

## **Assessment of surface radiation components at LASPEX sites**

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### **ABSTRACT**

The daytime variation of radiation components viz., incoming and reflected short wave, incoming long wave radiation and net radiation measured during LASPEX-97 experiment at five sites (Anand, Arnej, Sanand, Derol and Khandha) for four months (May, July, September and December) are presented. Results show that the maximum amount of short wave radiation is received at Arnej ( $707.02 \text{ Wm}^{-2}$ ) and minimum at Khandha ( $568.12 \text{ Wm}^{-2}$ ) during summer. Reflected short wave was lower at Khandha during all the seasons while the reflectivity and consumption of short wave radiation as net radiation was minimum.

**Key words:** Short-wave radiation, Reflectivity, Long-wave radiation, Net radiation

Radiant energy plays an important role not only in plant growth and development processes through photosynthesis and thermal effect but also in determining the climate near the ground depending upon the radiative properties of the surface. The net radiation, which is the balance of net short wave and net long-wave radiation, is the fundamental source of energy responsible for most of the physical processes taking place in the environment. The exchange processes of sensible; latent heat and momentum fluxes are largely determined by the radiation budget components particularly net radiation. Thus the information on diurnal and spatial variation of various components of radiation budget are required to be generated to understand the complex processes involved in biosphere and atmosphere. In view of this analysis was undertaken using data generated during LASPEX-97.

### **MATERIALS AND METHODS**

A multi-institutional, multi-disciplinary

land surface experiment (LASPEX-97) was conducted over Sabarmati river basin selecting four stations as grid points with central station at Anand. Other stations are Sanand, Arnej, Derol and Khandha. The different components of radiation viz. incoming and out going short wave radiation, incoming and outgoing long wave radiation and net radiation measured at all the sites during intensive observation period (IOP) of May, July, September and December months have been utilized in the present study. Hourly averages were worked out and its variation during day time are presented.

### **RESULTS AND DISCUSSION**

The incoming and reflected short wave radiation along with the net radiation observed at 0900, 1100, 1300, 1500 and 1700 hrs) IST in four months (May, July, September and December) for each station are depicted in Figs. 1 through 5. Average of day time hourly values of radiation components worked out

**Table 1 :** Daytime average (0900-1700 hrs) values of radiation components ( $Wm^{-2}$ ) at LASPEX sites

Components	Summer (May)	Monsoon (July)	Post Monsoon (September)	Winter (December)
<b>Anand</b>				
SW1	686	461	462	438
SW2	153(23)	98(21)	81(18)	71(16)
Rn	409(60)	328(71)	363(79)	272(62)
<b>Arnej</b>				
SW1	707	467	450	437
SW2	186(26)	92(20)	59(13)	--
Rn	378(53)	385(71)	280(62)	261(59)
<b>Sanand</b>				
SW1	694	482	437	418
SW2	165(24)	119(23)	99(23)	113(27)
Rn	380(55)	216(65)	328(75)	202(48)
<b>Derol</b>				
SW1	677	422	362	423
SW2	199(29)	118(28)	97(27)	127(30)
Rn	441(65)	291(69)	264(73)	262(62)
<b>Khandha</b>				
SW1	568	357	317	331
SW2	75(13)	68(19)	34(11)	32(10)
Rn	389(68)	260(73)	263(83)	229(69)

Values in parentheses shows the percentage in terms of incoming short wave radiation

are presented in Table 1. The results are discussed station wise.

#### *Anand*

The incoming short-wave radiation was observed to be more at 13 hrs during the whole season and it was  $850 Wm^{-2}$  during summer's

peak hour with other months recording approximately  $600 Wm^{-2}$  except in September (Fig.1-a). Daytime average (from 09 to 17 hrs) solar radiation received during summer was  $687 Wm^{-2}$  (Table 1) while during other seasons it ranged from 460 to  $438 Wm^{-2}$ . The reflected short-wave radiation during summer was more

than that in other seasons (Fig.1-b). It ranged from 80 to 120  $Wm^{-2}$  from 9 hr to 17 hr with 180  $Wm^{-2}$  at 13 hr during summer, and 37 to 78  $Wm^{-2}$  with 120  $Wm^{-2}$  during active monsoon season at the same hours. The albedo was observed to be 23, 21, 18 and 16 % during May, July, September and December respectively

Net radiation was higher (Fig.1-c) at 13 hr (500  $Wm^{-2}$ ). During other seasons it was around 400  $Wm^{-2}$  at this hour. It ranged from 200-500  $Wm^{-2}$  during summer, 100-420  $Wm^{-2}$  in monsoon, 190-400  $Wm^{-2}$  during monsoon withdrawal and 50-400  $Wm^{-2}$  in winter months during different hours of the day.

#### *Arnej*

Maximum amount of solar radiation received at ground was 920  $Wm^{-2}$  at Arnej during summer while during the other months it was approximately 550  $Wm^{-2}$ . Short grass was present near the tower site affecting the reflectivity of short wave radiation. During active monsoon phase, 30 mm rain occurred and during withdrawal phase 110 mm rain occurred during the IOP. The reflected short-wave radiation ranged from 100  $Wm^{-2}$  at 9 hr and increased up to 220  $Wm^{-2}$  at 13hr during summer and decreased to 140  $Wm^{-2}$  at 17 hr. The surface albedo decreased during monsoon season and was 20% and 13% during active and withdrawal phases of monsoon respectively against that of 26% during summer season. Higher reflectivity during summer might be due to dry grass surface. The lowest reflectivity (13%) was due to the water logging during September month. Soil acted as a sink and absorbed most of the incoming short wave radiation.

The net radiation at different hours ranged from 220 to 450  $Wm^{-2}$  in summer, 120 to 445  $Wm^{-2}$  in active monsoon phase, 125 to 370  $Wm^{-2}$  in withdrawal phase and 90-375  $Wm^{-2}$  in the winter season respectively.

#### *Sanand*

During summer, the incoming short-wave radiation ranged from 440  $Wm^{-2}$  at 09 and 17 hrs to 740 and 800  $Wm^{-2}$  at 11 and 13 hrs respectively (Fig.3.a). During other seasons at midday, it was almost same and was around 600  $Wm^{-2}$ . Very low values at 09 hrs during September and December were attributed to an instrumental error. Daytime average reflected short wave radiation was more during summer (165  $Wm^{-2}$ ) and minimum in the post monsoon (99  $Wm^{-2}$ ) months. During all the seasons the surface albedo was almost same in spite of the rain occurring during the monsoon periods.

Net radiation was observed to be more during summer in comparison to other seasons. The net radiation was low during active phase of monsoon, i.e., in July and ranged from 90  $Wm^{-2}$  at 9 hr to a maximum of 250  $Wm^{-2}$  at 1300 hrs. During this period no rain was experienced and it was cloudy. Daytime average net radiation was observed to be 380  $Wm^{-2}$  in summer, 216  $Wm^{-2}$  in active monsoon season, 328  $Wm^{-2}$  in post monsoon season and 202  $Wm^{-2}$  in winter season respectively (Table 1).

#### *Derol*

Fig. 4(a-c) depicts the diurnal variation at Derol where the soil was bare. The amount of solar radiation received was more or less same as that at Anand (440-875, 200-550, 90-450 and 175-550  $Wm^{-2}$  during summer, active monsoon, post monsoon and winter months



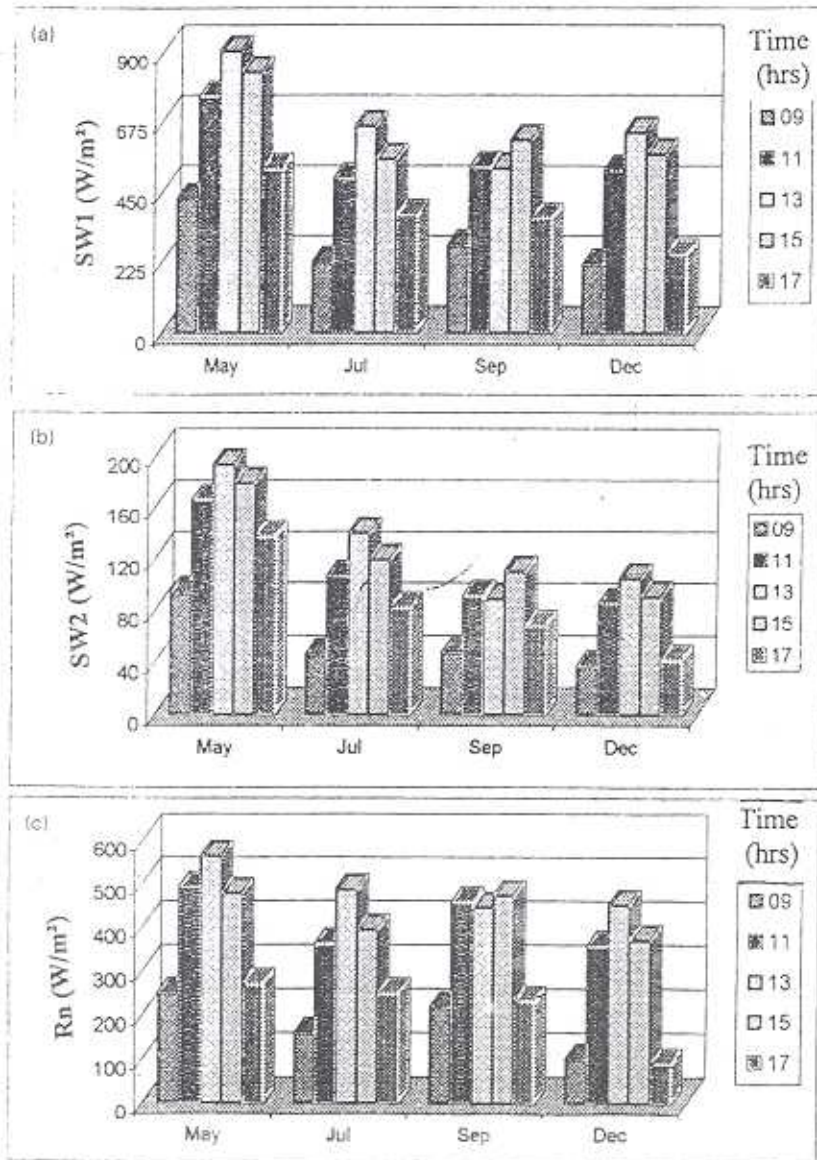


Fig. 1 : Seasonal variation of radiation components at Anand  
 (a) Incoming short wave radiation (SW1) (b) Outgoing short wave radiation (SW2) (c) Net radiation (Rn)

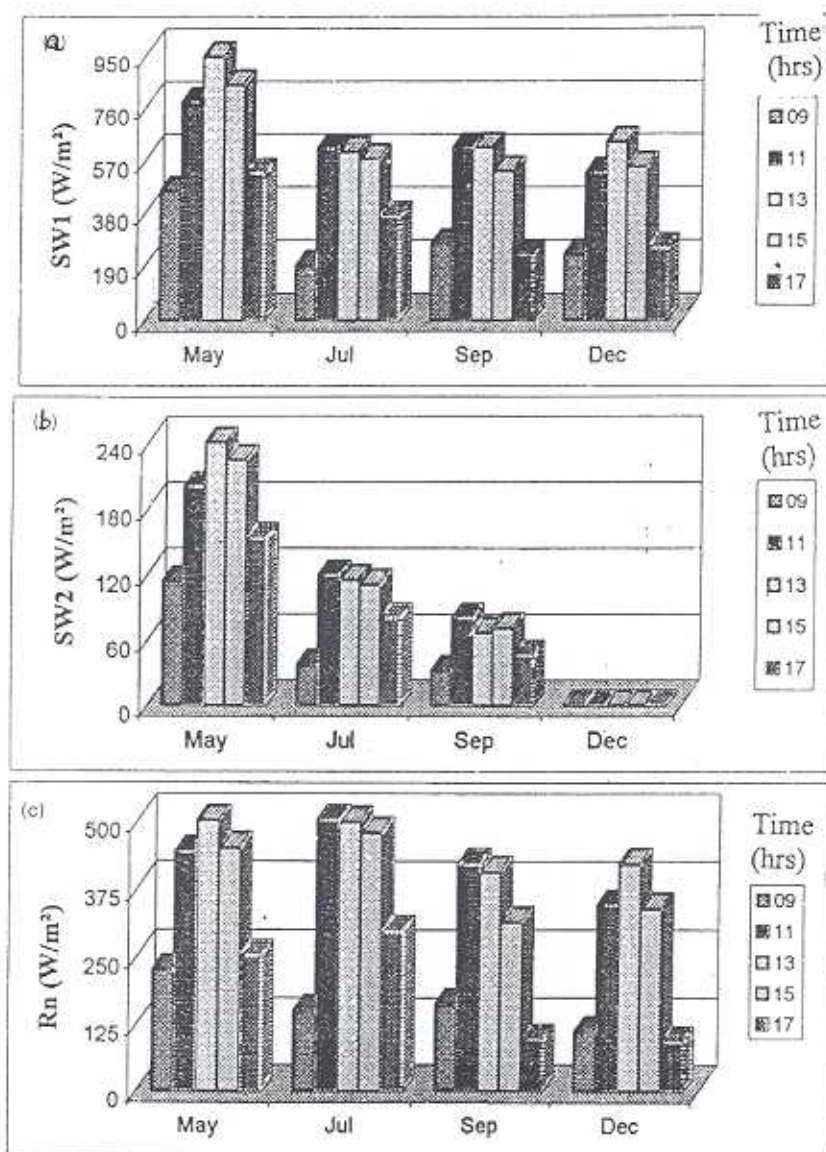


Fig. 2 : Seasonal variation of radiation components at Arnej  
 (a) Incoming short wave radiation (SW1) (b) Outgoing short wave radiation (SW2) (c) Net radiation (Rn)

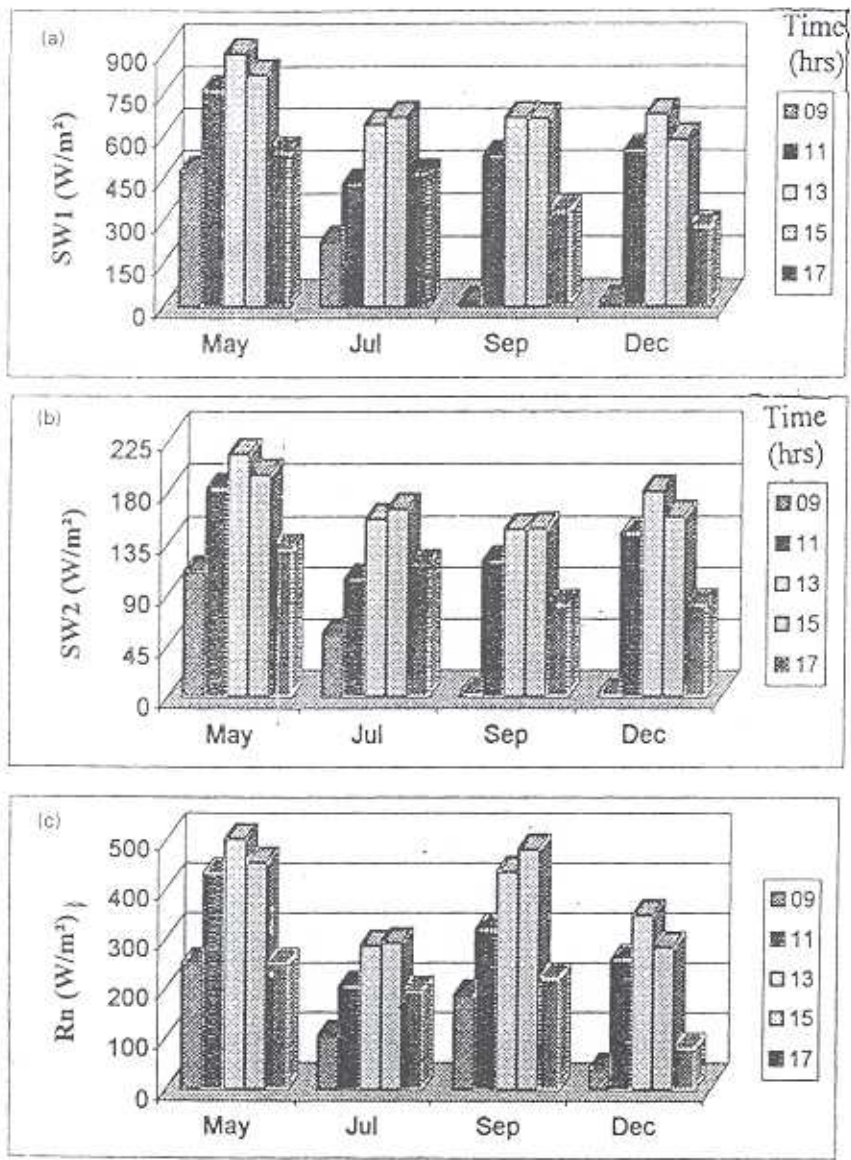


Fig. 3 : Seasonal variation of radiation components at Sanand  
 (a) Incoming short wave radiation (SW1) (b) Outgoing short wave radiation (SW2) (c) Net radiation (Rn)



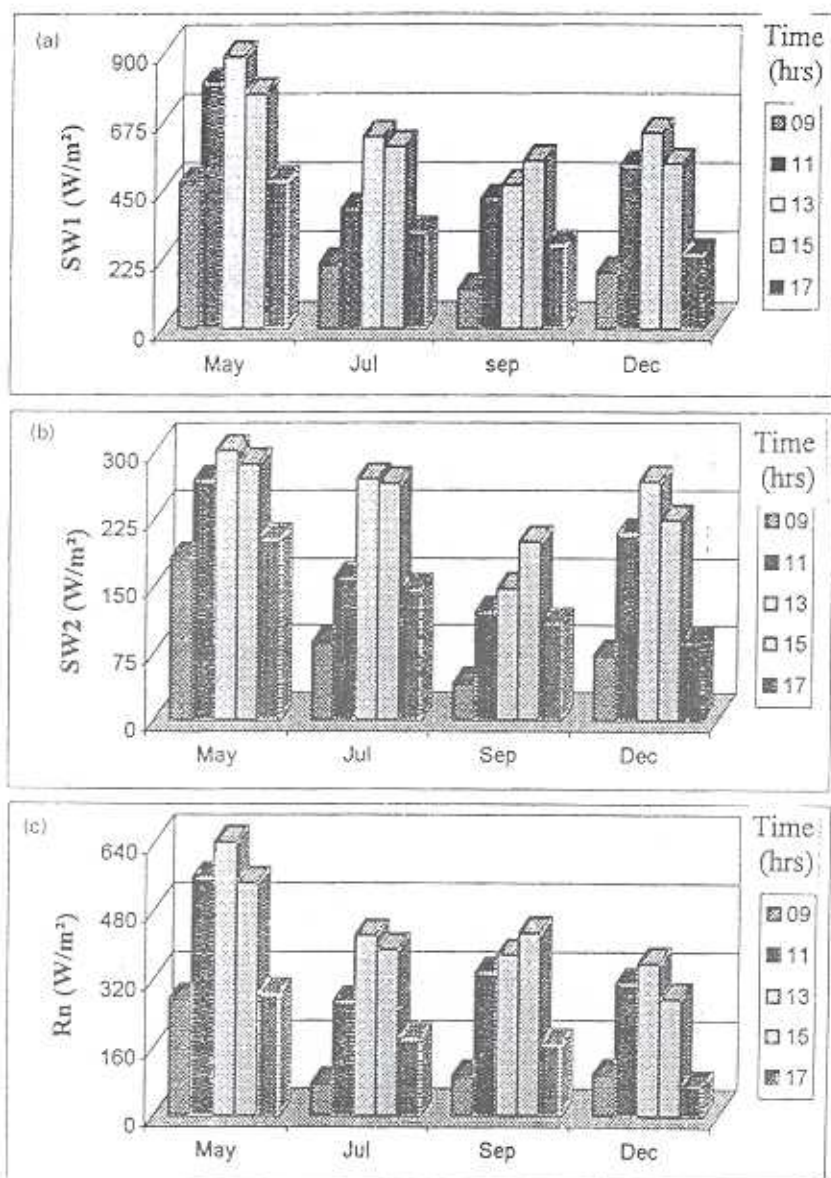


Fig. 4 : Seasonal variation of radiation components at Derol  
 (a) Incoming short wave radiation (SW1) (b) Outgoing short wave radiation (SW2) (c) Net radiation (Rn)

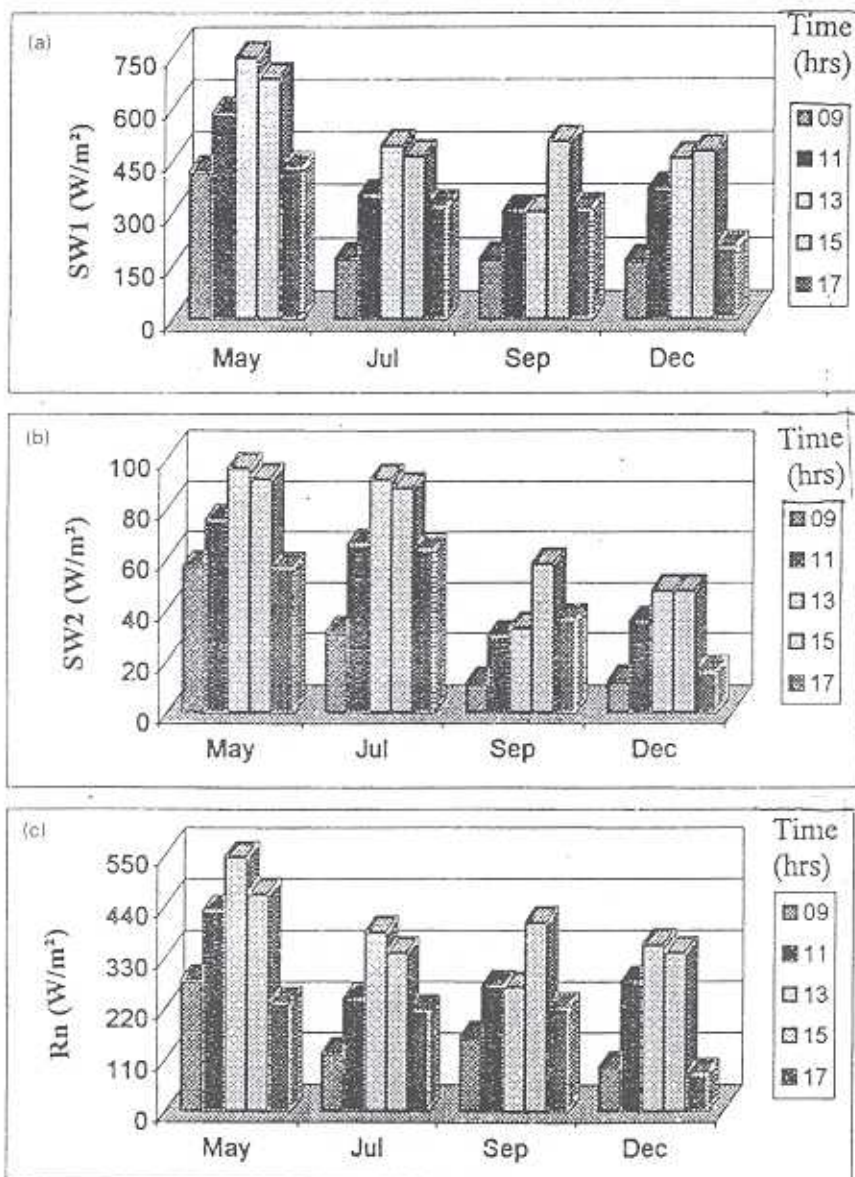


Fig. 5 : Seasonal variation of radiation components at Khandha  
 (a) Incoming short wave radiation (SW1) (b) Outgoing short wave radiation (SW2) (c) Net radiation (Rn)



respectively). Reflected short wave radiation was observed to be higher in all the seasons in comparison to other stations with soil being sandy with bare surface. During summer it ranged from 150-275  $Wm^{-2}$  with similar value at morning and evening hours (150-160  $Wm^{-2}$ ) while it ranged from 70-235  $Wm^{-2}$  during July. The reflectivity (albedo) during the observational periods at Derol was always high (27 to 30 percent). Net radiation during summer ranged from 240-570  $Wm^{-2}$ . In the other seasons, it ranged between 60-350  $Wm^{-2}$ , 60-360  $Wm^{-2}$  and 60-300  $Wm^{-2}$ . At 17 hr it was 140  $Wm^{-2}$  during active and withdrawal phases of monsoon.

#### *Khandha*

At Khandha low values of short wave radiation were observed (Fig.5.a). This may be due to the presence of several industries resulting in smog and pollutants in the environment all the time. During summer, it ranged from 340-750  $Wm^{-2}$  (from 9 hr and 17 hr to 13 hr) and from 140-450  $Wm^{-2}$  during rest of the seasons. But during monsoon phases irregular trend may be due to cloud cover. Approximately 13% of the incoming solar radiation was reflected back as albedo during summer followed by 19, 11 and 10% during July, September and December respectively.

Net radiation was maximum at 13 hr

during all the seasons except in September. It was 550, 330, 340 and 300  $Wm^{-2}$  at peak hours except in September in summer, active, post monsoon and winter months respectively.

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