Ambient Temperature Environment as a Possible Causative Factor for Human Origin and Its Implications for Life's Adaptability to Projected Climate Conditions

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Abstract

The establishment of baseline environmental conditions for plants and animals may be necessary in studying more meaningfully their migratory reactions to projected climate conditions that could be different from accustomed conditions. A better understanding of the environmental conditions that affected or controlled the evolutionary behavior and existence of life on earth is likely to ease the daunting uncertainty in determining the incremental effects of projected climate conditions on it. By analyzing the favorability of historical average temperature regimes for functional homeostasis in humans, the current work attempts to present natural ambient temperature environment as a possible causative factor for life's origin. This analysis is based on a thesis that the natural environmental conditions that favorably work today for humans had historically similar characteristics. On the basis of this thesis, it formulates and characterizes functional homeostasis regime in humans using present day's data. It applies the characterization to 36 city locations around the world to spot identify those locations that would have been naturally more favorable for the evolutionary processes in humans. The result shows that Addis Ababa, Ethiopia, has the most favorable environmental setting from these locations that would have helped functional homeostasis processes in humans. This finding is consistent with those from other kinds of analyses including deoxyribonucleic acid (DNA) and linguistics. As we try to draw a picture of past-future continuum of life on earth, this finding may serve as helpful evidence for and lead to the emerging quest to better understand the evolutionary forces that shaped and maintained it.

Introduction

Past studies on early human migration, including DNA analysis (Zhong, et al., 2010; Li, et al., 2008; Jakobsson, et al., 2008; Liu, et al., 2006), attempt to point to the geographical source of this migration. Africa, in general, and East Africa, in particular, have been noted to be the earliest habitats for the world's human population. A possible set of causative factors that made the continent and region more favorable homes for early hominids remains to be conclusively identified. Such identification is likely to have profound implications for the world's existing bio-diversity and its adaptability to projected environmental conditions.

It is presumed herein that the environmental condition that worked better in the past for bio-diversity is likely to work better in the future. Thus, this paper first theorizes that a closer look at three proxy factors would serve us as an indicator for a causative factor for a favorable home and condition for evolutionary physiological processes of early hominids. Then it demonstrates a strong correlation between the implications of this theory and the results from other forms of studies including DNA and linguistic analyses. The three factors are today's 1) long-term average temperature data of a given location as a proxy for that location's age old climate, 2) human body temperature as a proxy for an optimal condition for humanity's age old functional physiological processes, and 3) normal room or ambient temperature as a proxy for an optimal environmental condition for humanity's evolutionary physiological processes in harsh natural environment. This work specifically uses the average ambient temperature uniformity index, which is defined as a measure of the proximity of a given location's observed long term average temperature to the ambient temperature state. The proximity is measured in terms of both year round average temperature data and the inter-monthly persistence of the ambient temperate state. This uniformity index is then used to spot-identify and rank regions around the world for their favorable condition to have been the likely home of early hominids on earth before the age of the built environment. This analysis was done for multiple locations in each of Africa, Asia, Europe, North America, Oceania, and South America. The result shows that from the selected locations, Addis Ababa, Ethiopia, has the most favorable environmental setting that would have helped these processes in humans.

Methodology

The average normal body temperature of present day humans is 36.8 ± 0.7 degree Celsius (°C) (Pribor, 1986). We do not know for sure if the same or different normal body temperature prevailed in early hominids or during their evolutionary developmental processes that led to our present day's state of the normal human body system. However, for present day's state of the human body system, the normal room or ambient temperature is taken as 21 °C, according to West Midlands Public Health Observatory in England (Roberts, 2006). For the purpose of the current work, the environmental temperature range between those that cause hypothermia and hyperthermia in a human body are considered as the functional temperature homeostasis regime. This regime lies approximately between 0 °C (Hopkin, 2005) and 42 °C (Shier, 2009), the low and high point environmental temperatures, respectively, below and above which functional homeostasis gets impaired under a prolonged exposure time.

Hence, the application of the analysis in this work is based on two theories. The first theory is that the ambient temperature is a sound proxy for an optimal environmental condition in which the human body system evolved over the ages. The second theory is that a geographic region with the least overall and year round deviations of temperatures from this optimal environmental condition would have availed a more favorable natural environment for early humans and their evolutionary trajectory. On the basis of these theories, the temperature data of 36 sample cities around the world was analyzed to identify and rank those geographic locations that would have availed better environmental conditions in which the human body system could evolve with better ease.

With a temperature of 21 °C taken as the normal room or ambient temperature, the temperature departure index from the ambient state is given by Equation (1). As a measure for the ambience of environmental temperature within the functional temperature homeostasis regime, the ambient temperature uniformity index is defined as the root mean square error (RMSE) of the deviations of monthly average high and low temperatures from the ambient temperature state, which is given by Equation (2). The range index, which is a measure of the year round fluctuation between the average maximum and minimum temperature values, is given by Equation (3). Similarly, the steadiness index, which measures the year round persistence of the average maximum and minimum temperatures of a given location, is defined by Equation (4). This index indicates the absolute shifts of the monthly average maximum and minimum temperatures of a given month compared to the previous month, for all months.

$$T_{DI} = \frac{T}{21} - 1 \quad (1)$$

$$T_{UI} = \sqrt{\frac{\sum_{i=1}^{12}\left[\left(T_{ave_i}^{max} - 21\right)^2 + \left(T_{ave_i}^{min} - 21\right)^2\right]}{24}} \quad (2)$$

$$RI = \frac{\sum_{i=1}^{12}\left(T_{ave_i}^{max} - T_{ave_i}^{min}\right)}{12} \quad (3)$$

$$SI = \frac{\sum_{i=1}^{12} abs\left(T_{ave_i}^{max} - T_{ave_{i-1}}^{max}\right) + \sum_{i=1}^{12} abs\left(T_{ave_i}^{min} - T_{ave_{i-1}}^{min}\right)}{24} \quad (4)$$

where T is the observed temperature, T_{DI} is the instantaneous ambient temperature departure index, T_{UI} is the ambient temperature uniformity index, $T_{ave_i}^{max}$ and $T_{ave_i}^{min}$ are the long-term average monthly maximum and minimum temperatures for month i, respectively, *RI* is the range index, and *SI* is the steadiness index.

Results

According to equation (1), the ambient temperature departure index for a functional temperature homeostasis regime of humans ranges from -1.0 to +1.0, with a value of 0 indicating an ambient temperature condition (Figure 1). The ambient temperature departure indices of -1.0 and +1.0 indicate, respectively, the approximate threshold conditions for hypothermia and hyperthermia under a prolonged exposure time.

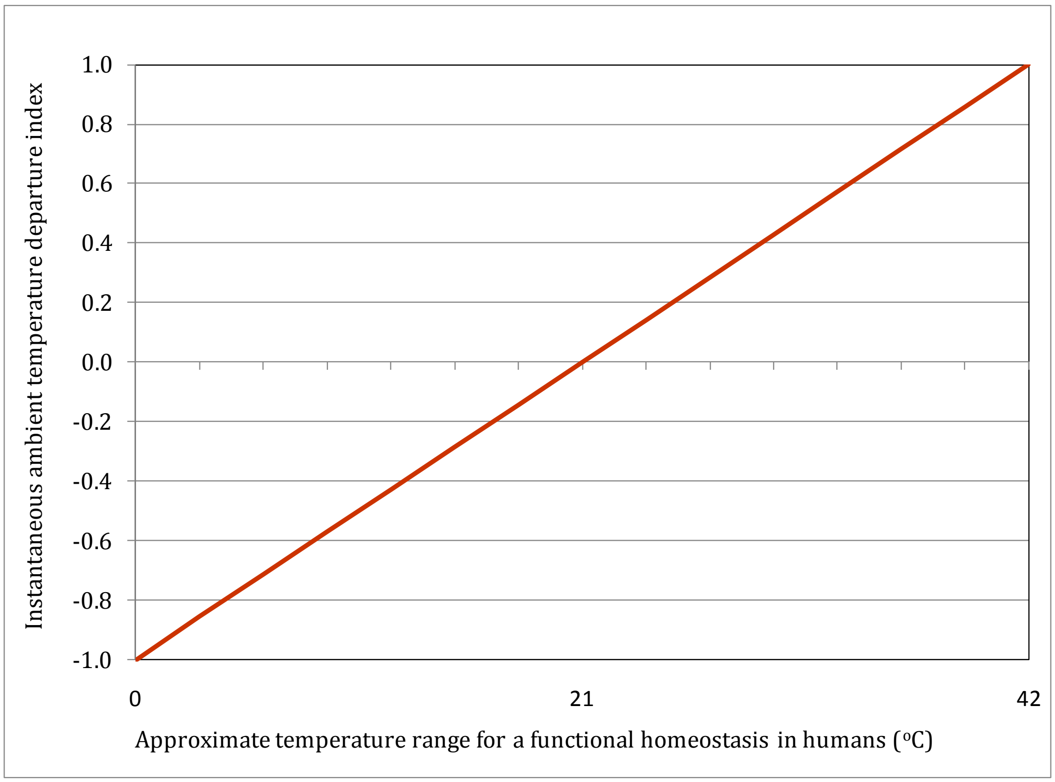

Figure 1. Instantaneous ambient temperature departure indices for a functional temperature homeostasis regime in humans

According to equation (2), the average ambient temperature uniformity index for a functional homeostasis regime ranges from 0 to 21. A zero index value indicates a steady ambient temperature state. Steady states of both hypothermia and hyperthermia have index values of 21.

In this work, the average ambient temperature uniformity index values for the selected sample cities were computed and ranked from the lowest to the highest in their continental subgroups of Africa, Asia, Europe, North America, Oceania, and South America. According to this index, Addis Ababa, Ethiopia, has the most optimal environmental condition from the selected locations in which the human body system would have evolved, as shown in Table 1. Figure 2 shows the ranked average ambient temperature uniformity index magnitudes for the selected cities around the world.

The results of the range index and steadiness index focus on selected cities from each continent, which have the lowest ambient temperature uniformity indices. A summary of the results of all these indices is presented in Table 2. The steadiness index results for the selected cities are also illustrated in Figure 3. While Addis Ababa has also the lowest range index, Manila, The Philippines, has the lowest steadiness index. Interestingly, Addis Ababa's steadiness index is practically the same as the ambient temperature steadiness index, which can be determined as (36.8 – 21)/21 = 0.75. An environment that has continuous ambient temperature of 21 in which a human with a constant body temperature of 36.8 lives would have a steadiness index of approximately 0.75. In general, low steadiness index values suggest high year round persistence of proximate environmental condition to the ambient temperature state. Other localities in different continents with low ambient temperature uniformity index are Jerusalem, Athens, Honolulu, and Rio de Janeiro.

This finding that Addis Ababa's vicinity may have been favorable for early human's functional homeostasis is consistent with earlier findings using other approaches such as DNA analysis, early plant domestications (Diamond, 2005), and an ongoing linguistic investigation by this author.

Table 1. Average ambient temperature uniformity index values for selected cities around the world

Africa		Asia		Europe		North America		South America and Oceania	
Addis Ababa	0.29	Jerusalem	0.44	Athens	0.41	Honolulu	0.30	Rio de Janeiro	0.30
Nairobi	0.32	New Delhi	0.45	Rome	0.44	Los Angeles	0.30	Buenos Aires	0.34
Lagos	0.34	Tokyo	0.45	Paris	0.50	Washington, D.C.	0.57	Mexico City	0.41
Accra	0.35	Islamabad	0.49	London	0.55	Vancouver	0.60	Bogota	0.48
Bamako	0.46	Tehran	0.55	Madrid	0.57	Toronto	0.74	Manila	0.35
Khartoum	0.50	Beijing	0.71	Berlin	0.66	Denver	0.77	Darwin	0.39
Cape Town	0.52	Moscow	0.88	Prague	0.71	Winnipeg	1.11	Canberra	0.55

Table 2. Average temperature range and steadiness indices for selected cities around the world

City	Addis Ababa	Jerusalem	Athens	Honolulu	Rio de Janeiro	Manila
Ambient temperature uniformity index	0.29	0.44	0.41	0.30	0.30	0.35
Range index	7.1	10.8	9.6	8.2	9.1	8.0
Steadiness index	0.75	2.50	3.00	0.83	1.00	0.67

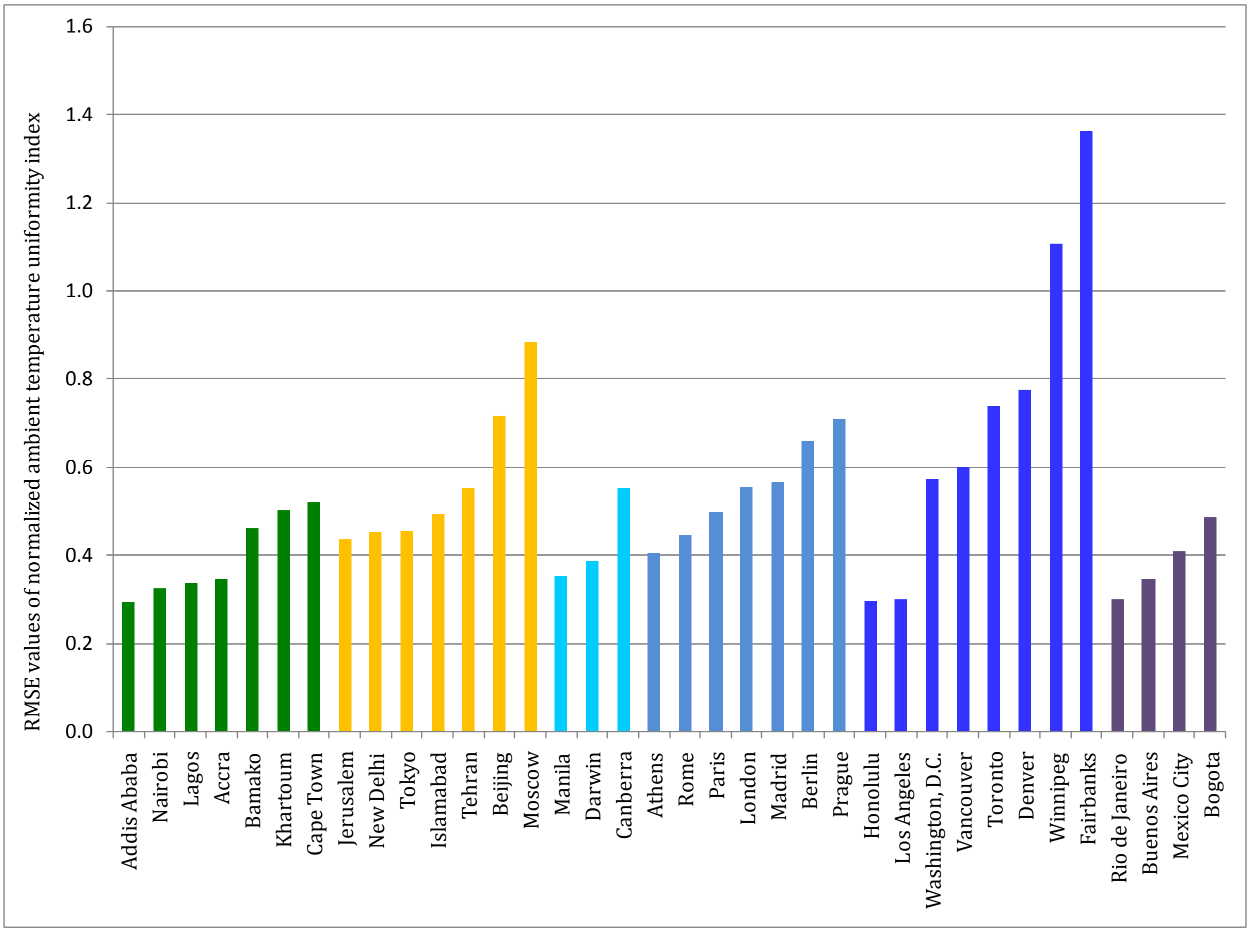

Figure 2. Average ambient temperature uniformity index values for selected cities around the world

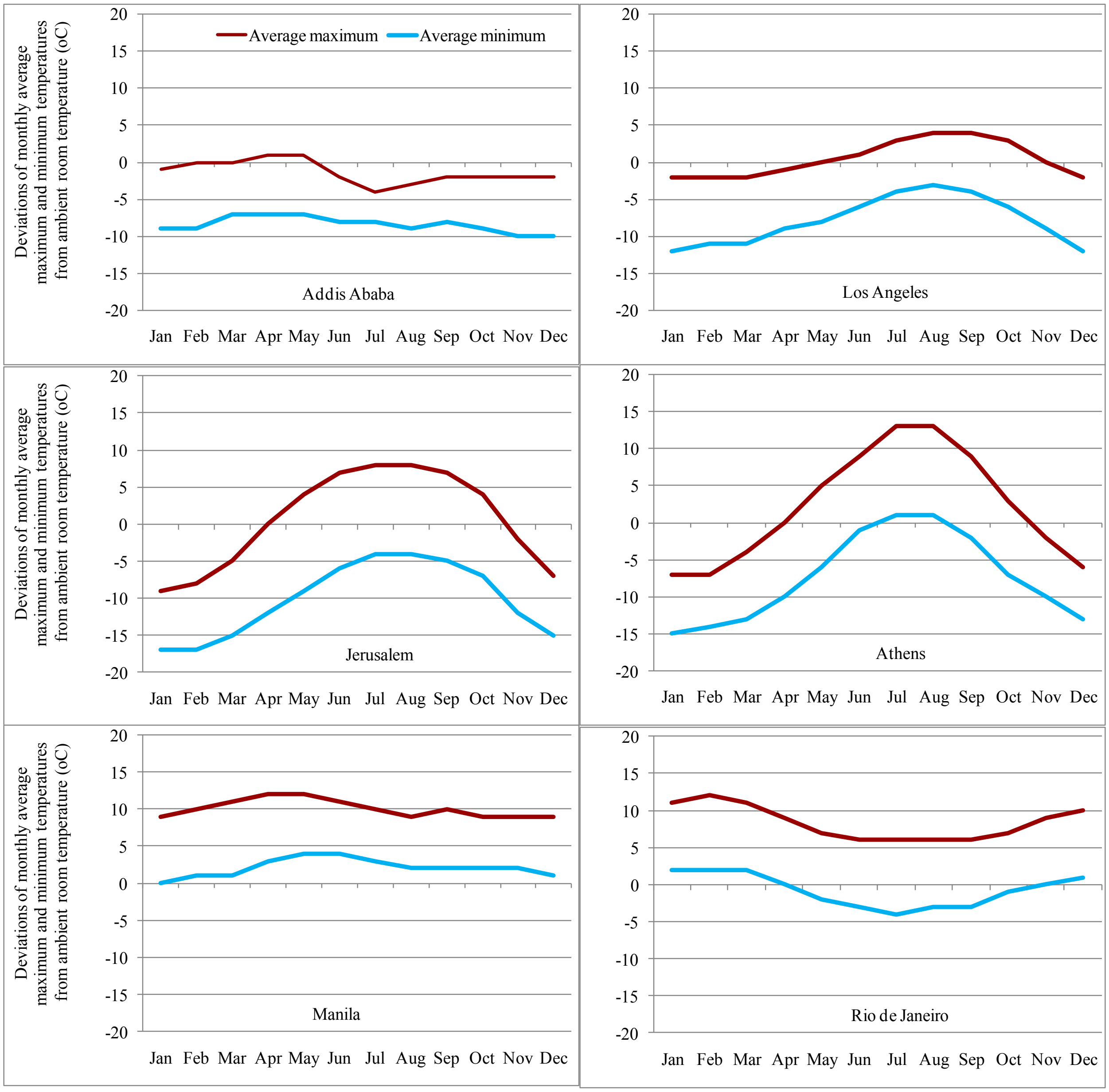

Figure 3. Illustration of ambient temperature steadiness for selected cities around the world

Discussion

As the quest about the impact of projected climate change on the habitat ranges of plants and animals shows bearings on planners and decision makers for the future, the curiosity to better understand the underlying causative factors of the historical comfort zones of these plants and animals comes into the picture of the past-future continuum of life on earth. Emerging studies report about the reactive responses of plants and animals to climate change through movements from their natural ranges (Loarie, et al., 2009). These studies point to far reaching implications because of these movements since some ecosystems, such as mountains, have 'nowhere to go'. On the other side of this past-future continuum of life lies the quest to better understand how environmental characteristics may have affected or controlled the evolution of humans and behavioral developments (National Academy of Sciences, 2010) and by extension the natural habitats of plants and animals. The intersections of these quests provides us both challenges and opportunities to make informed planning for the future while making efforts to better understand the environmental conditions of the past. The projection of environmental conditions would be more meaningful when we have sufficiently characterized and established historical environmental factors that were the undercurrents of its existence. The work reported herein has attempted to take a step in this direction by looking at historical ambient temperature data as a possible causative factor for the environment of human origin. While this attempt is limited to the use of homeostasis in humans to make a deduction about the environment of our origin, to the extent that we are part and parcel of ecosystems, it is likely to provide us a lead in the characterization of the history of ecosystems.

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