Variation of Net Radiation and Solar Spectrum in Thailand

Pannop Limhoon and Surat Bualert

***Abstract*—Variation of Net radiation and Solar spectrum in Thailand determine the Net radiation and Solar spectrum to compare the environment. The preparation databases amount of solar radiation to be aware change types quantity proportion and distribution of the ratio change each area can influence change the net radiation and spectrum of solar radiation that is received. Measuring and monitoring solar radiation at the wave length 350-1050 nm since November 2010 – February 2011 and March 2011 – March 2012 by instrument netradiometer, CNR4 and Spectroradiometer (EKO, MS-700). The results showed that net radiation was lowest in rainy season. In rainy season was highest decreasing percentage compared to summer. Seasonal variation of the averaged radiation at the wavelength range 351-1050nm showed a good agreement to net radiation, highest in summer rain and winter respectively. In the rainy season, massive cloud, and humidity in the air could absorb net radiation causes the net radiation decreasing at the wavelength range 700-1050 nm of the rainy season, more than other seasons. At the wavelength range 351-700nm, the net radiation decreasing in the winter caused by the station's location and wind direction which brought particles from the sea. Especially on sea salt affected the net radiation at the wave length range 351-700 nm. It showed a good agreement to [7] [10] which reported that in winter, % decrease was greater than any other seasons.**

***Index Terms*—Seasonal variation, diurnal variation, net radiation, short-wave, solar radiation, particle concentration.**

I. Introduction

Sun the most important energy source to the earth. Warming caused by short-wave, but because in many contaminants. So, this short wave radiation is reflected back into the atmosphere before the world or surface adsorption. Therefore, the amount of short wave Earth surface into smaller ones. The process that causes the light reflected in the atmosphere occurs due to a molecule of the substance in the air is much smaller than the radius of the optical wave length. Called a "scattering", this process occurs every direction so that the surface world into short wave and, therefore, caused by the Sun and the scattering by molecules of the substance are sometimes called "sky radiation". Short waves energy reached ground or surface is direct short wave radiation. Some part of them may reflect to the atmosphere is a reflection of the short-wave [1]. The world's surface when it is hot, both short and long waves. The surface world would release radiation into the atmosphere in the form of a long wave terrestrial radiation.

The net radiation was a balance between incoming and outgoing radiation.

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II. Material and Method

A. Study Area

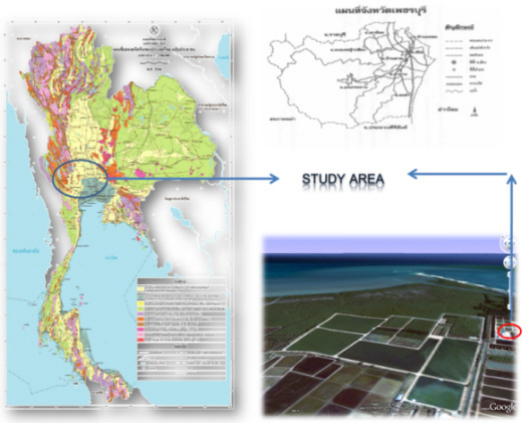


Fig. 1. Study area

The experiment was conducted at the experimental site of The King's Royally Initiated LeamPhakBia Environmental Research and Developmental Project (the Royal LERD-project) at Phetchaburi Province, Thailand.

B. Field Experimental

Netradiometer, CNR4 was used for measuring net radiation, incoming and outgoing shot wave and long wave. Spectroradiometer (EKO, MS-700) was used for measuring and monitoring solar radiation at the wave length 350-1050 nm since November 2010 – February 2011 and March 2011 – March 2012.

III. Result and Discussion

A. Net Radiation

The net radiation received at the Earth station project at Laem phak bia found that cosmic The highest net radiation received during the winter (November 2010 – February 2011) was 215.1 Watt per square meter during summer (July 2010 - August 2011) was 173.2 Watt per square meter. However, the maximum net radiation was in the summers 856.2 Watt per square meter. Considering the frequency of the radiation quantity was higher than 700 Watt per square meter. During the summer, the maximum frequency was 5.2 percent of all information. The summer and winter there were 1.7 and 3 percent of the total, respectively.

Analyzing the ratio between short wave radiation reflected from the Earth (Rsu) and incoming short wave solar radiation (Rsd) or reflection Ray (Albedo) found that the short-wave

radiation reflected in the summer rainy and winter were between 0.12-0.17 0.12 0.18 -0.12-0.17, respectively, and mean 0.136 by reflection radiation values found in the range is less than the summer season and winter.

B. Spectral of Incoming Solar Energy

February 2011. Because the distance between the noon sun with the world is the distance that is closer to the maximum. Adsorption and scattering in around a day. As a result, the departure of Ray. Variation of radiation characteristics of wavelength 300 to 1140 nanometer. I found that there were significant energy absorption at wave length 930 940 760 720 and 810 820 950 nanometer due to moisture and humidity in the atmosphere.

C. Spectral of Outgoing Radiation

During November 2010 – February 2011, the highest outgoing of radiation was 198 Watt per square meter per nanometer at 11.00 a.m. at the wavelength of 770-780 nanometer due to the angle of the Sun to the Earth is smaller and is not equal to zero. In the night time, the earth does not receive sunlight. Influence of ground heat (re-radiation as a long wave radiation) increase the energy at longer wavelength (1080 nanometer).

D. Diurnal Variation of Net Radiation

Net radiometer showed diurnal variation and seasonal variation of solar energy of Thailand, summer (March-May), rainy (June-October), winter (November-February).

Averaged net radiation in summer show the highest energy (672.68 W/m^2) at 12.00am as same as rainy (629.24 W/m^2) and winter season (665.08 W/m^2) (Fig. 2 and Table I).

TABLE I: DIURNAL AND SEASONAL VARIATION OF NET RADIATION IN THAILAND (MARCH 2011-MARCH2012)

	summer	rainy	winter
0	31.660802	24.58588	37.00404
1	30.876944	24.34862	36.19126
2	30.064729	24.51848	36.48737
3	29.994356	23.9909	35.89747
4	29.257221	24.53729	35.45195
5	29.392785	23.19034	35.13339
6	59.183704	50.78309	40.59572
7	180.02932	158.3263	129.6723
8	331.99239	304.5982	290.8405
9	490.15838	434.9566	457.6439
10	616.01807	540.5965	505.2063
11	672.88338	600.2261	505.3279
12	672.86117	629.2448	665.076
13	654.86847	617.9215	657.306
14	565.73807	502.5711	576.8558
15	431.3262	354.3477	428.5373
16	265.30518	219.5522	249.8194
17	112.49498	104.3283	96.61075
18	41.098409	35.35752	43.61779
19	33.782855	26.41272	40.10867
20	32.414715	27.03879	38.94094
21	31.789976	26.24463	38.0888
22	31.953966	25.17542	38.50981
23	32.294115	24.72264	38.14346

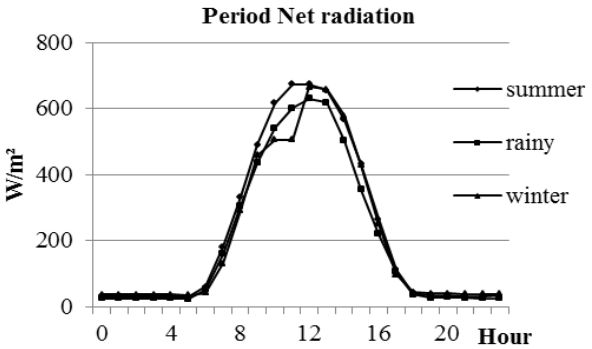
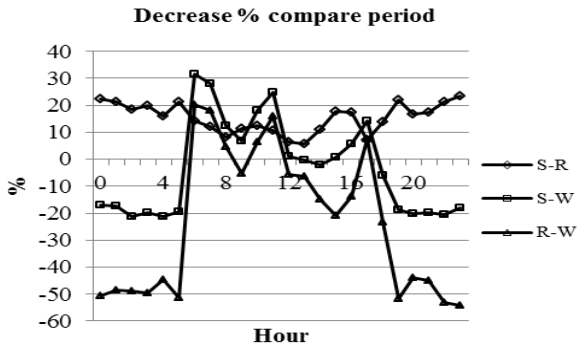


Fig. 2. Net radiation since March 2011 – March 2012.

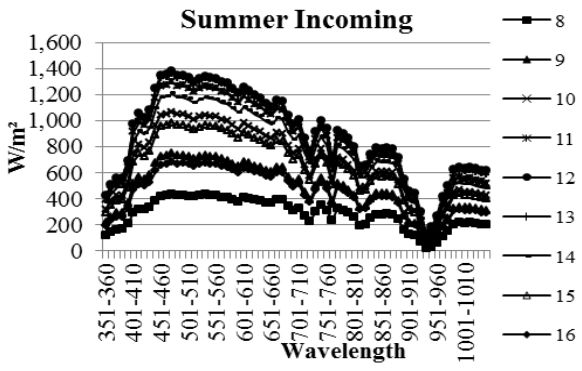
Fig. 2 showed that net radiation in rainy season was lower than summer and winter especially at 9.00-11.00am, net radiation was lowest due to the sun angle at winter time. The energy lost in the winter because Earth orbit away from the Sun than summer time. That causes solar radiation travel more far away. The solar radiation passé through the air and easy to scat especially on the short wave radiation such as ultraviolet (UV). Furthermore, in the morning the sun angle is perpendicular to the Earth.

Seasonal comparison showed that summer net radiation was decreased. In the winter time, sunshine duration was shorter than summer but the net radiation was higher that summer and rain season (Fig. 3) which was lower net radiation due to rainy cloud.



S-R = % decreasing of net radiation in rainy season compared to summer
S-W = % decreasing of net radiation in winter season compared to summer
R-W = % decreasing of net radiation in winter compared to rainy season

Fig. 3. Decreasing percentage (%) of net radiation in winter and rainy season compared to summer time .



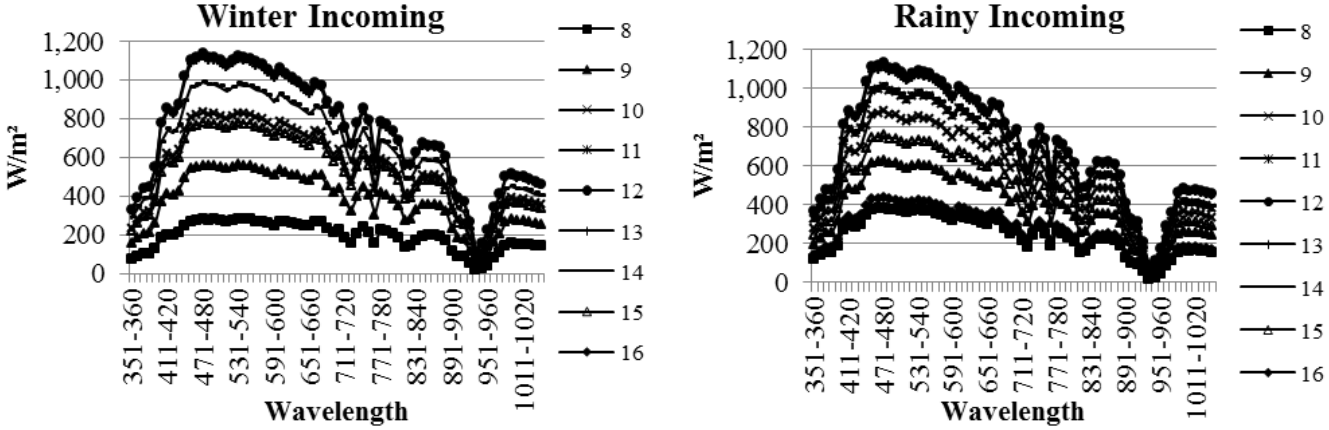


Fig. 4. Incoming solar radiation spectrum (wavelength 351-1050 nm) in summer season during March 2011-March2012

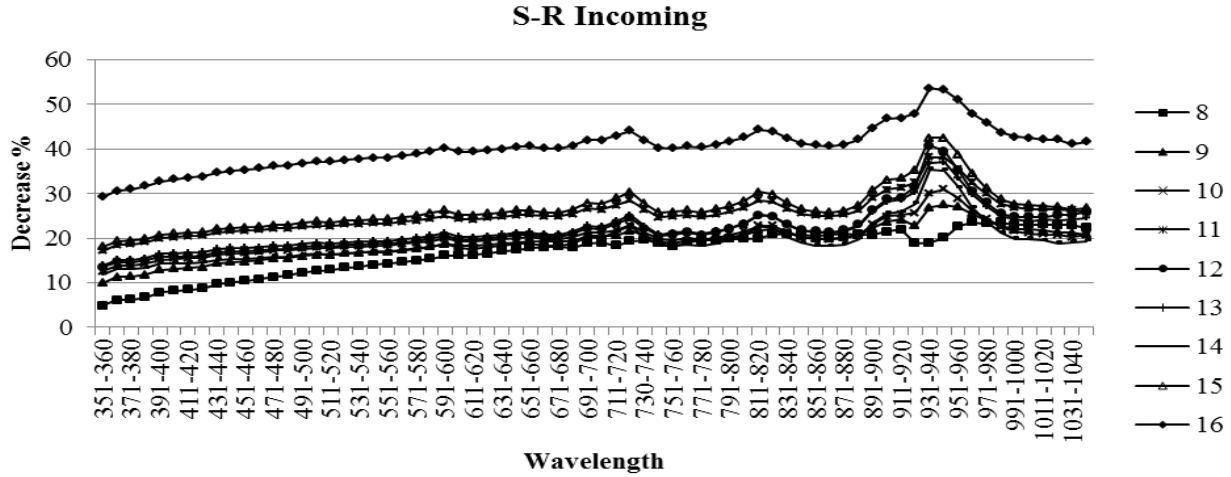


Fig. 5. Decreasing percentage (%) of solar spectrum (wavelength 351-1050 nm) in rainy season compare to summer time during March 2011-March2012

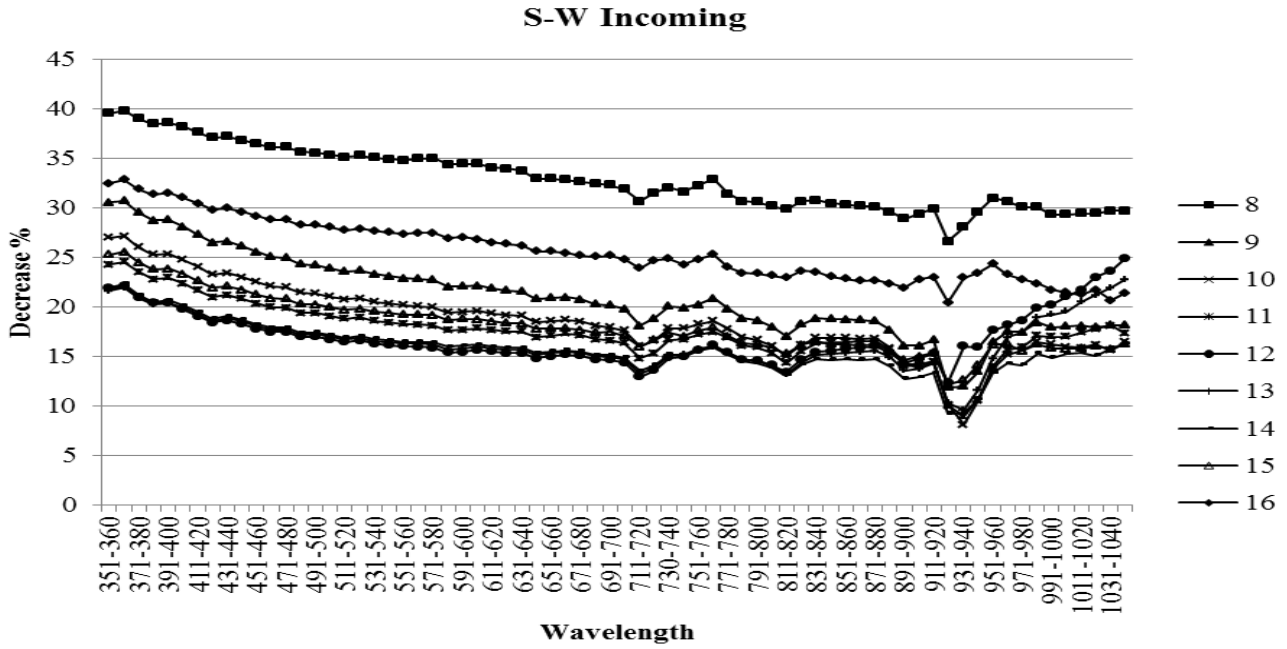


Fig. 6. Decreasing percentage (%) of solar spectrum (wavelength 351-1050 nm) in winter season compare to summer time during March 2011-March2012

The result showed that summers in Thailand was the highest net radiation among three seasons. The seasonal variation of net radiation showed in the Fig. 4. It agrees with [2]-[10] which reported that the environment was the major factor in summer and winter.

Comparison of decreasing percentage during the rainy season and the summer at the wavelength range 700-1050 nm radiation. In the daytime, the light is more than 75% decrease in winter compared to the summer, but at the wavelength range 351-700, winter compared to the summer with more

than 75% decrease in comparison with the summer rainy season (Fig. 5 and Fig. 6).

TABLE II: DECREASING PERCENTAGE OF NET RADIATION IN RAINY AND WINTER SEASON COMPARED TO SUMMER

	S-R	S-W	R-W
0	22.34599	-16.8765	-50.5093
1	21.14303	-17.2113	-48.6378
2	18.44771	-21.3627	-48.8158
3	20.01527	-19.6808	-49.6295
4	16.13252	-21.1733	-44.4819
5	21.10193	-19.5307	-51.5001
6	14.19413	31.40727	20.06056
7	12.05526	27.97157	18.09809
8	8.251447	12.39543	4.516674
9	11.26204	6.633466	-5.216
10	12.24341	17.9884	6.546506
11	10.79791	24.90111	15.8104
12	6.482226	1.15702	-5.69433
13	5.641889	-0.37221	-6.3737
14	11.16541	-1.96518	-14.7809
15	17.84694	0.646591	-20.937
16	17.24541	5.836983	-13.7859
17	7.259593	14.11994	7.39737
18	13.96865	-6.13011	-23.3621
19	21.81621	-18.7249	-51.8536
20	16.58483	-20.1335	-44.0188
21	17.44369	-19.8139	-45.1299
22	21.21348	-20.5165	-52.9659
23	23.44539	-18.1127	-54.2856

In the rainy season, it may be caused by a massive cloud, and humidity in the air, it makes those absorption net radiation [4] - [9], [11] caused the net radiation decreasing at the wavelength range 700-1050 nm of the rainy season, more than other seasons. At the wavelength range 351-700nm, the net radiation decreasing in the winter caused by the station's location and wind direction which brought particles from the sea. Especially on sea salt affected the net radiation at the wave length range 351-700 nm. It showed a good agreement to [7], [10] which reported that in winter, % decrease was greater than any other seasons.

IV. CONCLUSION

Net radiation was lowest in rainy season. In winter especially at 9.00-11.00am, net radiation was lowest due to solar angle in the winter. Furthermore, rainy season was highest decreasing percentage compared to summer. It was difference from winter (night time). The decreasing percentage was increase in the summer. Seasonal variation of the averaged radiation at the wavelength range 351-1050nm showed a good agreement to net radiation, highest in summer rain and winter respectively. In the rainy season, massive cloud, and humidity in the air could absorb net radiation causes the net radiation decreasing at the wavelength range 700-1050 nm of the rainy season, more than other seasons. At the wavelength range 351-700nm, the net radiation decreasing in the winter caused by the station's location and wind direction which brought particles from the sea. Especially on sea salt affected the net radiation at the wave length range 351-700 nm. It showed a good agreement to [7], [10] which reported that in winter, % decrease was greater than any other seasons.

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