GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES

A METHODOLOGICAL ASSESSMENT OF EXCESS HEAT FACTOR INDEX (EHF)

M. Sakthivel[*1], Dharani G[2] & Manoj Hari[3]
[*1]Associate Professor, University of Madras, India
[2&3]M.Sc. Student, University of Madras, India

ABSTRACT

Heat-wave is an important meteorological factor characterized by presence of abnormal heat, which has caused death historically over Indian region. Rising temperature on a global scale plays a vital role in increased frequency, duration and intensity of heat-waves. Excess heat factor calculation is used to identify the presence of heat waves. Different data sets such as satellite data and Station data are used for the analysis.

Keywords: *Heat-wave, EHF, Heat stress, Excess heat*

I. INTRODUCTION

Heat-wave is the weather condition occurring in earth's atmosphere which is characterized by increase in temperature to extreme level which adversely distresses living organisms. Human body disagree to adapt this sudden heat, this in turn causes disorder and demise. Globally surface temperature increased to 0.85°C over the period 1880-2012, the major reason is attributed to the increase of greenhouse gases in our earth (IPCC 2014). In India, state-wise average annual mean maximum temperature time-series shows increasing trends over many states of India (ref). Anthropogenic activities contribute majorly for these extreme events since mid-20th century (IPCC 2014). India ranks third among the world countries that are most frequently hit by natural disasters. In 2016, 17 natural disasters occurred over Indian region (ADSR-2016). Heat-waves plays a dominant role every year in these natural disaster events. Due to heat-waves more people are affected and in worst case death incidents are occurred. In the year 2016, 300 deaths occurred due to heat waves in the month of April which is incomparable to May 2015 which caused 2248 deaths in one event (ADSR-2015, 2016). Common health issues caused due to heat are stress, cramps, exhaustion, and syncope. Notable deadly illness caused due to extreme heat is 'Heat stroke', which causes death to all age group of people (AHAP-2016).

IMD defined Heat wave as the Period, when normal maximum temperature of a station is less than or equal to 40°C, where departure from normal is 5°C to 6°C is considered as the period of Heat wave and 7°C or more is considered as days of Severe Heat wave. Similarly, when normal maximum temperature is above 40°C where departure from 4°C to 5°C and 6°c is considered as a period of Heat wave and severe heat wave respectively.

When actual maximum temperature remains 45°C or more irrespective of normal maximum temperature is considered as Heat wave period, whereas in coastal regions when the maximum temperature of 40°C is reached it is declared as a period of Heat wave (MAUSAM-69).

II. DATA USED

Station data

Gridded daily temperature dataset (1969-2013) developed by Indian Meteorological department has been used in this study as climatology data to find out heat waves over selected parts of Indian region (Srivastava et al.2009). Mean temperature data for the months of March April May June (MAMJ) is averaged for each grid and it is used to create (T95) i.e. 95th percentile is calculated. In EHF it is used as a long term anomaly.

INSAT-3D data

To analyze heat waves present in Indian region INSAT-3D L2B_LST data for the years 2015-2018 in the calendar days of March, April, May, June has been used as base data. As heat wave analyzation requires air temperature, an equation is derived from *NCEP reanalysis climatological data* using Air temperature at 2m and Land surface temperature

Derived equation from above data

0.96811731X+8.80230379

In the place of 'X' land surface temperature(LST) data is substituted and new surface air temperature data (Air_T2m) data is derived for finding out heat wave. Newly derived air temperature dataset which is at the resolution of 0.0360° x 0.0360° (4km x 4km) is regretted to 1° x 1° due to the availability of climate data set on that resolution. Processed 2m Air temperature data from INSAT-3D_LST is used in this study.

III. METHODOLOGY

Excess heat

Abnormal raising trend of heat found in some spatial location is termed as excess heat. Excess heat is the period where high heat arising from a daytime temperature that is not sufficiently discharged overnight due to unusually high overnight temperature. Daily mean temperature (DMT) i.e. Maximum and Minimum temperature $(T=Tmax+Tmin/2)$ for three days is averaged to obtain three-day period temperature (TDP).

TDP together with climatological 95th percentile of the particular period (daily mean temperature for 1961-2013) is subtracted to obtain excessive heat index.

Significant excess heat or heat waves presence is recognized when EHIsig shows positive value. It indicates high temperature present over that region on a particular day.

$EHIsig= (Ti+Ti\text{-}1+Ti\text{-}2)/3 - T95$ (1) Units of EHIsig and DMT are °C.
Where Ti is the daily mean temperature and T95 is the climatology data as mentioned above.

Heat stress

Heat acclimatization refers to the biological adaptation that reduce physiological strain from heat injury. Usually it takes 2-6 weeks for people to adapt to changing weather conditions. In this index heat acclimatization is calculated to identify heat stress presence on the three-day period with reference to previous thirty days (4 weeks). From this index past weather is also calculated so that people adaptation to heat wave is considered.

$EHIaccl = (Ti+Ti\text{-}1+Ti\text{-}2)/3-(Ti\text{-}1 + \ldots\ldots\ Ti\text{-}30)/30$ (2)
Units of EHIaccl are °C.

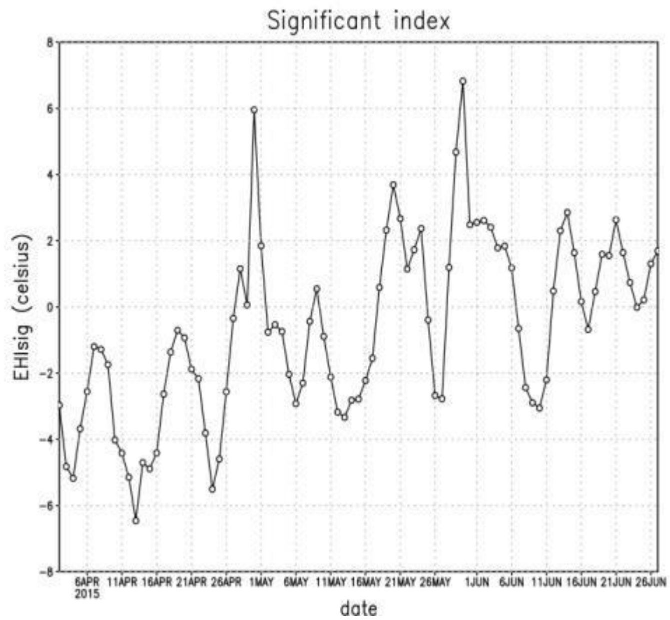
Where EHIaccl is the calculated anomaly which indicates three days averaged daily mean temperature with reference to past 30 days, Ti is the daily mean temperature mentioned in previous index. If EHIaccl is positive that represents the presence of heat stress, i.e. high temperature on that day compared with previous month, whereas negative value indicates low temperature.

Excess Heat factor (EHF)

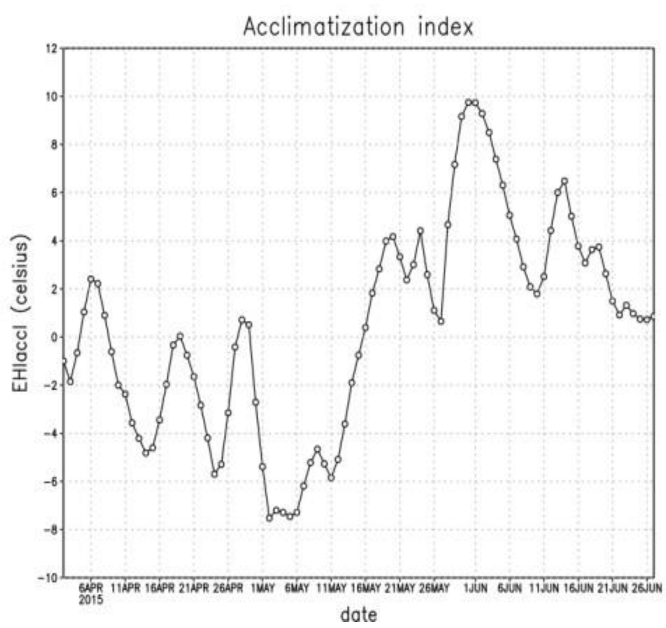
Excess heat and heat stress conjointly creates new index called excess heat factor, Where the long-term comparison and recent past comparison values are obtained. Multiplying EHIsig and EHIaccl produces resulting value for EHF.
$EHF = EHIsig \times max(1, EHIaccl)$ (3)

Positive EHF value indicates the presence of heat waves, whereas negative value indicates the no presence of heat wave. Significance value and acclimatization values directly influences the Excess heat factor.

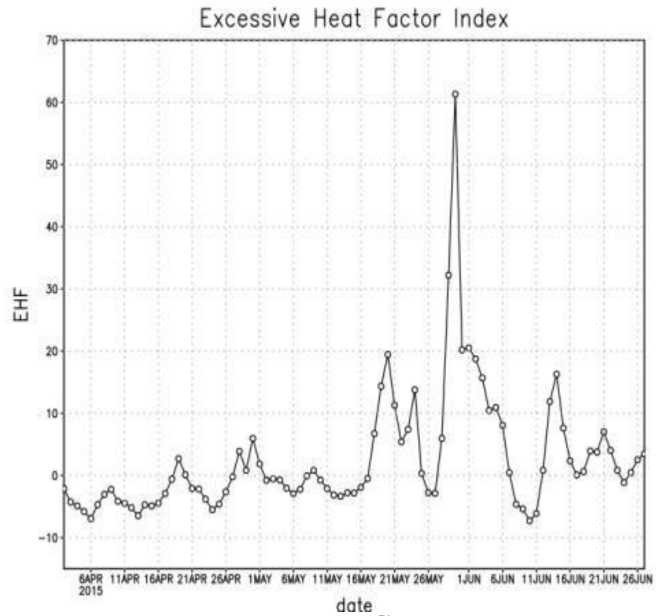
ISSN 2348 – 8034
Impact Factor- 5.070



a)



b)



C)

Figure 1. Calculation of different indices to get significant heat, heat stress and excess heat days for the year 2015 on the moths April, May, June. a) Significant index b) Acclimatization index c) Excessive heat factor index.

IV. CONCLUSION

Heat-waves are increasing in most of the places, proper planning is required to face these extreme events. From this study it is found that year 2017 consists of frequent, high intensity and long duration heat-waves compared with all other years. Year 2018 faces likely less number of heat-waves. In general, on May 2017, over coastal eastern parts most of the days consists of rainfall and high temperature it is found to be due to convectional rainfall influence and land-sea breeze activities, due to the presence of rainfall people feel comforted although high temperature is observed, during this season comparatively low death rate is observed. North western parts low cloud is observed and less rainfall accompanied by high temperature.

V. ACKNOWLEDGEMENTS

The Authors thank for the support given by the scientists of Satellite Meteorology and Oceanography Research and training division and Staff of Department of Geography, University of Madras.

REFERENCES

1. *Srivastava, A. K., Rajeevan, M. & Kshirsagar, S. R. Development of a high resolution daily gridded temperature data set (1969–2005) for the Indian region. Atmos Science Lett. doi: 10.1002/asl.232 (2009).*
2. *John R. Nairn 1, * and Robert J. B. Fawcett 2,3 "The Excess Heat Factor: A Metric for Heatwave Intensity and Its Use in Classifying Heatwave Severity" Int. J. Environ. Res. Public Health 2015.*
3. *MAUSAM, 67, 2 (April 2016), 513-528*
4. *MAUSAM, 69, 2 (April 2018), 335-358*
5. *AHMEDABAD HEAT ACTION PLAN 2016*
6. *J. V. Ratnam 1, Swadhin K. Behera 1, Satyaban B. Ratna 1, M. Rajeevan 2 & Toshio Yamagata "Anatomy of Indian heatwaves" scientific reports, April 2016.*
7. *CLIMATE CHANGE and EXTREME HEAT EPA October 2016.*