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ATMOSPHERIC EMISSION AT HIGH LATITUDES

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ABSTRACT

A series of balloon flights was performed from Fairbanks, Alaska with instrumentation designed to measure the atmospheric emission in the 10μ to 12μ region and the 17μ to 28μ region. Preliminary results from use of these flights is presented and discussed.

ATMOSPHERIC EMISSION AT HIGH LATITUDES

During a series of balloon flights made from Fairbanks, Alaska, in September, 1969, rapid temporal variations of the atmospheric radiance in the 10μ to 12μ regions were observed. Variations of this sort have not been observed during the many balloon flights made with the same instrumentation from Holloman A.F.B., New Mexico. In view of this, it has been tentatively concluded that these emissions are associated with auroral activity. The mechanism for the excitation of such emissions is not immediately evident, especially in view of the fact that it appears that the emission occurs primarily at 12μ. The observed emissions were well above the natural background radiation at balloon float altitude (30 km), however, they were comparable with the background radiation at 13 km so that it does not appear possible to observe the emissions from the ground or aircraft except under conditions when the background radiation was very low (exceedingly cold temperatures, low humidity). Further investigations of the phenomena appears to be limited to the area of high altitude platforms. In view of this, a second series of flights was undertaken as part of the effort under this contract. The effects observed during the 1969 flight occurred in the morning well after sunrise. It was therefore not possible to correlate the observations with any visible auroral phenomena. Emphasis was placed during this series of flights on obtaining simultaneous data concerning the visible and infrared emissions. If such a correlation could be found, it would help a great deal in understanding the infrared emissions. In order to accomplish this, it was necessary to incorporate a number of photometer units into the balloon-borne instrumentation. A check out flight was flown from Holloman A.F.B., on June 29, and three flights were performed with the instrumentation in Alaska.

Instrumentation

For this study, the two cold optics infrared instruments were flown. The first of these instruments was a filter radiometer and the second was a grating spectrometer. The instruments have been described in detail in previous reports.[1] Additional instrumentation consisting of a 6 channel visible photometer system, two magnetometers to obtain gondola orientation information and two pulsed cameras were used for these flights. As on previous flights, data recording was accomplished by means of an on-board digital magnetic tape recording system with FM/FM telemetry used as back up.

The visible photometers were designed to have the same field of view as the infrared instruments and were positioned on the gondola so that they were optically aligned with the infrared instruments. These units employed photomultiplier tubes as detectors. Two different tubes were used in order to get good responses over the full wavelength range desired. An RCA 4ᶜ equipped with a bialkali photocathode No. 115 was used for the wavelength regions from 3200 to 6000Å and an RCA 8644 with an S-20 spectral response was used for the regions from 6000 to 7800Å. During the flights, the following filters were used in the photometers: 3914Å BW25Å, 4229Å BW10Å, 4280Å BW10Å, 5725Å BW50Å, 6300Å BW25Å and 7625Å BW30Å. The photometers were operated in the dc mode and were calibrated at the AFCRL Optical Physics Laboratory facility. This facility uses a high temperature blackbody source equipped with various apertures as the calibration source. The calibration was run over the range of radiance values to be expected from weak to strong auroral events.

All photometer components were chosen so as to minimize any variation in sensitivity with temperature. Since the filter band pass is temperature dependent, the unit was designed so that all filters were mounted on a common plate and the temperature of the plate was thermostatically controlled. As a result of these factors, the temperature of the total system did not vary significantly during the flights.

The magnetometers used during these flights are standard units manufactured by Schonsted Engineering Company. Two units are used with the sensors mounted at right angles. Used in this configuration, the gondola orientation with respect to the earths magnetic field can be uniquely determined. The accuracy of this system is degraded some at the high latitudes, however, the calibration indicated that it was close to 2° which was adequate for the experiment.

Data recording was accomplished by means of two on-board digital magnetic tape recording systems with an FM/FM telemetry system used as back up. The gondola system was constructed of brazed conduit. Primary power for all systems was supplied by means of a silver-zinc battery pack.

Flight Details

Since practically no data are currently available concerning auroral emissions at wavelengths beyond 5μ it was decided to perform balloon flights with the infrared instrumentation set up to obtain data at various wavelengths beyond 5μ. Since the range of wavelengths that could be covered on any flight was limited, provision was made to change the spectral region covered by the instruments between flights. The earlier emissions had been observed in the 10μ to 12μ regions so the initial flights were made with the instrumentation set to obtain data in this region. The third flight of the Alaskan series was set up to obtain data in the 16μ to 30μ region. Further flights had been planned, however, the weather conditions did not permit these flights to be performed.

The first flight of the series was launched at 0125 ADT September 12. The launch was accomplished without incident and the balloon ascended with an average ascent rate of 250 m/min reaching a float altitude of 29 km. The balloon remained at float altitude until 0643 ADT when the flight was terminated by radio command. The instrumentation impacted in the White Mountains and was recovered by helicopter.

The second flight was launched at 0058 ADT September 15 and ascended with an average ascent rate of 250 m/kin. When the balloon reached 29 km something happened which caused the parachute to open which activated a "burst" switch and cut the payload loose from the balloon terminating the flight. Subsequent analysis of the data transmitted from the package indicates that the balloon probably burst and the activation of the "burst" switch was proper. Thus data were obtained only through the ascent phase of this flight. Recovery of the payload was again accomplished by helicopter without incident. The impact occurred about 10 miles east of Fairbanks.

The infrared instruments were changed to cover the 16μ to 30μ region and the third flight was launched at 0250 ADT September 23. The balloon ascended with an average ascent rate of 250 m/min. When the balloon reached floating altitude (29 km) the burst switch activated again and the flight was terminated. The instrumentation impacted about 40 miles southeast of Fairbanks and was recovered by helicopter without incident. The failure of these balloons as the instrumentation went into float is unusual and no explanation has been found for the unexpected behavior.

Results

The instrumentation functioned properly and data were obtained on all three flights. The infrared instruments were calibrated before and after each flight. These calibrations agreed to within the experimental accuracy achieved in any individual calibration. The data were reduced using the calibration factors determined from the preflight calibrations.

It requires approximately 2 hours to check out all of the instrumentation, inflate and launch the balloon, and an additional hour to get to an altitude where the background radiance was expected to be low enough to observe any auroral fluctuations. Therefore a decision to launch the balloon had to be made well in advance of the time the observations were going to be made. Since the aurora varies rapidly with time, it is not possible to predict the amount of auroral activity which will be present at the time the observations will be made. There was considerable auroral activity at the time of launch on September 12. The activity decreased after the equipment was launched, however, there was significant auroral activity during the period when the observations were made. The auroral activity was high at the time of launch on the September 15 flight. The activity persisted in this case and there was significant activity during the time data were taken. On September 23, the activity decreased between the time the decision was made to fly and the launch was accomplished. The activity continued to decrease and at the time the high altitude data were obtained, the auroral activity was slight. The data obtained with the filter radiometer on all these flights has been reduced. Reduction of the data obtained with the spectrometer has not been completed.

The data obtained with the filter radiometer on September 12 are given in Figures 1 through 5. The filter transmission curves are given in Figure 6. The data have been closely examined for any fluctuations similar to those found during the 1969 flight and none have been found. The overall levels as observed during these flights are higher than were observed during the 1969 flights. The reason for this has not been determined.

References:

1. Murcray, D. G., "Optical Properties of the Atmosphere" Six Month Technical Report Contract F19628-68-C-0233 June 1970.

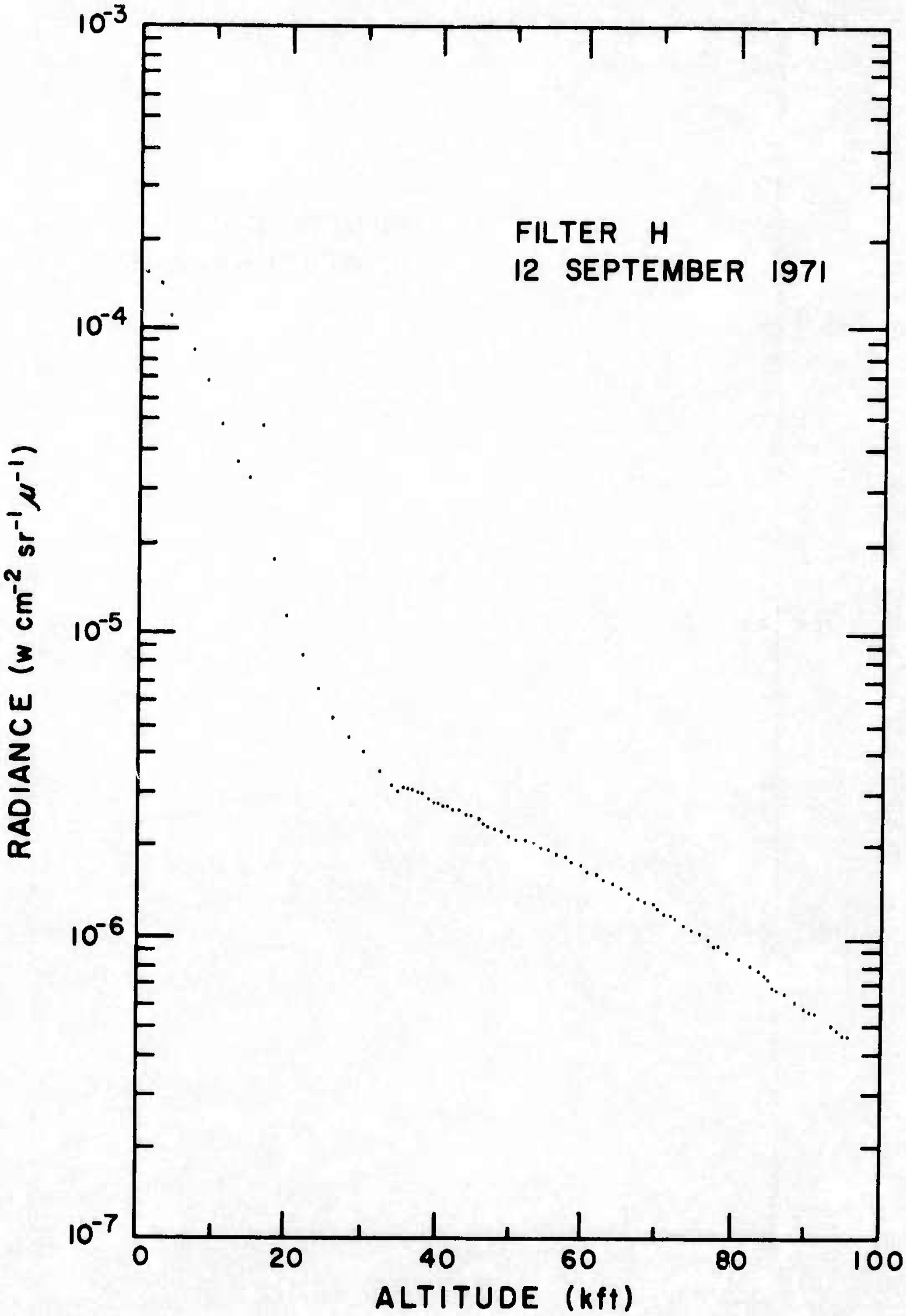

Figure 1. Radiance vs. Altitude for Filter H, 12 September 1971

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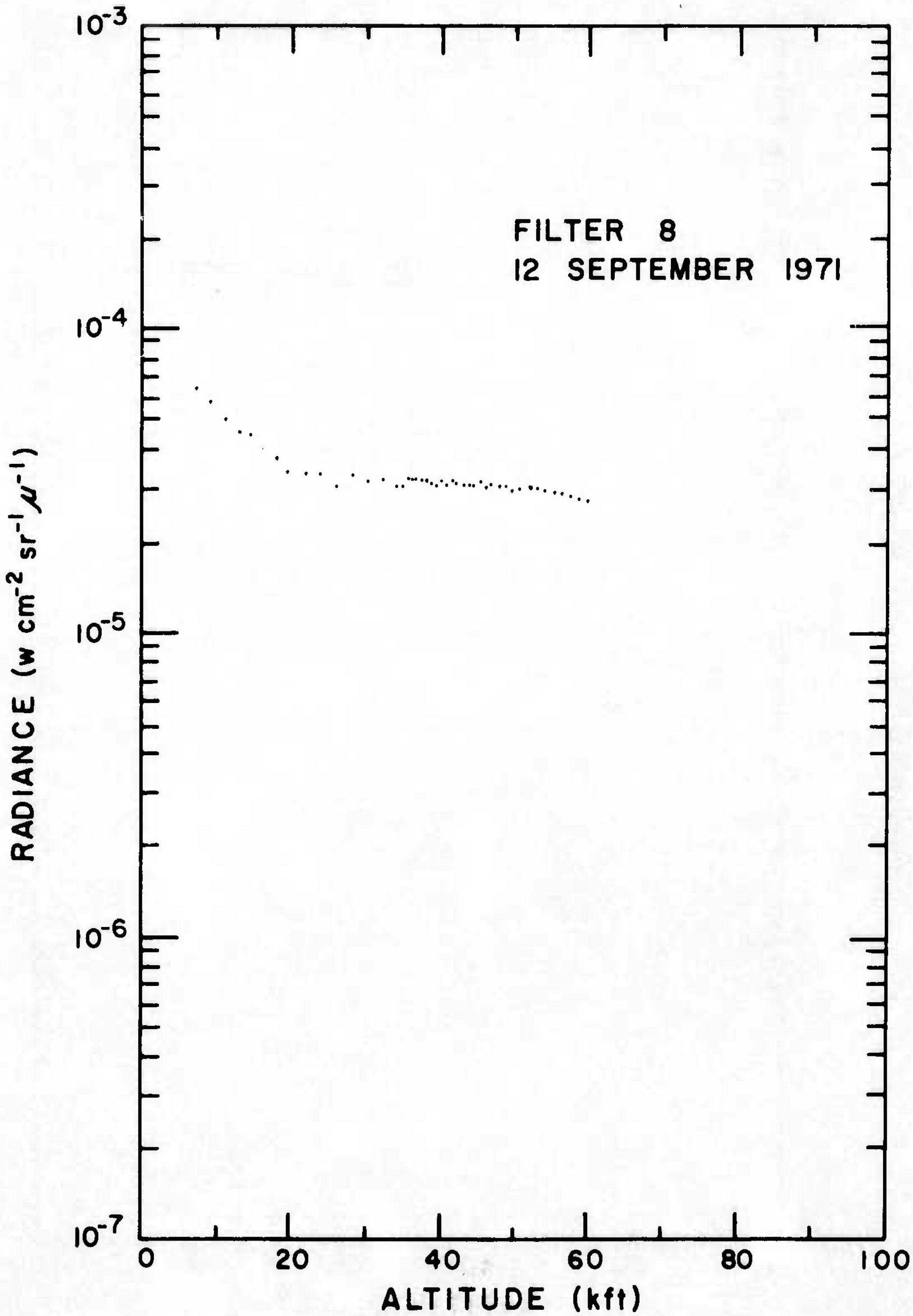

Figure 2. Radiance vs. Altitude for Filter 8, 12 September 1971

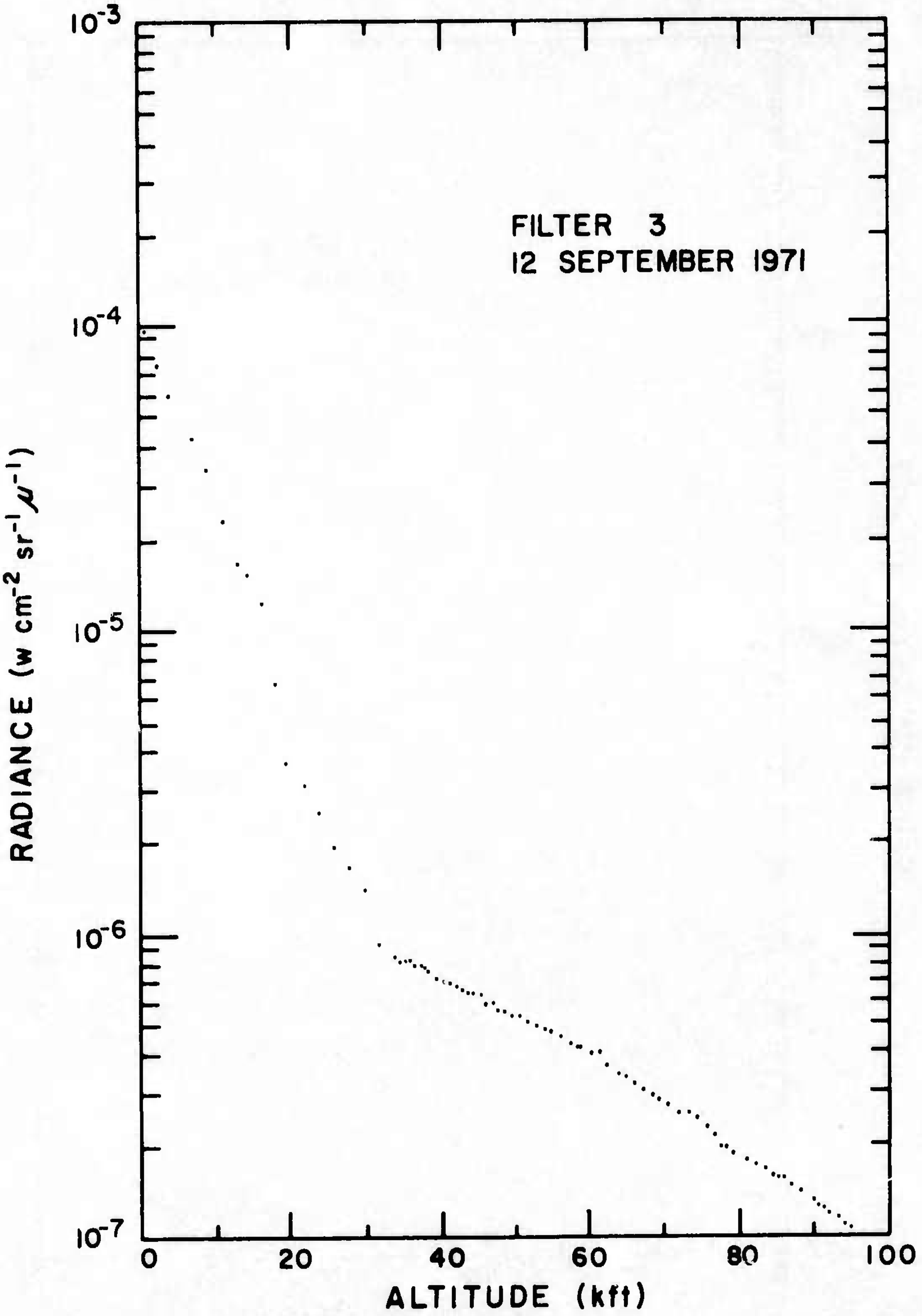

Figure 3. Radiance vs. Altitude for Filter 3, 12 September 1971

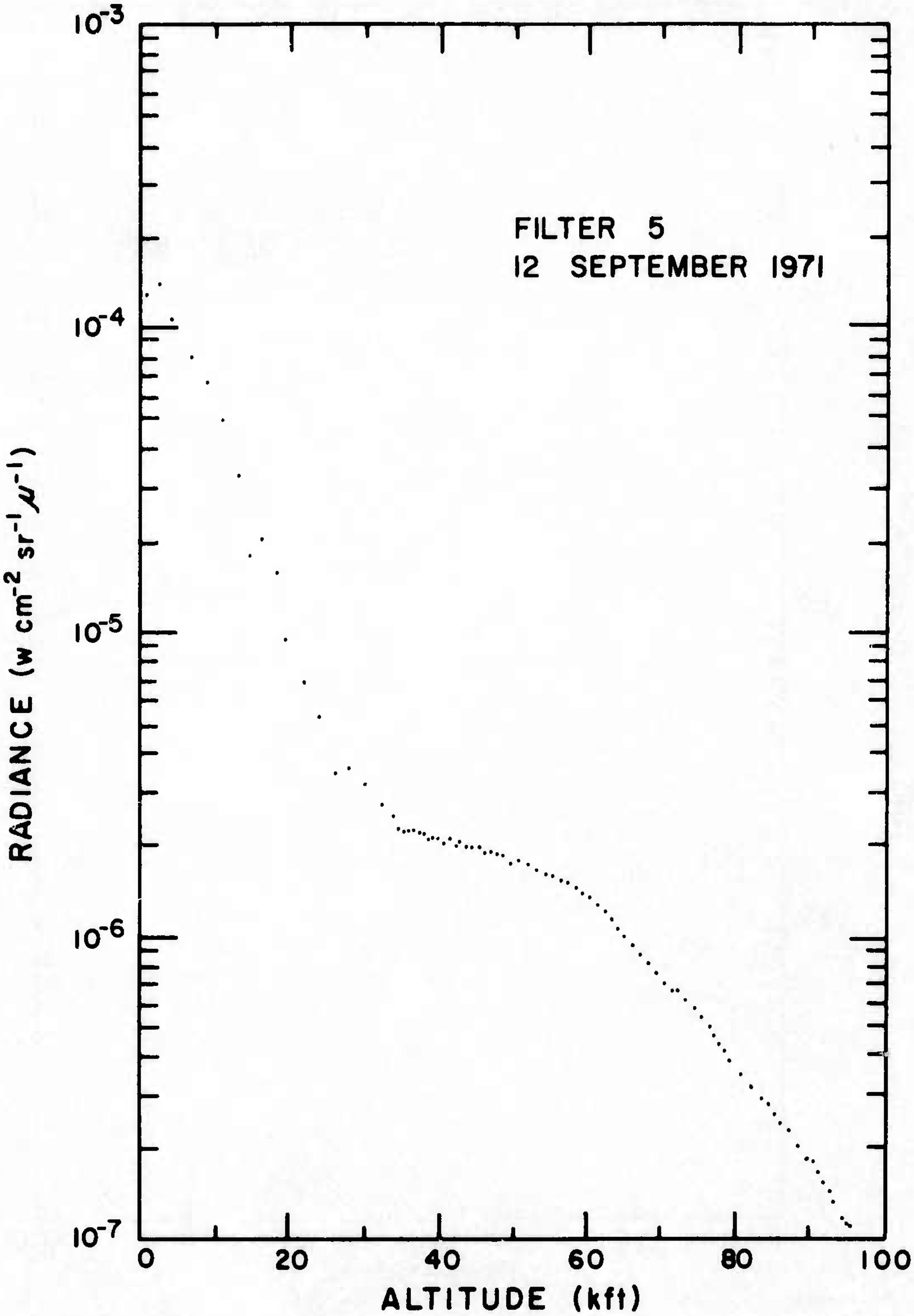

Figure 4. Radiance vs. Altitude for Filter 5, 12 September 1971

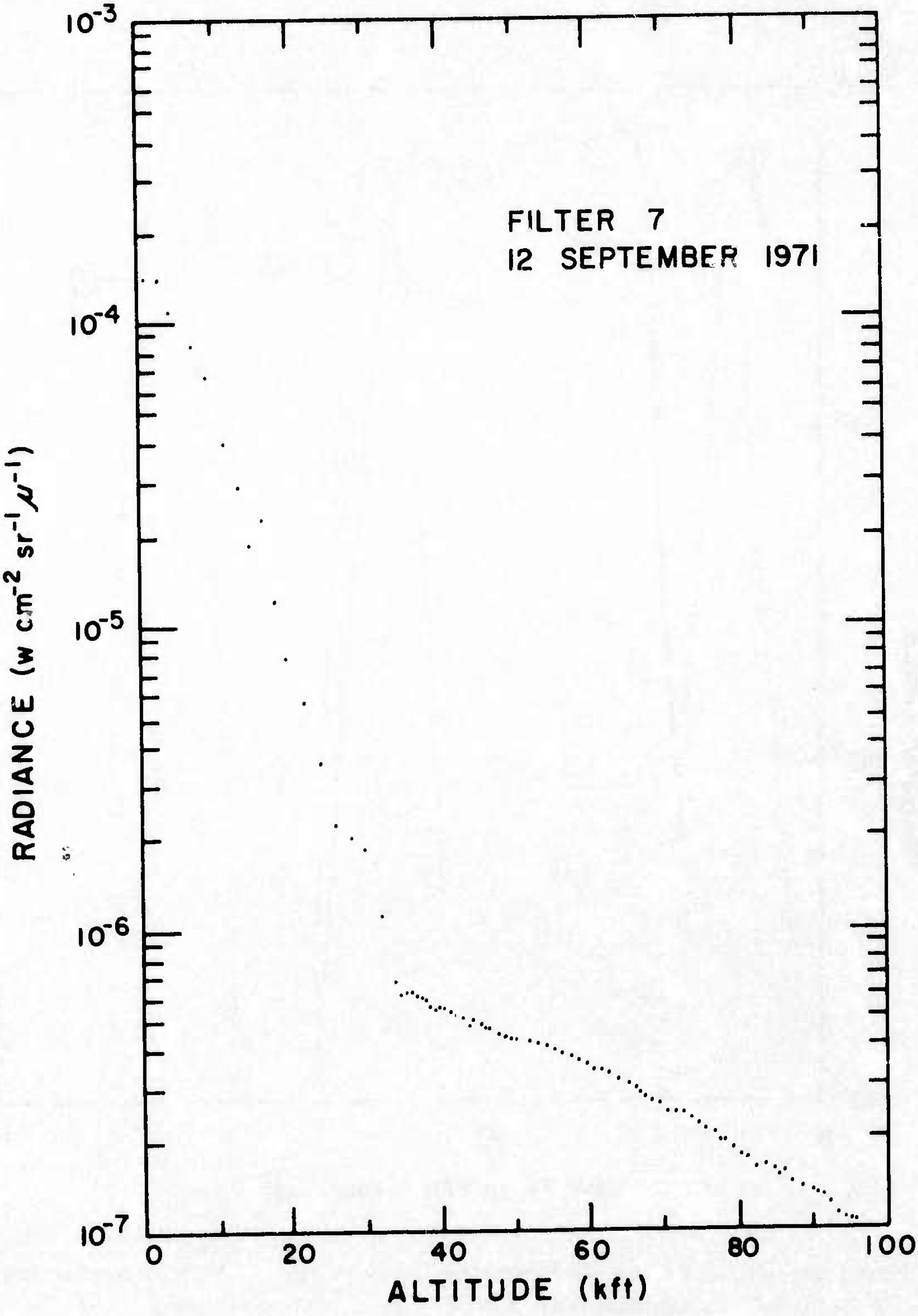

Figure 5. Radiance vs. Altitude for Filter 7, 12 September 1971

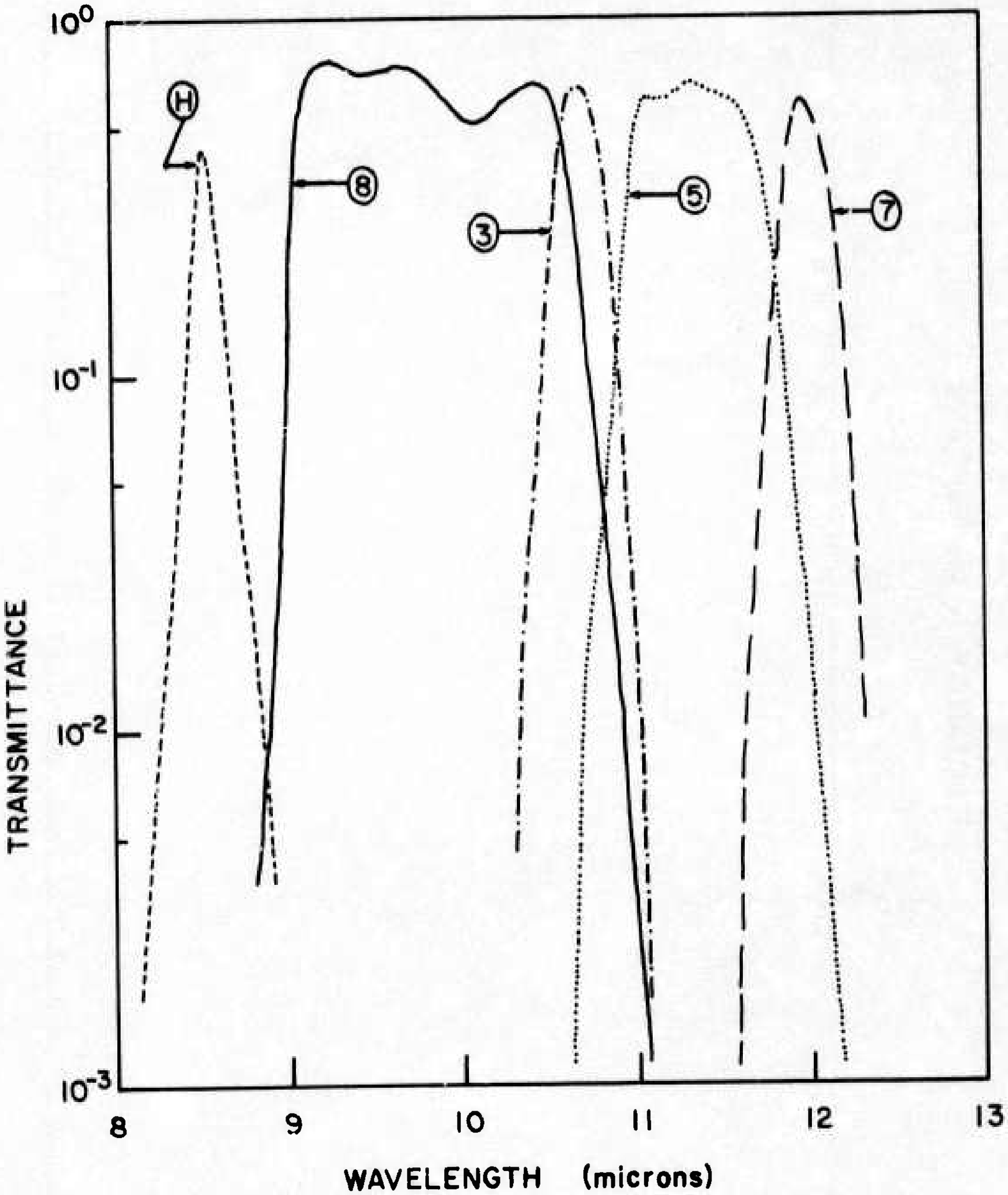

Figure 6. D. U. Filter Radiometer Curves for 12 and 15 September 1971, Fairbanks, Alaska

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