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STUDY OF EVAPOTRANSPIRATION OVER TELANGANA AND RAYALASEEMA REGIONS FOR THE YEAR 2019

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Abstract
This paper emphasizes the connection of evapotranspiration (ET) with some parameters over Telangana (TN) and Rayalaseema (RAYAL) regions. The parameters which we have utilized to study the ET parameter are rainfall (RF), soil moisture(SM), latent heat flux (LF), sensible heat flux (SF) and temperature (TEMP). The NASA's Global Land Data Assimilation System (GLDAS -2.1) dataset was utilized in this study during the year 2019. It is a very essential dataset for analyzing the water resources. The Telangana region is having more ET, SM and RF when compared to Rayalaseema region for 2019. Rainfall has shown 0.80 correlation with ET whereas LF, SM parameters showed 0.93 correlation with ET. ET is having less correlation with temperature when compared to other parameters in this study.

Keywords: Evapotranspiration, Monsoon, Latent heat, Sensible heat, GLDAS.

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INTRODUCTION

Water is an important element for all the living organisms on the earth. It plays a vital role in natural processes. It also helps in maintaining the hydrological balance. As the world's population has increased, the exploitation of water resources also increased. As a result, the scarcity of water resources occurs throughout the planet. This also reduced the quality of water. Recent studies reveals that almost 1/3rd of the global population are facing the shortage of water resources [1]. As we know that the extreme climate changes like elnino have intensified the shortage of water resources. According to a report by World Meteorology Organization (WMO), the scarcity of water resources is the biggest problem in many metropolitan cities. Almost 50% of people living in the metropolitan cities will face water scarcity by 2050. SO improving water resources for future generations has become a tough challenge for today's generation [2].

Rainfall is the major source for filling the water resources from atmosphere to earth's surface. This water flows on the land surface and reaches the rivers. When the water changes its state from liquid state to gaseous state (vapor), it is known as evaporation. The water from rivers evaporates and forms as clouds in the atmosphere. The excess water present in the plant's leaf surface is exhaled into the atmosphere as water vapor which is known as transpiration. The combination of evaporation and transpiration is called as evapotranspiration (ET). There are two types of ET. One is evaporation of water from soil surface and leaf surfaces of crop plants. Second type is maximum amount of water vapor losses from green vegetation lands. This is also known as Potential evapotranspiration (P_{ET}) [3]. Another major source of water vapor in the atmosphere is due to ET. All these processes contribute for the hydrological cycle on the earth's surface. Out of all the major water processes that contribute for hydrological cycle, ET plays a vital role in maintaining global hydrological balance. ET also operates the energy cycle from surface to the atmosphere [4]. So, continuous monitoring of evaporation rate is important for maintaining the water resources for agricultural based countries like India [5]. The ET parameter is influenced by many factors like temperature, humidity, wind speed and radiation. Lysimeters are mostly used for measuring ET [6]. Rao et al. have presented the results in their earlier studies [7-18].

As per Indian Meteorological Department (IMD), the climate of India has been divided into four seasons. (a) Winter season (December + January + February: DJF), (b) Pre-monsoon season (March + April + May: MAM), (c) Monsoon season (June + July + August + September: JJAS), (d) Post-monsoon season (October + November: ON) [19]. The basic objective of this study is to analyze the NASA's GLDAS 2.1 products in estimating the ET. We also tried to analyze the parameters like soil moisture, rainfall, temperature, latent heat flux and sensible heat flux. An attempt was made to understand the influence of other parameters on ET over TN and RAYAL.

DATA

NASA's Global Land Data Assimilation System Version 2 (GLDAS-2) products have three components namely GLDAS-2.0, GLDAS-2.1 and GLDAS-2.2. The GLDAS-2.0 product includes Princeton meteorological forcing input data which is available from 1948 to 2014 [20]. The GLDAS-2.1 product is a combined version of model and observation data which is available from 2000 to present. The GLDAS-2.2 product uses data assimilation (DA) techniques for giving data for different variables. The GLDAS products produce data for many variables such as precipitation, near-surface air temperature, downward shortwave and long wave radiation, specific humidity, wind speed, and surface pressure. In this study, the complete analysis was done on the TN region and RAYAL region. The TN region extends from 16 to 20° N latitudes and 77 to 82° E longitudes whereas RAYAL region lies between 12.5 and 16.5° N latitudes and 76 and 80.2° E. The monthly GLDAS-2.1 data was collected at 1.0° by 1.0° resolution for the year, 2019 [21].

METHODOLOGY

We have used water balance method for estimating evapo [22, 23] as shown in (1).

$$ET(w) = P - R - \Delta S \quad \text{--------} \quad (1)$$

Where ET (w) is the estimated value of ET by using the water balance method, P is the total precipitation (mm), R is the total stream flow and ΔS is the change in terrestrial water storage (TWSC).

RESULTS AND DISCUSSION

The monthly gridded GLDAS-2.1 data at 1.0 degree (~100 km) was collected for the AP region which is monitored for entire 2019. The results of this analysis were presented below:

An attempt was made to analyze the ET parameter as shown in Fig.1. In winter season, the mean ET values were ranging between 20 and 35 mm over TN and RAYAL. During pre-monsoon season, the ET values were below 25 mm over TN and RAYAL. It was observed that high mean ET values ranging from 90 to 115 mm were seen over TN during monsoon season. The ET values were ranging between 70 and 85 mm over RAYAL during monsoon season. During post-monsoon season, the ET values were ranging between 99 and 117 mm over TN and RAYAL.

In Fig.2, the monthly RF was shown and analyzed. In winter season, the mean RF values were ranging between 5 and 50 mm over TN and RAYAL. RAYAL was having better rainfall than TN in winter season. During pre-monsoon season, the RF values were below 100 mm over TN and RAYAL. It was observed that high mean RF values ranging from 700 to1100 mm were seen over TN during monsoon season. The RF values were ranging between 500 and 700 mm over RAYAL during monsoon season. During post-monsoon season, RAYAL has better rainfall than TN. RAYAL records from 150 to 240 mm RF values whereas TN records from 120 to 180 mm rainfall. TN receives more rainfall than RAYAL region which is supported by high ET values in 2019. Almost 0.82 correlations were observed between ET and RF.

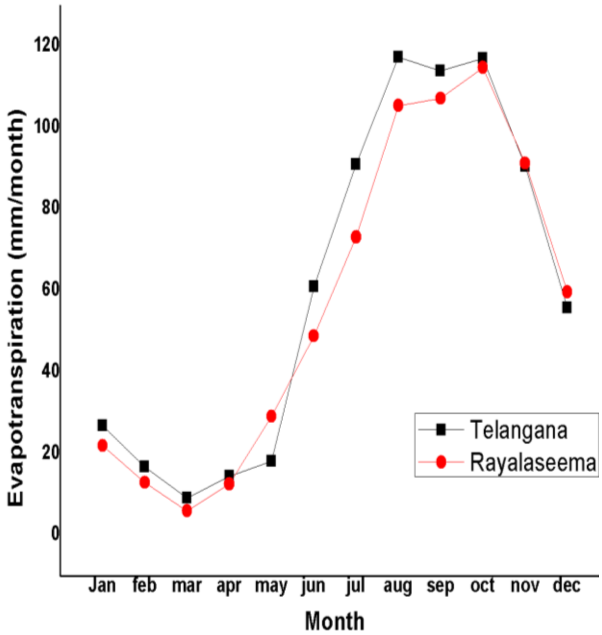
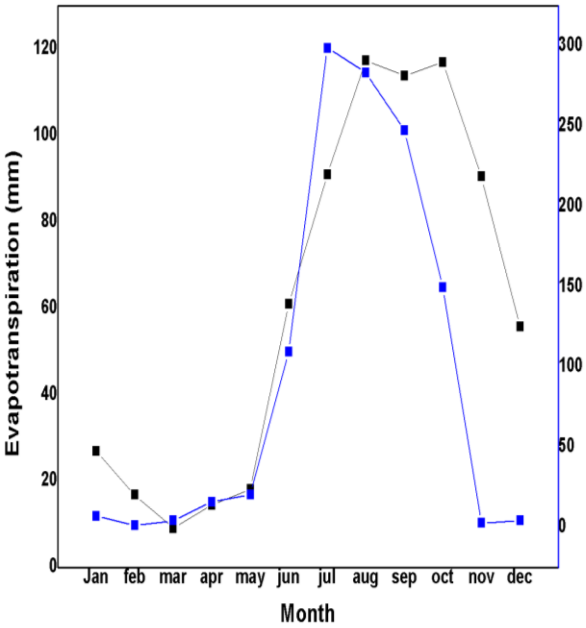
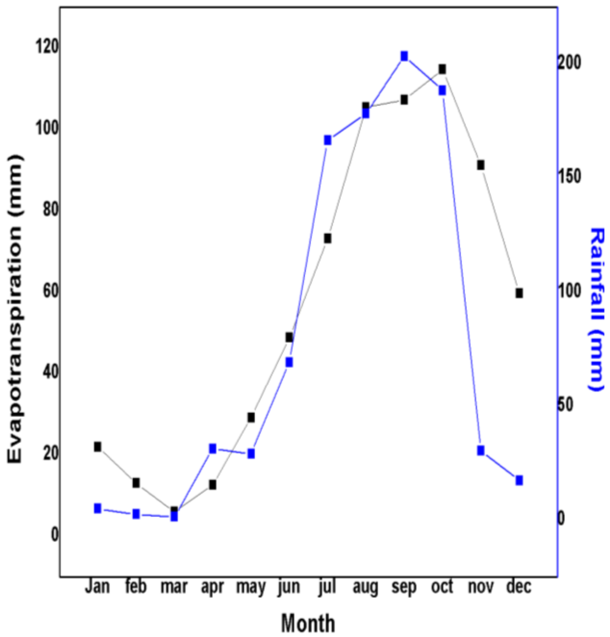


Fig.1 Monthly variations of ET on TN andRAYAL regions for the time period 2019.

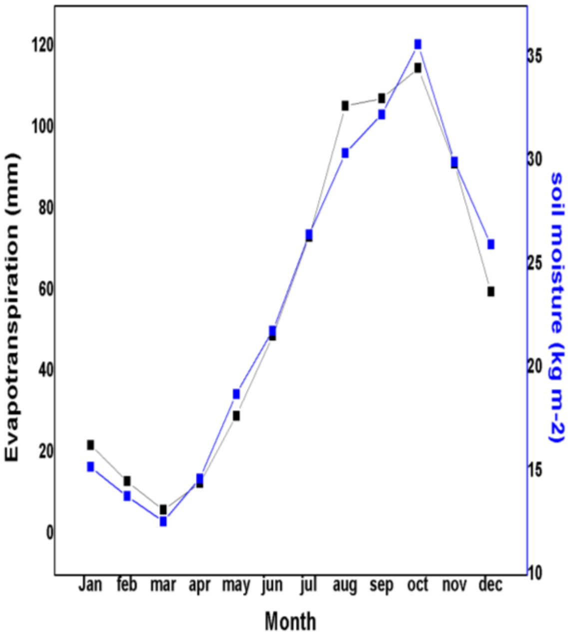


(b)

Fig. 2 Monthly variations of ET and RF on (a) RAYAL region, (b) TN region for the time period 2019.

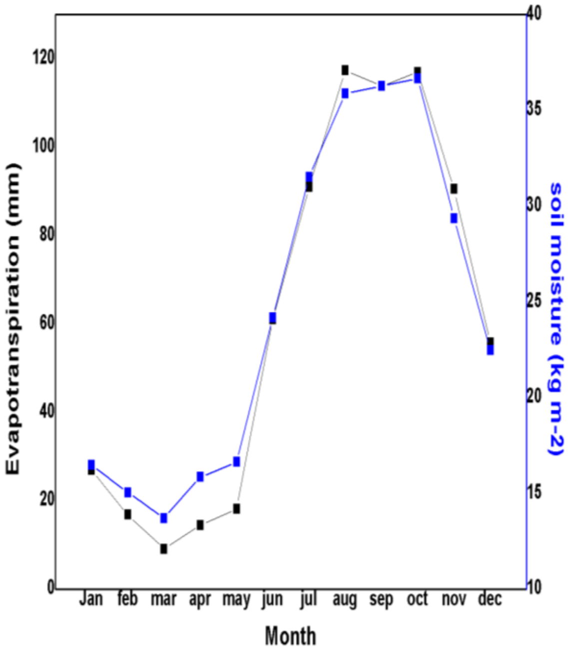


(a)



(a)

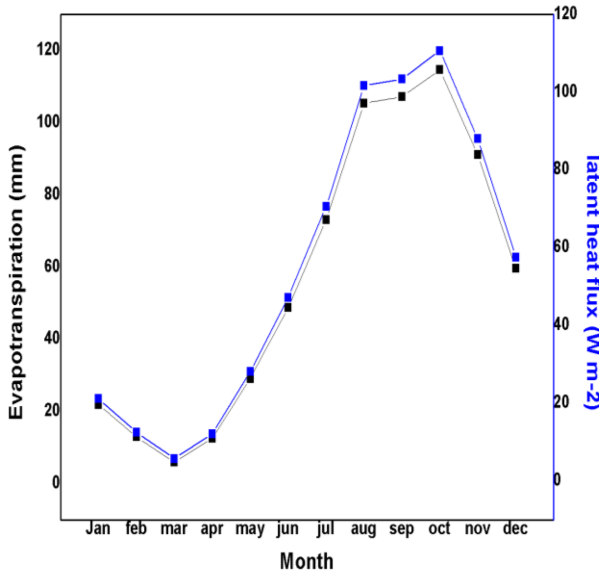
In Fig. 3, the mean seasonal SM values were displayed in spatial plots. In winter season, the mean SM values were low in TN when compared to RAYAL. The values were ranging between 15 and 24 kg m^{-2} over TN and RAYAL. During pre-monsoon season the north-east TN and northern RAYAL recorded 16-18 kgm^{-2} SM values. It was observed that high mean SM values ranging from 30 to 36 kgm^{-2} were seen over TN during monsoon season. The SM values were ranging between 25 and 30 kgm^{-2} over RAYAL during monsoon season. During post-monsoon season, the SM values were ranging between 30 and 36 kgm^{-2} over TN and RAYAL. The north-east TN and northern RAYAL are recorded good SM values in monsoon and post monsoon seasons. Almost 0.92 correlations were observed between ET and SM for the year 2019.



(b)

Fig. 3 Monthly variations of ET and SM on (a) RAYAL region, (b) TN region for the time period 2019.

In Fig. 4, the mean seasonal LF values were plotted. In winter season, the mean LF values were ranging between 20 and 35 Wm^{-2} over TN and RAYAL. During pre-monsoon season, the LF values were below 15 Wm^{-2} over TN and RAYAL.



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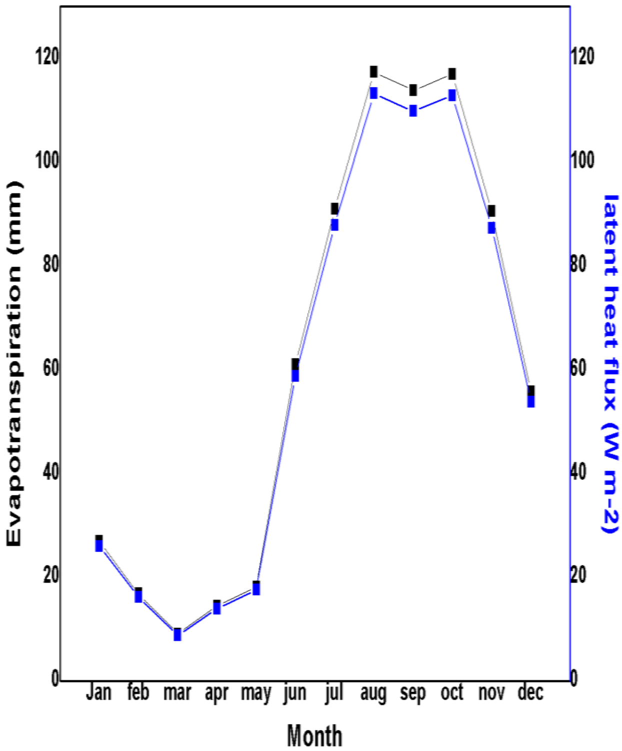


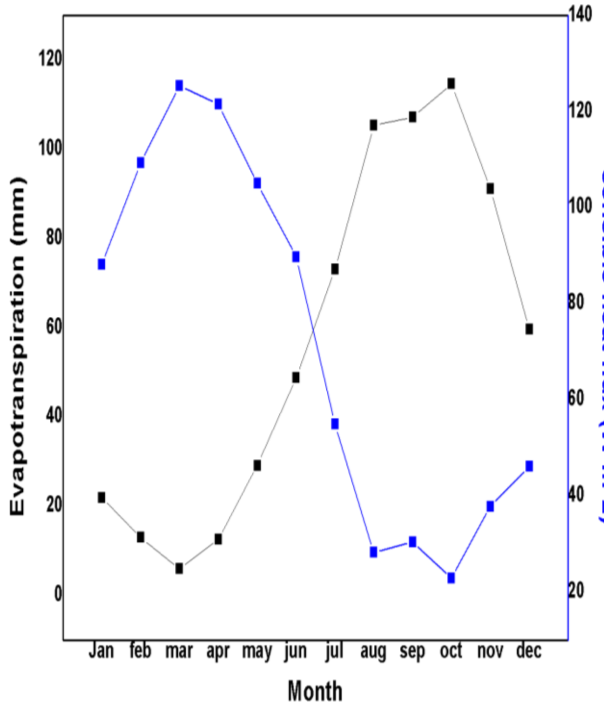
(b)

Fig. 4 Monthly variations of ET and LF on (a) RAYAL region, (b) TN region for the time period 2019.

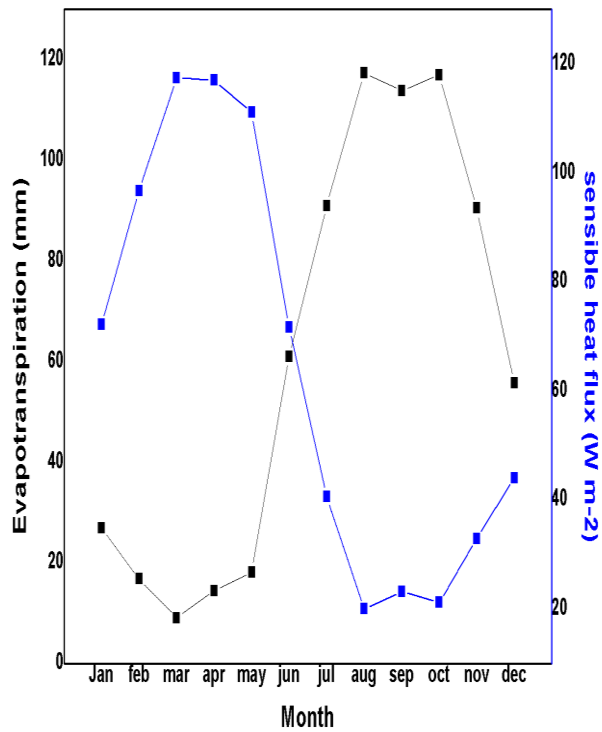
It was observed that high mean LF values ranging from 80 to 110 Wm^{-2} were seen over TN during monsoon season. The LF values were ranging between 65 and 85 Wm^{-2} over RAYAL during monsoon season. During post-monsoon season, the LF values were ranging between 85 and 111 Wm^{-2} over TN and RAYAL. Almost 0.95 correlations were observed between ET and LF for the year 2019.

In Fig. 5, the mean seasonal SF plots were analyzed. In winter season, the mean SF values were ranging between 70 and 85 Wm^{-2} over TN and RAYAL. During pre-monsoon season, the SF values were ranging between 105 and 125 Wm^{-2} over TN and RAYAL. It was observed that low mean SF values ranging from 25 to 40 Wm^{-2} were seen over TN during monsoon season. The SF values were ranging between 40 and 60 Wm^{-2} over RAYAL during monsoon season. During post-monsoon season, the SF values were ranging between 21 and 39 W m^{-2} over TN and RAYAL. Almost 0.91 negative correlations were observed between ET and SF for the year 2019.

An attempt was made to analyze the mean seasonal TEMP as shown in Fig. 6. In winter season, the mean TEMP values were ranging between 22 and 24.5 °C over TN and RAYAL. During pre-monsoon season, the TEMP values were above 32 °C over TN and RAYAL. It was observed that high mean TEMP values ranging from 32 to 35 °C were seen over TN during pre-monsoon season. In monsoon season, the mean TEMP values were ranging between 27 and 29.5 °C over TN and RAYAL. During post-monsoon season, the TEMP values were ranging between 23 and 25 °C over TN and RAYAL. Almost 0.45 correlations were observed between ET and TEMP for the year 2019.

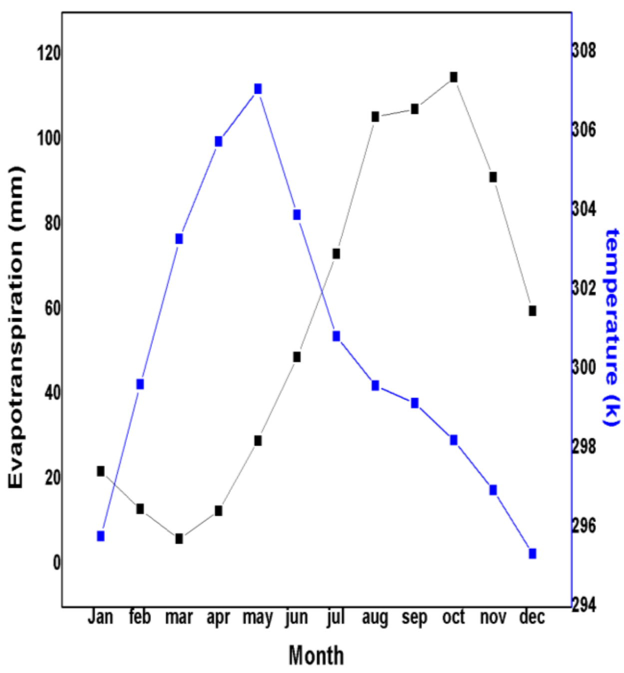


(a)



(b)

Fig. 5 Monthly variations of ET and SF on (a) RAYAL region, (b) TN region for the time period 2019.



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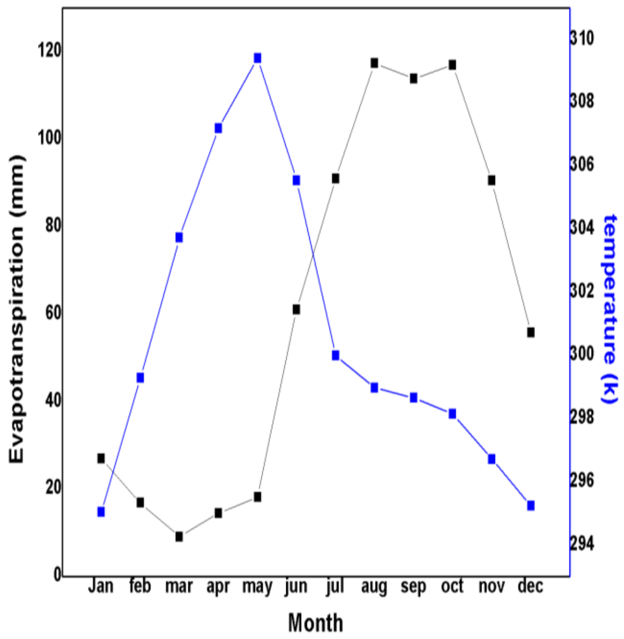

(b)

Fig. 6 Monthly variations of ET and TEMP on (a) RAYAL region, (b) TN region for the time period 2019.

CONCLUSION

The NASA's GLDAS 2.1 products were analyzed and monitored for the time period, 2019. An attempt was made to analyze evapotranspiration (ET) and its association with other parameters like soil moisture, rainfall, temperature, latent heat flux and sensible heat flux over TN and RAYAL regions.

During monsoon and post-monsoon seasons, high ET values were seen over TN and RAYAL regions. Rainfall is having good correlation with ET parameter. Even RF values also follow the same trend of ET parameter. High availability of soil moisture is seen over monsoon and post-monsoon seasons over TN and RAYAL regions. The north-east TN and northern RAYAL has shown high SM values. The latent heat net flux values higher in post-monsoon season than monsoon season. The sensible heat flux values were very low in post monsoon season than monsoon season. In fact, the sensible heat flux parameter is having strong negative correlation with ET. High temperatures values were seen in pre-monsoon season over TN and RAYAL.

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