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UNCLASSIFIED SP15-77-UA-43 ECOM-77-5 NL

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RESEARCH AND DEVELOPMENT TECHNICAL REPORT
ECOM-77-5

HIGH-LATITUDE PHOTODISSOCIATION RATES AND PREDICTED SOLAR FLUX INTENSITIES

An Addendum to ECOM-77-1, "STRATCOM-Related Photodissociation Rates and Solar Flux Intensities"

By

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July 1977

ECOM

UNITED STATES ARMY ELECTRONICS COMMAND - FORT MONMOUTH, NEW JERSEY 07703

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REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER: ECOM-77-5

2. GOVT ACCESSION NO.:

3. RECIPIENT'S CATALOG NUMBER:

4. TITLE (and Subtitle): HIGH-LATITUDE PHOTODISSOCIATION RATES AND PREDICTED SOLAR FLUX INTENSITIES - An Addendum to ECOM-77-1, "STRATCOM-Related Photodissociation Rates and Solar Flux Intensities".

5. TYPE OF REPORT & PERIOD COVERED: Special Report

6. PERFORMING ORG. REPORT NUMBER: SP15-77-UA-43

7. AUTHOR(s): Jerry Collins

8. CONTRACT OR GRANT NUMBER(s): DAAD07-74-C-0263

9. PERFORMING ORGANIZATION NAME AND ADDRESS:
Electrical Engineering Department
The University of Texas at El Paso
El Paso, Texas 79968

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS:

11. CONTROLLING OFFICE NAME AND ADDRESS:
US Army Electronics Command
Fort Monmouth, NJ 07703

12. REPORT DATE: July 1977

13. NUMBER OF PAGES: 28

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office):
Atmospheric Sciences Laboratory
US Army Electronics Command
White Sands Missile Range, NM 88002

15. SECURITY CLASS. (of this report): UNCLASSIFIED

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE:

16. DISTRIBUTION STATEMENT (of this Report):
Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report):

18. SUPPLEMENTARY NOTES:
Contract Monitor: Mr. Harold Ballard
Atmospheric Sciences Laboratory
White Sands Missile Range, NM 88002

19. KEY WORDS (Continue on reverse side if necessary and identify by block number):
Photodissociation rates
Solar flux intensities
65° north latitude

20. ABSTRACT (Continue on reverse side if necessary and identify by block number):
Photodissociation rates and predicted solar flux intensities have been reported previously by J. L. Collins for conditions closely corresponding to those of the STRATCOM (STRATospheric COMposition) balloon launches made by the Atmospheric Sciences Laboratory (ASL) at Holloman Air Force Base, New Mexico. This brief addendum to that report extends the calculations to include rates and solar flux intensities predicted for 65.3° north latitude. This is the location of the U. S. Army's Meteorological Rocket Station at Poker Flat, Alaska, where it is possible that such correlated experiments as the STRATCOM balloon launches

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20. ABSTRACT (cont)

will be made in the future.

TABLE OF CONTENTS

1. INTRODUCTION

Photodissociation rates have been reported recently[1] for 32° north latitude. These values were calculated for conditions closely corresponding to those of the STRATCOM balloon launches made by ASL at Holloman Air Force Base, New Mexico, as part of their experimental program to study the structure and composition of the upper atmosphere.

Future measurements could include balloon launches made from experimental stations at other latitudes; therefore, this brief addendum to the original report includes twenty-four photodissociation rates calculated for thirteen atmospheric species in the 10-50 altitude interval for 65.3° north latitude, the location of the U. S. Army's Meteorological Rocket Station in Poker Flat, Alaska. For purposes of comparison, these calculations were made for September 25, the date of calculations made for 32° north latitude.

2. INPUT DATA AND COMPUTATIONAL METHOD

Initially, photodissociation rates were calculated using the standard 32° north density profiles except for ozone and nitric acid. The ozone profile is based on the February-March 1975 measurements of Randhawa[2] at Poker Flat, with his best estimate for the seasonal variation and nitric acid being arbitrarily increased by about 30 percent. These initial rates were used in the ASL Chemical Kinetic Model, ASA[3], to predict new profiles using Olsen's[4] experimental temperature profile taken at Poker Flat during February-March 1975 with adjusted O_2 and N_2 profiles from the Fort Creely[5] model atmosphere (64° north latitude). The input density profiles for H_2O, NO_2, NO, N_2O, HNO_3, CO_2 and CH_4[6-22] were adjusted based on recent measurements, most of which were made at higher latitudes.

Using the profiles predicted by ASA, the photodissociation rates and solar flux intensities were recalculated, and a second calculation of the profiles was made using the new rates.

3. RESULTS

The numerical values of photodissociation reaction rates calculated for the maximum solar zenith angle on September 28, 1976, at 65.3° north latitude are listed with those previously reported for 32° north latitude for the convenience of the user. These values may be found in Appendix A with computerized plots of the high latitude rates. As before, zero rates are tabulated as 1.0×10^{-24}.

Plots of the solar flux at typical balloon flight altitudes are given in Figures 3.1 through 3.5.

FIG. 3.1 SOLAR FLUX INTENSITIES PREDICTED AT 47.5 KM.

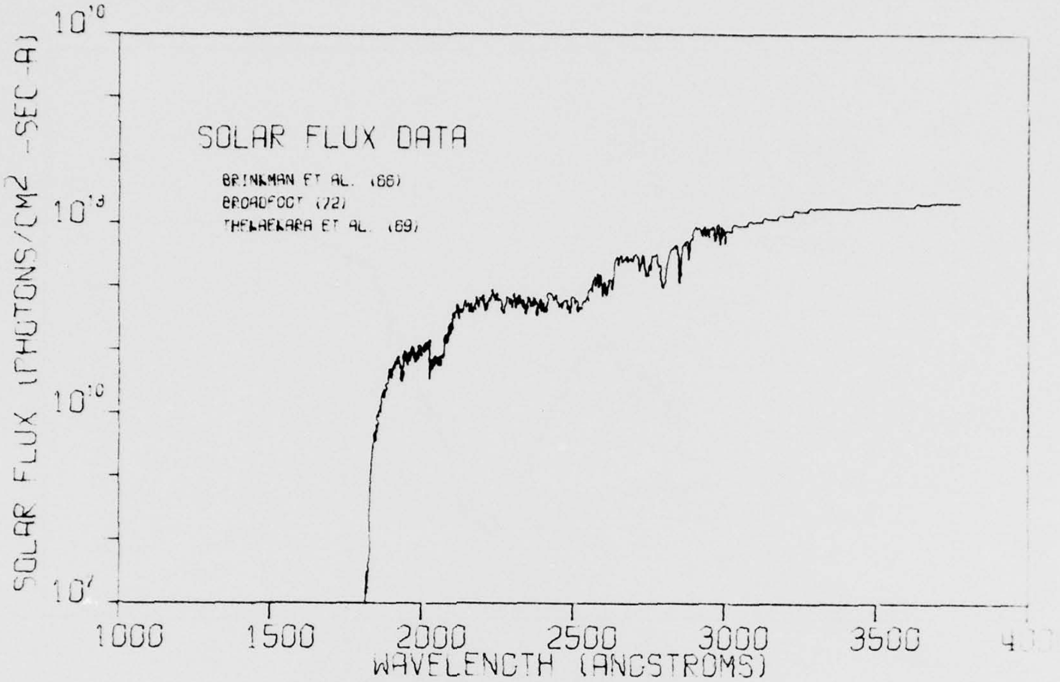


FIG. 3.2 SOLAR FLUX INTENSITIES PREDICTED AT 42.5 KM.

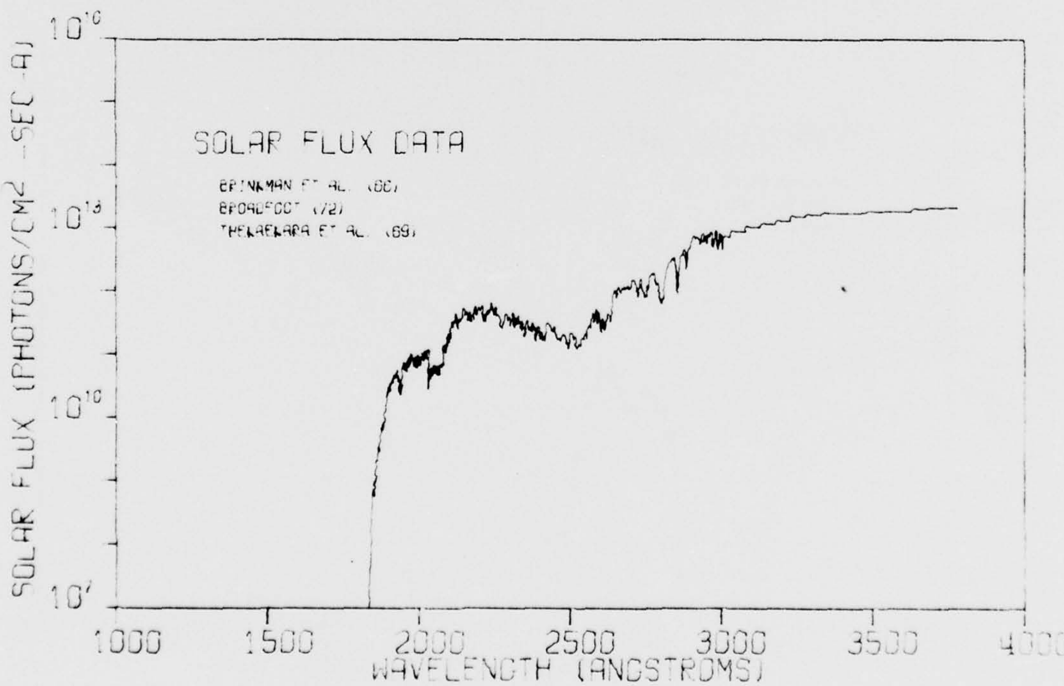


FIG. 3.3 SOLAR FLUX INTENSITIES PREDICTED AT 37.5 KM.

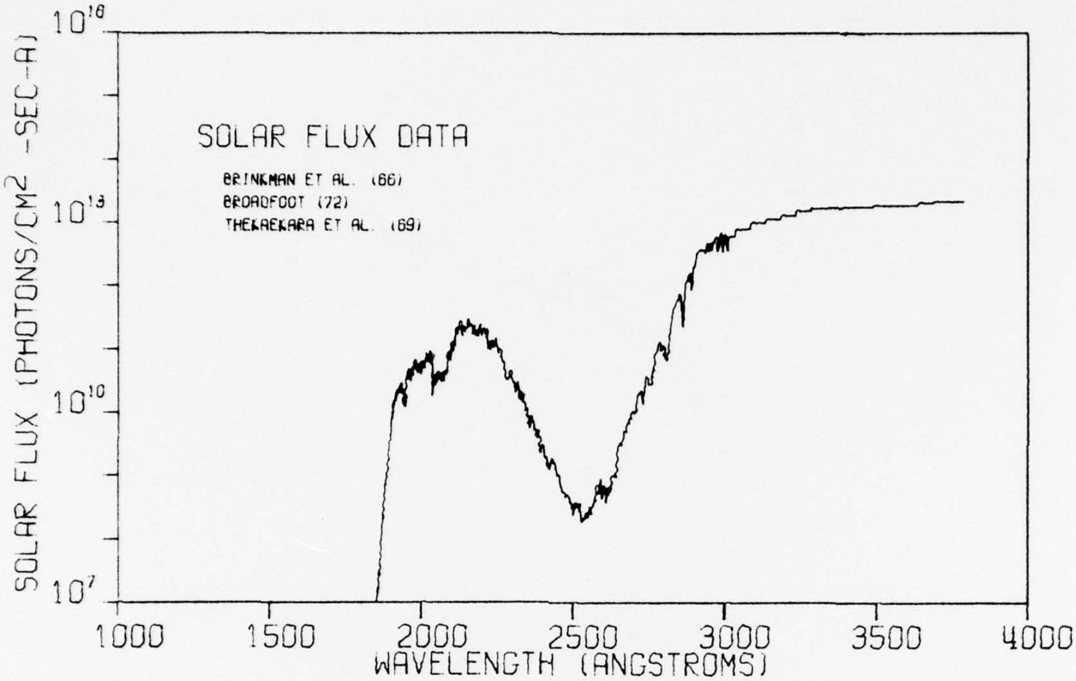


FIG. 3.4 SOLAR FLUX INTENSITIES PREDICTED AT 32.5 KM.

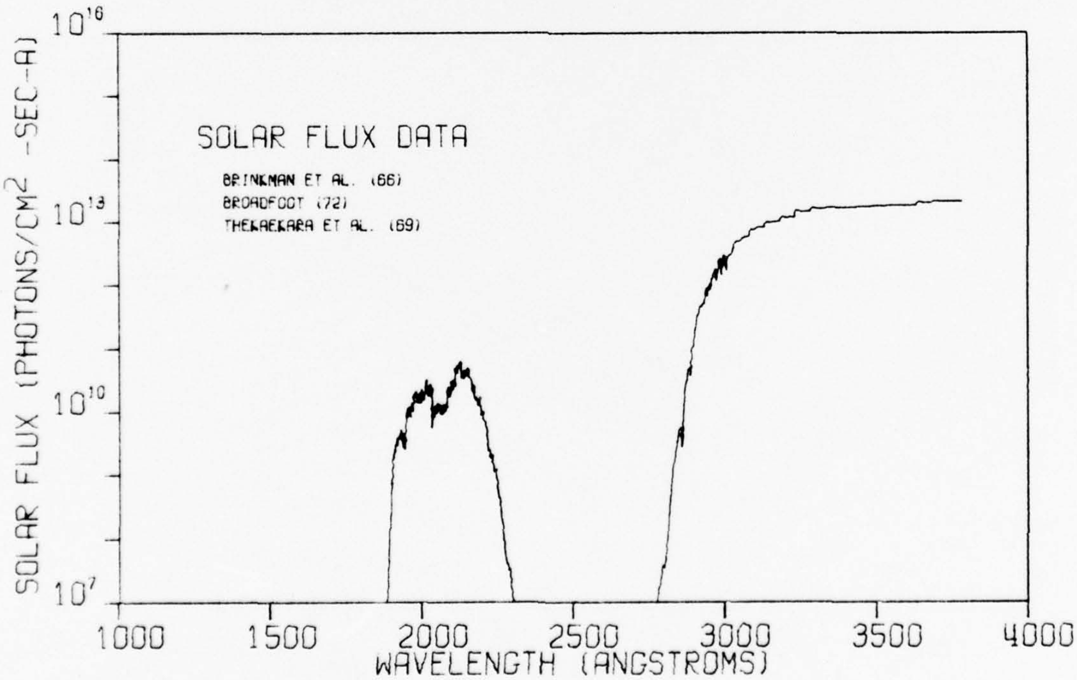
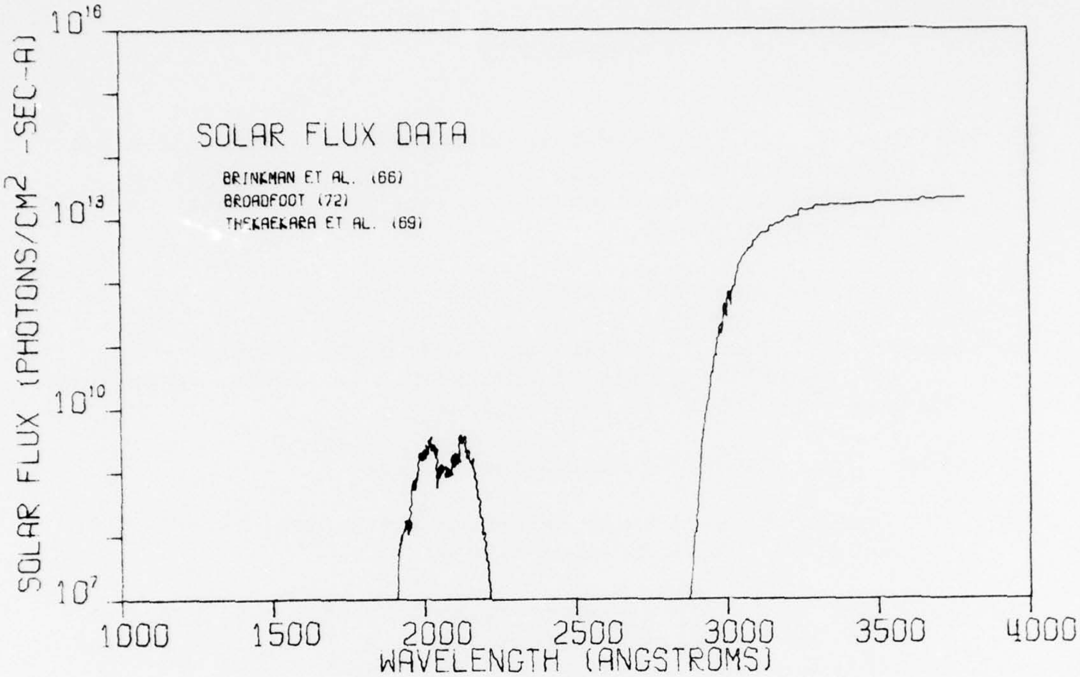


FIG. 3.5 SOLAR FLUX INTENSITIES PREDICTED AT 27.5 KM.



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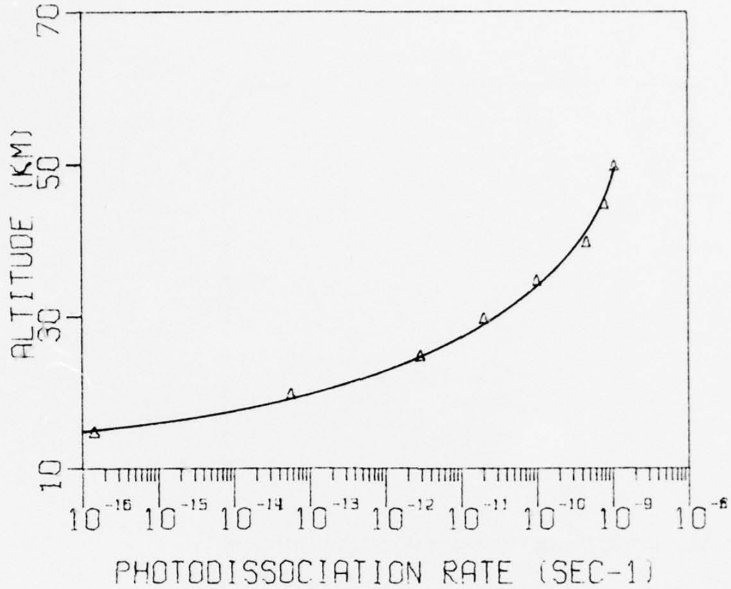
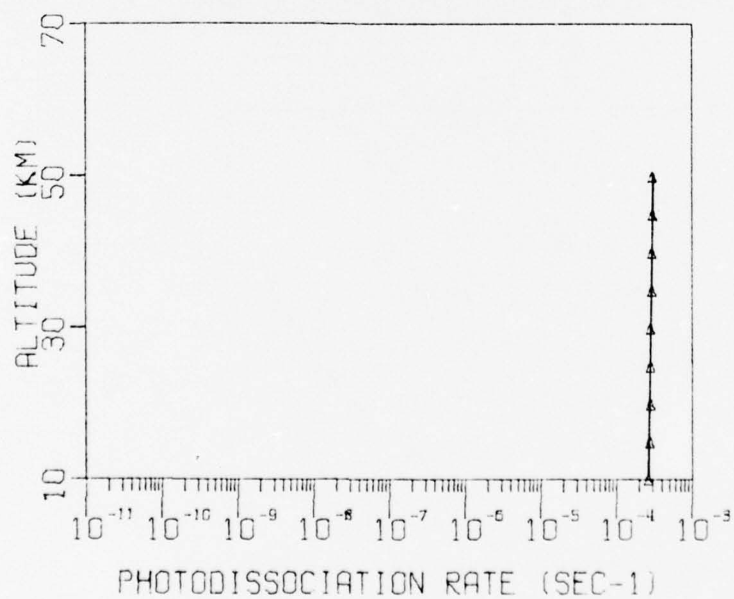
APPENDIX A

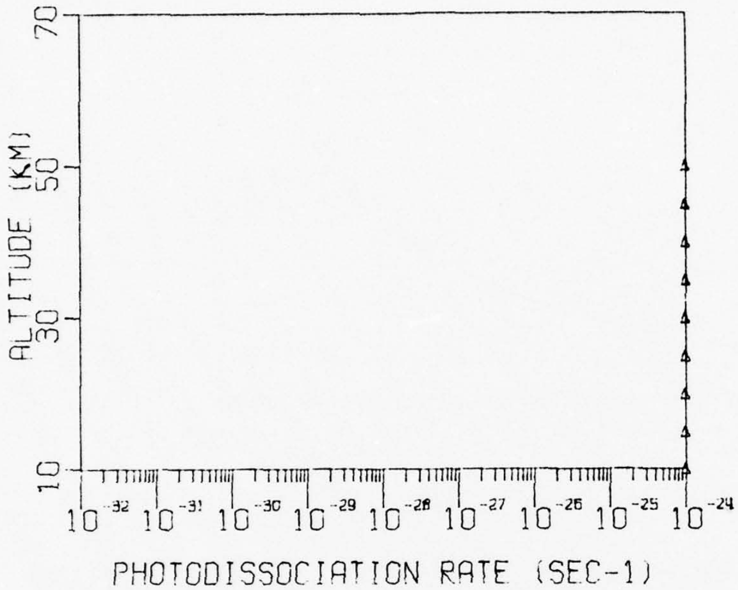
PHOTODISSOCIATION RATES



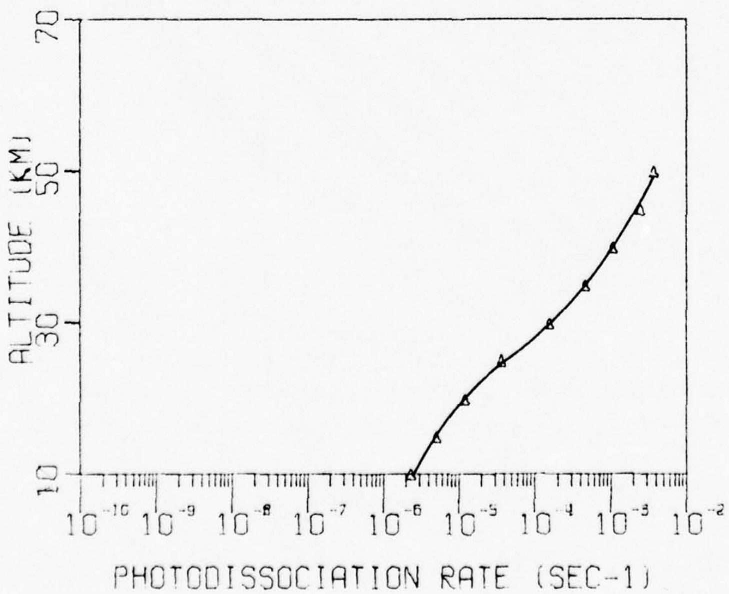
1 $O_2 + h\nu = O + O$ 175.9-242.4 NM. Ø = 1.000



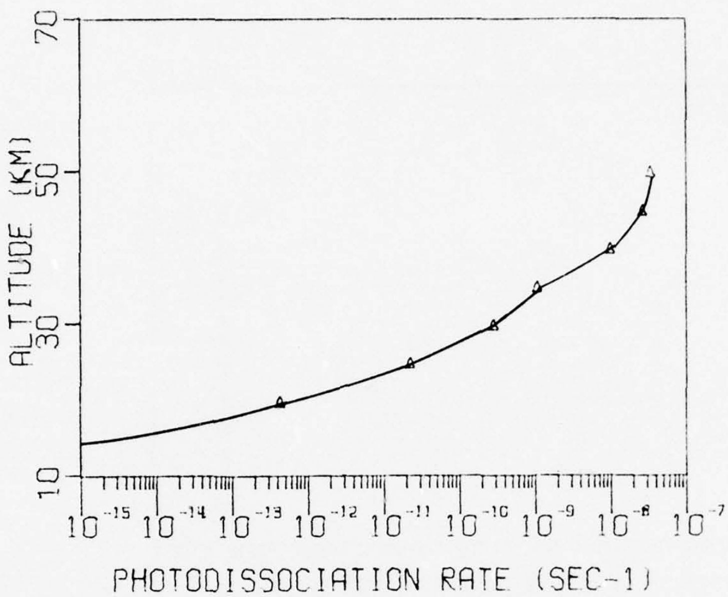
5 $O_3 + h\nu = O + O_2$ [440.0] Ø = 1.000



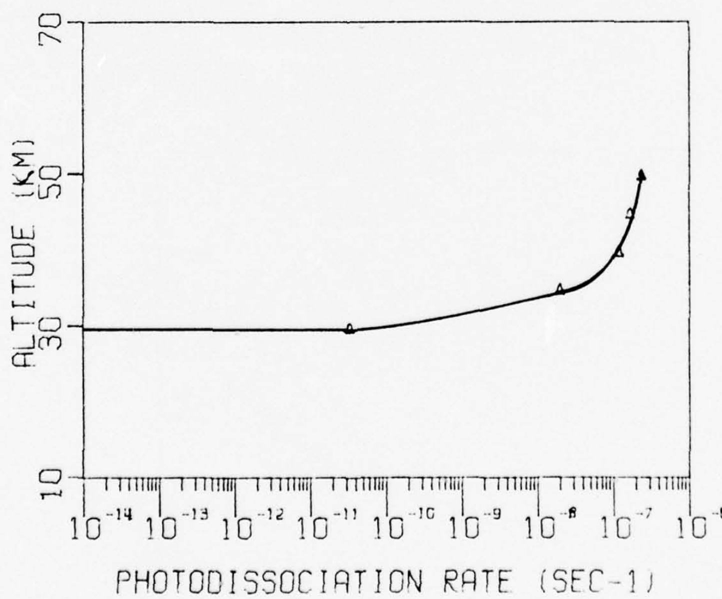
6 O3 + Hν = O + O21D 310.0-360.0 NM.



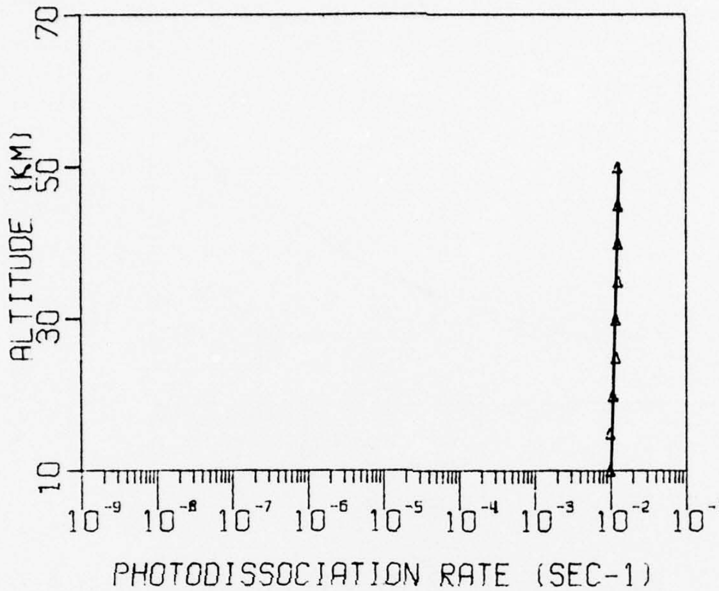
7 O3 + Hν = O1D + O21D [310.0 NM.] Ø IS VARIABLE



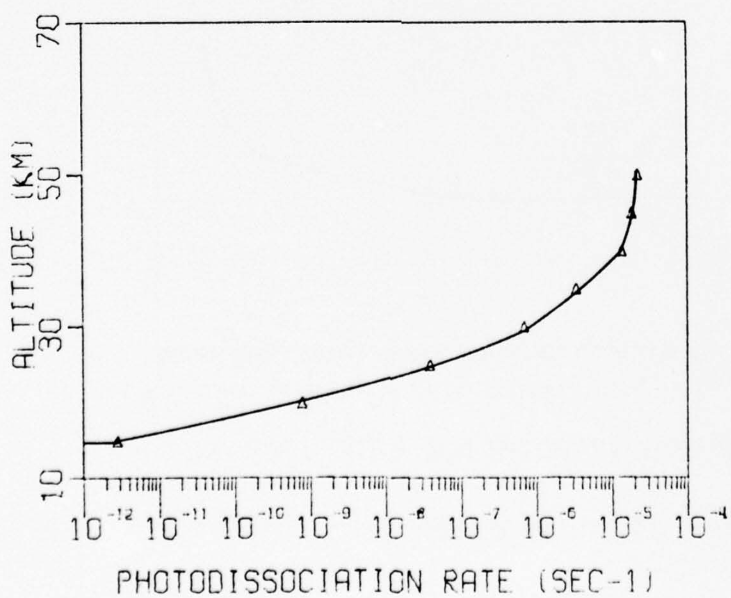
8 O3 + Hν = O1S + O21D [199.0 NM.] Ø = 0.01



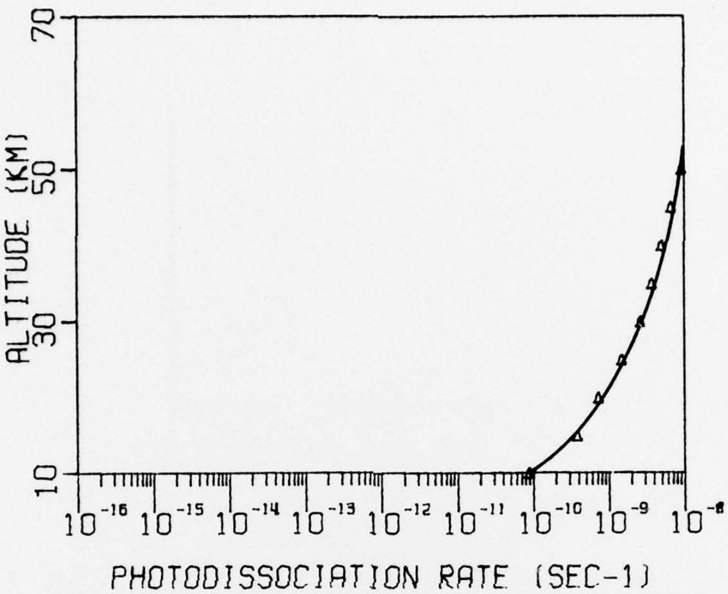
9 O3 + Hν = O + O21S [266.0 NM.] Ø = 0.05



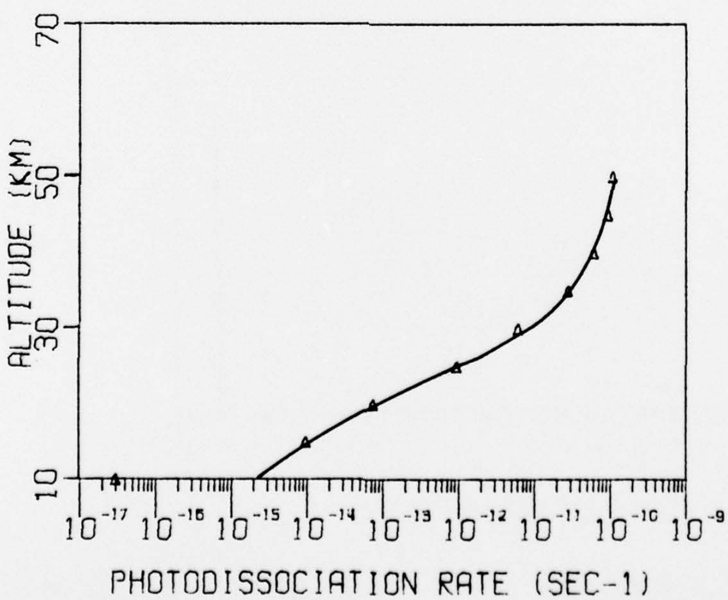
11 NO2 + Hν = O + NO [>190.0] Ø IS VARIABLE



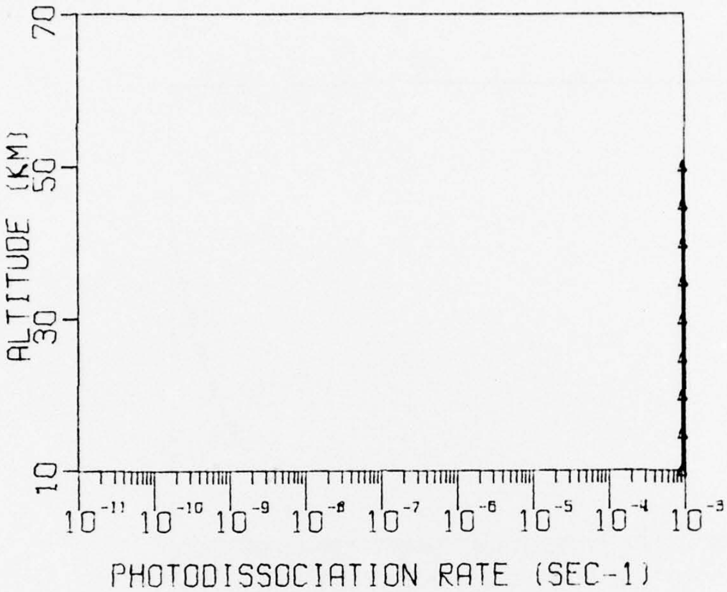
12 NO2 + Hν = O1D + NO [<190.0] Ø = 0.02-0.05



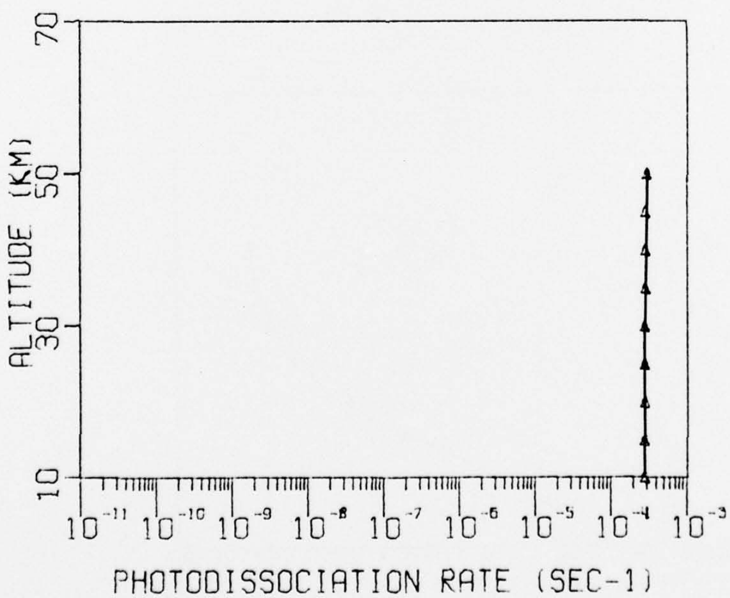
13 N2O + Hν = O1D + N2 [337.0 NM.] Ø = 1.00



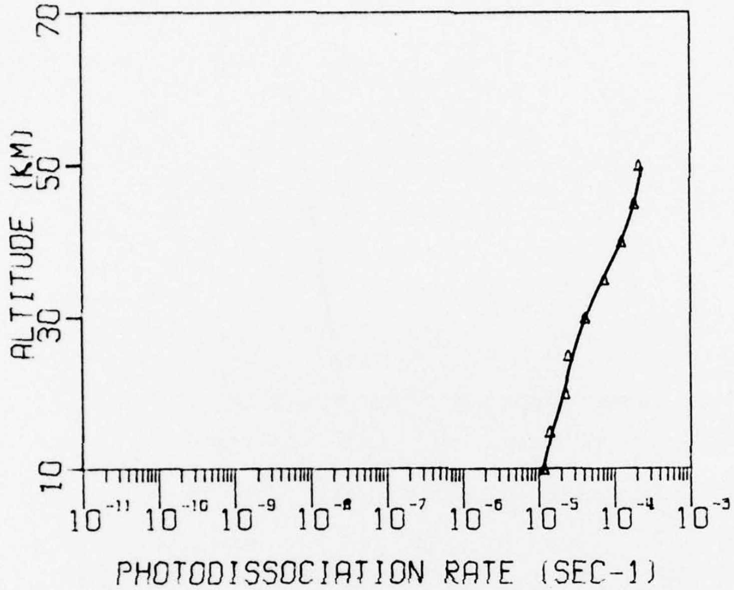
14 N2O + Hν = N + NO [255.0 NM.] Ø = 0.01



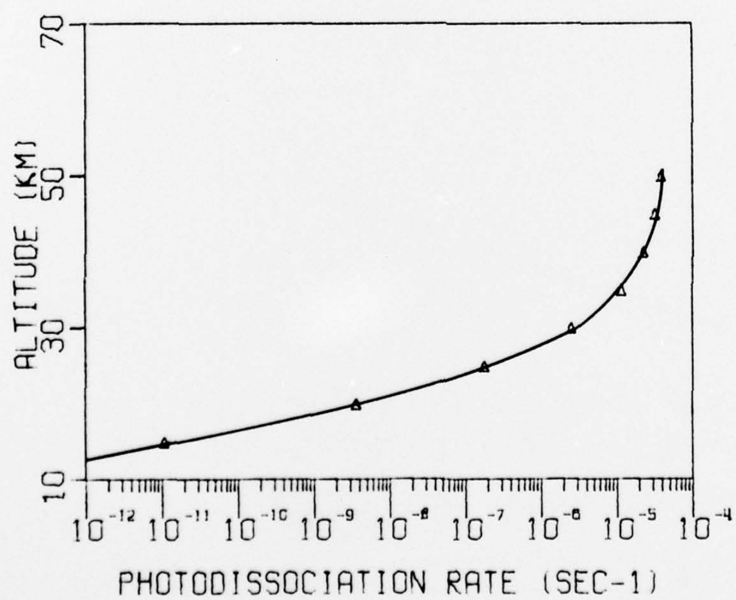
15 $NO_3 + h\nu = O + NO_2$ [578.0 NM.] Ø = 0.10



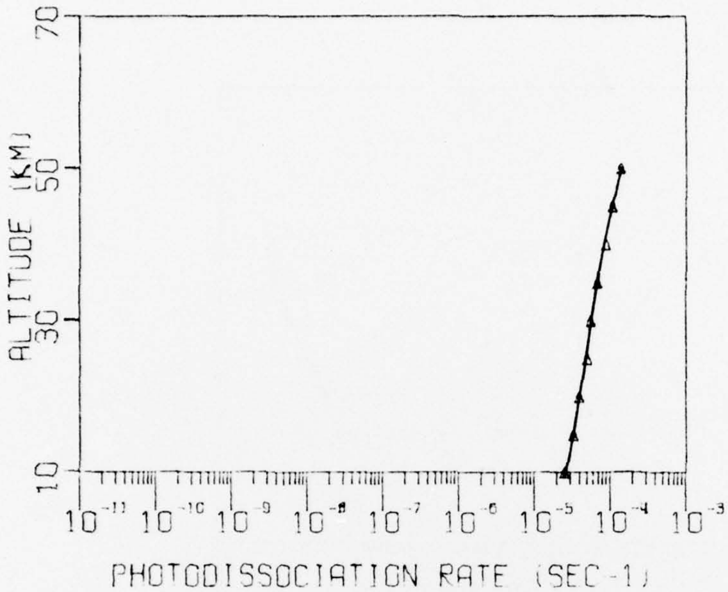
16 $NO_3 + h\nu = O_2 + NO$ [680.0 NM.] Ø = 0.01



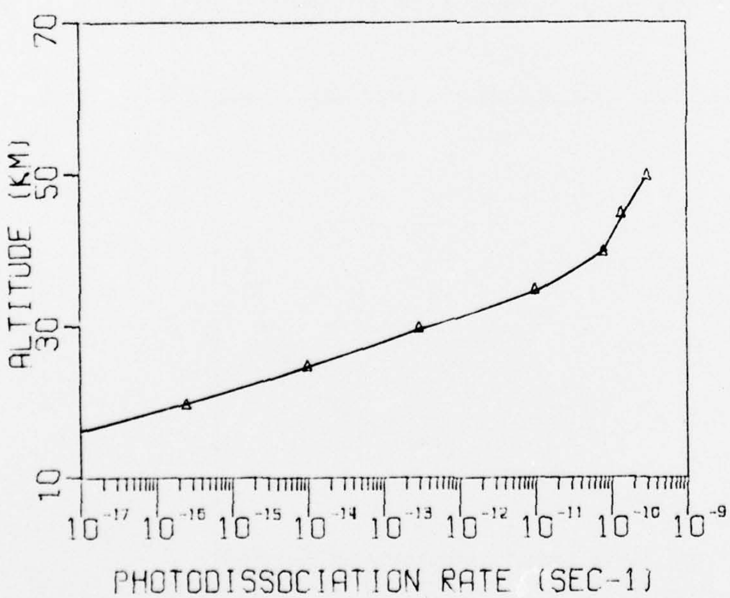
17 N2O5 + Hν = O + NO2 + NO2 [380.0 NM.] Ø = 0.50



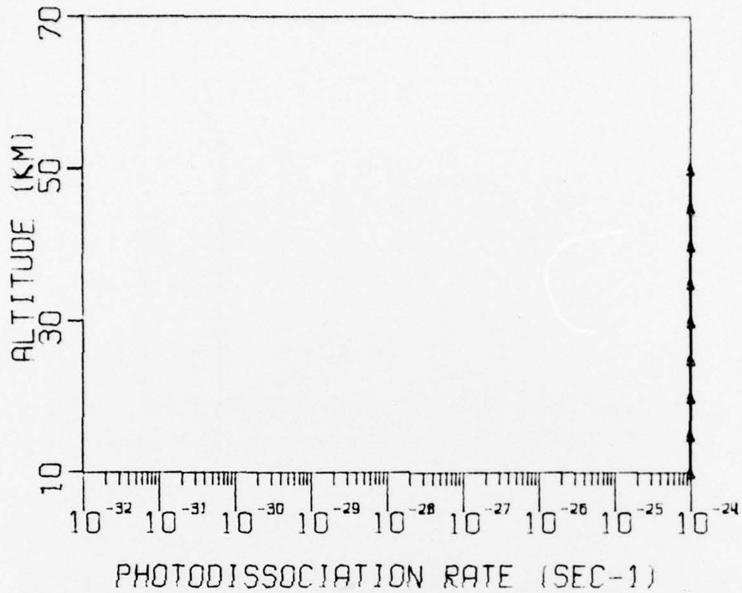
19 HO2 + Hν = O + OH [185.0 NM.] Ø = 1.00



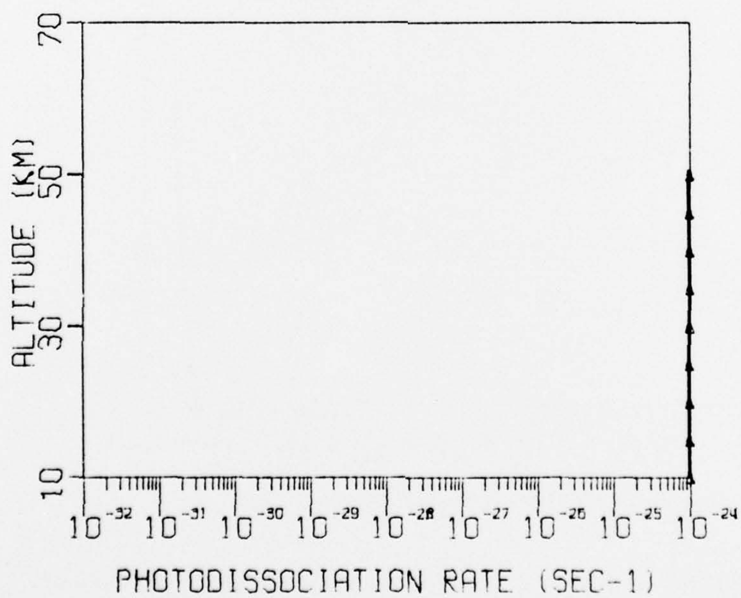
20 H2O2 + Hν = OH + OH [200.0-380.0] Ø = 1.00



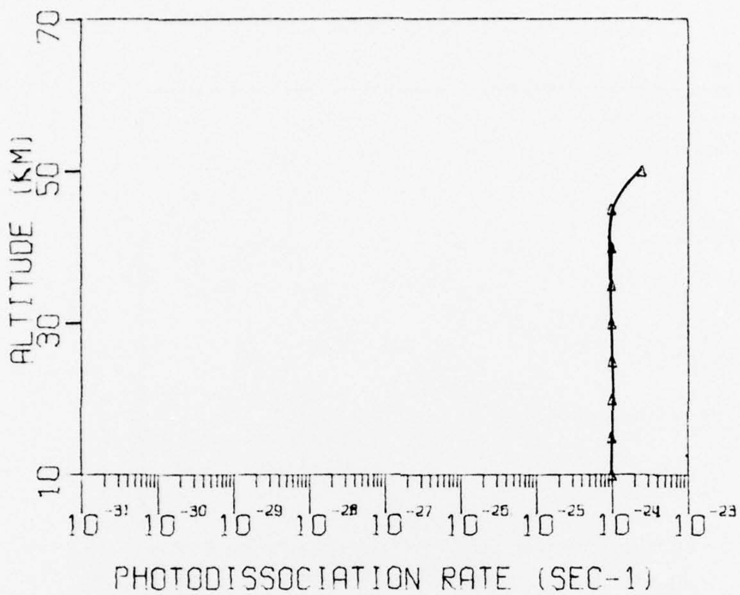
21 CO2 + Hν = O + CO [227.5 NM.] Ø = 1.00



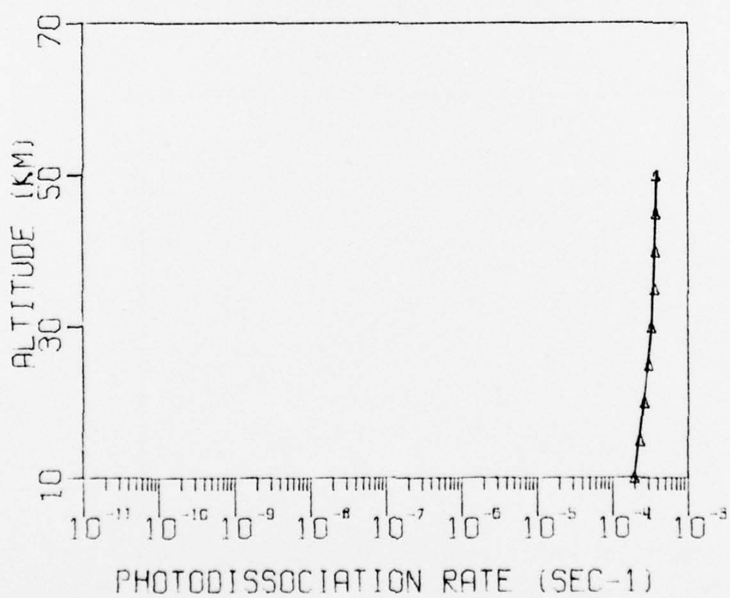
22 CO2 + Hν = O1D + CO [167.1 NM.] Ø = 1.00



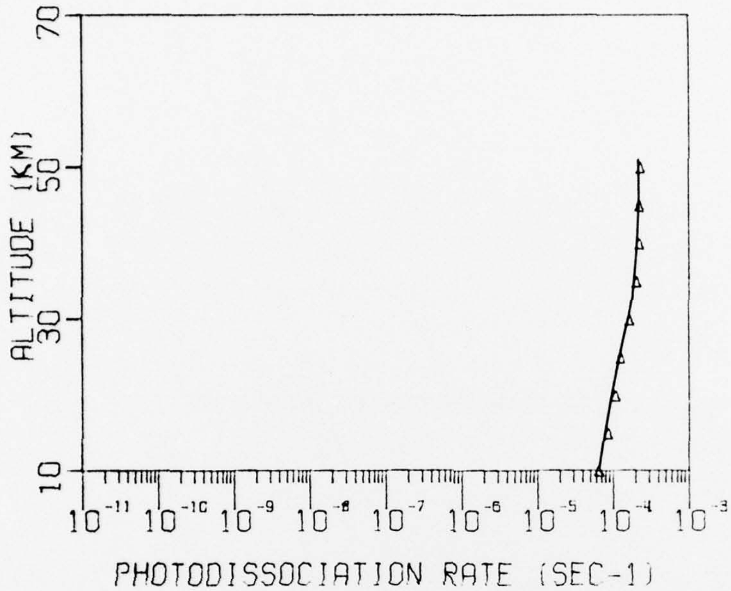
23 CH4 + Hν = H + CH3 [162.5 NM.] Ø = 0.33



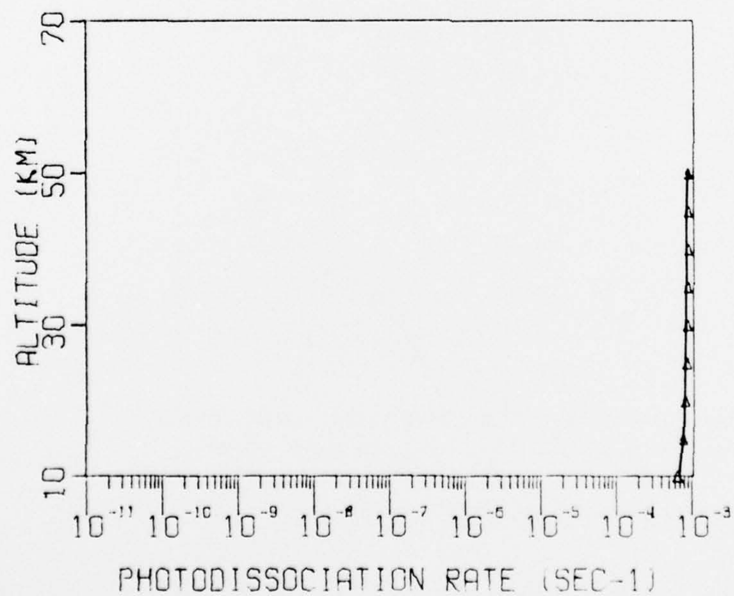
24 CH4 + Hν = H2 + CH2 [162.5 NM.] Ø = 0.67



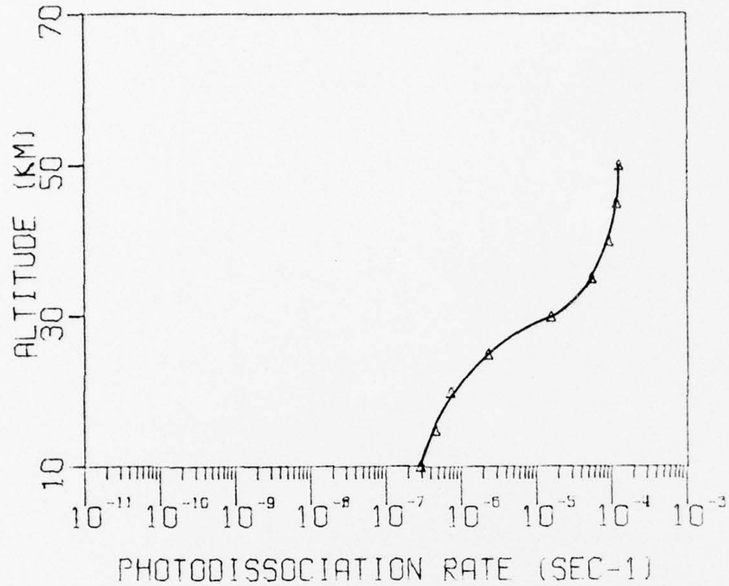
25 HCHO + Hν = H + CHO [360.0 NM.] Ø IS VARIABLE



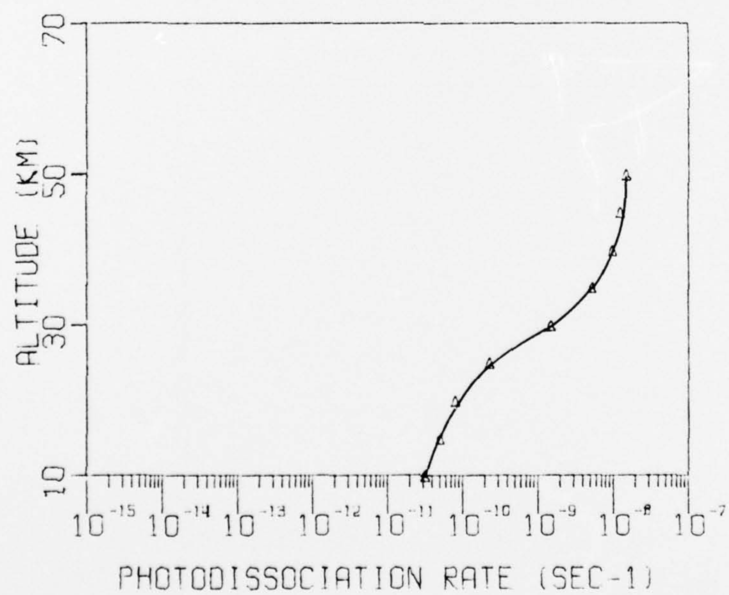
26 HCHO + Hν = H2 + CO [360.0 NM.] Ø IS VARIABLE



31 HNO2 + Hν = NO + OH [400.0 NM.] Ø = 1.00



32 $HNO_3 + h\nu = NO_2 + OH$ [190.0-325.0] Ø = 1.00



33 $HNO_3 + h\nu = NO_3 + H$ [210.0] Ø = 0.01

COMPARISON OF PHOTODISSOCIATION RATES

1 O2 + HV = O + O 175.9-242.4 NM. Ø = 1.000

KM.	32 N LATITUDE	65 N LATITUDE
50	.13-08	.11-08
45	.93-09	.80-09
40	.56-09	.46-09
35	.30-09	.10-09
30	.13-09	.20-10
25	.30-10	.29-11
20	.31-11	.56-13
15	.12-12	.14-15
10	.22-14	.49-19

5 O3 + HV = O + O2 (440.0) Ø = 1.000

KM.	32 N LATITUDE	65 N LATITUDE
50	.31-03	.31-03
45	.31-03	.31-03
40	.31-03	.30-03
35	.31-03	.30-03
30	.31-03	.29-03
25	.30-03	.29-03
20	.30-03	.29-03
15	.29-03	.28-03
10	.29-03	.27-03

6 O3 + HV = O + O21D 310.0-360.0 NM.

KM.	32 N LATITUDE	65 N LATITUDE
50	.10-23	.10-23
45	.10-23	.10-23
40	.10-23	.10-23
35	.10-23	.10-23
30	.10-23	.10-23
25	.10-23	.10-23
20	.10-23	.10-23
15	.10-23	.10-23
10	.10-23	.10-23

7 O3 + HV = O1D + O21D (310.0 NM.) Ø IS VARIABLE

KM.	32 N LATITUDE	65 N LATITUDE
50	.46-02	.38-02
45	.33-02	.25-02
40	.16-02	.11-02
35	.72-03	.47-03
30	.33-03	.16-03
25	.11-03	.36-04
20	.43-04	.12-04
15	.22-04	.50-05
10	.16-04	.23-05

8 $O_3 + H\nu = O^1S + O_2{}^1D$ (199.0 NM.) ϕ = 0.01

KM.	32 N LATITUDE	65 N LATITUDE
50	.35-07	.35-07
45	.27-07	.27-07
40	.19-07	.10-07
35	.11-07	.11-08
30	.48-08	.29-09
25	.99-09	.23-10
20	.77-10	.44-12
15	.17-11	.59-15
10	.22-14	.17-20

9 $O_3 + H\nu = O + O_2{}^1S$ (266.0 NM.) ϕ = 0.05

KM.	32 N LATITUDE	65 N LATITUDE
50	.15-05	.24-06
45	.75-06	.17-06
40	.22-06	.12-06
35	.41-07	.20-07
30	.65-10	.34-10
25	.95-15	.73-15
20	.10-23	.10-23
15	.10-23	.10-23
10	.10-23	.10-23

11 $NO_2 + H\nu = O + NO$ (>190.0) ϕ IS VARIABLE

KM.	32 N LATITUDE	65 N LATITUDE
50	.14-01	.13-01
45	.14-01	.13-01
40	.13-01	.13-01
35	.13-01	.13-01
30	.13-01	.12-01
25	.13-01	.12-01
20	.12-01	.11-01
15	.12-01	.10-01
10	.11-01	.10-01

12 $NO_2 + H\nu = O^1D + NO$ (<190.0) ϕ = 0.02-0.05

KM.	32 N LATITUDE	65 N LATITUDE
50	.35-04	.23-04
45	.30-04	.19-04
40	.21-04	.14-04
35	.12-04	.35-05
30	.49-05	.70-06
25	.97-06	.40-07
20	.92-07	.80-09
15	.44-08	.29-11
10	.17-09	.17-14

13 N2O + Hv = O1D + N2 (337.0 NM.) Ø = 1.00

KM.	32 N LATITUDE	65 N LATITUDE
50	.96-08	.94-08
45	.88-08	.57-08
40	.75-08	.51-08
35	.62-08	.38-08
30	.47-08	.27-08
25	.30-08	.15-08
20	.19-08	.74-09
15	.13-08	.39-09
10	.10-08	.90-10

14 N2O + Hv = N + NO (255.0 NM.) Ø = 0.01

KM.	32 N LATITUDE	65 N LATITUDE
50	.11-09	.11-09
45	.10-09	.95-10
40	.81-10	.61-10
35	.57-10	.28-10
30	.29-10	.61-11
25	.75-11	.98-12
20	.76-12	.76-13
15	.24-13	.97-14
10	.19-14	.30-16

15 NO3 + Hv = O + NO2 (578.0 NM.) Ø = 0.10

KM.	32 N LATITUDE	65 N LATITUDE
50	.97-03	.97-03
45	.97-03	.97-03
40	.97-03	.97-03
35	.97-03	.97-03
30	.97-03	.96-03
25	.96-03	.96-03
20	.96-03	.96-03
15	.95-03	.95-03
10	.94-03	.94-03

16 NO3 + Hv = O2 + NO (680.0 NM.) Ø = 0.01

KM.	32 N LATITUDE	65 N LATITUDE
50	.30-03	.30-03
45	.30-03	.29-03
40	.29-03	.29-03
35	.29-03	.29-03
30	.29-03	.28-03
25	.29-03	.28-03
20	.29-03	.28-03
15	.28-03	.28-03
10	.28-03	.28-03

17 N2O5 + HV = O + NO2 + NO2 (380.0 NM.) Ø = 0.5)

KM.	32 N LATITUDE	65 N LATITUDE
50	.23-03	.22-03
45	.20-03	.19-03
40	.15-03	.13-03
35	.10-03	.76-04
30	.60-04	.43-04
25	.38-04	.25-04
20	.27-04	.19-04
15	.23-04	.14-04
10	.21-04	.12-04

19 HO2 + HV = O + OH (185.0 NM.) Ø = 1.00

KM.	32 N LATITUDE	65 N LATITUDE
50	.52-04	.40-04
45	.44-04	.32-04
40	.31-04	.23-04
35	.18-04	.12-04
30	.82-05	.26-05
25	.19-05	.19-06
20	.20-06	.37-08
15	.86-08	.11-10
10	.24-09	.55-14

20 H2O2 + HV = OH + OH (200.0-380.0 NM.) Ø = 1.00

KM.	32 N LATITUDE	65 N LATITUDE
50	.14-03	.14-03
45	.12-03	.11-03
40	.10-03	.90-04
35	.82-04	.69-04
30	.68-04	.56-04
25	.56-04	.50-04
20	.49-04	.40-04
15	.45-04	.33-04
10	.40-04	.26-04

21 CO2 + HV = O + CO (227.5 NM.) Ø = 1.000

KM.	32 N LATITUDE	65 N LATITUDE
50	.51-09	.31-09
45	.34-09	.19-09
40	.18-09	.81-10
35	.80-10	.10-10
30	.21-10	.30-12
25	.27-11	.10-13
20	.90-13	.26-15
15	.50-15	.60-19
10	.25-18	.10-23

22 CO_2 + Hv = O1D + CO (167.1 NM.) ϕ = 1.0)

KM.	32 N LATITUDE	65 N LATITUDE
50	.10-23	.10-23
45	.10-23	.10-23
40	.10-23	.10-23
35	.10-23	.10-23
30	.10-23	.10-23
25	.10-23	.10-23
20	.10-23	.10-23
15	.10-23	.10-23
10	.10-23	.10-23

23 CH_4 + Hv = H + CH_3 (162.5 NM.) ϕ = 0.33

KM.	32 N LATITUDE	65 N LATITUDE
50	.11-16	.10-23
45	.31-23	.10-23
40	.10-23	.10-23
35	.10-23	.10-23
30	.10-23	.10-23
25	.10-23	.10-23
20	.10-23	.10-23
15	.10-23	.10-23
10	.10-23	.10-23

24 CH_4 + Hv = H_2 + CH_2 (162.5 NM.) ϕ = 0.67

KM.	32 N LATITUDE	65 N LATITUDE
50	.85-16	.26-23
45	.94-23	.10-23
40	.10-23	.10-23
35	.10-23	.10-23
30	.10-23	.10-23
25	.10-23	.10-23
20	.10-23	.10-23
15	.10-23	.10-23
10	.10-23	.10-23

25 HCHO + Hv = H + CHO (360.0 NM.) ϕ IS VARIABLE

KM.	32 N LATITUDE	65 N LATITUDE
50	.41-03	.39-03
45	.41-03	.39-03
40	.40-03	.38-03
35	.39-03	.37-03
30	.38-03	.34-03
25	.35-03	.31-03
20	.33-03	.27-03
15	.30-03	.24-03
10	.27-03	.20-03

26 HCHO + Hv = H2 + CO (360.0 NM.) Ø IS VARIABLE

KM.	32 N LATITUDE	65 N LATITUDE
50	.25-03	.24-03
45	.24-03	.23-03
40	.24-03	.23-03
35	.22-03	.21-03
30	.20-03	.17-03
25	.17-03	.13-03
20	.14-03	.11-03
15	.12-03	.87-04
10	.11-03	.66-04

31 HNO2 + Hv = NO + OH (400.0 NM.) Ø = 1.00

KM.	32 N LATITUDE	65 N LATITUDE
50	.93-03	.88-03
45	.93-03	.88-03
40	.93-03	.87-03
35	.92-03	.87-03
30	.91-03	.86-03
25	.89-03	.83-03
20	.88-03	.80-03
15	.86-03	.74-03
10	.79-03	.63-03

32 HNO3 + Hv = NO2 + OH (190.0-325.0 NM.) Ø = 1.0

KM.	32 N LATITUDE	65 N LATITUDE
50	.13-03	.13-03
45	.12-03	.12-03
40	.95-04	.93-04
35	.68-04	.55-04
30	.37-04	.16-04
25	.11-04	.23-05
20	.23-05	.74-05
15	.10-05	.46-06
10	.79-06	.29-06

33 HNO3 + Hv = NO3 + H (210.0) Ø = 0.01

KM.	32 N LATITUDE	65 N LATITUDE
50	.15-07	.15-07
45	.13-07	.13-07
40	.11-07	.10-07
35	.76-08	.54-08
30	.41-08	.15-08
25	.12-08	.23-09
20	.25-09	.82-10
15	.11-09	.51-10
10	.88-10	.32-10

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