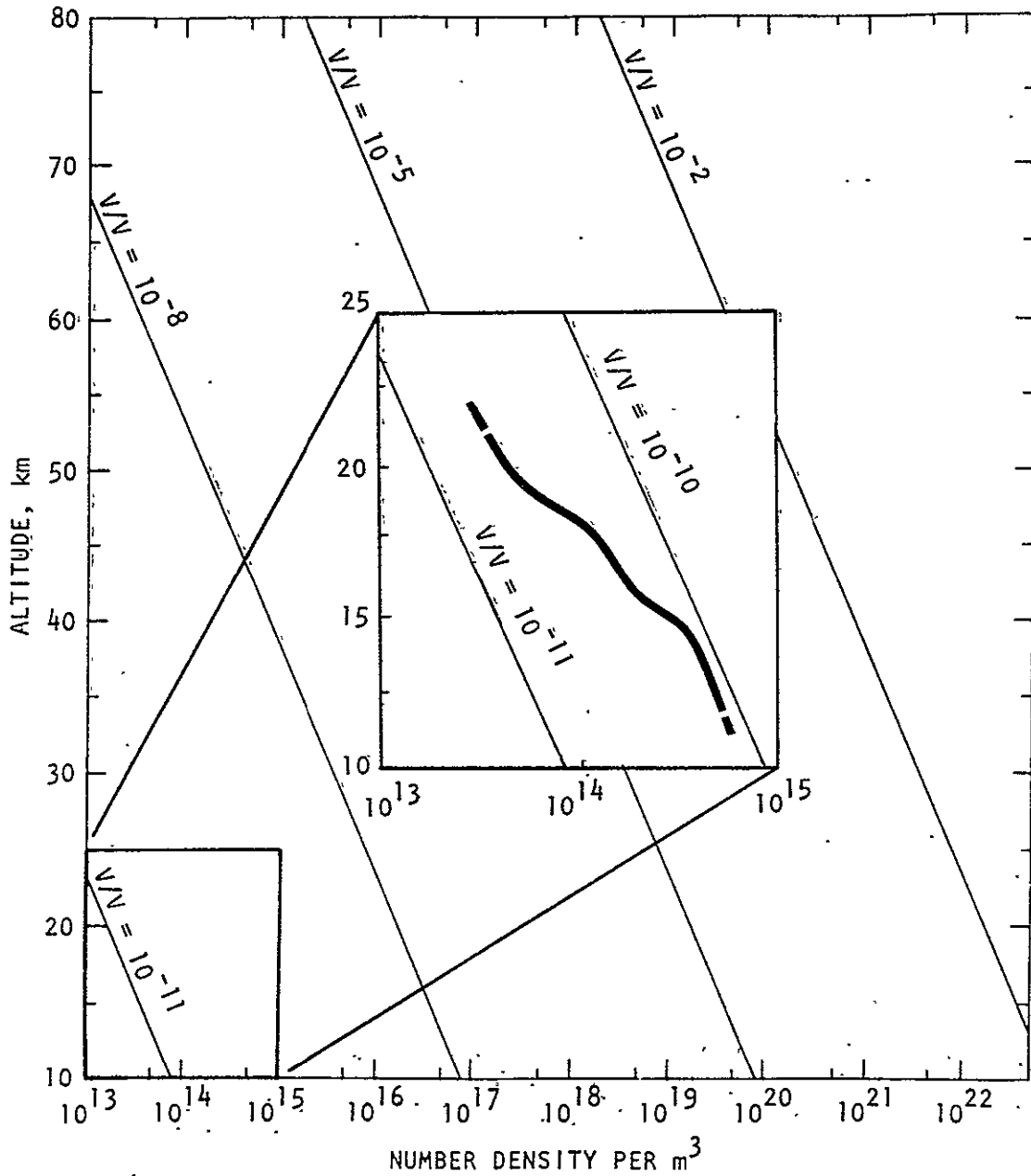


FIGURE B-17
 VERTICAL DISTRIBUTION OF FREON 11, AUTUMN,
 MID-LATITUDE [40]

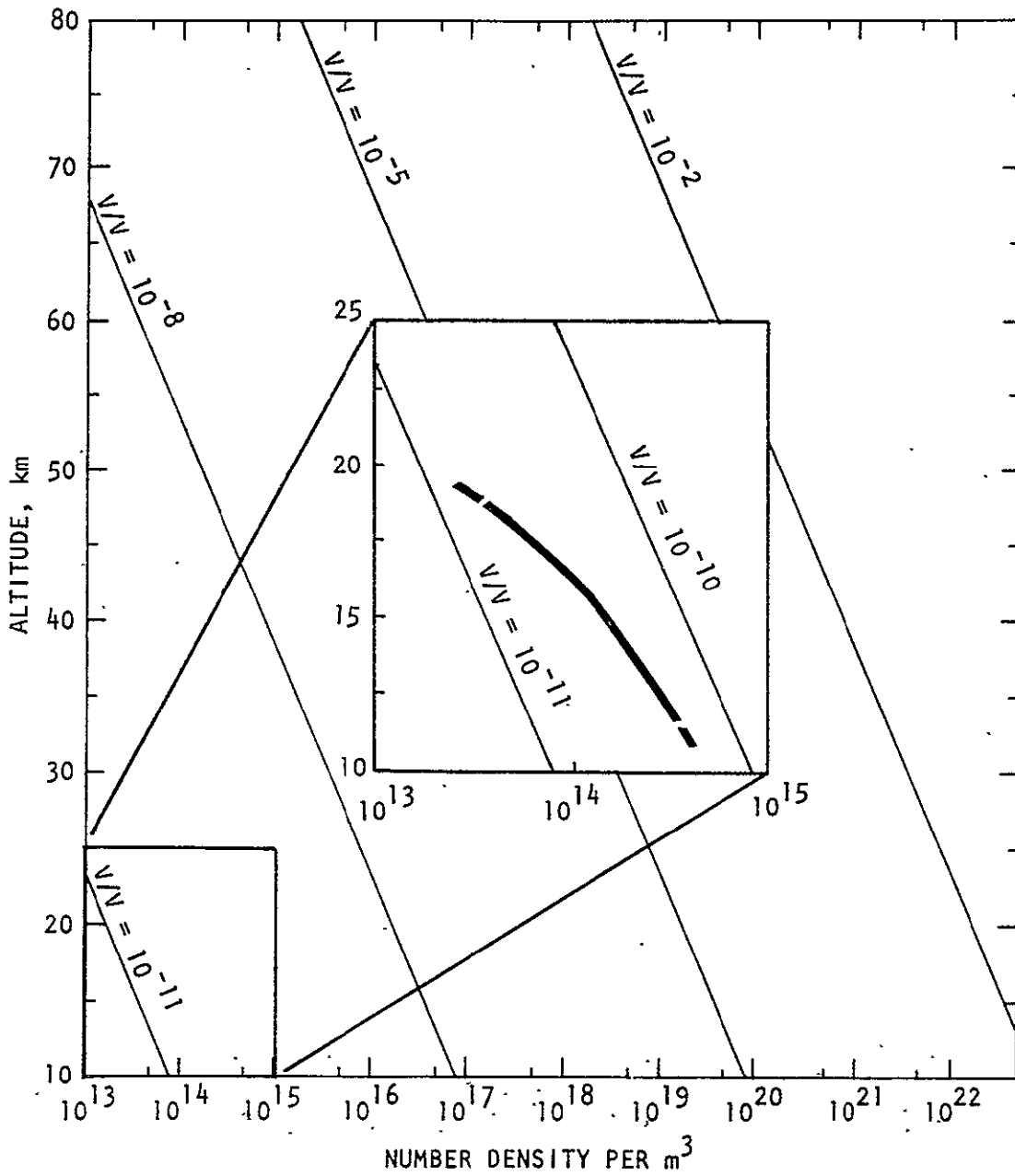


FIGURE B-18
 VERTICAL DISTRIBUTION OF FREON 11, AUTUMN, 70°N [40]

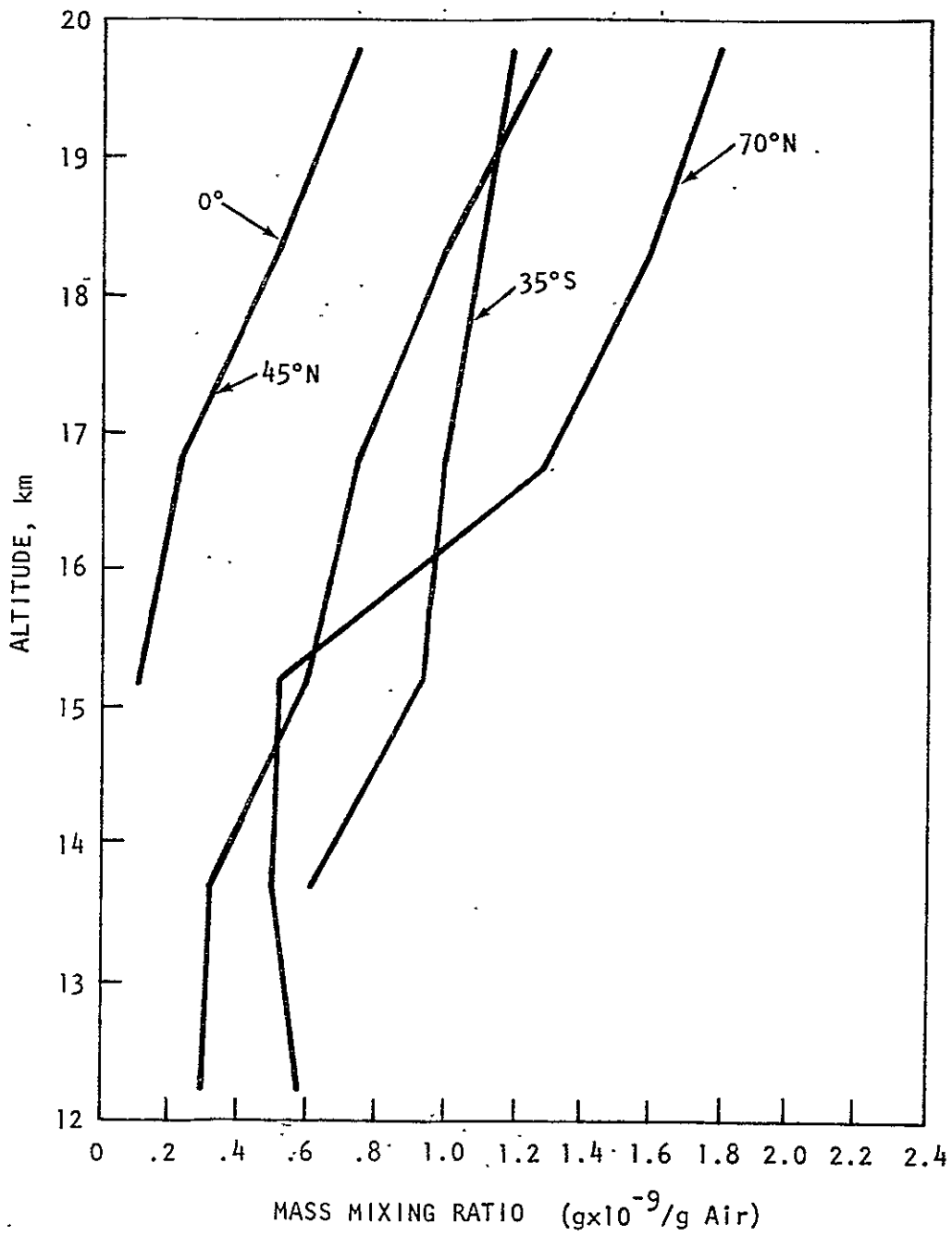


FIGURE B-19
VERTICAL DISTRIBUTION OF SULFATES [81]

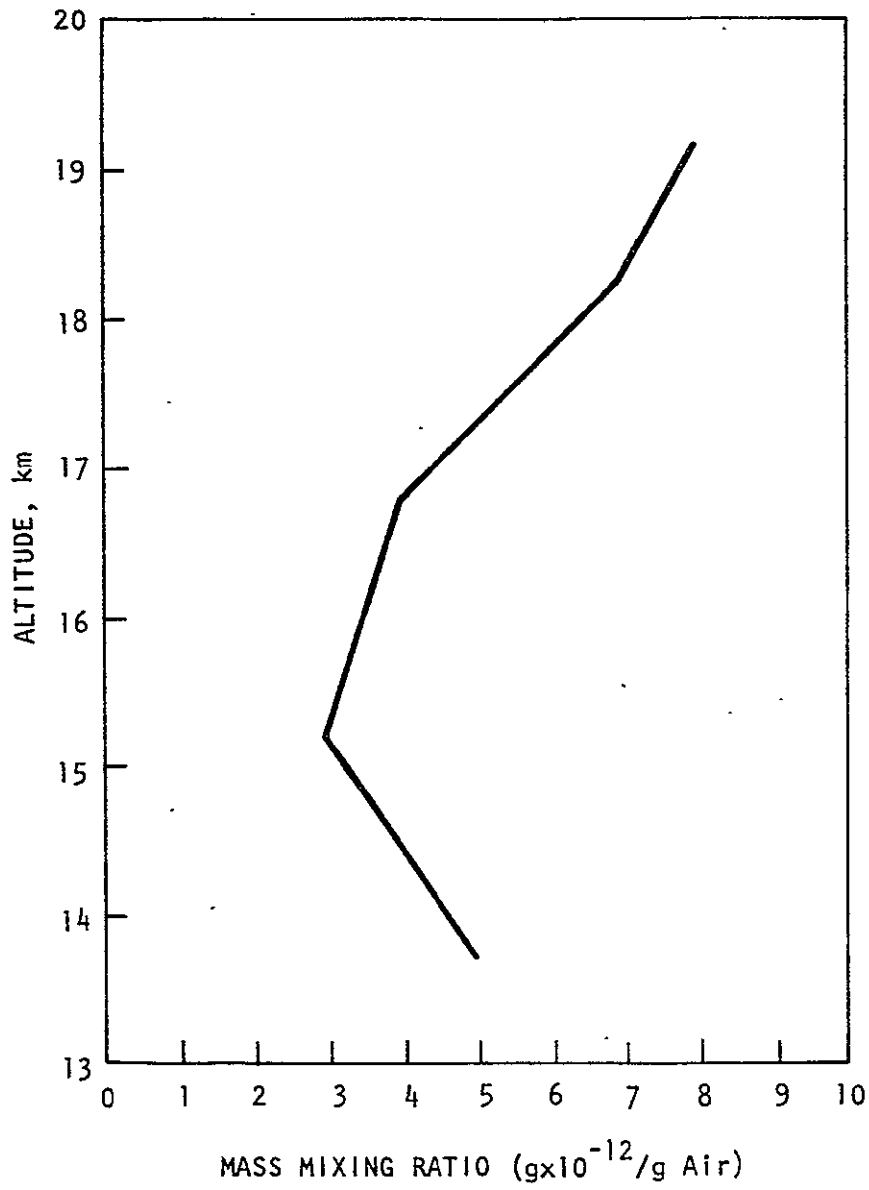
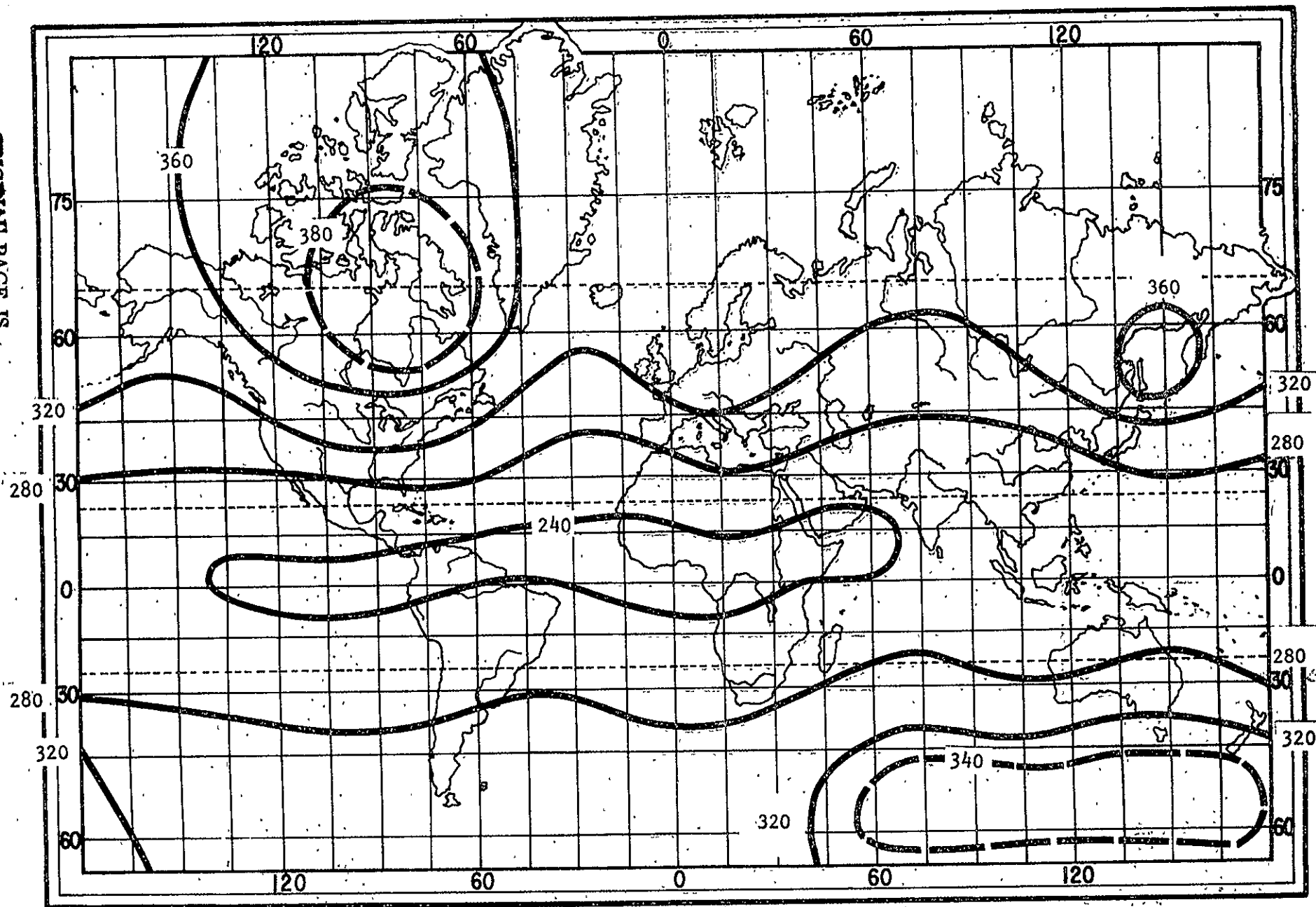


FIGURE B-20
ESTIMATED MID-LATITUDE VERTICAL PROFILE FOR BROMIDES [80]

ORIGINAL PAGE IS
OF POOR QUALITY

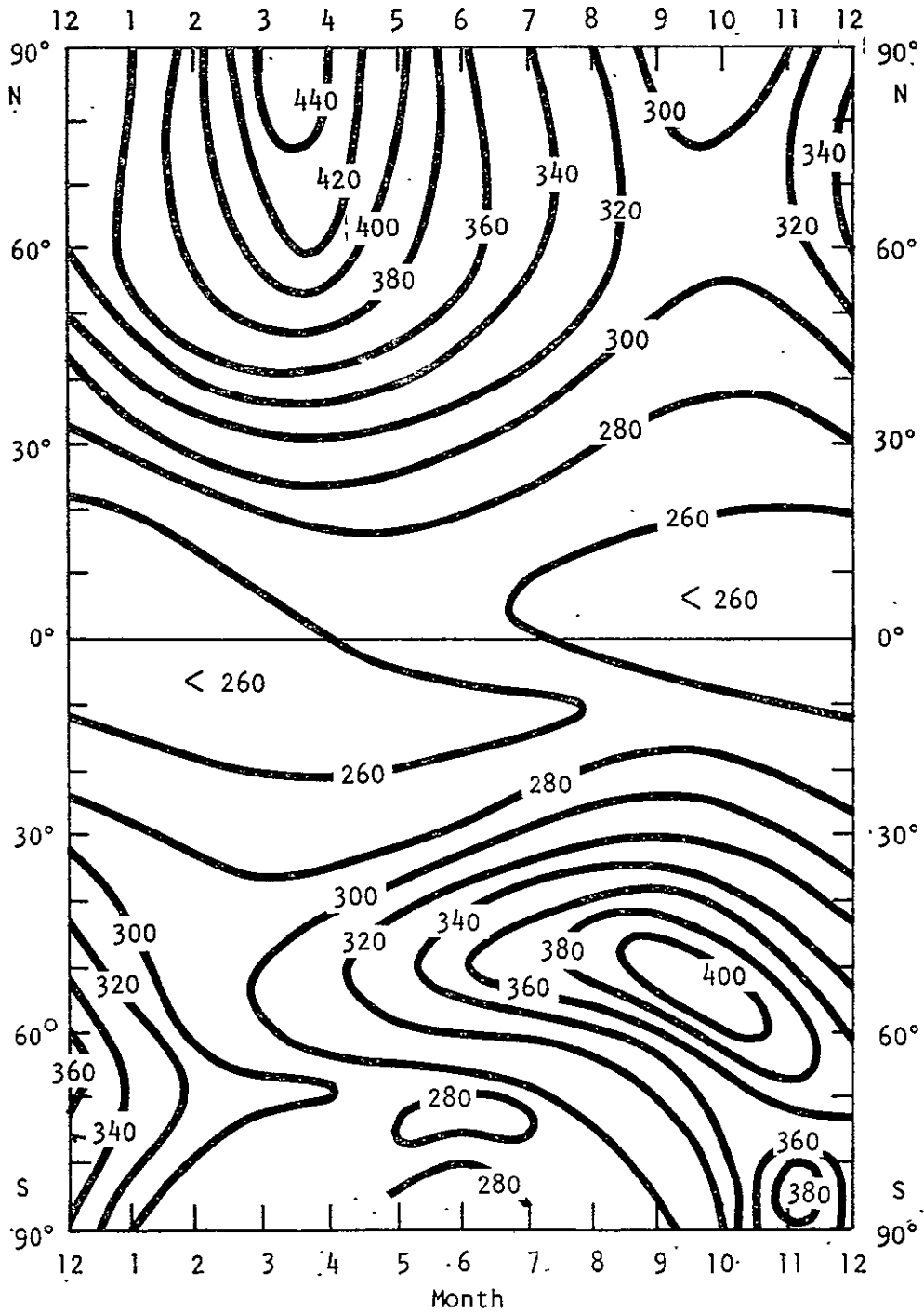
B-22

ORIGINAL PAGE IS
OF POOR QUALITY



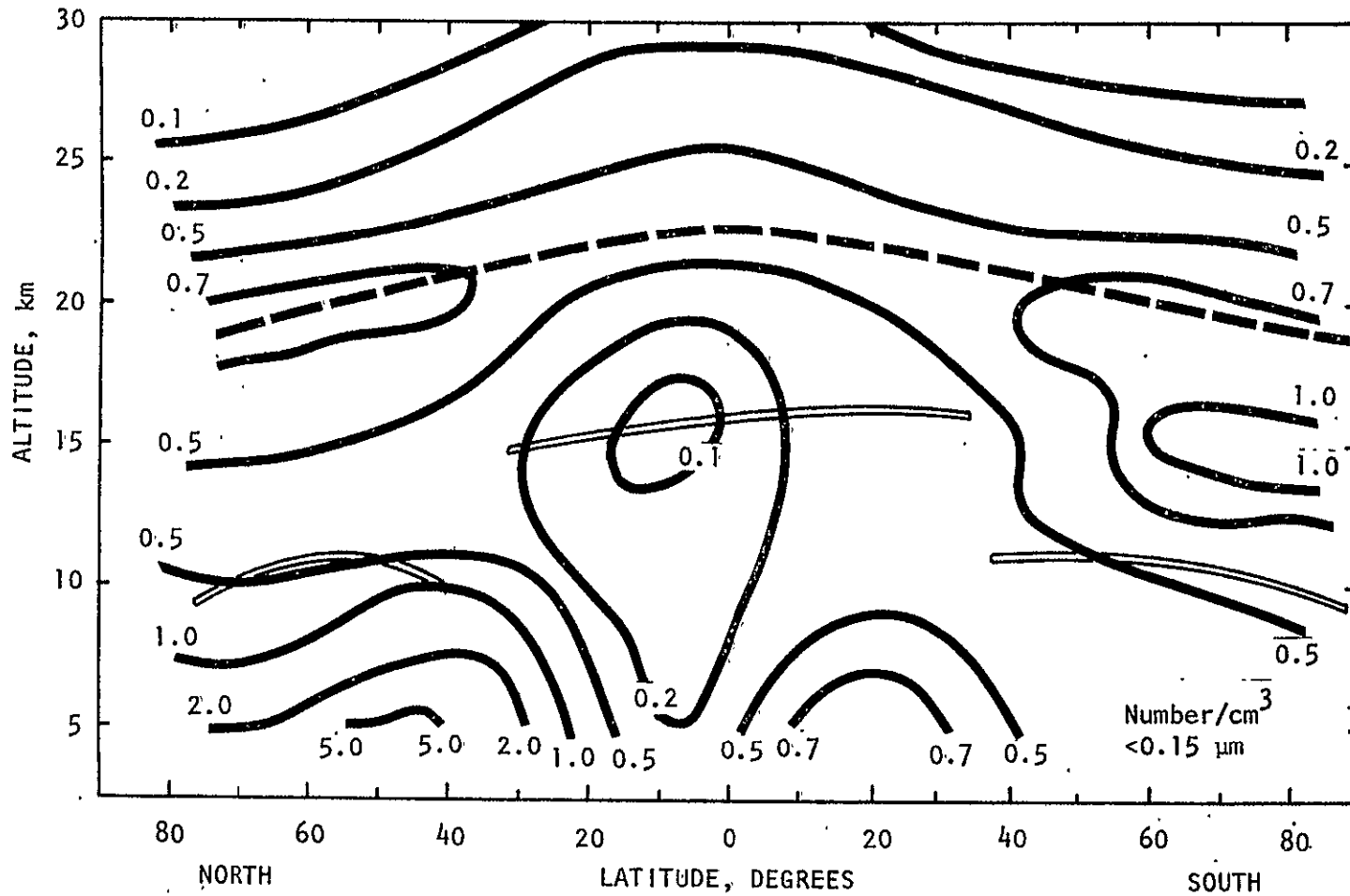
(Units: milli atm.-cm.)

FIGURE B-21
GLOBAL DISTRIBUTION OF TOTAL OZONE [40]



(The numbers are total amounts in the conventional units of 10^{-3} atm-cm STP.)

FIGURE B-22
 WORLDWIDE TOTAL OZONE AS A FUNCTION OF SEASON AND LATITUDE



(Solid lines are lines of constant aerosol concentrations [number cm⁻³]; open lines indicate the altitude of the tropopause.)

FIGURE B-23
LATITUDINAL DISTRIBUTION OF AEROSOLS^[66]

B-25

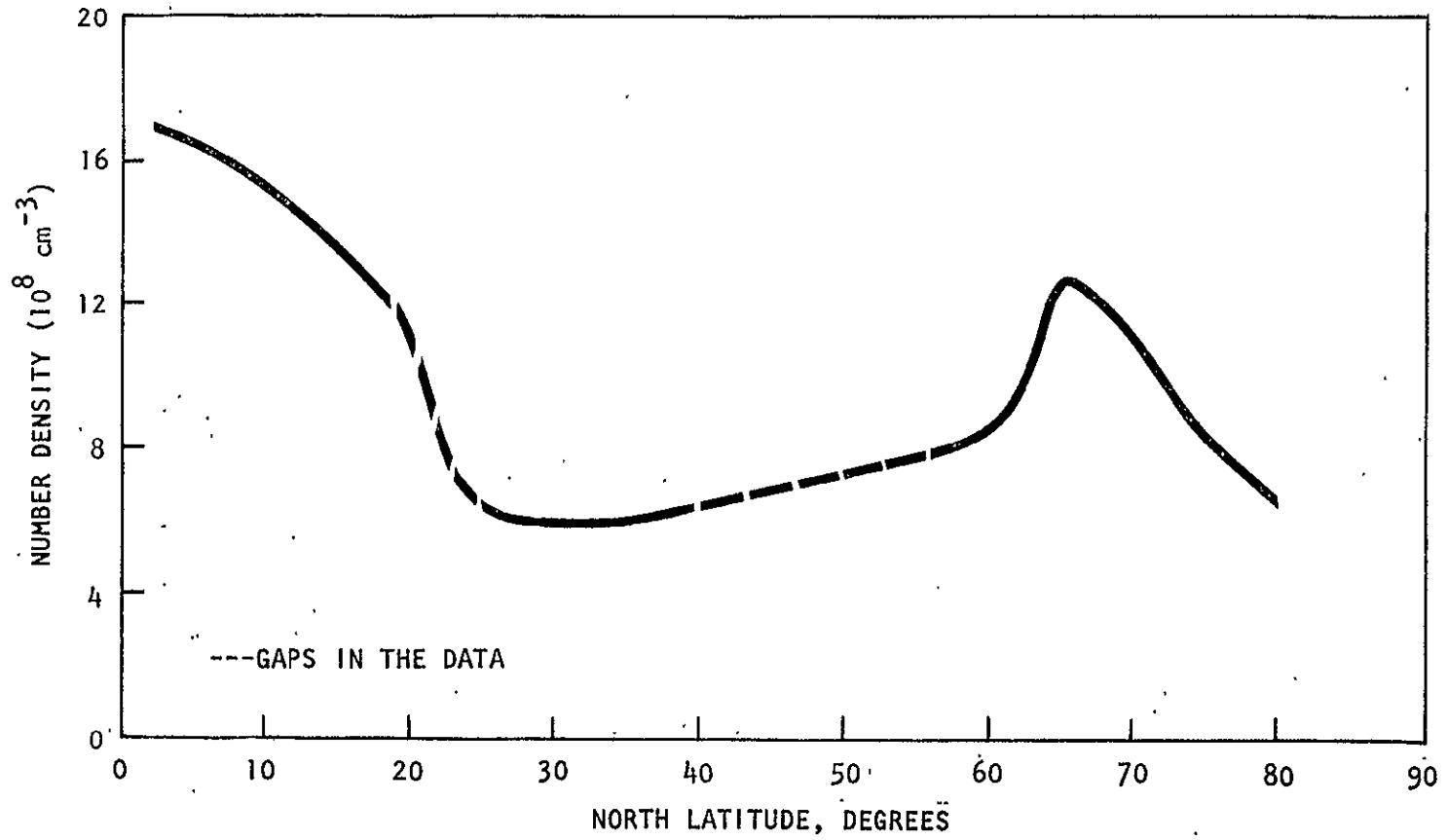


FIGURE B-24
AVERAGE LATITUDINAL DISTRIBUTION OF NITRIC OXIDE,
NO, AT 18.3 km [82]

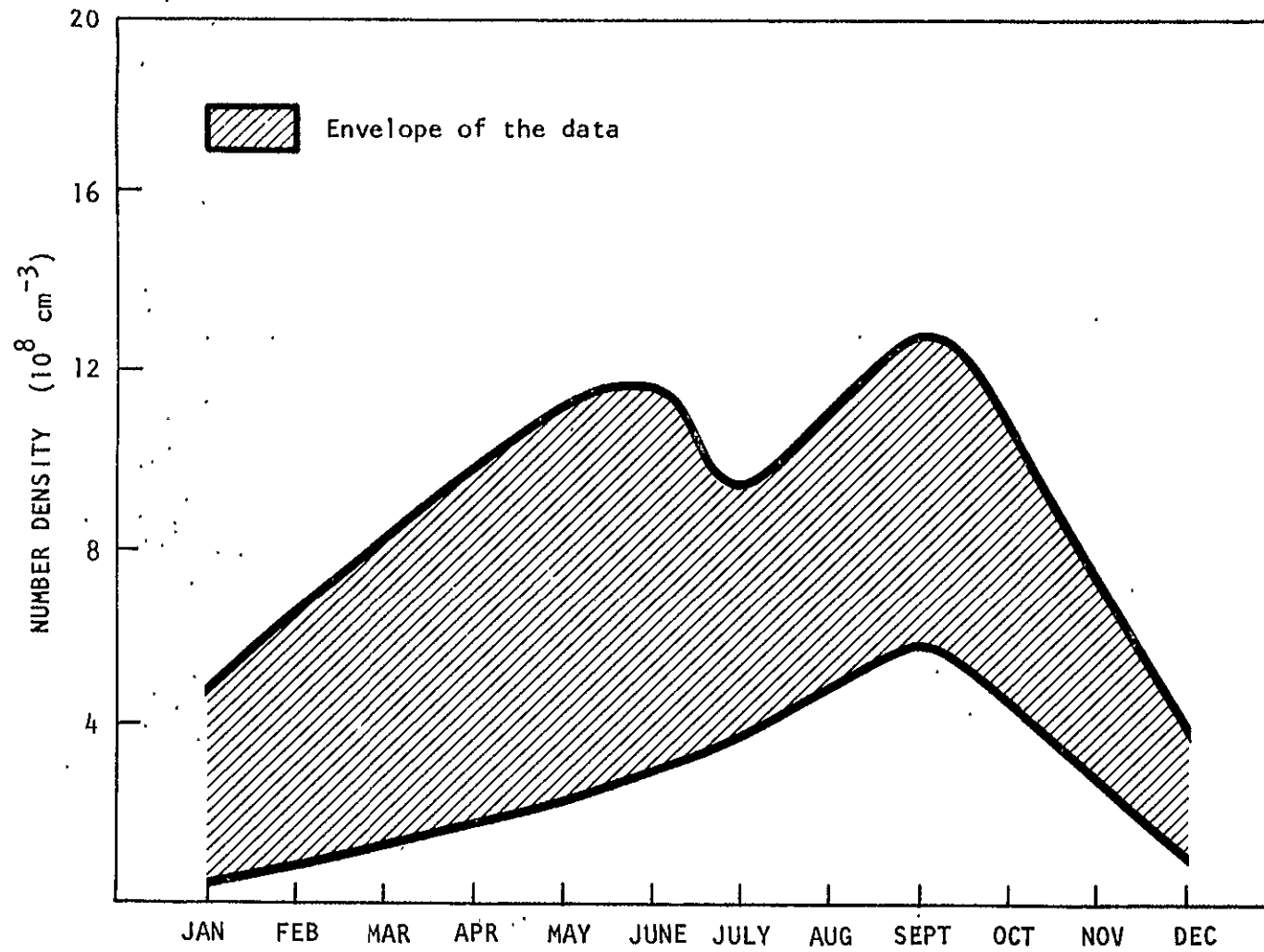


FIGURE B-25
SEASONAL DISTRIBUTION OF NO AT 21.3 km [82]

B-27

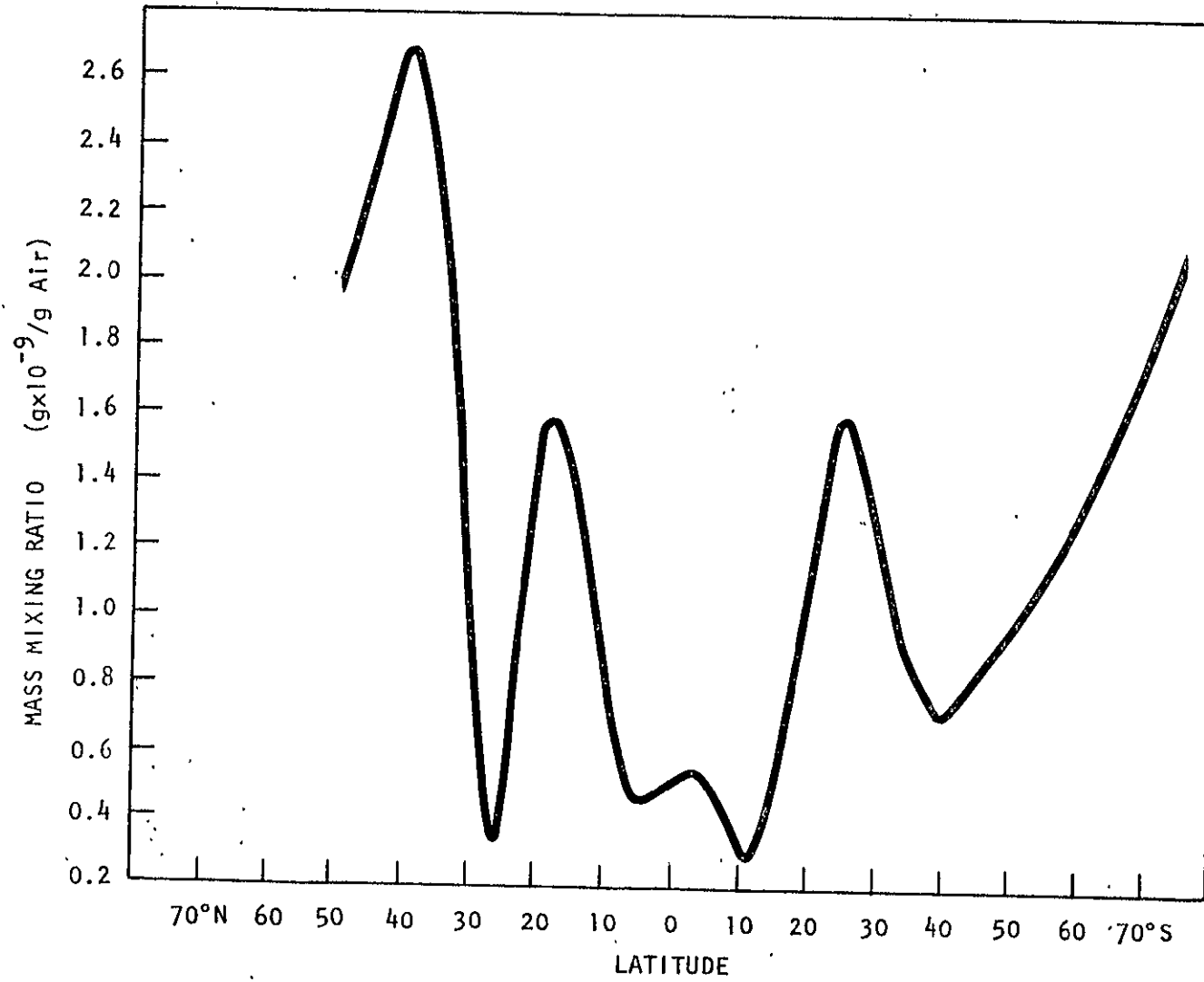


FIGURE B-26
LATITUDINAL DISTRIBUTION OF HNO₃ VAPOR AT 19 km [81]

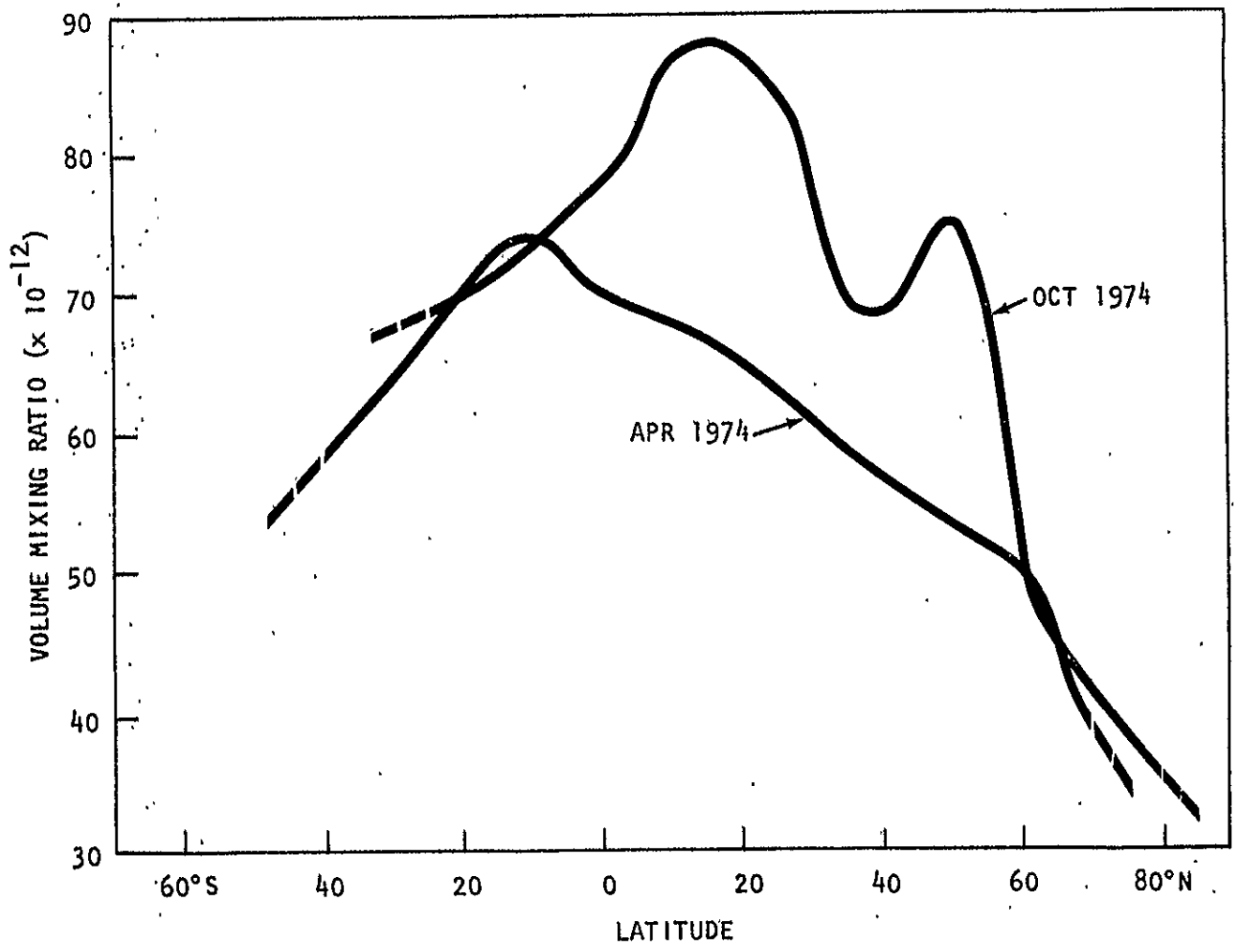


FIGURE B-27
LATITUDINAL VARIATION OF FREON 11 AT 17 km [83]

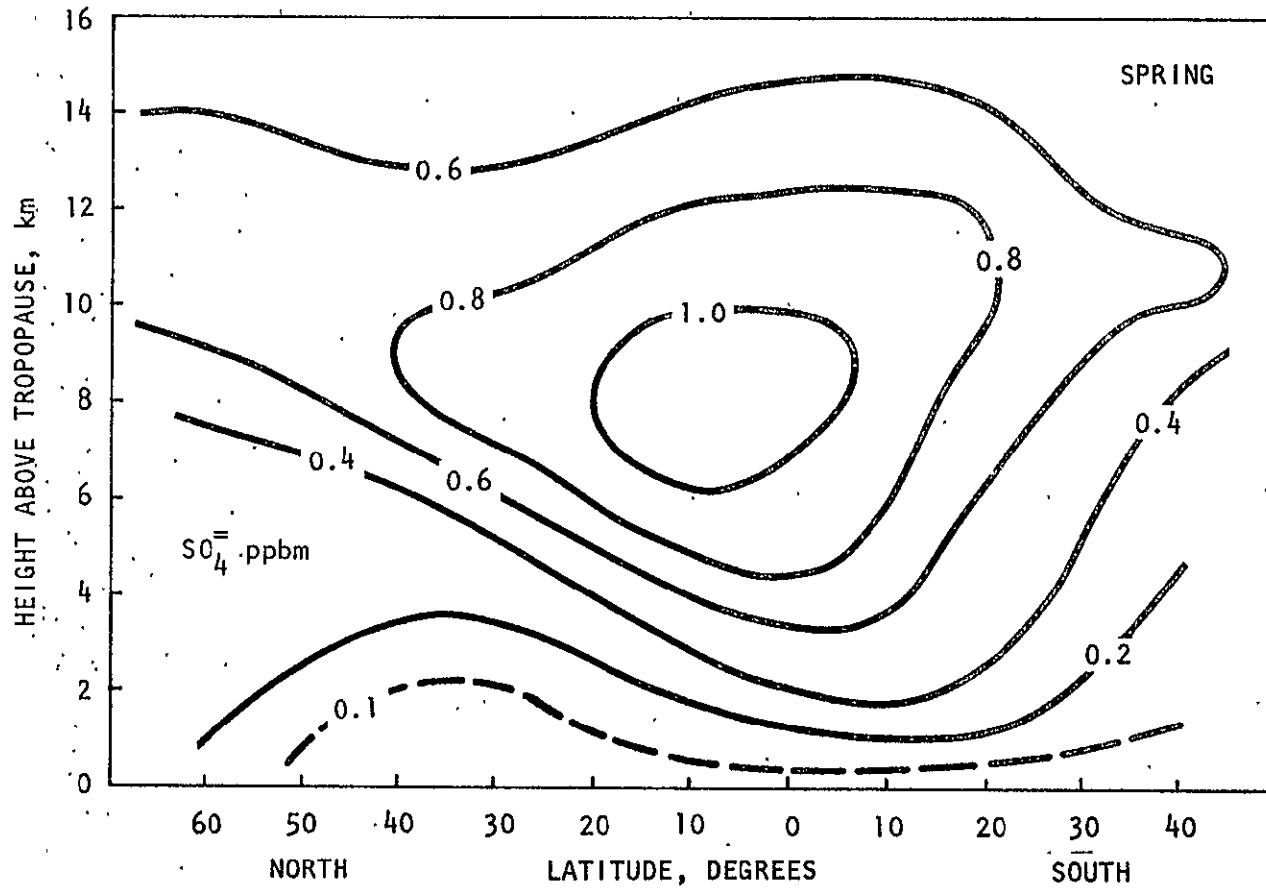


FIGURE B-28
LATITUDINAL DISTRIBUTION OF SULFATE [66]

B-30

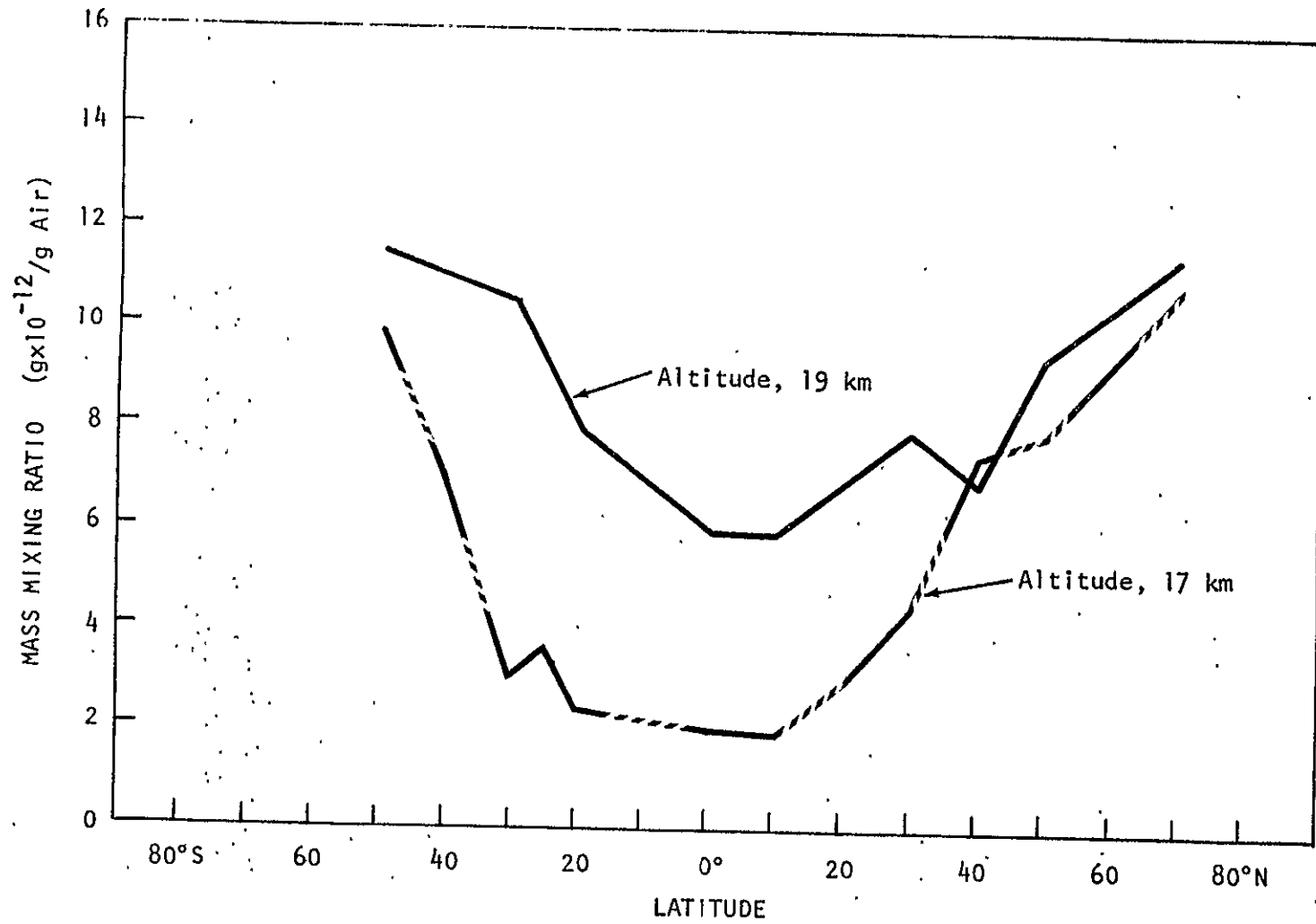


FIGURE B-29
ESTIMATED LATITUDINAL PROFILES FOR BROMIDES [80]

APPENDIX C

REFERENCES

NOTE: For the convenience of the user, the same set of references is presented in Volumes I, II and III of this report. Therefore, in any one volume, all references are not cited in the text.

APPENDIX C

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