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Spectral Radiance of Snow and Clouds in the Near Infrared Spectral Region

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The near infrared spectral radiance measurements of snow and cirrus and cumulus cloud backgrounds taken by the Air Force Geophysics Laboratory's flying laboratory are evaluated. From the analysis of the 124 spectra obtained, the spectral radiances or reflectance characteristics of snow and cirrus and cumulus clouds between 5500 and 7000/cm^{-1} (1.82-1.43 µm) were determined. Snow/cloud discrimination can be made by utilizing a sensor in the 5500 to 7000/cm^{-1} spectral region. Based on the analysis of these data, certain snow/cloud design parameters were identified; that is, slope of the spectral radiance

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absolute spectral and/or total radiance, and the location and value of the maximum spectral radiance for the snow and cirrus and cumulus cloud backgrounds. Finally, specific recommendations are made for an optimal operational snow/cloud discrimination radiometer.

Preface

The author wishes to acknowledge the participation and assistance of Brian P. Sandford and the technical crew members on the AFGL KC-135 who flew the various missions and collected the data, and to thank Mr. C. Elam of the USAF Environmental Technical Applications Center (ETAC) for supplying the ground truth data in the formats of 3D NEPH, radiosonde, and surface observations, and Mr. Vincent Falcone for introducing me to the research subject. Also, special thanks to Dr. Robert McClatchey who critically reviewed the manuscript, Ed Lefebvre for his invaluable programming skills, and Kathy Lowe for typing the manuscript.

Contents

Illustrations

Tables

Tables

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Spectral Radiance of Snow and Clouds in the Near Infrared Spectral Region

1. INTRODUCTION

The purpose of this investigation was to evaluate the near infrared spectral radiance measurements of snow and cloud backgrounds taken by the Air Force Geophysics Laboratory's flying laboratory (NKC-135 aircraft) so that a recommendation could be made for a sensor on the Defense Meteorological Satellite Program (DMSP) satellite to discriminate snow from clouds. Automated snow forecasts are a requirement of the Air Weather Service. At the present time, cloud and/or snow analyses are limited due to the difficulty of discriminating between snow and clouds from satellite imagery. An operational snow/cloud discriminating sensor on-board the DMSP satellite could eliminate these limitations and provide unique real-time data for improved analyses and forecasts.

The spectral reflectance of snow in the near infrared has been reported by O'Brien and Munis.[1] The lowest reflectance values of snow occur around 6667 and 5000 cm^{-1} (1.5 and 2.0 μm). Studies of the near infrared reflectance properties

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(Received for publication 17 November 1978)

1. O'Brien, H.W., and Munis, R.H. (1975) Red and Near Infrared Spectral Reflectance of Snow, ERP No. 332, US Army Cold Regions Research and Engineering Laboratory, Hanover, NH, 18 pp.

of snow using Skylab S192 data (Band 11) have been reported.[2,3] Again, the low reflectance of snow in the near infrared (Band 11 of the Skylab S192 Experiment) 6452-5714 cm^{-1} (1.55-1.75 μm) is a potential feature in discriminating clouds from snow.

2. AIRCRAFT MEASUREMENTS

In September 1976 and April 1977, the Air Force Geophysics Laboratory (AFGL) collected signatures of snow and cloud backgrounds in the near infrared. The spectral measurements were made with a Michelson interferometer with a field-of-view of 1.6°, full angle at a spectral resolution of 3.8 cm^{-1} in the 4000 to 8300 cm^{-1} (2.5 to 1.2 μm) region. This instrument is one of many used by AFGL on the NKC-135A aircraft, which is an infrared flying laboratory. A full description of the aircraft, instrumentation, and background measurements was reported by Sandford et al.[4]

The various backgrounds were measured at a 45° depression angle from the aircraft to record the snow or cloud background below the aircraft. When the selected snow or cloud measurement area is reached, the aircraft enters into a 45° right bank that is held for a full 360° orbit. Thus, the background is observed over a full 360° range of aspect angles.

The scan time for each interferogram from the interferometer is 1 sec, and the approximate average of 15 interferograms is used in the data analysis. The aspect angle changes 2.4° per sec so that the snow or cloud backgrounds are averages over sectors of 36° centered at the main aspect angles of 0°, 90°, 180°, and 270°. The four main aspect angles are defined and shown in Figure 1.

The Scientist-Director of the flight was solely responsible for choosing the target background and making notes pertinent to the run. A 16 mm camera coaligned with the interferometer was used to record the background scene. Relevant meteorological data such as 3D NEPH, radiosonde, and surface observations were obtained from the USAF Environmental Technical Applications Center (ETAC) for ground/cloud truth verification.

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2. Barnes, J.C., and Bowley, C.J. (1977) Study of Near-Infrared Snow Reflectance Using Skylab S192 Multispectral Scanner Data, ERT Document No. 1474F, Final Report, Contract No. AA-635201, Environmental Research & Technology Inc., Concord, MA, 48 pp.

3. Valovcin, F.R. (1976) Snow/Cloud Discrimination, AFGL-TR-76-0174, 16 pp.

4. Sandford, B.P., Schummers, J.H., Rex, J.D., Shumsky, J., Huppi, R.J., and Sluder, R.B. (1976) Aircraft Signatures in the Infrared 1.2 to 5.5 Micron Region, Volume I Instrumentation, Volume II Background Measurements, AFGL-TR-76-0133 (I) 89 pp and (II) 72 pp.

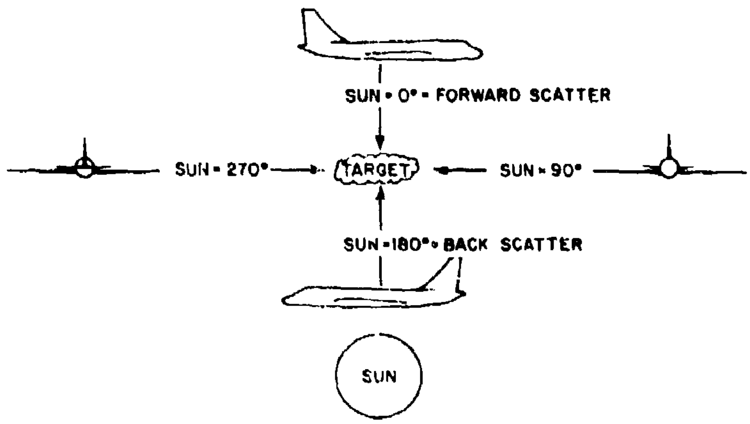

Figure 1. Aircraft Aspect Angles

A total of 124 spectra measurements (Snow 56, Cirrus 32, and Cumulus 36) were collected by the AFGL aircraft and analyzed at AFGL/OPI. Pertinent parameters of the background runs of the various spectra are summarized in Appendix A.

All spectra in this study are presented in absolute spectral radiance (N_ν), as seen from the aircraft, in units of watts per cm^2 per steradian per wavenumber (W cm^{-2}sr^{-1}(cm^{-1})$^{-1}$). The absolute spectral radiance (N_ν) can be converted to units of (N_μ), watts per cm^2 per steradian per micron (W cm^{-2}sr^{-1} μm^{-1}), as follows:

$$N_\mu = N_\nu \cdot \nu^2 \cdot 10^{-4}$$

where ν is wavenumber in cm^{-1}. In the majority of illustrations, the abscissa scale is given in wavenumbers and microns. In addition, each data point represents a spectral resolution of 1.9287 cm^{-1} averaged over a 21.2157 cm^{-1} interval.

3. SPECTRAL RADIANCE OF BACKGROUNDS

3.1 Snow Backgrounds

The absolute spectral radiance of snow was measured with the AFGL aircraft altitudes ranging from 26,000 to 33,000 feet. A total of 56 snow spectra were obtained in September 1976 and April 1977. In September 1976, the measurements were obtained in the states of Oregon, Washington, and Alaska. In April 1977, measurements were obtained in the Province of Quebec, Canada.

Each snow spectrum was analyzed individually and categorized according to the total integrated amount of measured spectral radiance between 5500 and 7000 cm^{-1}

(1.82-1.43 μm). These values of spectral radiance were arranged in increasing order, and the lowest-(highest) 25 percent of the snow spectra were designated as the 1st Quarter—(4th Quarter). Each quarter represents the sum of 14 snow spectra. The absolute spectral radiance of snow for the four quarters as a function of wavenumber is shown in Figure 2.

The maximum mean spectral radiance and its location for snow backgrounds for the four quarters is given in Table 1.

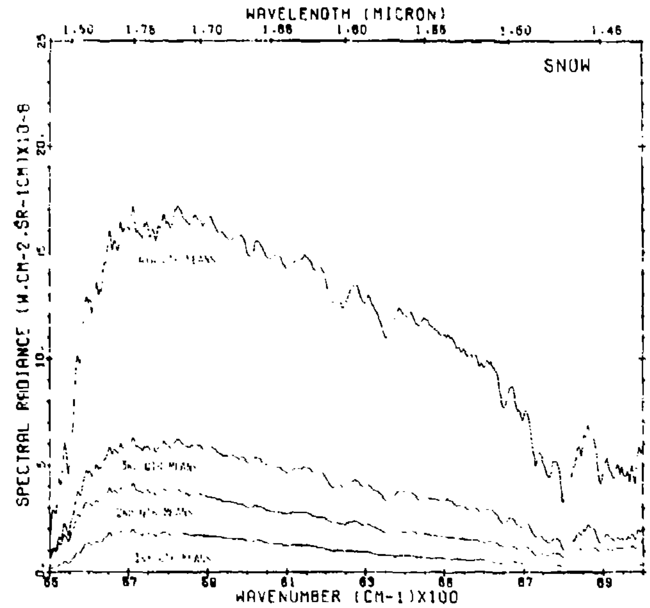

Figure 2. Spectral Radiance Over Snow, Quarterly Means

Table 1. Maximum Mean Spectral Radiance and its Location for Snow—Quarterly Means

Quarter	Value of Maximum Mean $(W\ cm^{-2} sr^{-1} (cm^{-1})^{-1})$	Location: Wavenumber (cm^{-1})	Location: Wavelength (μm)
1st	1.959×10^{-8}	5713	1.75
2nd	4.112×10^{-8}	5713	1.75
3rd	6.297×10^{-8}	5713	1.75
4th	17.224×10^{-8}	5825	1.72

Although the location of the maximum value of the 4th Quarter mean is technically at 5825 cm^{-1}, the value at 5713 cm^{-1} is 17.208 or 99.9 percent of the maximum. The spectral radiance normalized to the maximum mean for all 56 snow spectra as a function of wavenumber is shown in Figure 3. The value of the maximum mean spectral radiance (ordinate = 1) is 7.394×10^{-8} W $cm^{-2}sr^{-1}(cm^{-1})^{-1}$ and is located at 5713 cm^{-1}. Presentation of the data in this format allows one to compare the percentage of the maximum mean spectral radiance as a function of wavenumber. The filter curve between 5989 and 6780 cm^{-1} represents a preliminary DMSP snow/cloud discrimination sensor design that was evaluated on the aircraft-collected spectra.

Another feature that may be seen from Figure 3 is the slope of the reflected radiance as a function of wavenumber for snow spectra. It is large and positive between 5500 and 5713 cm^{-1}, and large and negative between 5825 and 6300 cm^{-1}.

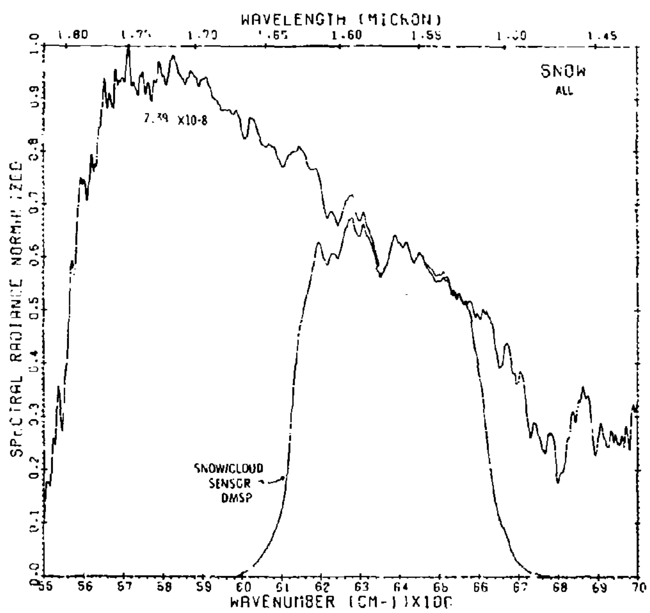

Figure 3. Spectral Radiance Normalized Over Snow—All Spectra, N = 56

The mean ($\overline{X}$) and the standard deviation (σ) as a function of wavenumber for all the snow spectra are shown in Figure 4. The ordinate (0-25) was maximized for the snow background spectra. The negative values of the mean minus sigma ($\overline{X}$ -σ) in

Figure 4 is an indication that the deviations among the snow spectra in the spectral interval 6100 to 7000 cm^{-1} are large. Also, it indicates that the sample N = 56 is not large enough to be completely and statistically representative of snow backgrounds. For example, at 6612 cm^{-1}, 51 snow spectra have a spectral radiance value of less than 10×10^{-8}, and the remaining 5 snow spectra have values between 10 and 25×10^{-8}.

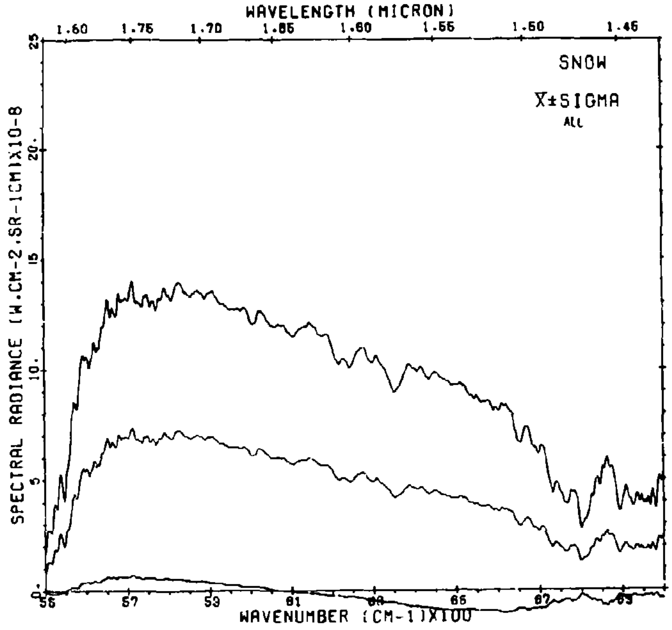

Figure 4. Snow—$\overline{X} \pm$ Sigma—All Spectra, N = 56

The maximum spectral radiance for snow (Figure 5) was measured by the AFGL aircraft on 25 April 1977 on the west bank of Lake Crescent in Quebec, Canada, on Mission 703, Run 5.

3.2 Cirrus Backgrounds

The majority of the cirrus background measurements were made at altitudes ranging from 31,000 to 39,000 feet. The separation between the aircraft and the tops of the cirrus clouds was from 200 to 2000 feet. The optical thicknesses of the cirrus clouds ranged from semi-transparent to opaque. On some occasions, lower alto-cumulus or alto-stratus were visible through the cirrus. A total of 32 cirrus spectra were obtained by the AFGL aircraft.

Each cirrus spectrum was analyzed individually and categorized according to the total integrated amount of measured spectral radiance between 5500 and 7000 cm^{-1}. The absolute spectral radiances for the four quarters, as previously defined for the cirrus background as a function of wavenumber, are shown in Figure 6. Each quarter represents the mean of eight cirrus spectra. Note that the ordinate scale (0-100) for cirrus clouds is four times that of the ordinate scale for snow in Figure 2.

The maximum mean spectral radiance and its location for cirrus backgrounds for each of the four quarters is given in Table 2.

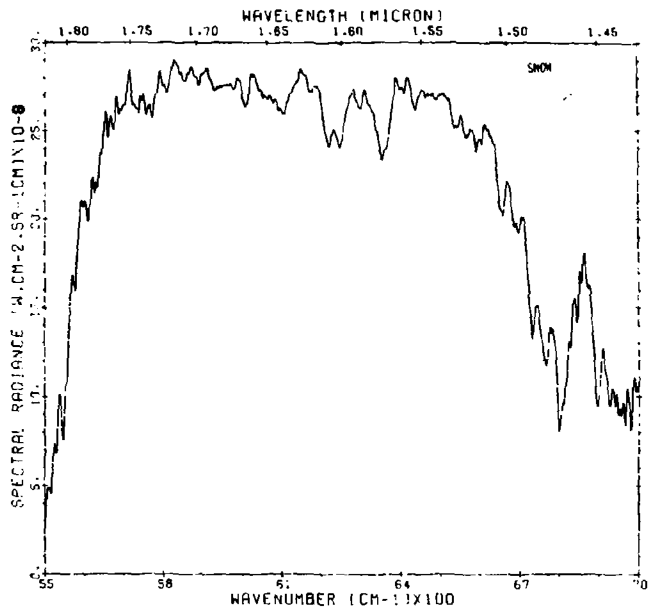

Figure 5. Maximum Spectral Radiance Measured Over Snow

Table 2. Maximum Mean Spectral Radiance and its Location for Cirrus—Quarterly Means

Quarter	Value of Maximum Mean $(W\ cm^{-2} sr^{-1} (cm^{-1})^{-1})$	Location: Wavenumber cm^{-1}	Location: Wavelength (μm)
1st	5.902×10^{-8}	5938	1.68
2nd	23.892×10^{-8}	7000	1.43
3rd	43.679×10^{-8}	5825	1.72
4th	67.315×10^{-8}	5825	1.72

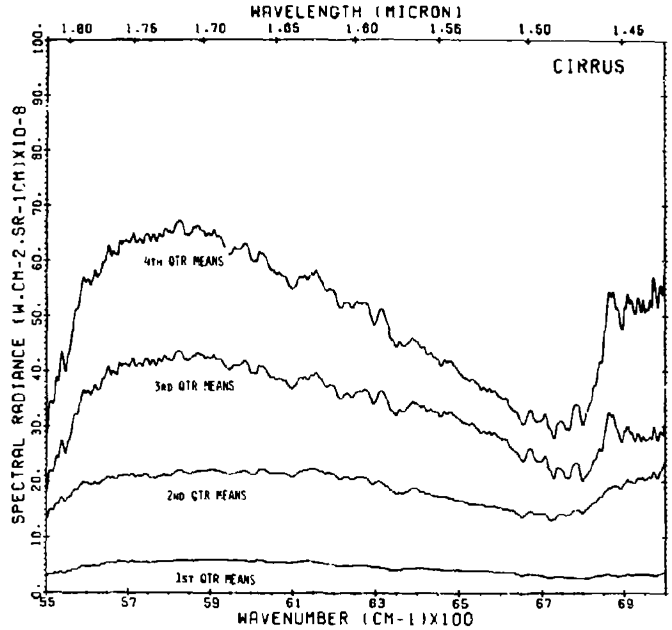

Figure 6. Spectral Radiance Over Cirrus, Quarterly Means

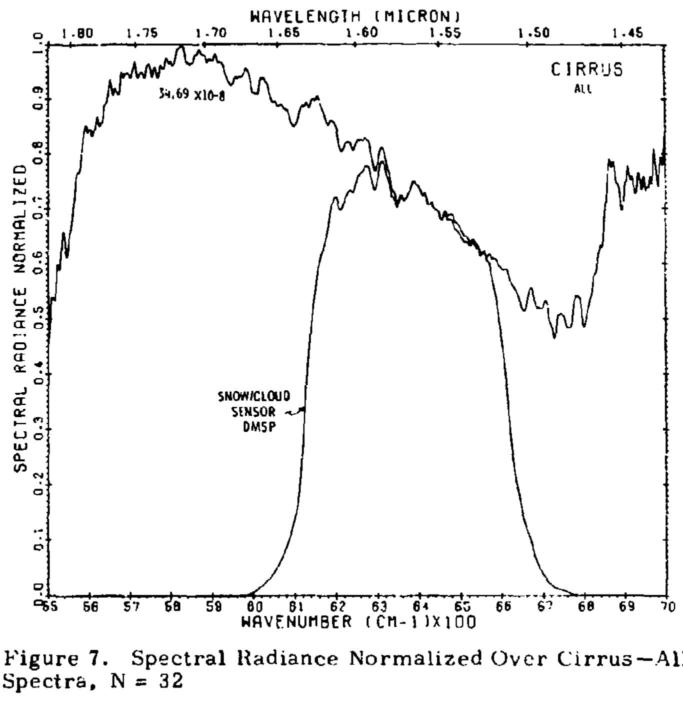

Figure 7. Spectral Radiance Normalized Over Cirrus—All Spectra, N = 32

The spectral radiance normalized to the maximum mean for all 32 cirrus spectra as a function of wavenumber is shown in Figure 7. The value of the maximum mean spectral radiance (ordinate = 1) is 34.687 × 10^{-8} W $cm^{-2}sr^{-1}(cm^{-1})^{-1}$ and is located at 5825 cm^{-1}.

The slope of the reflected radiance as a function of wavenumber for cirrus spectra can also be seen in Figure 7. A positive slope is seen between 5500 and 5825 cm^{-1}, a negative slope between 5825 and 6750 cm^{-1}, and a positive slope between 6750 and 6860 cm^{-1}.

Figure 8 shows the mean ($\overline{X}$) and standard deviations (σ) as a function of wavenumber for all of the cirrus spectra. Comparing Figure 8 with Figure 4 for snow spectra, it can be seen that the means and standard deviations for cirrus as a function of wavenumber are larger than those for snow.

The maximum absolute spectral radiance for cirrus was measured by the AFGL aircraft on 28 April 1977 on Mission 705, Run 10, and is shown in Figure 9. The maximum spectral radiance is 84.457 × 10^{-8} W $cm^{-2}sr^{-1}(cm^{-1})^{-1}$ and is located at 5827 cm^{-1}.

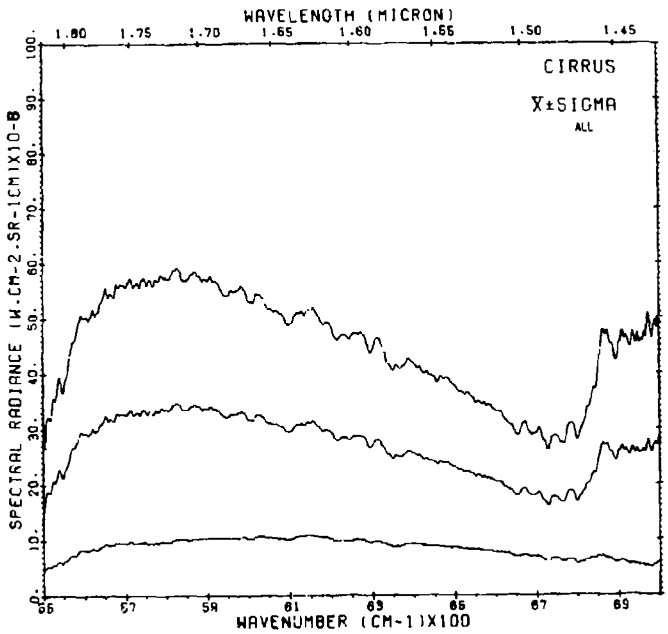

Figure 8. Cirrus—$\overline{X}$ ± Sigma—All Spectra, N = 32

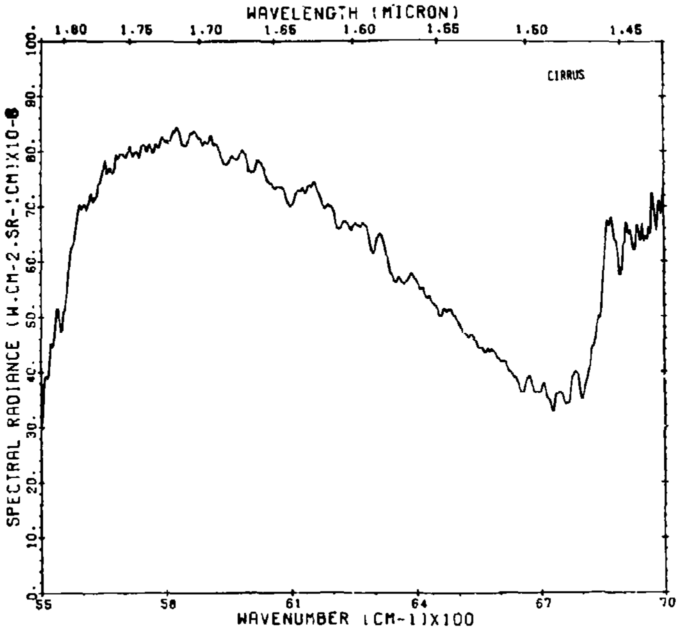

Figure 9. Maximum Spectral Radiance Measured Over Cirrus

3.3 Cumulus Backgrounds

The cumulus background measurements were made over stratocumulus and altocumulus clouds whose tops ranged between 6000 and 20,000 feet. The separation between the aircraft and the tops of the cumulus clouds was between 10,000 and 25,000 feet. A total of 36 cumulus spectra was obtained by the AFGL aircraft.

Again, each cumulus spectrum was analyzed individually and categorized according to the total integrated amount of measured spectral radiance between 5500 and 7000 cm^{-1}. The absolute spectral radiance for the quarterly means for the cumulus backgrounds as a function of wavenumber is shown in Figure 10. Note that the ordinate scale (0-150) for cumulus is a factor of 1.5 greater than the scale of cirrus (Figure 6), and a factor of 6 greater than the scale for snow (Figure 2). Each quarter represents the mean of nine cumulus spectra.

The maximum mean spectral radiance and its location for cumulus backgrounds for each of the four quarters is given in Table 3.

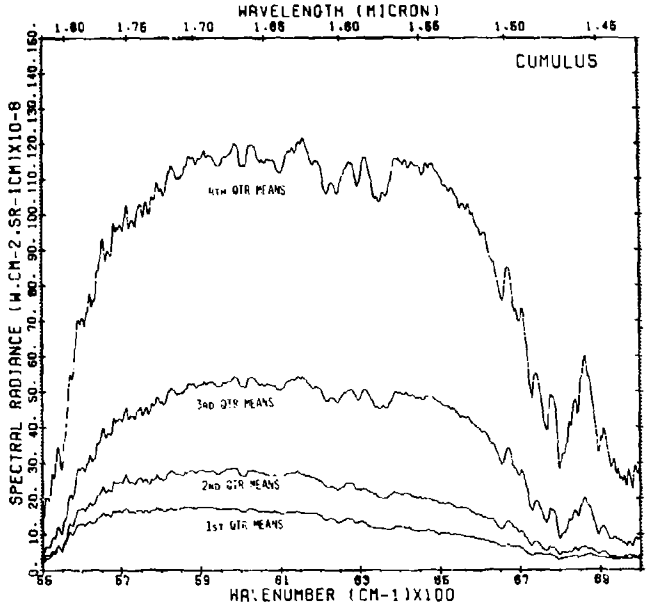

Figure 10. Spectral Radiance Over Cumulus, Quarterly Means

Table 3. Maximum Mean for Spectral Radiance and its Location for Cumulus—Quarterly Means

Quarter	Value of Maximum Mean ($W\ cm^{-2} sr^{-1} (cm^{-1})^{-1}$)	Location: Wavenumber (cm^{-1})	Location: Wavelength (μm)
1st	17.796×10^{-8}	5871	1.70
2nd	28.566×10^{-8}	5981	1.67
3rd	54.222×10^{-8}	6027	1.66
4th	121.630×10^{-8}	6156	1.62

Figure 11 shows the spectral radiance normalized to the maximum mean for all 36 cumulus spectra as a function of wavenumber. The value of the maximum mean spectral radiance (ordinate = 1) is 55.040×10^{-8} W $cm^{-2} sr^{-1} (cm^{-1})^{-1}$ and is located at 5985 cm^{-1}.

The slope of the reflected spectral radiance for cumulus spectra is also shown in Figure 11. A large positive slope is seen between 5500 and 5825 cm^{-1}, a zero slope between 5825 and 6200 cm^{-1}, and a large negative slope starting at 6400 cm^{-1} and continuing to 6800 cm^{-1}.

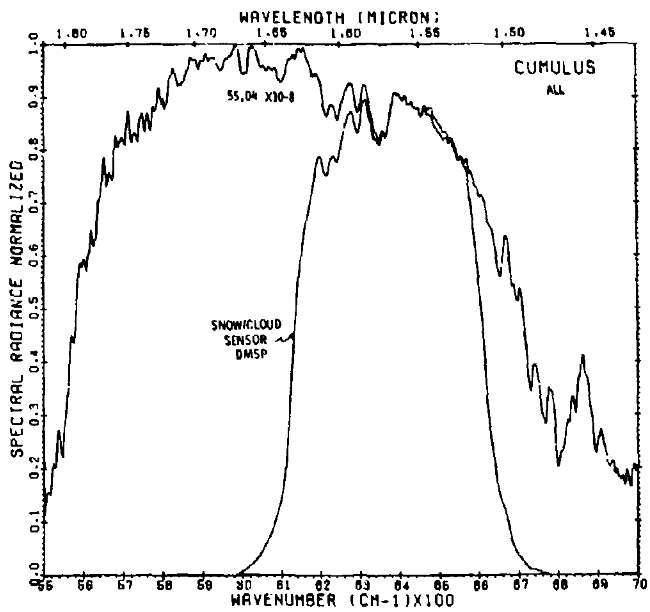

Figure 11. Spectral Radiance Normalized—Cumulus—All Spectra, N = 36

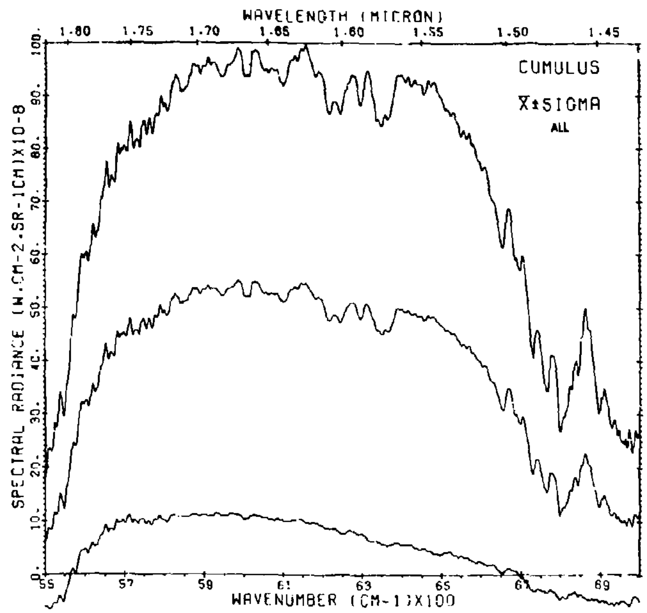

Figure 12. Cumulus $\overline{X} \pm$ Sigma—All Spectra, N = 36

The means ($\overline{X}$) and standard deviations (σ) as a function of wavenumber for all 36 cumulus spectra are shown in Figure 12. The negative values of the mean minus sigma ($\overline{X}$ -σ) curve in the spectra intervals 5500 to 5560 cm^{-1} and 6700 to 7000 cm^{-1} in Figure 12 are an indication that the deviations from the mean are large and that the sample of 36 cumulus spectra is not large enough to be completely representative of cumulus backgrounds.

Finally, the maximum spectral radiance over cumulus (Figure 13) was measured on 28 April 1977 on Mission 795, Run 16, in the vicinity of Lewiston, Maine. The maximum spectral radiance was 202.95 $\times 10^{-8}$ W $cm^{-2} sr^{-1} (cm^{-1})^{-1}$ and is located at 6156 cm^{-1}

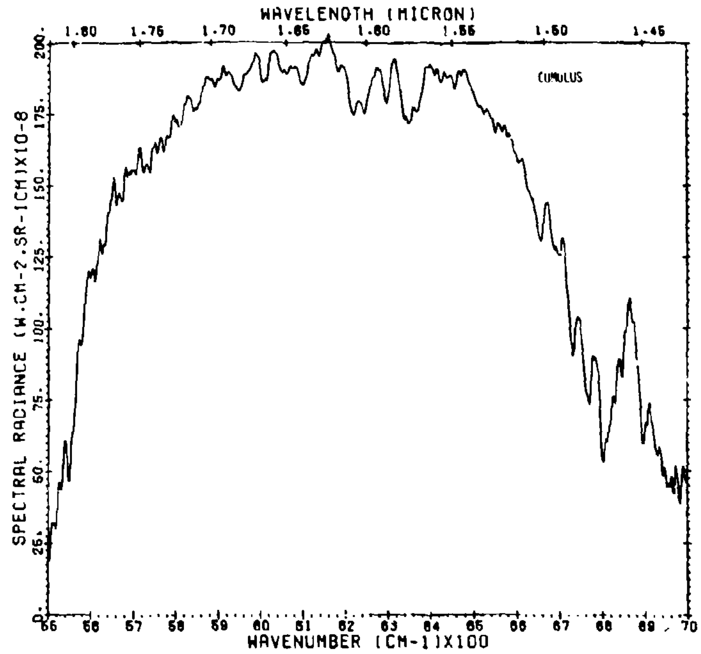

Figure 13. Maximum Spectral Radiance Measured Over Cumulus

3.4 Comparison of Backgrounds

The spectral radiance normalized to the value of the cumulus maximum (55.04 $\times 10^{-8}$ W $cm^{-2} sr^{-1} (cm^{-1})^{-1}$ and located at 5984.8 cm^{-1}) for all cumulus, cirrus, and snow spectra is illustrated in Figure 14 and tabulated in Table B1 in Appendix B. The range of the spectral radiance of snow backgrounds, when compared to the maximum spectral radiance of cumulus cloud backgrounds, has a minimum of 1.5 percent at 5500.7 cm^{-1} and a maximum of 13.4 percent at 5712.8 cm^{-1}. The range of the spectral radiance of cirrus backgrounds has a minimum of 28.4 percent at 5500.7 cm^{-1} and a maximum 63.0 percent at 5824.7 cm^{-1} (see Table B1). When all cumulus, cirrus, and snow spectra are considered, it can be seen that the location of the maximum spectral radiance measured is a function of wavenumber (wavelength). The location of the maximum mean spectral radiance for cumulus is 5985 cm^{-1}, for cirrus it is 5825 cm^{-1}, and for snow it is 5713 cm^{-1}.

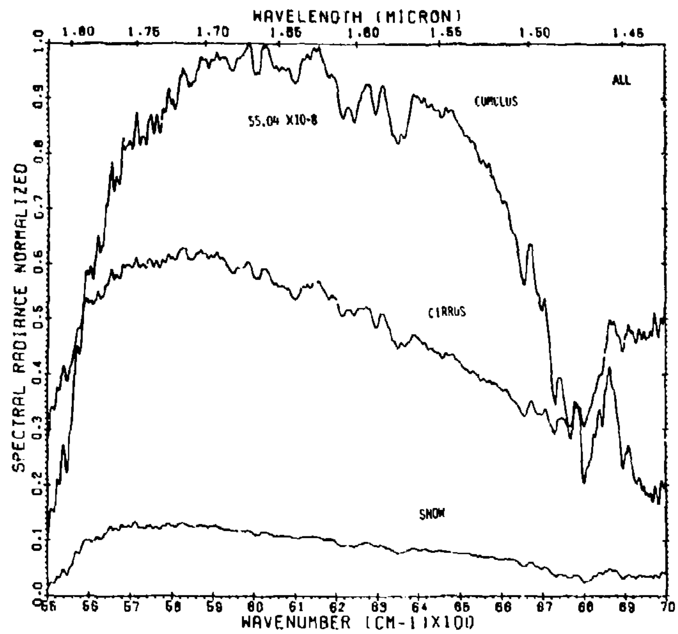

Figure 14. Spectral Radiance Normalized—All—Cumulus, Cirrus, and Snow

4. SNOW/CLOUD DISCRIMINATION SENSOR DESIGN PARAMETERS

Based on the analysis of the 124 spectra measurements obtained by AFGL's flying laboratory, the reflectance characteristics of snow and cirrus and cumulus clouds are significantly different in the 5500 to 7000 cm^{-1} spectral range; consequently, it appears that a sensor can be used to make snow/cloud discriminations in that spectral range. Many parameters were investigated and the following specific sensor design parameters will be reported:

- Absolute spectral radiance, averages and ratios
- Maximum spectral radiance
- Location of the maximum spectral radiance
- Slope of the spectral radiance.

4.1 Absolute Spectral Radiance

In Section 3, the absolute spectral radiance (W $cm^{-1} sr^{-1} (cm^{-1})^{-1}$) was averaged over 11 data points or 21.2157 cm^{-1} and plotted at intervals of 1.9287 cm^{-1}. The maximum spectral radiance averaged for the 56 snow spectra was 7.394×10^{-8}, for the 32 cirrus spectra it was 34.687×10^{-8}, and for the 36 cumulus spectra it was 55.040×10^{-8} W $cm^{-2} sr^{-1} (cm^{-1})^{-1}$.

4.1.1 AVERAGES

Spectral radiances averaged over 50 to 500 wavenumber intervals between 5500 and 7000 cm^{-1} and plotted at intervals of 50 cm^{-1} for cumulus (36 spectra), cirrus (32 spectra), and snow (56 spectra) are shown graphically in Figures 15, 16, and 17 respectively. The averaging is performed by summation of all the spectral radiances over 50 to 500 cm^{-1}, moved at intervals of 50 cm^{-1}, and plotted at the maximum wavenumber in the interval. All averages start at 5500 cm^{-1} and end at 7000 cm^{-1}. Thus, the average 50 cm^{-1} (100 cm^{-1}, etc.) represents the summation of the spectral radiances between 5500 and 5550 cm^{-1}, 5550 and 5600 cm^{-1}, etc. (5500 and 5600 cm^{-1}, 5500 and 5650 cm^{-1}, etc.). Note that the ordinate values of spectral radiance in Figure 17 (snow) are a factor of 10 less than the ordinate values in Figure 15 (cumulus) and Figure 16 (cirrus). Table 4 lists the spectral radiance as a function of wavenumber interval for all snow, cirrus, and cumulus spectra averaged over 50 cm^{-1}.

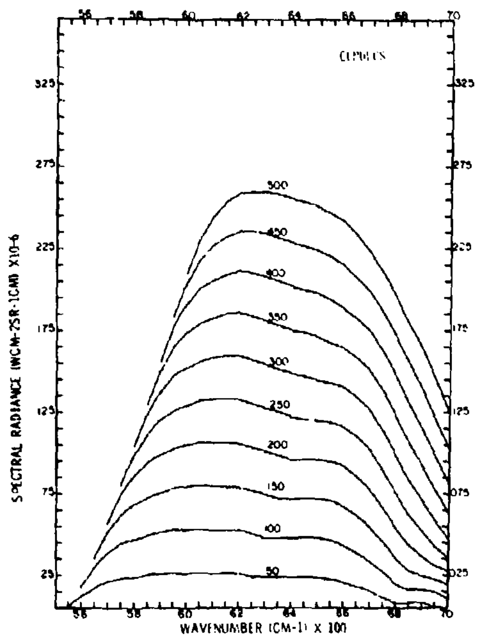

Figure 15. Spectral Radiance Averaged 50 to 500 cm^{-1}—Cumulus

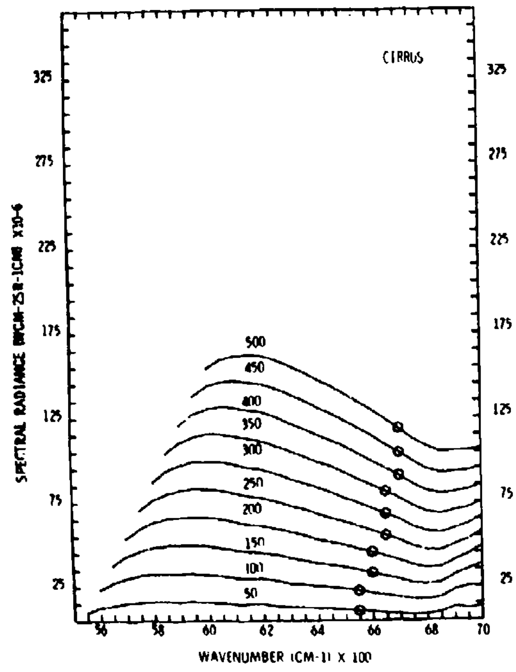

Figure 16. Spectral Radiance Averaged 50 to 500 cm^{-1}—Cirrus

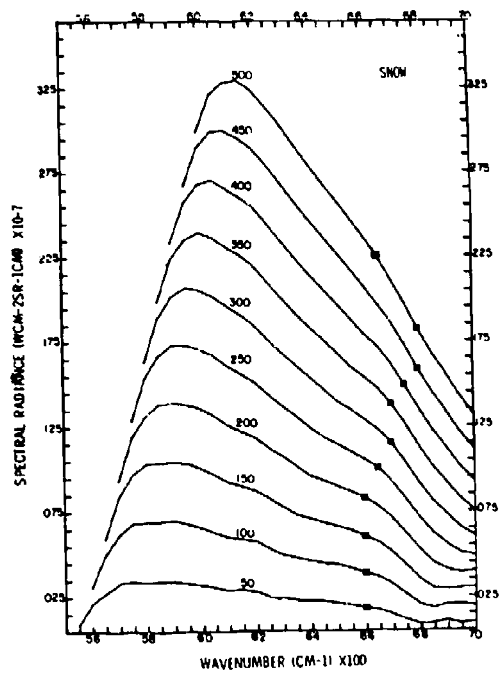

Figure 17. Spectral Radiance Averaged 50 to 500 cm^{-1}—Snow

Table 4. Spectral Radiance (W $cm^{-2} sr^{-1} (cm^{-1})^{-1}$) of Snow, Cirrus, and Cumulus Averaged Over 50 cm^{-1} Wavenumbers

Wavenumber Interval (cm^{-1})	Snow	Cirrus	Cumulus
5500-5550	9.258×10^{-7}	1.045×10^{-5}	5.670×10^{-6}
5550-5600	2.218×10^{-6}	1.339×10^{-5}	1.279×10^{-5}
5600-5650	2.816×10^{-6}	1.448×10^{-5}	1.718×10^{-5}
5650-5700	3.414×10^{-6}	1.618×10^{-5}	2.162×10^{-5}
5700-5750	3.491×10^{-6}	1.655×10^{-5}	2.314×10^{-5}
5750-5800	3.452×10^{-6}	1.664×10^{-5}	2.409×10^{-5}
5800-5850	*3.549×10^{-6}	*1.701×10^{-5}	2.548×10^{-5}
5850-5900	3.472×10^{-6}	1.699×10^{-5}	2.650×10^{-5}
5900-5950	3.375×10^{-6}	1.663×10^{-5}	2.669×10^{-5}
5950-6000	3.221×10^{-6}	1.636×10^{-5}	*2.698×10^{-5}
6000-6050	3.124×10^{-6}	1.599×10^{-5}	2.679×10^{-5}
6050-6100	2.970×10^{-6}	1.526×10^{-5}	2.617×10^{-5}
6100-6150	2.951×10^{-6}	1.539×10^{-5}	2.677×10^{-5}
6150-6200	2.854×10^{-6}	1.514×10^{-5}	2.642×10^{-5}
6200-6250	2.527×10^{-6}	1.420×10^{-5}	2.421×10^{-5}
6250-6300	2.488×10^{-6}	1.354×10^{-5}	2.399×10^{-5}
6300-6350	2.372×10^{-6}	1.335×10^{-5}	2.413×10^{-5}
6350-6400	2.257×10^{-6}	1.271×10^{-5}	2.386×10^{-5}
C400-6450	2.257×10^{-6}	1.240×10^{-5}	2.455×10^{-5}
6450-6500	2.160×10^{-6}	1.190×10^{-5}	2.401×10^{-5}
6500-6550	2.044×10^{-6}	1.117×10^{-5}	2.268×10^{-5}
6550-6600	1.890×10^{-6}	1.061×10^{-5}	2.104×10^{-5}
6600-6650	1.736×10^{-6}	9.779×10^{-6}	1.828×10^{-5}
6650-6700	1.485×10^{-6}	9.219×10^{-6}	1.585×10^{-5}
6700-6750	1.157×10^{-6}	*8.698×10^{-6}	1.169×10^{-5}
6750-6800	*8.872×10^{-7}	8.853×10^{-6}	8.409×10^{-6}
6800-6850	9.644×10^{-7}	1.009×10^{-5}	7.811×10^{-6}
6850-6900	1.119×10^{-6}	1.300×10^{-5}	9.123×10^{-6}
6900-6950	9.451×10^{-7}	1.256×10^{-5}	5.921×10^{-6}
6950-7000	1.022×10^{-6}	1.337×10^{-5}	*5.130×10^{-6}
5500-7000	6.914×10^{-5}	4.019×10^{-4}	5.870×10^{-4}

*Denotes maximum/minimum values.

The maximum/minimum values in Table 4 are designated by an *. Note in Table 4 that the spectral radiance averaged over 50 cm^{-1} for cumulus, in general, is greater than cirrus, which in turn is greater than snow. Also note in Table 4 that the spectral radiance for cumulus backgrounds is greater than that for cirrus backgrounds between wavenumber interval of 5650 to 6750 cm^{-1}. However, between the wavenumber intervals of 5500 to 5650 cm^{-1} and 6750 to 7000 cm^{-1}, the spectral radiance of cirrus backgrounds is greater than that of cumulus backgrounds.

The absolute spectral radiance averages over 50 to 500 cm^{-1} for 32 cirrus spectra as a function of wavenumber are shown in Figure 16. The hexagons on each line labeled 50 to 500 cm^{-1} in Figure 16 represents the maximum or end wavenumber for maximum spectral radiance ratios between cumulus and cirrus. The locations of the hexagons are obtained by taking ratios of the spectral radiance of cumulus to cirrus at the same wavenumber interval, and then plotting the location of the maximum ratio.

Figure 17 shows the absolute spectral radiance averaged over 50 to 500 cm^{-1} intervals for 56 snow spectra as a function of wavenumber. The boxed X in Figure 17 on the line marked 500 cm^{-1} represents the approximate spectral radiance that would be observed by the preliminary DMSP snow/cloud discrimination sensor design. The 50 percent transmission curve of this sensor lies between 6135 and 6625 cm^{-1}. The * on each line in Figure 17 represents the maximum or end wavenumber for maximum spectral radiance ratios between cumulus and snow.

Based on the analysis of the 56 snow spectra collected by the AFGL aircraft, the DMSP snow/cloud discrimination sensor could be improved by moving the 50 percent transmission approximately 150 cm^{-1}, so that it senses reflected energy in the 6300 to 6800 cm^{-1} spectral region. Again, depending on the averaging over 50 to 500 cm^{-1} intervals, the maximum spectral radiance ratios between cumulus and snow are found at the maximum wavenumber between 6600 and 6800 cm^{-1}, as compared to the ratios between cumulus and cirrus where the maximum wavenumbers are located between 6550 and 6700 cm^{-1}.

4.1.2 RATIOS

The ratio of the absolute spectral radiance of cumulus/cirrus and cumulus/snow averaged over 50 to 700 cm^{-1} intervals as a function of wavenumber between 5500 and 7000 cm^{-1} is shown in Figures 18 and 19 respectively. The spectral radiance ratio between cumulus and cirrus is shown in Figure 18, and generally runs between 0.4 and 2.0 over the wavenumber interval of 5500 to 7000 cm^{-1}, depending on the averaging of 50 to 700 cm^{-1}. Values less than 1.0 indicate that the cirrus backgrounds have a greater spectral radiance than that of cumulus backgrounds. The maximum ratios of 1.8 to 2.0 are found in the wavenumber interval of 6500 to 6700 cm^{-1}. The range of maximum spectral radiance ratios between cumulus and cirrus is 2.0, averaging over 50 cm^{-1} intervals between 6500 and 6550 cm^{-1}, and 1.8, averaging over 700 cm^{-1} intervals between 6000 and 6700 cm^{-1}. The maximum ratio between all cumulus and cirrus spectra that would be observed by the DMSP sensor would be 1.9. Cumulus/cirrus discrimination on an individual basis may be difficult. See Table 8, Section 5.1.

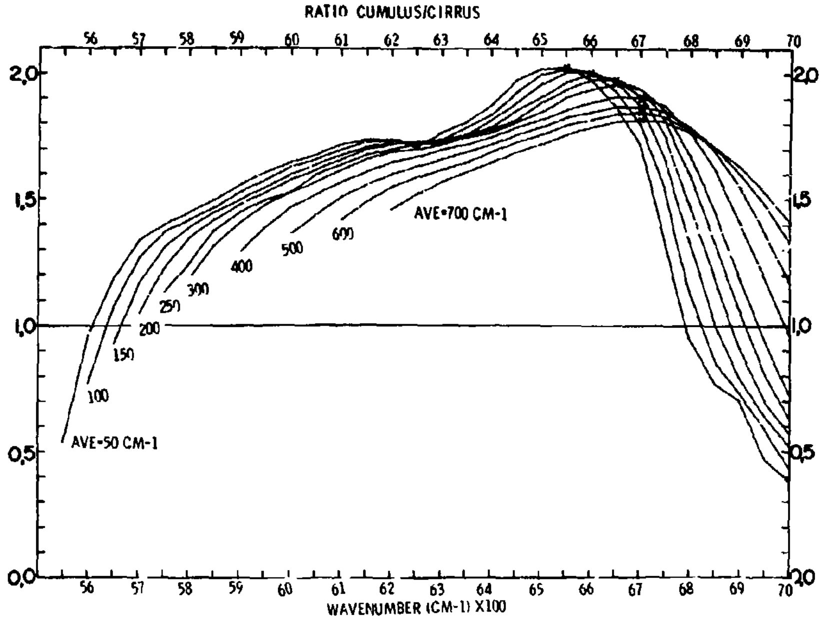

Figure 18. Ratio Cumulus/Cirrus

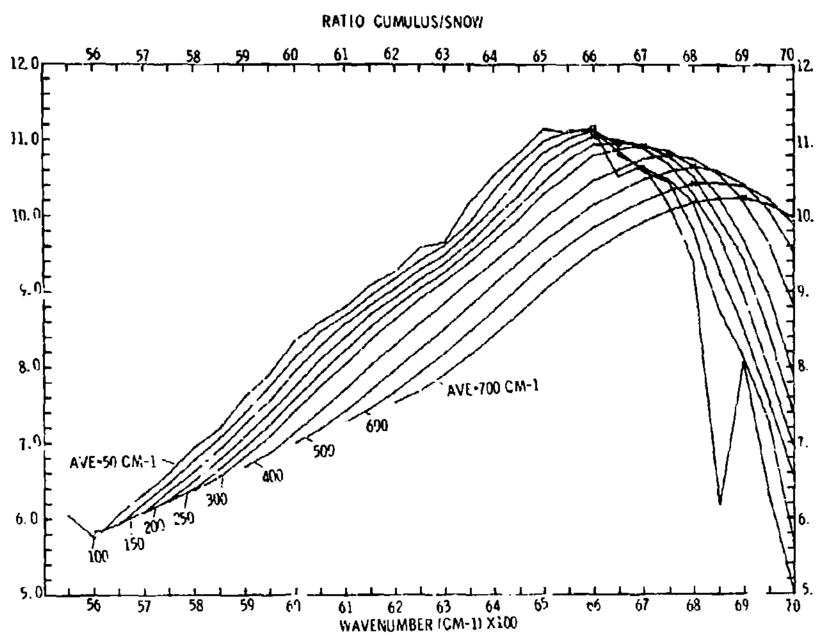

Figure 19. Ratio Cumulus/Snow

The spectral radiance ratios between cumulus and snow is illustrated in Figure 19. In the 5500 to 7000 cm^{-1} interval, the ratios have values between 5 and 11, depending on the averaging interval between 50 and 700 cm^{-1}. The maximum ratios of 10 and 11 are found in the wavenumber intraval of 6600 to 6900 cm^{-1}. The range of maximum spectral radiance ratios between cumulus and snow is 11.2, averaging over 50 cm^{-1} between 6550 and 6600 cm^{-1}, and 10.3, averaging over 700 cm^{-1} intervals between 6200 and 6900 cm^{-1} (1.61-1.45 μm). The DMSP sensor would observe a reflectance ratio of 10.3 between cumulus and snow; again, sufficient to discriminate between cumulus and snow backgrounds.

4.2 Maximum Spectral Radiance

The maximum spectral radiance values in the spectral range of 5500 to 7000 cm^{-1} for each of the 124 measured spectra are shown in Figure 20. The range or lowest and highest values of the maximum spectral radiance observed for snow and cirrus and cumulus clouds is shown graphically to the right of spectra No. 125. These values are tabulated in Table 5.

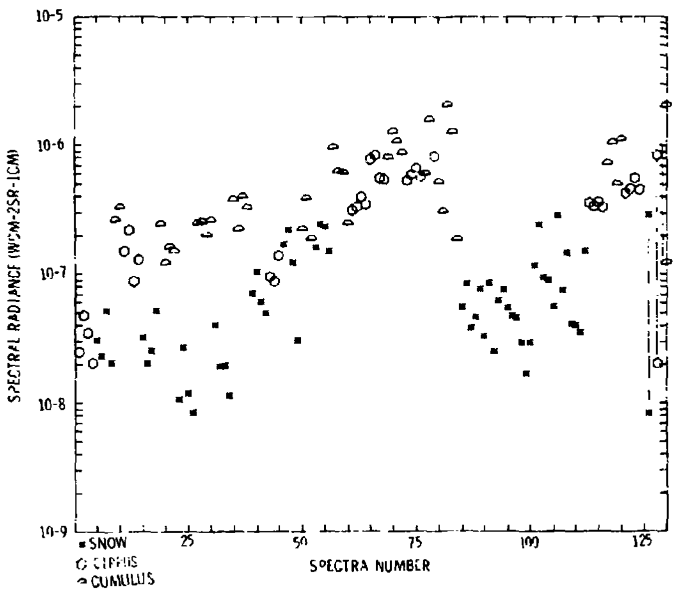

Figure 20. Maximum Spectral Radiance for Cumulus, Cirrus, and Snow

Table 5. Maximum Spectral Radiance (W $cm^{-2} sr^{-1} (cm^{-1})^{-1}$)

Value	Snow	Cirrus	Cumulus
Lowest	8.417×10^{-9}	2.041×10^{-8}	1.215×10^{-7}
Highest	2.905×10^{-7}	8.446×10^{-7}	2.029×10^{-6}

In general, the maximum spectral radiance of snow on any given day is lower than that of either cirrus or cumulus. Thresholding the maximum spectral radiance at a value equal to 1×10^{-7}, the number of spectra categorized as under (over) for the three different backgrounds are as follows: snow 43 under (13 over), cirrus 7 under (25 over), cumulus 0 under (36 over). Increasing the threshold value to 1.5×10^{-7}, the number of spectra categorized are as follows: snow 47 under (9 over), cirrus 9 under (23 over), cumulus 2 under (34 over).

4.3 Location of the Maximum Spectral Radiance

Figure 21 shows the spectral location of the maximum spectral radiance for the 124 collected spectra. About 93 percent (52 out of 56) of the snow spectra show the location of the maximum spectral radiance to be between 5650 and 5825 cm^{-1}. In the case of cumulus, approximately 89 percent (32 out of 36) of cumulus spectra show the location to be between 5860 and 6435 cm^{-1}. The location of the maximum spectral radiance of cirrus spectra, on the other hand, is similar to that of snow, sometimes similar to that of cumulus, and sometimes its location is unique—such as the seven spectra located at 7000 cm^{-1}.

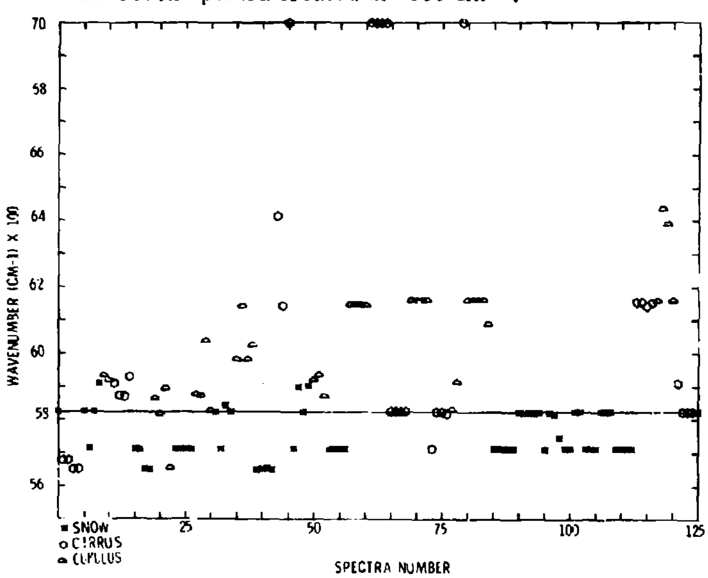

Figure 21. Location of the Maximum Spectral Radiance for Cumulus, Cirrus, and Snow

4.4 Slope of the Spectral Radiance

The slope of the spectral radiance for the three different backgrounds was discussed in Section 3. Another way of analyzing the slope of the reflected radiance as a function of wavenumber for the 124 collected spectra for the three different backgrounds may be seen in Figures 22 and 23. By taking the ratios of the spectral radiance in the wavenumber interval 5500 to 5615 cm^{-1} to the spectral radiance in the wavenumber interval 5715 to 5825 cm^{-1}, the slope characteristic for both snow and cumulus spectra is positive-large. As can be seen in Figure 22, the ratio values for snow and cumulus are in general between 5 and 50, which is defined as large. In the case of cirrus, the ratio is generally less than 2.5 (defined as small), as depicted by the hexagons in Figure 22, and thus the slope is positive-small for cirrus backgrounds. The value of the slope between wavenumber intervals of 5500 and 5825 cm^{-1} may be used to discriminate cirrus from snow or cumulus.

Figure 23 shows the slope of the spectral radiance in the wavenumber intervals of 5715 to 5825 cm^{-1} and 6060 to 6125 cm^{-1} for snow and cumulus spectra. All 56 snow spectra show a negative slope (value greater than 1). In the case of cumulus backgrounds, 29 out of 36 cumulus spectra show a positive slope (value equal to or less than 1). Thus, the slope between 5825 and 6125 cm^{-1} for cumulus backgrounds is generally positive-small, and for snow it is negative. Again the value and sign of the slope between wavenumber interval 5715 and 6125 cm^{-1} may be used to discriminate snow from cumulus.

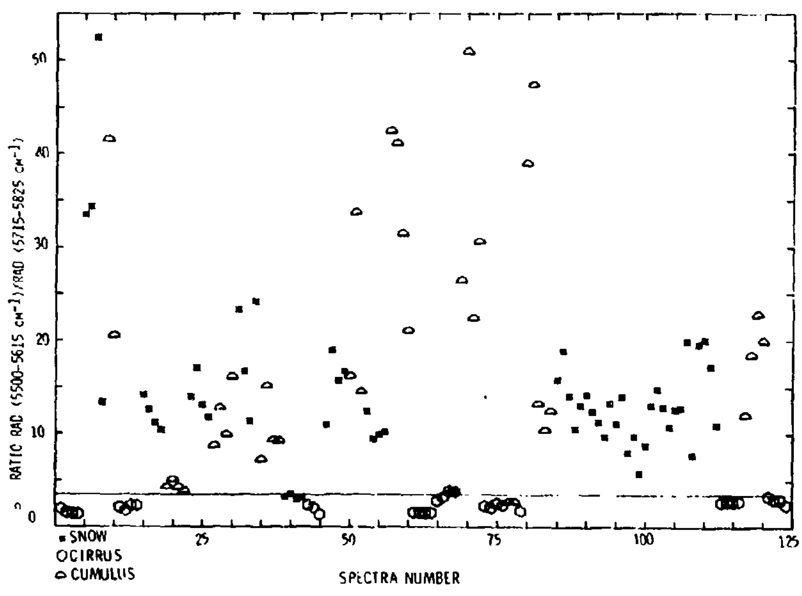

Figure 22. Ratio of Radiance at 5500—5615 cm^{-1} to Radiance at 5715—5825 cm^{-1}

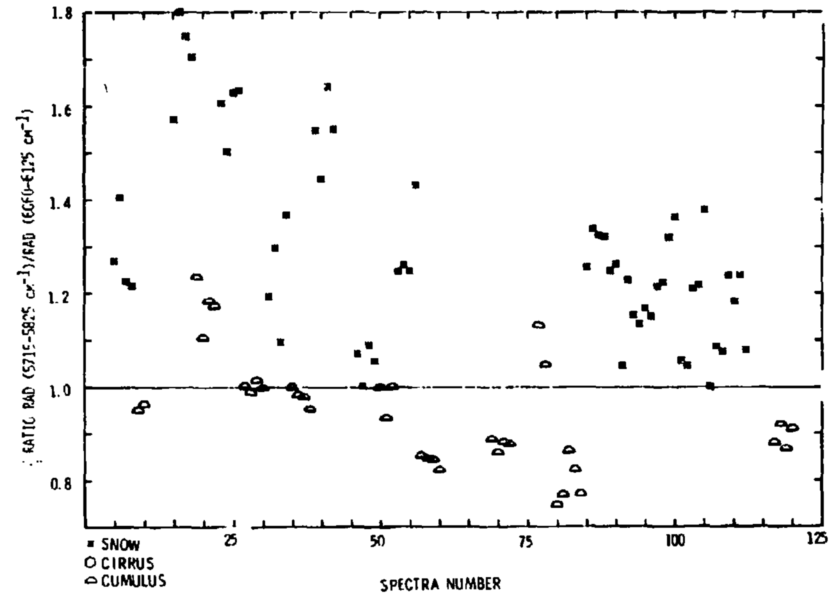

Figure 23. Ratio of Radiance at 5715–5825 cm^{-1} to Radiance at 6060–6125 cm^{-1}

The various properties of the slope are summarized in Table 6.

Table 6. Slope of Spectral Radiance

	Between 5500–5825 cm^{-1} (1.82–1.72 μm)	Between 5715–6125 cm^{-1} (1.75–1.63 μm)
A) Cumulus	Positive-Large (>5.0)	*Positive (<1.0)*
B) Cirrus	*Positive-Small (<2.5)*	Positive/Negative
C) Snow	Positive-Large (>5.0)	*Negative (>1.0)*

*Can be used to discriminate between cumulus/cirrus/snow.

5. RECOMMENDATIONS

Analysis of the 124 AFGL-measured spectra of snow and cirrus and cumulus clouds shows marked differences in their spectral reflectance characteristics in the near IR spectral region. These differences in the 5500 to 7000 cm^{-1} spectral region could be used in snow/cloud discrimination. Specifically, a snow/cloud discrimination sensor design in the near IR spectral region should consider the following parameters: absolute spectral and/or total radiance; slope of the spectral radiance; and the location and value of the maximum spectral radiance. Based on the analysis of the spectra measured over snow/cloud backgrounds, the following recommendations are made for an optimal operational snow/cloud discrimination sensor design.

5.1 Narrow Spectral Band Radiometer-Imager

As designed, this preliminary DMSP snow/cloud sensor should be more than adequate in snow/cloud discrimination. However, a slight improvement may be obtained in the cumulus/snow signal ratios by moving this experimental snow/cloud SSP sensor 150 cm^{-1} to larger wavenumbers (shorter wavelength). The 100 percent transmission that presently lies approximately in the interval of 6375 to 6450 cm^{-1} (1.57-1.55 μm) should be moved to the interval of 6525 to 6600 cm^{-1} (1.53-1.52 μm). The 50 percent transmission that lies in the 6135 to 6625 cm^{-1} interval (1.63-1.51 μm) should be moved to the interval of 6285 to 6775 cm^{-1} (1.59-1.48 μm) for maximum spectral radiance ratios between cumulus and snow.

On the average, the absolute spectral and/or total radiance for cumulus backgrounds is greater than that for cirrus backgrounds which in turn is greater than that for snow backgrounds. The reflectance characteristics of the three different backgrounds in the near IR could be categorized or defined as follows: cumulus-high (white), cirrus-medium (gray), and snow-low (black). Using this definition, a narrow spectral band radiometer or imager could be designed for maximum cumulus/snow (white/black) or cumulus/cirrus (white/gray) spectral radiance ratios, as shown in Table 7 below.

Table 7. Radiometer Bandwidth vs Optimum Spectral Band

Radiometer Bandwidth (cm^{-1})	Optimum Spectral Band Wavenumber (cm^{-1})	Optimum Spectral Band Wavelength (cm^{-1})	Spectral Radiance Ratios Cumulus/Snow	Spectral Radiance Ratios Cumulus/Cirrus
50	6550-6600	1.53-1.52	11.2	2.0
100	6500-6600	1.54-1.52	11.2	2.0
200	6400-6600	1.56-1.52	11.1	2.0
300	6400-6700	1.56-1.49	10.9	1.9
400	6350-6750	1.58-1.48	10.8	1.9
500	6300-6800	1.59-1.47	10.7	1.8
600	6200-6800	1.61-1.47	10.4	1.8
700	6200-6900	1.61-1.45	10.3	1.6

The preliminary DMSP snow/cloud SSP sensor would require a visible channel for comparison in a snow/cloud discrimination decision. In addition, a thresholding capability should be utilized on the sensor. The value of thresholding could be two-way (snow/cloud) or three-way (snow/cirrus/cumulus). Using the response curve of the preliminary snow/cloud sensor and assigning a value of total radiance less than 5×10^{-5} W $cm^{-2}sr^{-1}$ to define black, the snow/cloud discrimination results on the aircraft-measured spectra are as follows: snow 48/56 or 86 percent and clouds 57/68 or 84 percent would be correctly observed. Further discrimination with clouds could be accomplished by using a three-way thresholding value such as black, less than 5×10^{-5} W $cm^{-2}sr^{-1}$; gray, 5×10^{-5}-1.75×10^{-4}; and white, greater than 1.75×10^{-4} W $cm^{-2}sr^{-1}$. The results are shown in Table 8.

Table 8. Three-Way Thresholding

Total Radiance (W $cm^{-2}sr^{-1}$) ($<5 \times 10^{-5}$)	(5×10^{-5}-1.75×10^{-4})	($>1.75 \times 10^{-4}$)
Color: Black	Gray	White
Snow 48 (86%)	8 (14%)	0 (0%)
Cirrus 8 (25%)	16 (50%)	8 (25%)
Cumulus 3 (8%)	17 (47%)	16 (44%)

As seen in Table 8, three-way thresholding would not make any significant contribution to cirrus/cumulus discrimination.

5.2 Three-Detector, Narrow-Spectral-Band, Near-IR Radiometer

If the spectral radiance or reflectance is sufficient, serious consideration should be made for a three-detector, narrow-spectral-band, near-IR radiometer that utilizes the slope of the spectral radiance. As previously discussed, the slope of the spectral radiance for cirrus in the 5500 to 5825 cm^{-1} interval is positive-small (less than a factor of 2.5), whereas for snow and cumulus it is positive-large (greater than a factor of 5). This feature should allow one to discriminate cirrus from snow or cumulus clouds. Next, in the case of snow backgrounds, the slope of the spectral radiance in the 5825-6125 cm^{-1} interval is negative, whereas it is positive for cumulus backgrounds. This feature should allow one to discriminate between snow and cumulus.

The three-detector, near-IR radiometer could be designed as follows: Detector No. 1 should sense the reflectance in the 5500 to 5615 cm^{-1} spectral band; Detector No. 2 in the 5715 to 5825 cm^{-1} spectral band, and Detector No. 3 in the 6060 to 6125 cm^{-1} spectral band. The instrument could be preprogrammed to compare the reflectance of the three detectors. If the comparisons between Detectors No. 1 and No. 2 give a small value (that is, a value less than a factor of 3), the background is cirrus. If the value is large (that is, a value greater than a factor of 5), compare Detector No. 2 with No. 3; if the value is positive (negative slope) the background is snow. If the comparison of Detector No. 2 with No. 3 gives a negative value (positive slope) or zero value, the background is cumulus. In addition, a thresholding capability on Detectors No. 2 and No. 3 could aid in discriminating snow from cumulus (that is, large reflectances on either Detectors would represent a cumulus rather than snow background).

If we utilize this principle on the aircraft-measured spectra, the snow/cirrus/cumulus discrimination results are as follows: cirrus, 31/32 or 97 percent correct; snow, 52/56 or 93 percent correct; and cumulus, 30/36 or 83 percent correct. In general, the above percentages are a definite improvement over those for the instrument described in Section 3.1

5.3 Multispectral Radiometer

A multispectral radiometer operating in the spectral interval of from 5625 to 6450 cm^{-1} with a spectral resolution of 15 to 20 cm^{-1} could be designed in order to utilize the location and value of the maximum spectral radiance for discrimination between snow and cirrus and cumulus cloud backgrounds.

If we utilize this principle on the aircraft-measured spectra, the snow/cirrus/cumulus discrimination results are as follows: snow, 52/56 or 93 percent correct; cirrus, 21/32 or 66 percent correct; and cumulus, 33/36 or 92 percent correct.

5.4 Conclusions

Based on the results of the analysis performed on the aircraft-measured spectra, it appears that the three-detector, near-IR Radiometer described in Section 3.2 would have the highest potential of discriminating snow and cirrus and cumulus clouds. In addition, this type of instrument that utilizes the slope of the spectral radiance could obviate the need of a visible channel for comparison purposes, and could easily be preprogrammed for on-board processing of the signal. The data rate from this type of instrument could be very minimal.

The Radiometer-Imager described in Section 3.1 should be adequate for snow/cloud discrimination. However, when the attempt is made to discriminate cirrus from cumulus, it may be difficult. It would probably require a variable thresholding capability as a function of latitude and solar elevation angle to optimize the cirrus/cumulus discrimination. The need of a visible channel for comparison purposes and the data rate required would be a negative feature of this instrument.

Finally, the multispectral radiometer could be quite useful for snow/cumulus discrimination. Nothing would be gained by using this instrument in trying to identify cirrus backgrounds.

Appendix A

Mission Parameters

A number of relevant parameters are listed for each snow (Table A1), cirrus (Table A2), and cumulus (Table A3) background run performed in September 1976 and 1977. The information for each heading follows:

Spectra No.	—	Reference number used in main text
Mission No.	—	Reference number for mission identification
Run	—	Reference number for run identification
Date	—	Day, month, year
Time	—	Universal time, hours and minutes
Lat N	—	North latitude, decimal degrees
Long W	—	West longitude, decimal degrees
Solar Az	—	Solar azimuth, true bearing, decimal degrees
Solar El	—	Solar elevation, decimal degrees
Alt T	—	True altitudes of aircraft, feet
Remarks	—	Information relative to location, height, and texture

Table A1. Mission Parameters for Snow, N = 56

Spectra No.	5-8	15-18	23-26	31-34	39-42	46-49	53-56
Mission No.	TR46	TR45	TR45	TR45	TR45	TR44	TR44
Run	6	1	4	7	11	1	4
Date	21 Sept 76	20 Sept 76	20 Sept 76	20 Sept 76	20 Sept 76	18 Sept 76	18 Sept 76
Time	22:36	20:12	20:48	21:17	22:01	17:42	21:17
Lat N	68.12	61.82	60.40	60.28	61.40	46.20	46.85
Long W	146.63	143.33	141.22	141.58	141.75	121.50	121.77
Solar Az	197.1	160.5	173.1	181.2	193.8	136.6	208.4
Solar El	22.1	28.6	31.2	31.5	30.6	37.7	42.2
Alt T	27000	26000	26000	26000	33000	28000	31000
Remarks	Brooks Range 6000	Nebesna Glacier 7500	Columbus Glacier 6000	Yantse Glacier 3500	Mt. Bona 14500	Mt. Adams 12300	Mt. Rainer 14400

Spectra No.	85-90	91-96	97-101	102-106	107-112
Mission No.	703	703	703	703	703
Run	1	2	4	5	7
Date	25 Apr 77	25 Apr 77	25 Apr 77	25 Apr 77	25 Apr 77
Time	16:11	16:23	17:15	17:21	18:03
Lat N	51.58	51.50	51.17	51.10	51.67
Long W	68.50	68.67	73.33	73.25	79.42
Solar Az	171.6	176.0	188.8	191.7	198.2
Solar El	51.4	51.6	51.8	51.6	50.4
Alt T	29000	29000	28000	23000	28000
Remarks	Lake Manicouagan	Snow Cov. Terrain 1/2 rocks 1/2 trees	Lake Mistassini no puddles	West Bank of Lake Crescent	Hudson Bay some puddles

Table A2. Mission Parameters for Cirrus, N = 32

Spectra No.	1-4	11-14	43-45	61-64	65-68	73-76
Mission No.	TR46	TR46	TR45	TR44	705	705
Run	4	10	19	8	1	5
Date	21 Sept 76	21 Sept 76	20 Sept 76	19 Sept 76	28 Apr 77	28 Apr 77
Time	21:25	23:55	23:27	00:53	16:19	16:43
Lat N	72.32	63.90	63.02	63.08	43.33	43.25
Long W	148.83	150.17	142.6	142.12	67.33	67.08
Solar Az	175.6	215.3	216.1	237.5	176.5	188.9
Solar El	19.0	23.2	24.2	17.6	60.8	60.7
Alt T	37000	37000	39000	37000	31000	31000
Remarks	Thin	Thin	Mod-Thick	Thin	Thick	Thick
	36000	35000	37500	36000	31000	31000

Spectra No.	79	113-116	121-124
Mission No.	705	702	702
Run	10	1	17
Date	28 Apr 77	22 Apr 77	22 Apr 77
Time	17:51	18:10	22:06
Lat N	46.50	45.67	44.00
Long W	67.42	68.75	71.00
Solar Az	215.6	218.8	272.4
Solar El	53.2	51.0	15.3
Alt T	33000	29000	37000
Remarks	Thick	Thick	Semi T.
	31000	?	37000

Table A3. Mission Parameters for Cumulus, N = 36

Spectra No.	9-10	19-22	27-30	35-38	50-52	57-60
Mission No.	TR46	TR45	TR45	TR45	TR44	TR44
Run	8	2	5	8	2	6
Date	21 Sept 76	20 Sept 76	20 Sept 76	20 Sept 76	18 Sept 76	18 Sept 76
Time	22:57	20:18	20:57	21:22	17.46	21:33
Lat N	68.08	61.72	60.45	60.22	46.2	46.85
Long W	149.27	143.42	142.08	141.88	121.48	121.77
Solar Az	200.0	162.1	174.7	182.3	137.7	213.4
Solar El	22.1	28.9	31.2	31.5	38.2	40.8
Alt T	27000	25000	26000	26000	28000	31000
Remarks	7-8K	15-16K	10-12K	9-10K	12-13K	14-15K
Spectra No.	69-72	77-78	80-81	82-84	118-120	
Mission No.	705	705	705	705	702	
Run	3	9	13	16	5	
Date	28 Apr 77	28 Apr 77	28 Apr 77	28 Apr 77	22 Apr 77	
Time	16:30	17:35	18:46	19:08	19:10	
Lat N	43.25	45.42	43.83	44.00	43.13	
Long W	66.83	69.00	68.31	70.50	72.70	
Solar Az	182.8	207.6	235.0	238.1	235.2	
Solar El	60.9	56.2	48.6	46.5	46.8	
Alt T	31000	33000	31000	24000	28000	
Remarks	10-14K	20K	6-10K	6-10K	13-15K	

Appendix B

Spectral Radiance Normalized and Ratios

Table B1. Spectral Radiance Normalized and Ratios — All

INFRARED DATA 2075 WORDS, AVERAGE EVERY ELEVEN

	WAVE NUMBER	WAVE LENGTH	CU	CI	SN	CU/CI	CU/SN		WAVE NUMBER	WAVE LENGTH	CU	CI	SN	CU/CI	CU/SN
1	5500.7	1.818	.109	.284	.015	.36	7.39	61	5616.4	1.781	.619	.538	.103	1.15	6.03
2	5502.6	1.817	.115	.293	.017	.40	6.88	62	5618.3	1.780	.641	.545	.106	1.17	6.03
3	5504.5	1.817	.137	.319	.021	.43	6.46	63	5620.2	1.779	.650	.548	.107	1.19	6.06
4	5506.4	1.816	.150	.329	.023	.46	6.44	64	5622.2	1.779	.637	.543	.104	1.17	6.11
5	5508.4	1.815	.156	.339	.024	.46	6.54	65	5624.1	1.778	.620	.536	.102	1.16	6.06
6	5510.3	1.815	.155	.339	.024	.46	6.58	66	5626.0	1.777	.619	.536	.103	1.16	6.02
7	5512.2	1.814	.155	.339	.024	.45	6.59	67	5627.9	1.777	.630	.539	.104	1.17	6.05
8	5514.2	1.814	.153	.339	.023	.45	6.73	68	5629.9	1.776	.632	.540	.104	1.17	6.10
9	5516.1	1.813	.151	.335	.023	.45	6.67	69	5631.8	1.776	.632	.540	.104	1.17	6.10
10	5518.0	1.812	.159	.339	.025	.47	6.72	70	5633.7	1.775	.645	.544	.106	1.19	6.07
11	5519.9	1.812	.177	.350	.029	.51	6.04	71	5635.7	1.774	.675	.552	.111	1.22	6.09
12	5521.9	1.811	.197	.366	.037	.54	5.39	72	5637.6	1.774	.701	.560	.114	1.25	6.17
13	5523.8	1.810	.210	.376	.035	.56	5.95	73	5639.5	1.773	.707	.561	.114	1.26	6.22
14	5525.7	1.810	.208	.375	.034	.55	6.08	74	5641.4	1.773	.705	.561	.114	1.26	6.21
15	5527.7	1.809	.201	.371	.033	.54	6.10	75	5643.4	1.772	.715	.565	.116	1.27	6.17
16	5529.6	1.808	.202	.372	.034	.54	6.00	76	5645.3	1.771	.731	.570	.118	1.28	6.17
17	5531.5	1.808	.216	.361	.037	.57	5.82	77	5647.2	1.771	.744	.575	.120	1.29	6.18
18	5533.4	1.807	.240	.394	.042	.61	5.69	78	5649.2	1.770	.761	.580	.123	1.31	6.17
19	5535.4	1.807	.262	.406	.046	.64	5.65	79	5651.1	1.770	.782	.588	.126	1.33	6.20
20	5537.3	1.806	.277	.415	.048	.66	5.68	80	5653.0	1.769	.786	.590	.126	1.33	6.25
21	5539.2	1.805	.271	.415	.047	.65	5.76	81	5654.9	1.768	.766	.583	.122	1.31	6.29
22	5541.2	1.805	.259	.419	.044	.62	5.86	82	5656.9	1.768	.739	.574	.119	1.29	6.21
23	5543.1	1.804	.244	.400	.041	.61	5.98	83	5658.8	1.767	.730	.571	.119	1.28	6.17
24	5545.0	1.803	.229	.391	.035	.58	6.56	84	5660.7	1.767	.740	.574	.121	1.29	6.14
25	5546.9	1.803	.221	.385	.037	.57	6.05	85	5662.7	1.766	.754	.579	.122	1.30	6.17
26	5548.9	1.802	.230	.388	.038	.59	5.89	86	5664.6	1.765	.758	.580	.122	1.31	6.21
27	5550.8	1.802	.259	.401	.045	.65	5.73	87	5666.5	1.765	.753	.577	.120	1.30	6.25
28	5552.7	1.801	.287	.412	.050	.70	5.75	88	5668.4	1.764	.750	.575	.119	1.30	6.28
29	5554.7	1.800	.298	.414	.051	.72	5.82	89	5670.4	1.764	.746	.574	.119	1.30	6.30
30	5556.6	1.800	.307	.417	.053	.74	5.81	90	5672.3	1.763	.742	.572	.118	1.30	6.31
31	5558.5	1.799	.321	.422	.055	.76	5.80	91	5674.2	1.762	.751	.574	.119	1.31	6.29
32	5560.4	1.798	.340	.433	.059	.79	5.76	92	5676.2	1.762	.781	.583	.124	1.34	6.29
33	5562.4	1.798	.356	.440	.064	.81	5.59	93	5678.1	1.761	.814	.594	.125	1.37	6.35
34	5564.3	1.797	.395	.452	.071	.87	5.53	94	5680.0	1.761	.828	.599	.129	1.38	6.44
35	5566.2	1.797	.420	.464	.075	.91	5.63	95	5682.0	1.760	.820	.596	.127	1.37	6.48
36	5568.2	1.796	.439	.474	.078	.93	5.62	96	5683.9	1.759	.806	.592	.124	1.36	6.48
37	5570.1	1.795	.451	.480	.080	.94	5.64	97	5685.8	1.759	.805	.592	.125	1.36	6.46
38	5572.0	1.795	.445	.482	.078	.93	5.70	98	5687.7	1.758	.815	.596	.126	1.37	6.49
39	5573.9	1.794	.440	.482	.077	.91	5.73	99	5689.7	1.758	.815	.597	.125	1.37	6.50
40	5575.9	1.793	.436	.483	.076	.90	5.74	100	5691.6	1.757	.813	.596	.125	1.36	6.49
41	5577.8	1.793	.441	.485	.077	.91	5.73	101	5693.5	1.756	.819	.598	.126	1.37	6.50
42	5579.7	1.792	.463	.492	.081	.94	5.71	102	5695.5	1.756	.823	.598	.126	1.38	6.51
43	5581.7	1.792	.492	.511	.086	.96	5.73	103	5697.4	1.755	.820	.597	.126	1.38	6.50
44	5583.6	1.791	.517	.513	.090	1.02	5.75	104	5699.3	1.755	.816	.595	.125	1.37	6.49
45	5585.5	1.790	.529	.515	.093	1.04	5.78	105	5701.2	1.754	.808	.592	.125	1.37	6.47
46	5587.4	1.790	.558	.524	.096	1.07	5.79	106	5703.2	1.753	.806	.592	.126	1.36	6.43
47	5589.4	1.789	.575	.532	.099	1.08	5.79	107	5705.1	1.753	.823	.597	.128	1.38	6.42
48	5591.3	1.789	.565	.537	.101	1.05	5.60	108	5707.0	1.752	.838	.600	.130	1.40	6.43
49	5593.2	1.788	.587	.536	.101	1.09	5.83	109	5709.0	1.752	.848	.603	.132	1.41	6.44
50	5595.2	1.787	.561	.531	.094	1.06	5.96	110	5710.9	1.751	.863	.608	.134	1.42	6.46
51	5597.1	1.787	.579	.529	.099	1.10	5.84	111	5712.8	1.750	.874	.611	.134	1.43	6.51
52	5599.0	1.786	.587	.530	.107	1.11	5.86	112	5714.7	1.750	.864	.607	.132	1.42	6.55
53	5600.9	1.785	.592	.532	.100	1.11	5.90	113	5716.7	1.749	.837	.598	.128	1.40	6.56
54	5602.9	1.785	.593	.532	.101	1.11	5.95	114	5718.6	1.749	.817	.592	.125	1.38	6.56
55	5604.8	1.784	.588	.531	.098	1.11	6.02	115	5720.5	1.748	.814	.592	.124	1.37	6.55
56	5606.7	1.784	.573	.526	.095	1.09	6.05	116	5722.5	1.748	.823	.595	.125	1.38	6.58
57	5608.7	1.783	.571	.524	.095	1.09	5.98	117	5724.4	1.747	.830	.597	.125	1.39	6.64
58	5610.6	1.782	.578	.527	.097	1.10	5.99	118	5726.3	1.746	.831	.598	.124	1.39	6.69
59	5612.5	1.782	.602	.531	.099	1.13	6.06	119	5728.2	1.746	.830	.599	.124	1.39	6.71
60	5614.4	1.781	.617	.537	.100	1.14	6.15	120	5730.2	1.745	.830	.599	.123	1.39	6.72

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INFRARED DATA 2975 WORDS, AVERAGE EVERY ELEVEN

	WAVE NUMBER	WAVE LENGTH	CU	CI	SN	CU/CI	CU/SN		WAVE NUMBER	WAVE LENGTH	CU	CI	SN	CU/CI	CU/SN
121	5732.1	1.745	.826	.597	.123	1.39	6.72	181	5847.8	1.710	.926	.607	.126	1.53	7.35
122	5734.0	1.744	.817	.592	.122	1.38	6.72	182	5849.7	1.709	.930	.608	.126	1.53	7.4[illegible]
123	5736.0	1.743	.816	.592	.122	1.38	6.69	183	5851.7	1.709	.93[illegible]	.609	.125	1.53	7.44
124	5737.9	1.743	.834	.595	.125	1.39	6.68	184	5853.6	1.708	.93[illegible]	.609	.125	1.53	7.46
125	5739.8	1.742	.854	.604	.127	1.41	6.73	185	5855.5	1.708	.933	.611	.125	1.53	7.46
126	5741.7	1.742	.859	.606	.127	1.42	6.79	186	5857.5	1.707	.942	.616	.126	1.53	7.47
127	5743.7	1.741	.861	.607	.126	1.42	6.81	187	5859.4	1.707	.950	.619	.126	1.53	7.51
128	5745.6	1.740	.867	.608	.127	1.43	6.81	188	5861.3	1.706	.951	.618	.126	1.54	7.53
129	5747.5	1.740	.871	.608	.128	1.43	6.81	189	5863.[illegible]	1.706	.952	.619	.127	1.54	7.52
130	5749.5	1.739	.864	.603	.127	1.43	6.83	190	5865.2	1.705	.958	.620	.127	1.54	7.52
131	5751.4	1.739	.848	.597	.124	1.42	6.84	191	5867.1	1.704	.968	.623	.128	1.55	7.56
132	5753.3	1.738	.835	.593	.122	1.41	6.84	192	5869.3	1.704	.974	.624	.128	1.56	7.60
133	5755.2	1.738	.839	.595	.123	1.41	6.84	193	5871.0	1.703	.975	.623	.128	1.56	7.63
134	5757.2	1.737	.854	.601	.124	1.42	6.88	194	5872.9	1.703	.972	.621	.127	1.57	7.63
135	5759.1	1.736	.865	.604	.125	1.43	6.93	195	5874.8	1.702	.970	.619	.127	1.57	7.64
136	5761.0	1.736	.875	.605	.125	1.44	6.95	196	5876.7	1.702	.974	.618	.127	1.57	7.65
137	5763.0	1.735	.868	.602	.125	1.44	6.96	197	5878.7	1.701	.970	.618	.127	1.57	7.66
138	5764.9	1.735	.857	.596	.123	1.43	6.95	198	5880.6	1.701	.971	.618	.127	1.57	7.67
139	5766.8	1.734	.829	.592	.121	1.42	6.94	199	5882.5	1.700	.971	.618	.126	1.57	7.7[illegible]
140	5768.7	1.733	.836	.592	.121	1.41	6.95	200	5884.5	1.699	.965	.615	.125	1.57	7.72
141	5770.7	1.733	.845	.596	.121	1.42	6.97	201	5886.4	1.699	.957	.611	.124	1.57	7.71
142	5772.6	1.732	.852	.592	.124	1.4[illegible]	6.98	202	5888.3	1.698	.954	.609	.124	1.57	7.69
143	5774.5	1.732	.878	.607	.125	1.45	7.01	203	5890.2	1.698	.957	.611	.125	1.57	7.68
144	5776.5	1.731	.881	.606	.125	1.45	7.01	204	5892.2	1.697	.962	.613	.125	1.57	7.66
145	5778.4	1.731	.876	.603	.125	1.45	7.00	205	5894.1	1.697	.969	.614	.126	1.58	7.70
146	5780.3	1.730	.873	.601	.125	1.45	6.99	206	5896.0	1.696	.970	.614	.125	1.58	7.71
147	5782.2	1.729	.874	.602	.125	1.45	6.97	207	5898.0	1.696	.970	.612	.126	1.58	7.71
148	5784.2	1.729	.882	.605	.127	1.46	6.96	208	5899.9	1.695	.969	.611	.126	1.59	7.69
149	5786.1	1.728	.897	.610	.129	1.47	6.97	209	5901.8	1.694	.969	.611	.126	1.59	7.69
150	5788.0	1.728	.913	.614	.13[illegible]	1.49	7.00	210	5903.8	1.694	.971	.613	.126	1.59	7.7[illegible]
151	5790.[illegible]	1.727	.916	.615	.130	1.49	7.03	211	5905.7	1.693	.976	.616	.126	1.59	7.72
152	5791.9	1.727	.908	.614	.129	1.48	7.03	212	5907.6	1.693	.982	.619	.127	1.59	7.76
153	5793.8	1.726	.896	.610	.128	1.47	7.03	213	5909.5	1.692	.983	.619	.126	1.59	7.79
154	5795.7	1.725	.889	.608	.127	1.46	7.03	214	5911.5	1.692	.976	.615	.125	1.59	7.8[illegible]
155	5797.7	1.725	.891	.609	.127	1.46	7.03	215	5913.4	1.691	.970	.610	.124	1.59	7.80
156	5799.6	1.724	.898	.611	.127	1.47	7.07	216	5915.3	1.691	.970	.609	.124	1.59	7.8[illegible]
157	5801.5	1.724	.892	.610	.126	1.46	7.08	217	5917.3	1.690	.973	.610	.124	1.59	7.85
158	5803.5	1.723	.881	.606	.125	1.45	7.06	218	5919.2	1.689	.974	.611	.123	1.59	7.91
159	5805.4	1.723	.879	.605	.124	1.45	7.07	219	5921.1	1.689	.974	.611	.122	1.60	7.97
160	5807.3	1.722	.883	.607	.125	1.45	7.07	220	5923.0	1.688	.974	.610	.122	1.60	8.01
161	5809.2	1.721	.886	.608	.125	1.46	7.06	221	5925.0	1.688	.974	.608	.121	1.60	8.04
162	5811.2	1.721	.896	.611	.127	1.47	7.06	222	5926.9	1.687	.975	.607	.121	1.61	8.06
163	5813.1	1.720	.911	.616	.129	1.48	7.11	223	5928.8	1.687	.975	.604	.121	1.61	8.07
164	5815.0	1.720	.926	.620	.130	1.49	7.14	224	5930.8	1.686	.972	.600	.121	1.62	8.05
165	5817.[illegible]	1.719	.937	.624	.131	1.50	7.16	225	5932.7	1.686	.967	.597	.121	1.62	8.01
166	5818.9	1.719	.945	.626	.131	1.50	7.17	226	5934.6	1.685	.964	.595	.121	1.62	8.0[illegible]
167	5820.8	1.718	.939	.625	.131	1.51	7.17	227	5936.5	1.684	.961	.592	.12[illegible]	1.62	8.02
168	5822.7	1.717	.947	.627	.132	1.51	7.18	228	5938.5	1.684	.956	.589	.119	1.62	8.0[illegible]
169	5824.7	1.717	.955	.630	.132	1.52	7.23	229	5940.4	1.683	.953	.587	.119	1.62	7.96
170	5826.6	1.716	.953	.630	.132	1.51	7.23	230	5942.3	1.683	.952	.586	.119	1.63	8.01
171	5828.5	1.716	.947	.629	.131	1.51	7.22	231	5944.3	1.682	.951	.584	.118	1.63	8.03
172	5830.5	1.715	.945	.627	.131	1.51	7.24	232	5946.2	1.682	.950	.583	.118	1.63	8.04
173	5832.4	1.715	.943	.625	.130	1.51	7.25	233	5948.1	1.681	.952	.583	.118	1.63	8.07
174	5834.3	1.714	.937	.620	.129	1.51	7.25	234	5950.0	1.681	.954	.584	.118	1.63	8.09
175	5836.2	1.713	.928	.614	.128	1.51	7.26	235	5952.0	1.680	.958	.585	.118	1.64	8.11
176	5838.2	1.713	.921	.609	.127	1.51	7.25	236	5953.9	1.680	.960	.588	.118	1.64	8.16
177	5840.1	1.712	.922	.608	.127	1.52	7.25	237	5955.8	1.679	.959	.592	.118	1.64	8.21
178	5842.0	1.712	.927	.609	.127	1.52	7.28	238	5957.8	1.678	.971	.593	.118	1.64	8.22
179	5844.0	1.711	.92[illegible]	.608	.127	1.52	7.30	239	5959.7	1.678	.972	.593	.118	1.64	8.24
180	5845.9	1.711	.923	.607	.126	1.52	7.31	240	5961.6	1.677	.972	.591	.118	1.64	8.24

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INFRARED DATA 2075 WORDS, AVERAGE EVERY ELEVEN

	WAVE NUMBER	WAVE LENGTH	CU	CI	SN	CU/CI	CU/SN		WAVE NUMBER	WAVE LENGTH	CU	CI	SN	CU/CI	CU/SN
241	5963.5	1.677	.973	.591	.118	1.65	8.24	301	6079.3	1.645	.953	.555	.109	1.72	8.77
242	5965.5	1.676	.975	.592	.118	1.65	8.25	302	6081.2	1.644	.955	.555	.109	1.72	8.79
243	5967.4	1.676	.976	.593	.119	1.65	8.26	303	6083.1	1.644	.956	.555	.106	1.72	8.84
244	5969.3	1.675	.977	.593	.118	1.65	8.28	304	6085.0	1.643	.952	.552	.105	1.73	8.85
245	5971.3	1.675	.978	.593	.113	1.65	8.32	305	6087.0	1.643	.946	.548	.107	1.73	8.86
246	5973.2	1.674	.979	.593	.117	1.65	8.37	306	6088.9	1.642	.939	.544	.106	1.73	8.86
247	5975.1	1.674	.983	.594	.117	1.65	8.41	307	6090.8	1.642	.934	.540	.106	1.73	8.83
248	5977.0	1.673	.987	.596	.117	1.66	8.44	308	6092.8	1.641	.934	.539	.106	1.73	8.84
249	5979.0	1.673	.990	.598	.117	1.66	8.45	309	6094.7	1.641	.933	.538	.105	1.73	8.87
250	5980.9	1.672	.994	.600	.118	1.66	8.45	310	6096.6	1.640	.929	.535	.104	1.73	8.89
251	5982.8	1.671	1.000	.603	.118	1.66	8.47	311	6098.5	1.640	.928	.535	.104	1.73	8.91
252	5984.8	1.671	1.000	.603	.118	1.66	8.49	312	6100.5	1.639	.929	.537	.104	1.73	8.95
253	5986.7	1.670	.998	.600	.117	1.66	8.48	313	6102.4	1.639	.931	.538	.104	1.73	8.98
254	5988.6	1.670	.995	.599	.117	1.66	8.50	314	6104.3	1.638	.933	.539	.104	1.73	9.00
255	5990.5	1.669	.992	.597	.117	1.66	8.51	315	6106.3	1.638	.937	.541	.104	1.73	9.03
256	5992.5	1.669	.985	.593	.116	1.66	8.50	316	6108.2	1.637	.944	.545	.104	1.73	[illegible]
257	5994.4	1.668	.973	.588	.115	1.66	8.50	317	6110.1	1.637	.952	.549	.105	1.73	9.06
258	5996.3	1.668	.958	.581	.113	1.65	8.49	318	6112.1	1.636	.960	.553	.105	1.74	9.11
259	5998.3	1.667	.947	.576	.112	1.65	8.47	319	6114.0	1.635	.965	.555	.106	1.74	9.13
260	6000.2	1.667	.945	.574	.111	1.64	8.48	320	6115.9	1.635	.966	.557	.106	1.74	9.11
261	6002.1	1.666	.946	.575	.111	1.65	8.52	321	6117.8	1.635	.972	.560	.107	1.74	9.11
262	6004.0	1.666	.945	.577	.111	1.65	8.54	322	6119.8	1.634	.972	.560	.107	1.74	9.11
263	6006.0	1.665	.945	.573	.111	1.65	8.52	323	6121.7	1.634	.971	.558	.107	1.74	[illegible]
264	6007.9	1.664	.947	.574	.111	1.65	8.52	324	6123.6	1.633	.972	.556	.107	1.74	9.09
265	6009.8	1.664	.946	.573	.111	1.65	8.51	325	6125.6	1.633	.974	.559	.107	1.74	9.06
266	6011.8	1.663	.945	.572	.111	1.65	8.48	326	6127.5	1.632	.979	.562	.107	1.74	9.11
267	6013.7	1.663	.952	.575	.112	1.66	8.47	327	6129.4	1.631	.981	.563	.107	1.74	9.13
268	6015.6	1.662	.967	.582	.114	1.66	8.48	328	6131.3	1.631	.978	.561	.107	1.74	9.11
269	6017.5	1.662	.983	.589	.115	1.67	8.49	329	6133.3	1.630	.974	.558	.108	1.75	9.05
270	6019.5	1.661	.993	.592	.116	1.68	8.53	330	6135.2	1.630	.971	.556	.107	1.75	9.04
271	6021.4	1.661	.994	.592	.116	1.68	8.57	331	6137.1	1.629	.974	.557	.107	1.75	9.07
272	6023.3	1.660	.994	.591	.116	1.68	8.58	332	6139.1	1.629	.980	.560	.108	1.75	[illegible]
273	6025.3	1.660	.995	.591	.116	1.68	8.58	333	6141.0	1.628	.987	.564	.108	1.75	[illegible]
274	6027.2	1.659	.997	.592	.116	1.68	8.61	334	6142.9	1.628	.991	.566	.109	1.75	[illegible]
275	6029.1	1.659	.996	.591	.115	1.69	8.63	335	6144.8	1.627	.992	.567	.109	1.75	9.13
276	6031.0	1.658	.993	.588	.115	1.69	8.64	336	6146.8	1.627	.992	.567	.108	1.75	9.15
277	6033.0	1.658	.992	.586	.114	1.69	8.66	337	6148.7	1.626	.988	.565	.108	1.75	9.14
278	6034.9	1.657	.990	.585	.114	1.69	8.69	338	6150.6	1.626	.986	.564	.108	1.75	9.13
279	6036.8	1.656	.984	.582	.113	1.69	8.71	339	6152.6	1.625	.988	.566	.108	1.75	9.18
280	6038.8	1.656	.977	.577	.112	1.69	8.71	340	6154.5	1.625	.992	.569	.107	1.74	9.25
281	6040.7	1.655	.971	.573	.112	1.70	8.69	341	6156.4	1.624	.994	.570	.107	1.74	9.28
282	6042.6	1.655	.967	.571	.111	1.69	8.68	342	6158.3	1.624	.992	.569	.107	1.74	9.28
283	6044.5	1.654	.962	.567	.111	1.69	8.68	343	6160.3	1.623	.986	.565	.106	1.74	9.29
284	6046.5	1.654	.958	.565	.110	1.70	8.71	344	6162.2	1.623	.980	.562	.105	1.74	9.32
285	6048.4	1.653	.956	.563	.109	1.70	8.74	345	6164.1	1.622	.975	.559	.104	1.74	9.36
286	6050.3	1.653	.955	.563	.109	1.70	8.77	346	6166.1	1.622	.970	.557	.104	1.74	9.36
287	6052.3	1.652	.959	.565	.109	1.70	8.79	347	6168.0	1.621	.967	.554	.104	1.74	9.33
288	6054.2	1.652	.963	.565	.109	1.70	8.80	348	6169.9	1.621	.965	.553	.103	1.75	9.35
289	6056.1	1.651	.957	.562	.109	1.70	8.79	349	6171.8	1.620	.960	.550	.103	1.75	9.33
290	6058.0	1.651	.953	.560	.109	1.70	8.77	350	6173.8	1.620	.954	.546	.103	1.75	9.28
291	6060.0	1.650	.951	.559	.109	1.70	8.76	351	6175.7	1.619	.950	.543	.103	1.75	9.24
292	6061.9	1.650	.951	.559	.109	1.70	8.76	352	6177.6	1.619	.944	.541	.103	1.75	9.19
293	6063.8	1.649	.953	.560	.109	1.70	8.75	353	6179.6	1.618	.940	.538	.103	1.75	9.14
294	6065.8	1.649	.957	.561	.109	1.71	8.75	354	6181.5	1.618	.939	.538	.103	1.75	9.12
295	6067.7	1.648	.958	.561	.109	1.71	8.76	355	6183.4	1.617	.940	.538	.103	1.75	9.12
296	6069.6	1.648	.957	.560	.109	1.71	8.77	356	6185.3	1.617	.943	.540	.103	1.74	9.14
297	6071.5	1.647	.955	.559	.109	1.71	8.76	357	6187.3	1.616	.946	.543	.103	1.74	9.18
298	6073.5	1.647	.952	.557	.109	1.71	8.76	358	6189.2	1.616	.945	.543	.103	1.74	9.21
299	6075.4	1.646	.951	.556	.108	1.71	8.77	359	6191.1	1.615	.941	.541	.102	1.74	9.20
300	6077.3	1.645	.952	.556	.108	1.71	8.78	360	6193.1	1.615	.940	.541	.102	1.74	9.24

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INFRARED DATA 2075 WORDS, AVERAGE EVERY ELEVEN

	WAVE NUMBER	WAVE LENGTH	CU	CI	SN	CU/CI	CU/SN		WAVE NUMBER	WAVE LENGTH	CU	CI	SN	CU/CI	CU/SN
361	6195.0	1.614	.939	.541	.131	1.74	9.31	421	6310.7	1.585	.923	.511	.091	1.81	10.12
362	6196.9	1.614	.935	.539	.130	1.74	9.36	422	6312.6	1.584	.923	.510	.090	1.81	10.22
363	6198.8	1.613	.932	.537	.099	1.73	9.42	423	6314.6	1.584	.921	.510	.089	1.81	10.31
364	6200.8	1.613	.927	.535	.098	1.73	9.51	424	6316.5	1.583	.916	.508	.089	1.80	10.34
365	6202.7	1.612	.918	.531	.096	1.73	9.54	425	6318.4	1.583	.907	.503	.088	1.80	10.27
366	6204.6	1.612	.906	.525	.095	1.72	9.54	426	6320.3	1.582	.899	.499	.088	1.80	10.22
367	6206.6	1.611	.892	.518	.094	1.72	9.52	427	6322.3	1.582	.892	.495	.088	1.80	10.19
368	6208.5	1.611	.882	.513	.093	1.72	9.48	428	6324.2	1.581	.882	.490	.087	1.80	10.15
369	6210.4	1.610	.874	.510	.092	1.71	9.46	429	6326.1	1.581	.874	.486	.086	1.80	10.12
370	6212.3	1.610	.869	.508	.092	1.71	9.49	430	6328.1	1.580	.871	.485	.086	1.80	10.13
371	6214.3	1.609	.868	.507	.091	1.71	9.52	431	6330.0	1.580	.864	.481	.085	1.80	10.12
372	6216.2	1.609	.865	.507	.091	1.70	9.54	432	6331.9	1.579	.853	.474	.084	1.80	10.10
373	6218.1	1.608	.866	.508	.091	1.70	9.55	433	6333.9	1.579	.841	.468	.084	1.80	10.07
374	6220.1	1.608	.870	.510	.091	1.70	9.51	434	6335.8	1.578	.834	.463	.083	1.80	10.05
375	6222.0	1.607	.877	.513	.092	1.71	9.52	435	6337.7	1.578	.833	.461	.082	1.81	10.11
376	6223.9	1.607	.883	.516	.092	1.71	9.58	436	6339.6	1.577	.834	.461	.081	1.81	10.24
377	6225.8	1.606	.885	.517	.092	1.71	9.60	437	6341.6	1.577	.832	.459	.080	1.81	10.36
378	6227.8	1.606	.885	.517	.092	1.71	9.58	438	6343.5	1.576	.829	.456	.079	1.82	10.45
379	6229.7	1.605	.886	.517	.092	1.71	9.61	439	6345.4	1.576	.824	.452	.078	1.82	10.50
380	6231.6	1.605	.885	.517	.092	1.71	9.65	440	6347.4	1.575	.821	.449	.078	1.83	10.56
381	6233.6	1.604	.887	.518	.091	1.71	9.67	441	6349.3	1.575	.819	.448	.077	1.83	10.64
382	6235.5	1.604	.883	.517	.091	1.70	9.67	442	6351.2	1.575	.819	.447	.076	1.83	10.72
383	6237.4	1.603	.874	.514	.090	1.70	9.67	443	6353.1	1.574	.824	.450	.077	1.83	10.76
384	6239.3	1.603	.866	.511	.090	1.70	9.66	444	6355.1	1.574	.833	.455	.077	1.83	10.8
385	6241.3	1.602	.860	.509	.089	1.69	9.67	445	6357.0	1.573	.837	.458	.077	1.83	10.82
386	6243.2	1.602	.857	.508	.089	1.69	9.66	446	6358.9	1.573	.836	.457	.078	1.83	10.77
387	6245.1	1.601	.859	.509	.089	1.69	9.67	447	6360.9	1.572	.833	.455	.078	1.83	10.66
388	6247.1	1.601	.866	.512	.090	1.69	9.64	448	6362.8	1.572	.830	.453	.078	1.83	10.6
389	6249.0	1.600	.873	.516	.091	1.69	9.67	449	6364.7	1.571	.828	.452	.079	1.83	10.50
390	6250.9	1.600	.879	.517	.091	1.70	9.67	450	6366.6	1.571	.830	.452	.080	1.83	10.43
391	6252.8	1.599	.887	.519	.092	1.71	9.66	451	6368.6	1.570	.832	.453	.08	1.84	10.4
392	6254.8	1.599	.895	.521	.093	1.72	9.66	452	6370.5	1.57	.837	.454	.081	1.84	10.37
393	6256.7	1.598	.897	.520	.093	1.73	9.62	453	6372.4	1.569	.846	.456	.082	1.85	10.34
394	6258.6	1.598	.900	.519	.094	1.73	9.58	454	6374.4	1.569	.854	.458	.083	1.86	10.34
395	6260.6	1.597	.907	.520	.095	1.75	9.58	455	6376.3	1.568	.859	.459	.083	1.87	10.32
396	6252.5	1.597	.914	.521	.095	1.75	9.61	456	6378.2	1.568	.867	.460	.084	1.88	10.32
397	6264.4	1.596	.914	.519	.095	1.76	9.62	457	6380.1	1.567	.875	.463	.084	1.89	10.37
398	6266.3	1.596	.916	.518	.095	1.77	9.59	458	6382.1	1.567	.884	.465	.085	1.9	10.4
399	6268.3	1.595	.920	.519	.096	1.77	9.59	459	6384.0	1.566	.894	.468	.086	1.91	10.40
400	6270.2	1.595	.925	.521	.095	1.77	9.61	460	6385.9	1.566	.903	.472	.086	1.92	10.46
401	6272.1	1.594	.927	.522	.096	1.77	9.63	461	6387.9	1.565	.908	.473	.086	1.92	10.53
402	6274.1	1.594	.926	.522	.096	1.77	9.62	462	6389.8	1.565	.909	.472	.086	1.93	10.57
403	6276.0	1.593	.924	.520	.096	1.78	9.59	463	6391.7	1.565	.908	.471	.086	1.93	10.62
404	6277.9	1.593	.925	.519	.096	1.78	9.65	464	6393.6	1.564	.906	.469	.085	1.93	10.67
405	6279.8	1.592	.926	.519	.096	1.78	9.65	465	6395.6	1.564	.904	.468	.084	1.93	10.7
406	6281.8	1.592	.922	.517	.095	1.78	9.71	466	6397.5	1.563	.906	.468	.084	1.94	10.74
407	6283.7	1.591	.913	.511	.094	1.79	9.75	467	6399.4	1.563	.907	.467	.084	1.94	10.76
408	6285.6	1.591	.902	.505	.093	1.79	9.74	468	6401.4	1.562	.903	.465	.084	[illegible]	.74
409	6287.6	1.590	.893	.500	.092	1.79	9.73	469	6403.3	1.562	.900	.463	.084	.95	10.77
410	6289.5	1.590	.886	.495	.091	1.79	9.71	470	6405.2	1.561	.898	.461	.083	1.95	10.81
411	6291.4	1.589	.878	.490	.091	1.79	9.68	471	6407.1	1.561	.895	.458	.083	1.95	10.77
412	6293.3	1.589	.873	.486	.090	1.80	9.66	472	6409.1	1.560	.893	.456	.083	1.96	10.71
413	6295.3	1.588	.872	.484	.090	1.80	9.70	473	6411.0	1.560	.895	.456	.084	1.96	10.68
414	6297.2	1.588	.875	.485	.090	1.80	9.76	474	6412.9	1.559	.899	.458	.084	1.96	10.68
415	6299.1	1.588	.880	.488	.090	1.80	9.81	475	6414.9	1.559	.902	.459	.085	1.97	10.66
416	6301.1	1.587	.887	.491	.090	1.80	9.84	476	6416.8	1.558	.901	.457	.085	1.97	10.65
417	6303.0	1.587	.897	.497	.091	1.81	9.90	477	6418.7	1.558	.895	.452	.084	1.98	10.62
418	6304.9	1.586	.909	.503	.092	1.81	9.93	478	6420.6	1.557	.888	.448	.083	1.98	10.65
419	6306.8	1.586	.917	.507	.092	1.81	9.95	479	6422.6	1.557	.886	.446	.083	1.99	10.71
420	6308.8	1.585	.922	.509	.092	1.81	10.01	480	6424.5	1.557	.886	.445	.082	1.99	10.79

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INFRARED DATA 2075 WORDS, AVERAGE EVERY ELEVEN

	WAVE NUMBER	WAVE LENGTH	CU	CI	SN	CU/CI	CU/SN		WAVE NUMBER	WAVE LENGTH	CU	CI	SN	CU/CI	CU/SN
481	6426.4	1.556	.887	.446	.081	1.99	10.90	541	6542.2	1.529	.803	.398	.071	2.02	11.35
482	6428.4	1.556	.887	.446	.081	1.99	11.01	542	6544.1	1.528	.801	.398	.071	2.01	11.33
483	6430.3	1.555	.889	.448	.080	1.99	11.09	543	6546.0	1.528	.796	.395	.071	2.02	11.16
484	6432.2	1.555	.892	.448	.080	1.99	11.18	544	6547.9	1.527	.788	.391	.072	2.02	11.0[illegible]
485	6434.1	1.554	.889	.445	.079	2.00	11.21	545	6549.9	1.527	.783	.388	.071	2.02	10.96
486	6436.1	1.554	.884	.442	.079	2.00	11.14	546	6551.8	1.526	.782	.388	.071	2.01	11.04
487	6438.0	1.553	.882	.442	.080	2.00	11.05	547	6553.7	1.526	.784	.390	.070	2.01	11.16
488	6439.9	1.553	.881	.441	.080	2.00	10.98	548	6555.7	1.525	.788	.392	.070	2.01	11.29
489	6441.9	1.552	.880	.440	.081	2.00	10.91	549	6557.6	1.525	.788	.392	.069	2.01	11.39
490	6443.8	1.552	.879	.440	.081	2.00	10.86	550	6559.5	1.525	.785	.391	.069	2.01	11.38
491	6445.7	1.551	.879	.439	.081	2.00	10.82	551	6561.4	1.524	.782	.390	.069	2.01	11.31
492	6447.6	1.551	.880	.439	.082	2.00	10.77	552	6563.4	1.524	.778	.387	.069	2.01	11.21
493	6449.6	1.550	.881	.438	.082	2.01	10.77	553	6565.3	1.523	.775	.385	.070	2.01	11.13
494	6451.5	1.550	.876	.435	.081	2.01	10.76	554	6567.2	1.523	.777	.385	.069	2.01	11.18
495	6453.4	1.550	.868	.431	.081	2.01	10.70	555	6569.2	1.522	.780	.387	.069	2.02	11.30
496	6455.4	1.549	.864	.429	.081	2.02	10.66	556	6571.1	1.522	.783	.389	.069	2.01	11.34
497	6457.3	1.549	.867	.430	.081	2.02	10.74	557	6573.0	1.521	.781	.389	.070	2.01	11.24
498	6459.2	1.548	.868	.430	.080	2.02	10.85	558	6574.9	1.521	.772	.385	.070	2.00	11.09
499	6461.1	1.548	.871	.432	.079	2.02	10.99	559	6576.9	1.520	.760	.382	.070	1.99	10.94
500	6463.1	1.547	.879	.436	.079	2.02	11.11	560	6578.8	1.520	.758	.382	.069	1.98	10.93
501	6465.0	1.547	.884	.438	.079	2.02	11.20	561	6580.7	1.520	.760	.384	.069	1.98	11.07
502	6466.9	1.546	.884	.438	.079	2.02	11.26	562	6582.7	1.519	.757	.384	.068	1.97	11.15
503	6468.9	1.546	[illegible]	.435	.078	2.02	11.23	563	6584.[illegible]	1.519	.752	.384	.067	1.96	11.22
504	6470.8	1.545	.875	.433	.078	2.02	11.17	564	6586.5	1.518	.748	.383	.066	1.95	11.33
505	6472.7	1.545	.876	.432	.078	2.02	11.18	565	6588.4	1.518	.742	.382	.065	1.94	11.37
506	6474.6	1.544	.878	.434	.078	2.02	11.26	566	6590.4	1.517	.737	.380	.066	1.94	11.2[illegible]
507	6476.6	1.544	.880	.435	.078	2.02	11.33	567	6592.3	1.517	.733	.377	.066	1.94	11.03
508	6478.5	1.544	.878	.434	.078	2.02	11.33	568	6594.2	1.516	.731	.376	.066	1.95	10.99
509	6480.4	1.543	.878	.435	.077	2.02	11.34	569	6596.2	1.516	.730	.375	.066	1.95	11.05
510	6482.4	1.543	.879	.435	.077	2.02	11.37	570	6598.1	1.516	.729	.375	.065	1.94	11.13
511	6484.3	1.542	.875	.433	.077	2.02	11.34	571	6600.0	1.515	.722	.373	.065	1.93	11.12
512	6486.2	1.542	.868	.430	.077	2.02	11.33	572	6601.9	1.515	.714	.371	.065	1.92	10.99
513	6488.1	1.541	.863	.427	.076	2.02	11.32	573	6603.9	1.514	.710	.371	.066	1.92	10.83
514	6490.1	1.541	.861	.426	.076	2.02	11.33	574	6605.8	1.514	.711	.371	.067	1.92	10.68
515	6492.0	1.540	.860	.426	.076	2.02	11.31	575	6607.7	1.513	.714	.372	.067	1.92	10.59
516	6493.9	1.540	.856	.424	.076	2.02	11.24	576	6609.7	1.513	.714	.371	.067	1.92	10.58
517	6495.9	1.539	.854	.423	.076	2.02	11.19	577	6611.6	1.512	.713	.372	.067	1.92	10.66
518	6497.8	1.539	.851	.422	.076	2.02	11.17	578	6613.5	1.512	.710	.372	.066	1.91	10.73
519	6499.7	1.538	.849	.421	.076	2.02	11.14	579	6615.4	1.512	.705	.370	.066	1.91	10.65
520	6501.6	1.538	.848	.419	.076	2.03	11.12	580	6617.4	1.511	.698	.366	.067	1.91	10.43
521	6503.6	1.538	.845	.416	.076	2.03	11.09	581	6619.3	1.511	.690	.361	.067	1.91	10.28
522	6505.5	1.537	.842	.414	.076	2.03	11.03	582	6621.2	1.510	.677	.358	.066	1.89	10.23
523	6507.4	1.537	.838	.413	.077	2.03	10.93	583	6623.2	1.510	.666	.356	.066	1.87	10.16
524	6509.4	1.536	.834	.410	.077	2.03	10.82	584	6625.1	1.509	.663	.355	.066	1.87	10.12
525	6511.3	1.536	.832	.409	.077	2.03	10.82	585	6627.0	1.509	.661	.353	.065	1.87	10.15
526	6513.2	1.535	.833	.409	.075	2.03	10.93	586	6628.9	1.509	.657	.352	.065	1.87	10.18
527	6515.1	1.535	.833	.409	.076	2.04	11.01	587	6630.9	1.508	.656	.351	.064	1.87	10.21
528	6517.1	1.534	.837	.408	.076	2.04	10.99	588	6632.8	1.508	.654	.348	.064	1.88	10.20
529	6519.0	1.534	.833	.406	.076	2.05	10.97	589	6634.7	1.507	.651	.347	.063	1.88	10.26
530	652[illegible].9	1.5[illegible]4	[illegible]	.4[illegible]5	.076	2.[illegible]5	1[illegible].97	590	6636.7	1.507	.646	.346	.062	1.87	10.42
531	6522.9	1.5[illegible]	.824	.403	.075	2.[illegible]5	10.99	591	6638.6	1.506	.635	.344	.060	1.85	10.65
532	6524.8	1.533	.821	.403	.074	2.04	11.05	592	6640.5	1.506	.622	.341	.058	1.82	10.77
533	6526.7	1.532	.822	.404	.074	2.03	11.18	593	6642.4	1.505	.614	.338	.057	1.82	10.75
534	6528.6	1.532	.824	.405	.073	2.03	11.31	594	6644.4	1.505	.606	.335	.056	1.81	10.78
535	6530.6	1.531	.823	.406	.072	2.03	11.41	595	6646.3	1.505	.592	.331	.054	1.79	10.88
536	6532.5	1.531	.822	.405	.072	2.03	11.44	596	6648.2	1.504	.586	.327	.053	1.77	10.86
537	6534.4	1.530	.819	.404	.072	2.03	11.36	597	6650.2	1.504	.574	.326	.053	1.76	10.81
538	6536.4	1.530	.815	.402	.072	2.03	11.26	598	6652.1	1.503	.565	.324	.053	1.75	10.71
539	6538.3	1.529	.810	.400	.072	2.03	11.23	599	6654.0	1.503	.561	.323	.053	1.74	10.61
540	6540.2	1.529	.806	.399	.071	2.02	11.28	600	6655.9	1.502	.562	.324	.053	1.73	10.54

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INFRARED DATA 2075 WORDS, AVERAGE EVERY ELEVEN

	WAVE NUMBER	WAVE LENGTH	CU	CI	SN	CU/CI	CU/SN		WAVE NUMBER	WAVE LENGTH	CU	CI	SN	CU/CI	CU/SN
601	6657.9	1.502	.568	.327	.054	1.74	10.48	661	6773.6	1.476	.332	.326	.036	1.02	9.30
602	6659.8	1.502	.583	.332	.056	1.76	10.48	662	6775.5	1.476	.350	.333	.036	1.05	9.65
603	6661.7	1.501	.600	.337	.057	1.78	10.50	663	6777.5	1.475	.35[illegible]	.336	.036	1.04	9.75
604	6663.7	1.501	.614	.341	.058	1.80	10.57	664	6779.4	1.475	.345	.338	.036	1.02	9.61
605	6665.6	1.500	.627	.344	.059	1.82	10.71	665	6781.3	1.475	.346	.341	.036	1.02	9.52
606	6667.5	1.500	.636	.348	.059	1.83	10.82	666	6783.2	1.474	.345	.341	.036	1.01	9.53
607	6669.4	1.499	.636	.349	.059	1.82	10.83	667	6785.2	1.474	.339	.341	.036	1.00	9.52
608	6671.4	1.499	.635	.350	.059	1.81	10.77	668	6787.1	1.473	.331	.339	.035	.98	9.50
609	6673.3	1.499	.633	.350	.059	1.81	10.81	669	6789.0	1.473	.323	.339	.034	.95	9.51
610	6675.2	1.498	.621	.346	.057	1.80	10.88	670	6791.0	1.473	.310	.337	.032	.92	9.64
611	6677.2	1.498	.602	.340	.056	1.77	10.84	671	6792.9	1.472	.283	.328	.029	.86	9.63
612	6679.1	1.497	.585	.335	.054	1.74	10.84	672	6794.8	1.472	.248	.317	.027	.78	9.36
613	6681.0	1.497	.569	.332	.053	1.71	10.83	673	6796.7	1.471	.220	.309	.024	.71	9.05
614	6682.9	1.496	.556	.329	.052	1.69	10.79	674	6798.7	1.471	.204	.305	.024	.67	8.63
615	6684.9	1.496	.549	.328	.051	1.67	10.72	675	6800.6	1.470	.204	.307	.024	.67	8.43
616	6686.8	1.495	.542	.326	.051	1.66	10.59	676	6802.5	1.470	.213	.311	.025	.68	8.51
617	6688.7	1.495	.543	.327	.051	1.66	10.58	677	6804.5	1.470	.221	.316	.026	.7[illegible]	8.62
618	6690.7	1.495	.544	.328	.051	1.66	10.72	678	6806.4	1.469	.228	.321	.026	.71	8.73
619	6692.6	1.494	.535	.327	.049	1.64	10.81	679	6808.3	1.469	.232	.325	.026	.71	8.82
620	6694.5	1.494	.524	.326	.049	1.61	10.76	680	6810.2	1.468	.231	.328	.026	.7[illegible]	8.76
621	6696.4	1.493	.518	.327	.049	1.58	10.67	681	6812.2	1.468	.232	.331	.027	.70	8.63
622	6698.4	1.493	.514	.328	.049	1.57	10.52	682	6814.1	1.468	.240	.336	.028	.71	8.56
623	6700.3	1.492	.516	.328	.050	1.57	10.29	683	6816.0	1.467	.245	.339	.029	.72	8.54
624	6702.2	1.492	.528	.331	.052	1.60	10.24	684	6818.0	1.467	.249	.341	.030	.73	8.41
625	6704.2	1.492	.539	.335	.052	1.61	10.37	685	6819.9	1.466	.262	.346	.032	.76	8.27
626	6706.1	1.491	.536	.336	.051	1.60	10.42	686	6821.8	1.466	.280	.355	.034	.79	8.31
627	6708.0	1.491	.528	.336	.051	1.57	10.31	687	6823.7	1.465	.290	.362	.035	.8[illegible]	8.36
628	6709.9	1.490	.515	.332	.051	1.55	10.16	688	6825.7	1.465	.290	.365	.035	.79	8.32
629	6711.9	1.490	.496	.324	.049	1.53	10.04	689	6827.6	1.465	.286	.366	.035	.78	8.2[illegible]
630	6713.8	1.489	.478	.316	.048	1.51	9.98	690	6829.5	1.464	.286	.368	.036	.73	7.96
631	6715.7	1.489	.462	.311	.046	1.48	9.99	691	6831.5	1.464	.300	.373	.039	.80	7.79
632	6717.7	1.489	.449	.310	.044	1.45	10.12	692	6833.4	1.463	.320	.382	.041	.84	7.88
633	6719.6	1.488	.435	.308	.042	1.41	10.25	693	6835.3	1.463	.331	.389	.041	.85	8.02
634	6721.5	1.488	.415	.306	.040	1.36	10.29	694	6837.2	1.463	.334	.394	.042	.85	8.01
635	6723.4	1.487	.391	.302	.039	1.29	10.11	695	6839.2	1.462	.335	.399	.042	.84	8.02
636	6725.4	1.487	.371	.298	.038	1.25	9.81	696	6841.1	1.462	.326	.400	.040	.82	8.09
637	6727.3	1.486	.361	.294	.037	1.23	9.76	697	6843.0	1.461	.309	.396	.039	.78	7.99
638	6729.2	1.486	.352	.292	.035	1.20	9.91	698	6845.0	1.461	.304	.398	.039	.76	7.77
639	6731.2	1.486	.344	.294	.035	1.17	9.89	699	6846.9	1.461	.317	.408	.041	.78	7.72
640	6733.1	1.485	.354	.302	.036	1.17	[illegible]	700	6848.8	1.460	.341	.422	.044	.81	7.81
641	6735.0	1.485	.373	.313	.037	1.19	10.03	701	6850.7	1.460	.362	.435	.045	.83	8.10
642	6736.9	1.484	.386	.318	.038	1.21	10.04	702	6852.7	1.459	.371	.445	.044	.83	8.42
643	6738.9	1.484	.393	.319	.039	1.23	10.09	703	6854.6	1.459	.372	.455	.044	.82	8.48
644	6740.8	1.484	.395	.319	.039	1.24	10.21	704	6856.5	1.458	.381	.467	.045	.82	8.44
645	6742.7	1.483	.394	.320	.039	1.23	10.21	705	6858.5	1.458	.396	.479	.047	.83	8.50
646	6744.7	1.483	.393	.321	.038	1.22	10.28	706	6860.4	1.458	.407	.490	.048	.83	8.55
647	6746.6	1.482	.387	.321	.037	1.21	10.46	707	6862.3	1.457	.414	.497	.048	.83	8.57
648	6748.5	1.482	.372	.319	.036	1.17	10.41	708	6864.2	1.457	.408	.498	.047	.82	8.65
649	6750.5	1.481	.361	.318	.036	1.13	10.17	709	6866.2	1.456	.393	.492	.046	.80	8.61
650	6752.4	1.481	.352	.317	.035	1.11	10.01	710	6868.1	1.456	.379	.468	.045	.78	8.44
651	6754.3	1.481	.338	.313	.035	1.08	9.79	711	6870.0	1.456	.374	.491	.045	.76	8.31
652	6756.2	1.480	.326	.309	.034	1.06	9.70	712	6872.0	1.455	.374	.495	.046	.76	8.21
653	6758.2	1.480	.314	.306	.032	1.03	9.69	713	6873.9	1.455	.371	.495	.046	.75	8.11
654	6760.1	1.479	.300	.305	.032	.99	9.44	714	6875.8	1.454	.362	.488	.045	.74	7.98
655	6762.0	1.479	.296	.306	.032	.97	9.24	715	6877.7	1.454	.346	.479	.044	.72	7.85
656	6764.0	1.478	.293	.305	.032	.96	9.27	716	6879.7	1.454	.329	.471	.042	.70	7.75
657	6765.9	1.478	.285	.304	.031	.94	9.13	717	6881.6	1.453	.316	.470	.041	.67	7.72
658	6767.8	1.478	.282	.305	.032	.93	8.93	718	6883.5	1.453	.307	.470	.039	.65	7.80
659	6769.7	1.477	.290	.309	.033	.94	8.86	719	6885.5	1.452	.298	.466	.038	.64	7.94
660	6771.7	1.477	.307	.316	.034	.97	8.97	720	6887.4	1.452	.286	.460	.035	.62	8.12

INFRARED DATA 2075 WORDS, AVERAGE EVERY ELEVEN

	WAVE NUMBER	WAVE LENGTH	CU	CI	SN	CU/CI	CU/SN
721	6889.3	1.452	.268	.451	.033	.59	8.20
722	6891.2	1.451	.250	.444	.031	.56	8.03
723	6893.2	1.451	.236	.440	.031	.54	7.70
724	6895.1	1.450	.228	.440	.031	.52	7.35
725	6897.0	1.450	.230	.447	.032	.52	7.19
726	6899.0	1.449	.243	.460	.034	.53	7.23
727	6900.9	1.449	.256	.471	.035	.54	7.29
728	6902.8	1.449	.257	.472	.036	.55	7.20
729	6904.7	1.448	.256	.472	.037	.54	6.92
730	6906.7	1.448	.265	.483	.039	.55	6.86
731	6908.6	1.447	.272	.491	.039	.55	6.96
732	6910.5	1.447	.269	.487	.038	.55	7.03
733	6912.5	1.447	.260	.479	.037	.54	7.06
734	6914.4	1.446	.249	.474	.036	.53	7.01
735	6916.3	1.446	.242	.476	.035	.51	6.95
736	6918.2	1.445	.237	.479	.035	.49	6.81
737	6920.2	1.445	.229	.476	.035	.48	6.64
738	6922.1	1.445	.218	.468	.033	.47	6.53
739	6924.0	1.444	.209	.461	.033	.45	6.41
740	6926.0	1.444	.206	.458	.032	.45	6.35
741	6927.9	1.443	.203	.458	.033	.44	6.22
742	6929.8	1.443	.203	.463	.034	.44	6.02
743	6931.7	1.443	.207	.473	.035	.44	5.87
744	6933.7	1.442	.212	.482	.036	.44	5.82
745	6935.6	1.442	.213	.481	.037	.44	5.77
746	6937.5	1.441	.210	.476	.036	.44	5.78
747	6939.5	1.441	.203	.468	.035	.43	5.86
748	6941.4	1.441	.192	.462	.034	.42	5.70
749	6943.3	1.440	.199	.465	.035	.41	5.44

	WAVE NUMBER	WAVE LENGTH	CU	CI	SN	CU/CI	CU/SN
750	6945.2	1.440	.196	.475	.036	.41	5.45
751	6947.2	1.439	.197	.478	.035	.41	5.59
752	6949.1	1.439	.187	.468	.034	.43	5.56
753	6951.0	1.439	.182	461	.033	.39	5.45
754	6953.0	1.438	.183	.464	.034	.40	5.43
755	6954.9	1.438	.183	.466	.034	.39	5.46
756	6956.8	1.437	.180	465	.033	.39	5.46
757	6958.7	1.437	.179	.466	.034	.38	5.20
758	6960.7	1.437	.183	.472	.036	.39	5.11
759	6962.6	1.436	.185	.478	.035	.39	5.23
760	6964.5	1.436	.177	.475	.033	.37	5.32
761	6966.5	1.435	.169	.469	.033	.36	5.18
762	6968.4	1.435	.172	.476	.035	.36	4.96
763	6970.3	1.435	.187	497	.037	.38	5.00
764	6972.3	1.434	.197	.511	.038	.38	5.16
765	6974.2	1.434	.192	.506	.037	.38	5.22
766	6976.1	1.433	.184	.493	.035	.37	5.22
767	6978.0	1.433	.176	.483	.033	.36	5.29
768	6980.0	1.433	.167	.472	.032	.35	5.23
769	6981.9	1.432	.165	.466	.034	.35	4.91
770	6983.8	1.432	.179	.475	.038	.38	4.75
771	6985.8	1.431	.195	.488	.041	.40	4.76
772	6987.7	1.431	.204	.497	.043	.41	4.76
773	6989.6	1.431	.208	511	.044	.41	4.77
774	6991.5	1.430	.203	.497	.043	.41	4.75
775	6993.5	1.430	.195	.490	.042	.40	4.66
776	6995.4	1.430	.194	.496	.042	.39	4.67
777	6997.3	1.429	.197	.510	.042	.39	4.67
778	6999.3	1.429	.204	.524	.044	.39	4.6.