

Spring 1975

The radiation weekend

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Recommended Citation

Manning, J., D. Miller and A. Siebers. 1975. The radiation weekend. *Field Station Bulletin* 8(1): 13-14.

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THE RADIATION WEEKEND

The following descriptions of a 24-hour cycle of the flows of radiant energy in November 1974 were written as follow-up assignments to a class exercise measuring these energy flows at the Field Station (Meteorology 511 - Dynamic Meteorology I: Radiation). All the flows of short-wave (or solar) radiation (wave length less than 3 micrometers) and long-wave radiation (wave lengths 3 to 50 micrometers) were measured, and their interrelations calculated.

The S.I. units are those for energy flux density – watts per square meter (w m^{-2}). (One $\text{cal cm}^{-2} \text{hr}^{-1}$ or 1 ly hr^{-1} in the older cgs system equals 11.6 w m^{-2} .)

A few definitions: “albedo” is reflectivity of the grass to solar radiation; “intake” refers to short-wave and long-wave radiation absorbed by the grass.

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Our first measurements were taken at 1326, when the net flux of short-wave radiation was 280 w m^{-2} . As the altitude of the sun decreased the net short-wave and the net total radiation decreased steadily until 1630, approximately sunset. The radiational fluxes were in equilibrium about one hour before sunset. It is apparent from the graphs that clear sky conditions prevailed from 1300 to 1630 since no erratic variations appear in any of the radiational fluxes.

Throughout the night, from 1615 to 0700, the net radiation remained essentially constant at -66.5 w m^{-2} . The standard deviation during this period is 10.9 w m^{-2} . Clear sky conditions also are evident during the night from examination of graph number one.

The net radiation begins increasing rapidly at 0700, corresponding to sunrise, as the flux of short-wave radiation increases. The increase in net radiation from 0700 to 1100 is 360 w m^{-2} . Clouds obscured the sun partially at about 1000 and 1245, as evidenced by the decrease in the vertical component of direct solar radiation. This also shows up in the increase in downward atmospheric radiation.

The variance of short-wave radiation is much greater than that of long-wave radiation. During day-time hours the net radiation closely follows the pattern of the net short-wave radiation.

Over the entire period covered by the measurements there was a net radiative energy surplus of 346 w m^{-2} .

Anthony Siebers

A complete twenty four hour record of radiation was made at the Cedar-Sauk Field Station by students of the Radiation and Energy Exchange course. Hourly readings were taken from 1200 CST on 8 November 1974 to 1200 on 9 November. The equipment used and fluxes measured were:

Kipp pyradiometer	diffuse and total short wave downward, total short wave upward
Georgi solarimeter	direct solar short wave
Schulze pyradiometer (double)	downward and upward all wave
Thornthwaite net radiometer	net all wave
Barnes infrared thermometer	surface radiation temperature

More than enough data were available to determine each element of the total radiation budget. The duplication provided a means of detecting inaccurate data.

The weather was clear throughout the period until midmorning on the 9th when a fairly heavy cloud cover developed. There were enough breaks in the cloud cover to continue direct solar measurements, however. Small fluctuations were noted in the downward short wave radiation on the afternoon of the 8th, probably indicating significant turbidity. The vertical component of direct solar radiation was 264 w m^{-2} at 1300 on the 8th and 287 w m^{-2} at 1100 on the 9th. The maximum was 390 w m^{-2} at 1200 on the 9th. The diffuse short wave radiation increased substantially after 1000 on the 9th due to the cloud cover.

The surface was a short grass surface with albedo around 0.22. The surface temperature (assuming unity emissivity) was close to the air temperature during the day and dropped to a minimum of -8.5°C during the predawn hours. The air temperature varied from 17°C on the 8th and 12°C on the 9th to an overnight low of 3°C .

The upward long wave radiation was greater than the downward throughout the period. The upward long wave ranged from around 460 w m^{-2} at midday both days to about 300 w m^{-2} during the early morning hours, paralleling the surface temperature. Long wave from the sky varied from 388 w m^{-2} to 229 w m^{-2} .

The total radiation budget showed a deficit from 1400 on the 8th until 0800 on the 9th. The deficit was made up during the daytime hours, with a radiation surplus of 195 w m^{-2} over the 24 hour period.

Joe Manning