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Estimation of Net Long Wave Radiation From Air Temperature and Relative Humidity

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ABSTRACT

The aim of this study to determine the net long wave radiation for the selected locations during the study period (2007-2017).The fluctuation of the Net long wave radiation, Air temperature, Relative humidity have been discussed. Comparing the two locations the net long wave radiation air temperature and relative humidity was higher in the location I. The highest value of Net long wave radiation for the two locations are 3.77MJm^{-2}d^{-1} (2012) and 2.88MJm^{-2}d^{-1}(2007) respectively. The lowest value of net long wave radiation occurred in the year 2007 and 2010 with respect to the location I and II. This shows the meteorological parameters like Air temperature and Relative humidity affect the climate during the study period.

Key words: *Net long wave radiation, Air temperature, Relative humidity*

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1. INTRODUCTION

Climate change generally refers to any change in climate over the time caused naturally or by anthropogenic responses. The climate change and its extensive variability due to anthropogenic impacts have got a special attention by (IPCC, 2001). In another sense, climate change means the shifting of climatic or meteorological parameters viz. precipitation, maximum temperature, minimum temperature, solar radiation, relative humidity, wind speed etc. And many other factors whereas global warming or cooling which refers the changes of the surface temperature (Back and Bretherton,2005). The inter-governmental panel on climate change (IPCC) determined through a consensus -based scientific process that human activity is having significant net warming effect on the globe. Human interference with the climate change poses risks for human and natural system. Increases in the atmospheric concentrations of radioactively active substance have initiated changes in the global climate that are projected to become substantially large in the future (NRC 2010).

Long wave radiation (R_L) represents the emitted radiation from the atmospheric contents and the earth surface with a wave length ranged between (4-100) micron (Dharmaratine and Anthony 1999).Cloud base absorbs a large quantity of terrestrial radiation and it reradiates it towards the earth surface, so the net radiation lost from the earth surface is reduced in presence of cloud. Incoming long wave radiation ($R_L\downarrow$) depends on air temperature and atmospheric emissivity .The composition of the atmosphere (Richard and Roger 2003). Outgoing long wave radiation ($R_L\uparrow$) depend on surface emissivity and surface temperature (Muhammad, 1983).Net long wave radiation (R_{nl}) represents the difference between the incoming long wave radiation and the outgoing long wave radiation. Normally the outgoing long wave radiation is greater than the incoming long wave radiation, so R_{nl} represents the energy losses. R_{nl} is rarely available because of economic and technical limitation (Samani et al 2007).

Outgoing Long wave Radiation is the energy radiating from the Earth as infrared radiation at low energy to Space. OLR is a critical component of the Earth's energy budget, and represents the total radiation going to space emitted by the atmosphere. Earth's radiation balance is quite closely achieved since the OLR very nearly equals the Short wave absorbed Radiation received at high energy from the sun. Thus, the Earth's average temperature is very nearly stable. The OLR is affected by clouds and dust in the atmosphere, which tend to reduce it to below clear sky values. The OLR is dependent on the temperature of the radiating body. It is affected by the Earth's skin temperature, skin surface emissivity; atmospheric temperature, water vapor profile, and cloud cover (Susskind et al, 2011). Air temperature also plays an essential role in physical processes of evapotranspiration, photosynthesis, and heat transfer (Lakshmi et al., 2001). As a result, many land surface process models including those in climatology, hydrology, and ecology require air temperature as an input variable (Huld et al, 2000). Humidity is the amount of water vapor in the air. Water vapor is the gaseous state of water and is invisible. Humidity indicates the likelihood of precipitation, dew or fog. Higher humidity reduces of effectiveness of sweating in cooling the body by reducing the rate of evaporation of moisture from the skin. Atmospheric humidity is a measure of water held in the air as gas

2. METHODOLOGY

2.1 Study area

The first location belongs to Western Ghats is the Horticultural Research Station, Pechiparai is located in Vilavancode Taluk of Kanyakumari District. The hill region of the district lies 35 km away from the coast and spreads from the east to the west. This site is situated in the natural surroundings at the foot hills of Western Ghats about 10 km away from Kulasekharam, 23 km from Marthandam, 45 km from Nagercoil and 75 km from Trivandrum. It is situated on the bank of Pechiparai main canal about 1.5 km away from the Pechiparai dam. The study area is geographically situated at 8.08°N and 77.57°E with an altitude of 76 m above MSL. The next location is geographically situated at 8˚46ˈ North latitude and 77˚4ˈ East longitude with an altitude of 40 m above MSL. The mean annual rainfall of the farm is 736.7 mm which is being received in 40 rainy days. The Research Institute farm has a total extent of 480 hectares comprising red laterite of sandy soil. Thamiraparani river flows towards the region providing the water resource for irrigation other than rainfall

2.2 NET LONG WAVE RADIATION (R_{nl})

The rate of long wave energy emission is proportional to the absolute temperature of the surface raised to the fourth power. This relation is expressed quantitatively by the Stefan-Boltzmann law. The net energy flux leaving the earth's surface is, however, less than that emitted and given by the Stefan-Boltzmann law due to the absorption and downward radiation from the sky. Water vapour, clouds, carbon dioxide and dust are absorbers and emitters of long wave radiation. Their concentrations should be known when assessing the net outgoing flux. As humidity and cloudiness play an important role, the Stefan-Boltzmann law is corrected by these two factors when estimating - the net outgoing flux of long wave radiation. It is thereby assumed that the concentrations of the other absorbers are constant:

$$R_{nl} = \sigma\left[\frac{T_{\max}k^4 + T_{\min}k^4}{2}\right]\left(0.34 - 0.14\sqrt{e_a}\right)\left(1.35\frac{R_s}{R_{so}} - 0.35\right) \text{-----------------------} (1)$$

Where,

R_{nl} → Net outgoing long wave radiation [$MJm^{-2}day^{-1}$],
σ → Stefan-Boltzmann constant [$4.903 \times 10^{-9} MJ\ K^{-4}\ m^{-2}\ day^{-1}$],
$T_{max, K}$ → Maximum absolute temperature during the 24-hour period [K=°C+273.16],
$T_{min, K}$ → Minimum absolute temperature during the 24-hour period [K=°C+273.16]
e_a → Actual vapour pressure [kPa],
R_s/R_{so} → Relative shortwave radiation (limited to ≤ 1.0),
R_s → Solar radiation [$MJ\ m^{-2}\ day^{-1}$],
R_{so} → Clear-sky radiation [$MJ\ m^{-2}\ day^{-1}$].

An average of the maximum air temperature to the fourth power and the minimum air temperature to the fourth power is commonly used in the Stefan-Boltzmann equation for 24-hour time steps. The term ($0.34-0.14\sqrt{e_a}$) expresses the correction for air humidity, and may be smaller if the humidity increases. The effect of cloudiness is expressed

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by (1.35 R_s/R_{so} - 0.35). The term becomes smaller if the cloudiness increases and hence R_s decreases. The smaller the correction terms, the smaller the net outgoing flux of long wave radiation.

3. RESULT AND DISCUSSION

The variation of Net long wave radiation with air temperature and Relative humidity were analyzed and calculated using equation (1) for the location I and location II and discussed here

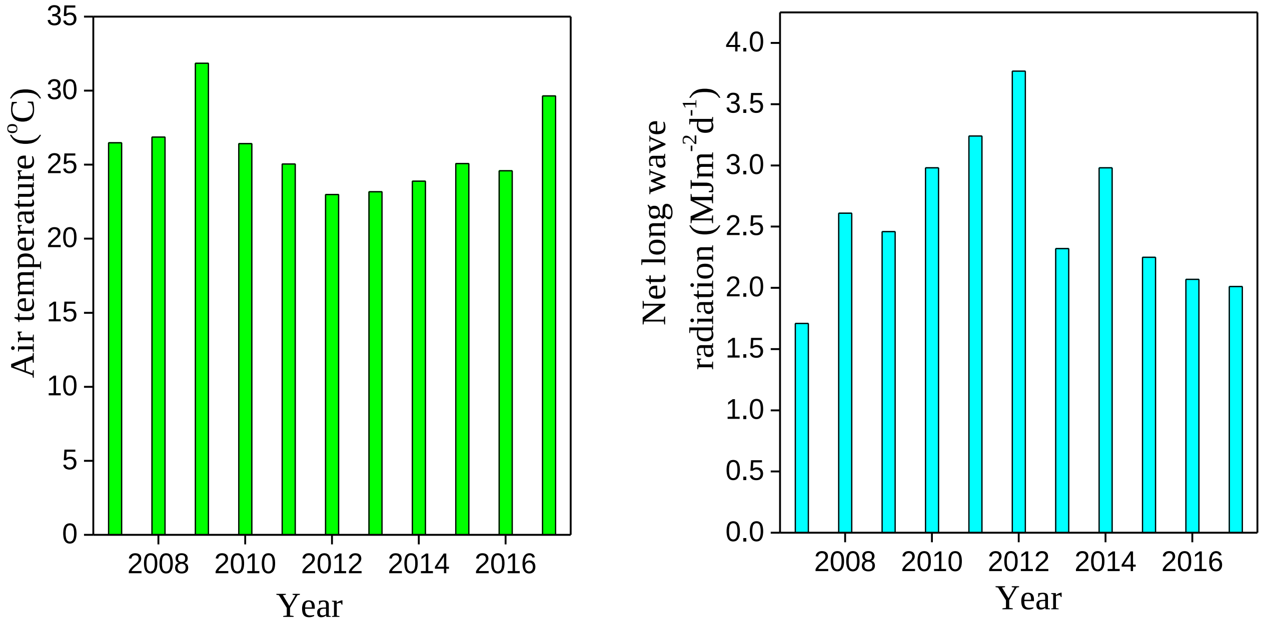

Figure 1 Variation of Air temperature and Net long wave radiation in location I

Figure 1 shows how the outgoing long wave radiation varies with air temperature. The first highest value of air temperature attained in the year 2009 which has the value 31.85°C. The second highest value attained in the year 2017 (29.65°C). The lowest value obtained in the year 2012 (22.98°C). But the highest value of outgoing long wave radiation occurred in the year 2012 (3.77$MJm^{-2}d^{-1}$). The lowest value of outgoing long wave radiation was occurred in the year 2007 (1.71 $MJm^{-2}d^{-1}$).The outgoing long wave radiation for the year 2009 and 2017 was in the range 2.46 $MJm^{-2}d^{-1}$ and 2.01 $MJm^{-2}d^{-1}$ respectively. Comparing the outgoing long wave radiation and air temperature the lowest value of air temperature shows the highest value of outgoing long wave radiation it may due to cloud coverage of the environment, because the cloud cover also affect the outgoing long wave radiation

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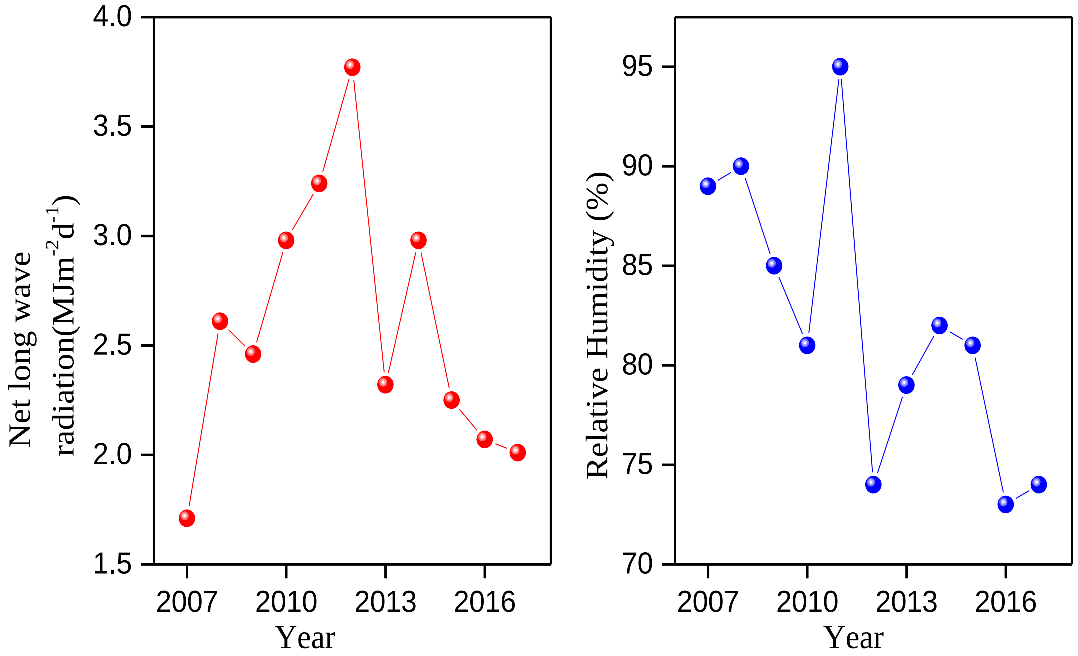

Figure 2 Variation of Relative humidity and Net long wave radiation in location I

The variation of Relative humidity with Net long wave radiation is shown in the figure 2. The maximum value of Relative humidity was obtained in the year 2011.In 2011 the Net long wave radiation is 3.24 MJm^{-2}d^{-1}. The minimum value of Relative humidity obtained in the year 2012 and 2017. While in Net long wave radiation for the year 2012 and 2017 are 1.71 MJm^{-2}d^{-1} and 2.01 MJ m^{-2}d^{-1}.

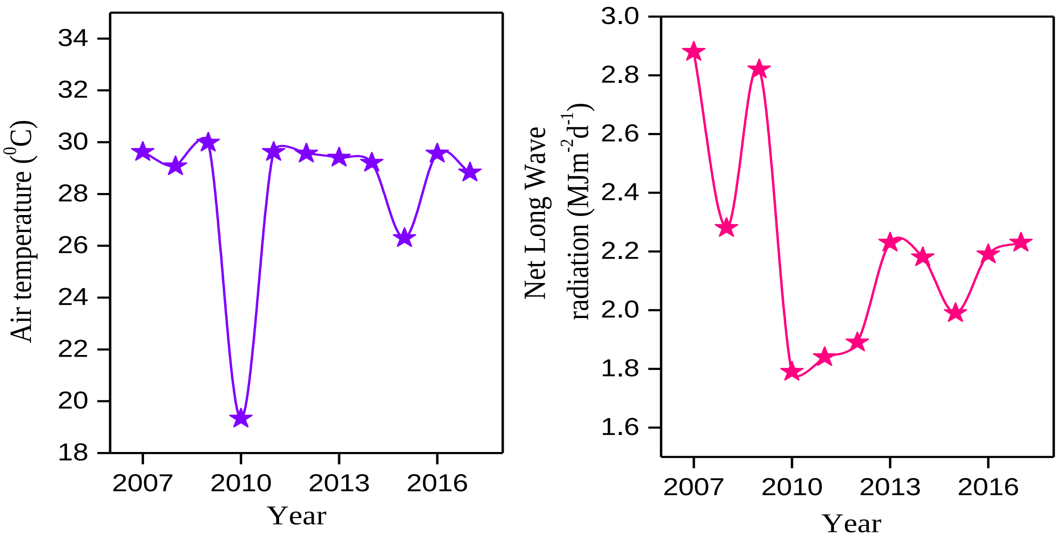

Figure 3 Variation of Air temperature and Net long wave radiation in location II

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The comparison of Net long wave radiation and air temperature for the location II was shown in the figure 3.The highest value of air temperature 29.56 °C occurred in the years 2013 and 2014 during the study period. For the Net long wave radiation the value is 2.23 $MJm^{-2}d^{-1}$ for the same two years which is the second highest value of net long wave radiation in the study period. The lowest value of air temperature occurred in the year 2011 (25.05°C) but the Net long wave radiation value for the year 2011 is 1.89 $MJm^{-2}d^{-1}$.This shows the Net long wave radiation varies with respect to air temperature.

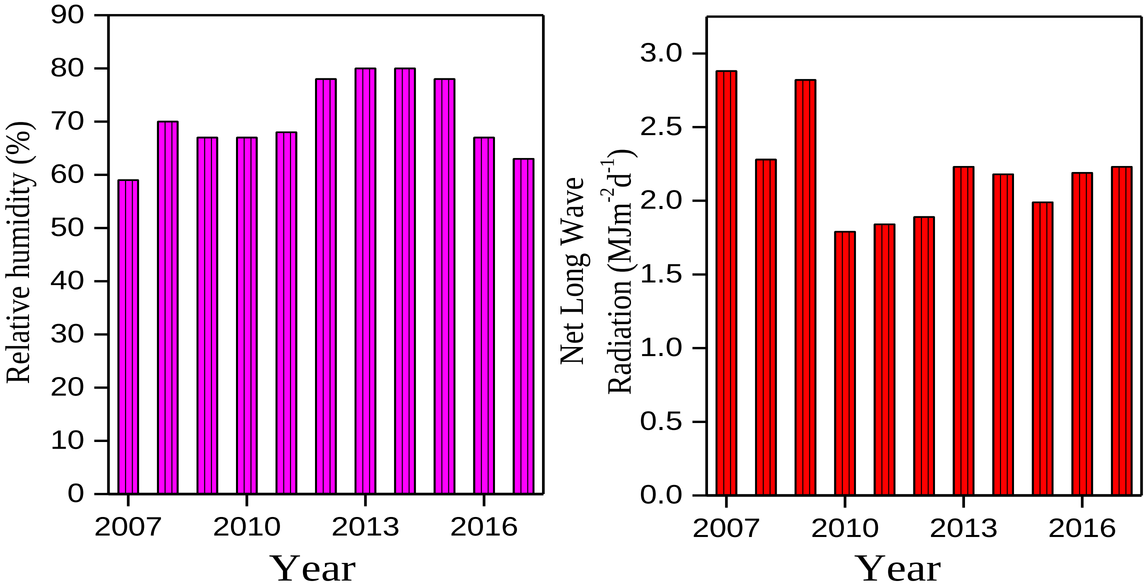

Figure 4 Variation of Relative humidity and Net long wave radiation in location II

The variation of Relative humidity and Net long wave radiation for the location II during the study period 2007- 2017 was shown in the figure 4. The figure 4 shows the ups and down in Relative humidity and Net long wave radiation. The maximum Relative humidity obtained in the years 2012 and 2014 which has the value of 80%.The minimum Relative humidity 59% is obtained in the year 2007.The maximum value of Net long wave radiation occurred in the year 2007 which shows that the Net long wave radiation increases with decreasing of Relative humidity.

4. CONCLUSION

The main purpose of this paper was to calculate the variation of Net long wave radiation from air temperature Relative humidity for the two locations during the study period (2007-2017). Comparing the two locations, the location I shows the highest value of Net long wave radiation than the location II. The highest value of Net long wave radiation occurred in the year 2012 in the location I. For the location II the highest value obtained in the year 2007 and for the location II the Net long wave radiation increasing with decreasing Relative humidity. It can be conclude that the air temperature and Relative humidity can affect directly are indirectly Net long wave radiations through change in climatic.

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