PRACE ORYGINALNE
ORIGINAL PAPERS

Scientific Review – Engineering and Environmental Sciences (2017), 26 (4), 415–422
Sci. Rev. Eng. Env. Sci. (2017), 26 (4)
Przegląd Naukowy – Inżynieria i Kształtowanie Środowiska (2017), 26 (4), 415–422
Prz. Nauk. Inż. Kszt. Środ. (2017), 26 (4)
http://iks.pn.sggw.pl
DOI 10.22630/PNIKS.2017.26.4.40

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Trends in mean maximum temperature, mean minimum temperature and mean relative humidity for Lautoka, Fiji during 2003–2013

Key words: climate change, statistical downscaling, temperature trends, time series, water vapor

Introduction

Temperature change is a popular metric for summarizing the state of global climate. The preceding two to three decades has seen numerous researches pertaining to the character of climatic variations and leanings of surface air temperature in diverse areas of the Earth at diverse time scales. The present type of temperature change research has been given much attention globally in the past few decades due to its impact on global warming, socio-economic issues and natural resources. It also brings on numerous trend revealing studies on air temperature time cycles to assess and validate climate change apprehension. According to the assessment report, 2012, presented by the Intergovernmental Panel on Climate Change (IPCC), worldwide regular surface temperature would likely to rise from 2° to 4.5°C by 2100 (Stocker et al. 2013).

Commonly, changes in climatic situations are rough in resolution and may not necessarily be regularly or directly applied to local scale studies to recognize the possible influence of the climate change. Several studies established that the detected heating trend during the last hundred years happened largely because of the enhancement in the average seasonal minimum temperatures relatively than the average seasonal maximum temperatures (Daly, Conklin & Unsworth, 2010; Tang & Arnone, 2013; Sawadogo et al. 2014). These changes were related to numerous reasons like global warming, amplified concentrations of anthropogenic greenhouse gases, aerosols (that may also wield cooling effects on the climate in various circumstances), enhanced cloud cover and development. In the South Pacific region, the disparities of the air temperature for the past few decades emerge to be analogous to the disparities of temperature which have been witnessed globally.

Lautoka is small part of Fiji but still have a substantial share of agricultural land of the nation. The city day-to-day dataset requirements are to be judiciously observed to expose local climate changes so as to support studies on scenario construction and influences of definite regions. This investigation is beneficial to appeal consciousness of local government and to match outcomes with those in other regions of the country, henceforth adding up to the national study. Fiji is dependable with the global warming circumstances and too has also encountered warming up in the last century.

Meteorologists indicate the amount of moisture in the atmosphere in many different ways. One of this is the relative humidity (RH), which is the most frequently contributed dimension of humidity as it is frequently used in weather forecasts. It is a vital portion of weather information since it specifies the probability of precipitation, dew, or fog. The relative humidity determines the amount of water vapour present in air which is expressed as a percentage of the amount of vapour needed for saturation at the same temperature (Miloshevich, Paukkunen, Vömel & Oltmans, 2004).

Recently, Fiji's daily surface air temperature data and relative humidity with a thick surveillance network and steady observation practices have become accessible to the scientific diaspora. In the current work, efforts have been made to examine variations in temperature and relative humidity extremes centered on a daily temperature and relative humidity dataset obtained from Fiji Meteorological Services (FMS), Fiji during the period 2003–2013.

Aims and objectives

The objective of the current study is to investigate mean maximum temperature, mean minimum temperature along with diurnal temperature range and mean relative humidity and determine the trends in Lautoka's temperature and relative humidity during the period 2003–2013.

Material and methods

The statistics used in this research were obtained from the Nadi Centre of Fiji Meteorological Services (FMS), Fiji. The data compromises of time cycles of year wise monthly average of maximum and minimum surface air temperature as well as relatively humidity for the period ranging from 2003 to 2013 for the Lautoka weather observatory. Annual mean temperature for each year was computed from the obtained data and after that it was statistically treated for further analysis. Same procedure was adopted for calculating the average relative humidity. To know the trends in temperature and relative humidity and its effect on climate change require that data be homogenous.

Results and discussion

Annual temperature discussion

The global mean surface air temperature has escalated about 0.5°C during the last century. Investigation has revealed that this increase has given rise to, in part, from the daily minimum temperature growing at a rapid rate or declining at a slower rate than the daily maximum, resulting in a decrease in the DTR for many regions of the world.

Analogous fluctuations have been established in other parts of the world as statistics are available, permitting more global analyses (Shahid, Harun & Ayob, 2012; Qua, Wan & Hao, 2014). However, in some zones the design has been different. In parts of New Zealand (Weber et al. 1997) and alpine regions of central Europe (Zhang, Vincent, Hogg & Niitsoo, 2000), maximum and minimum temperature have enhanced at comparable rates, but in India, the DTR has grown due to the decrease in the minimum temperature (Peterson, 1998). To assess these unpredictable results, we directed an explicit investigation on the Fijian scene.

The analysis of monthly averaged maximum and minimum temperatures and the DTR at western division Lautoka station were done. For each time series from the station was exposed individually to homogeneity analyses and adjustments as per the latest developed methods (Roy & Balling, 2005). Overall, these homogeneity adjustments have slight influence on large-area averages, but they can have a clear influence on minor regions (Kim, Rao & Annable, 1999), specifically when equating inclinations at specific or neighboring areas.

The data obtained in this study covers 34% of the total western area, but still large parts of the western division that continued to be unevaluated due to deficiency of data, predominantly in the remote location, and streamlining these data remains a difficulty, as displayed by data obtained. Variations and alteration points noticed in decade term surface temperature of annual mean maximum, annual mean minimum for Lautoka are featured in this paper.

Maximum temperature is the daily recorded higher temperatures (Fig. 1), it can be realized that usually growing annual trend is expected for maximum temperature in Lautoka. Statistically treated outcomes demonstrate that there might be a general incremental trend of maximum temperature for the study site for the period of 2001–2013 in the range of 0.1–0.5°C.

We do not contemplate that the results are too reliable; nevertheless, the western wide temperature surge is obvious even with this approach. Hence, the situation approves for maximum western areas with the trend of maximum temperature change. It can also be indicated that, with respect to the impending climate in Fiji, there is great assurance that the temperature will surge, however, the present work concentrates merely on the western division.

Linearly regressed annual maximum temperature and trend the relationship

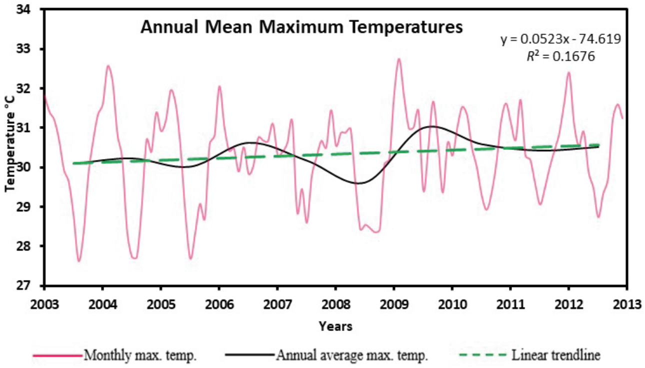

FIGURE 1. Annual mean maximum temperature

shows a regression of R^2 = 0.167. This suggests that western division has a prevailing role in the adjustment of the annual maximum temperature fields.

Minimum temperature is the daily recorded lower temperatures: with respect to minimum temperature the prospective situation does not displays associated trends through the study site. Decreasing annual trend is visible for minimum temperature with the range of from –0.1°C to –0.91°C; here the prediction shows (Fig. 2) that minimum temperatures have decreased somewhat faster than maximum temperatures. Regression analysis was done and the regression analysis shows R^2 = 0.375.

The annual mean temperature (Fig. 3) has generally decreased; this is not consistent with most of the global areas, but unique to western division of Fiji. The anomalies in the trend is dominated by the mean minimum temperatures, even though variability is observed among the mean minimum and maximum trend, generally decreasing annual trend is seen in the annual mean temperature range of 0.06–0.49°C for Lautoka.

Diurnal temperature range is the difference between the maximum and minimum temperature during the day. The local effects for instance urbanization, irrigation, desertification, and deviations in local land practice can all disturb the

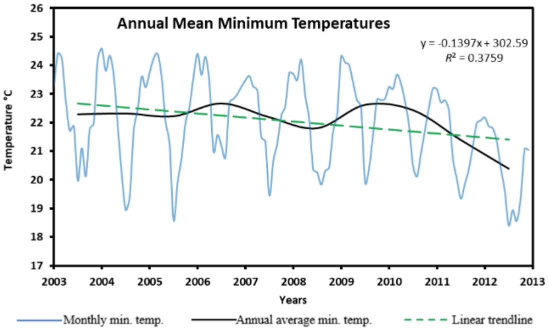

FIGURE 2. Annual mean minimum temperature

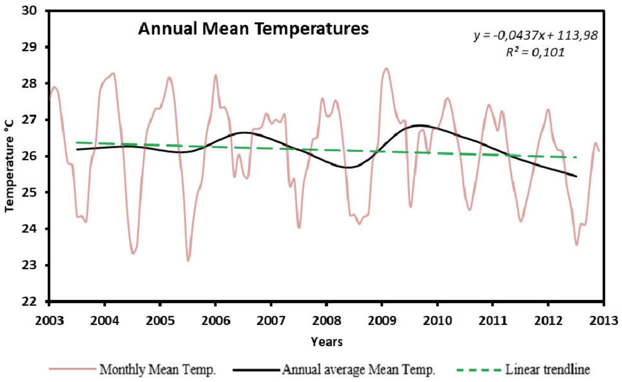

FIGURE 3. Annual mean temperatures

DTR (Chen & Kan, 2008). In precise, developed regions repeatedly indicates a slenderer DTR than proximate rural areas (Smith, Corvalán & Kjellström, 1999). Large-scale climatic effects on the DTR include increases in cloud cover, surface evaporative cooling from precipitation, greenhouse gases, and tropospheric aerosols (Mitchell & Jones, 2005; Scanlon, Reedy & Sully, 2005). The annual mean DTR (Fig. 4) for broader Lautoka area is increasing, in the given time frame the increase in DTR is in the range of 0.21––1.01°C. The trend analysis predicts future variation in the temperatures would increase at the same or higher rate with a regression of $R^2 = 0.606$.

The monthly maximum mean temperatures (Fig. 5) from 2003 to 2013 are indicated from December to March, these are the months has the higher frequency in which the maximum temperatures occur. This are the peak hot and wet months annually.

Relative humidity (RH)

The relative humidity determines the quantity of water vapour available in air which is conveyed as a percentage of the

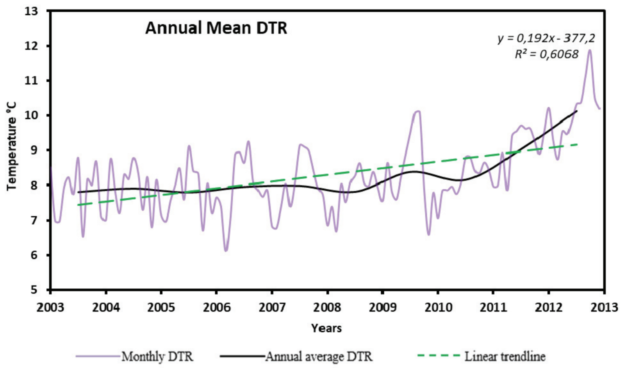

FIGURE 4. Annual mean diurnal temperature range (DTR)

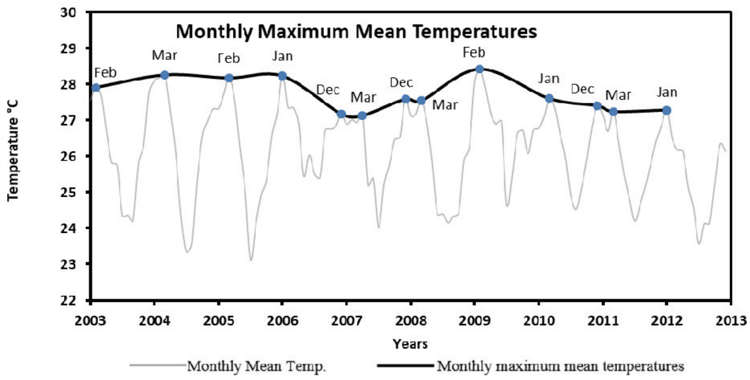

FIGURE 5. Monthly maximum mean temperature with peak maximum temperatures in respective months (The monthly mean temperatures has also been plotted for comparison purposes)

quantity of vapour needed for saturation at the identical temperature.

The relative humidity of the atmosphere over the 10 year period is shown in (Fig. 6). This clearly highlights that the water vapour content in the atmosphere is increasing at our site in Lautoka.

This could also be due to increase in temperature since when the temperature increases, the equilibrium vapour pressure of water in the atmosphere also increases. Nevertheless, the consequence of climate change is visible and an increased level of water vapour is also accounting to the increase in temperature. The atmospheric temperature and RH are inter-dependent on each other and an increase in one will always increase the other. The presence of water vapour adds to the global warming and thus to climate change (Sophie & David, 2013). Figure 6 shows that over the 11 year period, the overall annual RH is growing at a speed of 0.06% each year. Over this period, the mean RH has increased 5%, from 69% in 2003 to 74% in 2013. There were some fluctuations due to seasonal variances and changes in short-lived weather patterns. The predictability of RH is not good; however, the general trend of in-

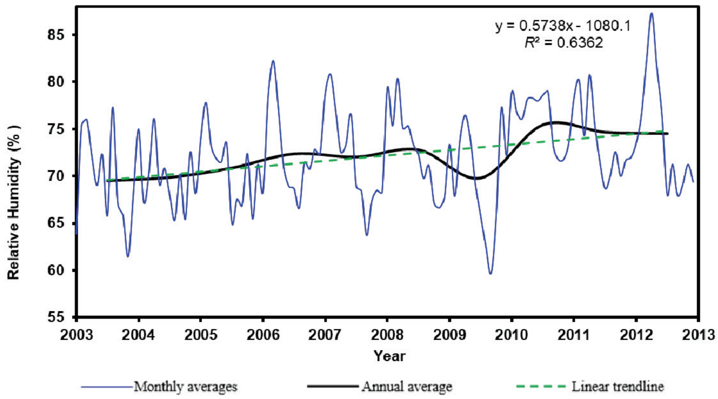

FIGURE 6. Yearly mean relative humidity

crease in RH is lucid. This effect is not favorable and hence enhances the concerns of climate change. The changes are noticeable in Fiji and the increase in RH does contribute to this as the vicious cycle of increase in RH is incessant.

Acknowledgement

Authors thankfully acknowledge the support from Fiji Meteorological Services (FMS), Fiji for providing mean maximum temperature, mean minimum temperature and mean relative humidity for Lautoka, Fiji during 2003–2013, and University of Fiji, Fiji for giving us this opportunity with a valuable platform enabling successful conduct of this research.

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Summary

Trends in mean maximum temperature, mean minimum temperature and mean relative humidity for Lautoka, Fiji during 2003–2013. The current work observes the trends in Lautoka's temperature and relative humidity during the period 2003–2013, which were analyzed using the recently updated data obtained from Fiji Meteorological Services (FMS). Four elements, mean maximum temperature, mean minimum temperature along with diurnal temperature range (DTR) and mean relative humidity are investigated. From 2003–2013, the annual mean temperature has been enhanced from 0.02° to 0.08°C. The heating is more in minimum temperature than in maximum temperature, resulting in a decrease of diurnal temperature range. The statistically significant increase was mostly seen during the summer months of December and January. Mean relative humidity (MRH) has also increased from 3 to 8%. The bases of abnormal climate conditions are also studied. These bases were defined with temperature or humidity anomalies in their appropriate time sequences. These established the observed findings and exhibited that climate has been becoming gradually damper and heater throughout Lautoka during this period. While we are only at an initial phase in the probable inclinations of temperature changes, ecological reactions to recent climate change are already evidently noticeable. So it is proposed that it would be easier to identify climate alteration in a small island nation like Fiji.

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