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The Differential of Traditional Heat Equation and the Taylor Series to Analyze the Heat Parameter towards Study of La Nina Effects of Climate Change

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ABSTRACT

The current research work deals with the ideology of studying and analyzing the patterns in climate change with respect to a mathematical overview. The domain of mathematics that deals with such problems is chosen to be as of constituting the traditional heat equations arising from the ordinary differential equations and the similar technique derived from the taylor series keeping the parameters responsible for climate change to be the same. Both the approaches shall focus on a similar characteristic of the climate change known as La Nina. It is also expected to see some other mathematical tools to put a light on the similar pattern of analysis.

1. Introduction.

1.1 Climate Change:

The term climate change as pertaining to human kind is a very important aspect affecting and governing it. It affects the various postulates of the society at a large including human life primarily, thereby animal life and civilization in various forms. The aspect of climate change can be further bifurcated into various components depending upon the origin and type of change occurred. Some changes that occur infinitesimally are often neglected in day to day life and considered as a constant change.

However, those change that have a drastic effect on the society become a topic of concern and a research study as in to find out ways and techniques to deal with it or analyze it. In our current research work we intend to focus on one such major aspect of the climate change known as the "La Nina" which is an effect of the major change in the atmospheric temperatures in contrast to the "El Nino" effect.

1.2 "La Nina" and the Factors affecting its effect:

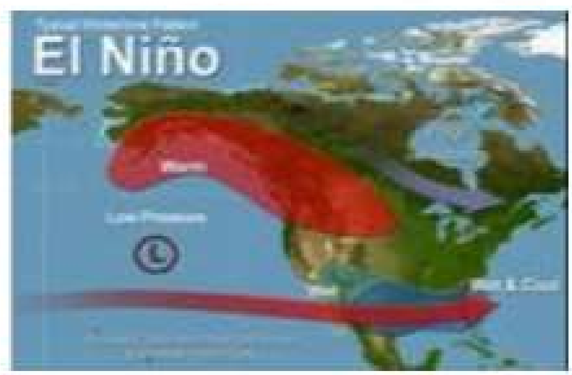

Diagram 1.1
Visualization of the El Nino
In contrast to the La Nina effects

Diagram 1.2

Visualization of the La Nina

As known Earth is continuously in a volatile motion. This motion is majorly carried out in two forms. The one below the earth's surface is studied under the geology domain. Whereas the studies related to the atmosphere surrounding the earth is majorly studied under climatology. Climatology not only studies the behavior and the anatomy of the particular phenomenon but also widens the scope of understanding the change in such patterns which is the result of climate change. One such climate change effect known as the "La Nina" effect is our major object of study.

The major phenomenon of La Nina is the reduction of the oceanic temperature by a few degrees. This effect is opposite to the "El Nino" which is the aspect of increase in the ocean temperatures by the considerable amount of difference as in the case of "La Nina". The considerable change in temperatures result in various other events linked in the similar pattern in the surroundings. Some of the major factors affecting the "La Nina" effect is the change in the oceanic wind temperature and thereby affecting the other two major parameters known as pressure in atmosphere and humidity. This in turn gives rise to various other ocean originated catastrophes like the severe convective storms, severe thunder storms, storm surge and hurricanes. These catastrophes then tend to travel and meet the civilizations on the banks of the coastal line that cause devastation at a large scale.

1.3 Mathematical Overview:

In the current scenario there are certain mathematical approaches that deal with the climate change problem related to El Nina and La Nino. However, we are going to consider the two basic approaches related to one parameter affecting this phenomenon. The traditional heat equation based on the differential expansion and the Taylor series expansion. As known heat is a differential entity varying with reference to time and other certain parameters so it can act as a function of time and pressure as the certain change in any of the parameter intends to change the heat parameter.

2. The traditional Heat equation:

While working with the heat equation the major part of the problem originated when the heat equation was studied under a homogenous material. However, when we consider a non-homogenous domain like the oceanic atmosphere which has a large amount of gases that keep changing with respect to time and pressure behaves a slightly different when considering the boundary values of these equations. Consider a scenario of heat function *H* depending on time *t* at a position *p.*

The expression of heat equation may be given by:

$$H_t(p,t) = (q(p)\ \ H_p(p,t)_p) + \psi(p,t) \qquad (2.1)$$

Where q(p) may be considered as the coefficient of the entity pertaining to the variable heat transfer with respect to position 'p'. Whereas on the other part of the equation $\psi(p,t)$ may be considered as the generation point of heat forming its basis or origin. In case of climate change the source and the medium may be considered for the given equation. The further process of treating this kind of relation is to find the derivative of the next version that gives scope to understand its behavior with reference to the boundary values. We shall also see certain characteristics of the above relation when it is treated under boundary values to get the Sturm-Liouville results as a desirable quantity.

Let us first understand the version of the relation (2.1) as follows. While consideration let us primarily consider the surrounding of the medium of heat transfer to follow the propagation in a homogenous pattern.

$$H_t(p,t) = \ \ q\,.H_{pp}(p,t)_p + \psi(p,t) \qquad (2.2)$$

The above version is due to the differential variation of the relation (2.1) when we consider q(p) = q which is independent of *p.*

This is also the case when the medium is considered to be homogenous and the entity is expected to change infinitesimal with respect to the change in its position.

For any equation as it is considered to follow a precise path of travelling from a particular point to a desired destination, we shall take into consideration the boundary value of the domain.

As known in each case of the traditional heat equations, we shall introduce the boundary values accordingly.

$$H(p,o) = H^0(p)$$

Let us take into consideration the climate change at a domain level and supposing it to be bounded to assign the specific values for their boundaries.

$$H(x,p) = X(p), \qquad H(Y,p) = Y(p)$$

On contrary to the assuming boundary values of the relation over the domain we take into consideration the results of Sturm- Liouville conditions that cater the boundary value for a specific domain for a differential relation.

The introduction of a linear operator to (2.1) and (2.2) ahead distributes the variables accordingly, provided (2.1) is bound to derivate again.

Before which to distribute the boundary values over (2.2) we see the following scenario.

$$L(X) = 0, \qquad L(Y) = 0$$

$$L(H_1X + H_2Y) = H_1L(X) + H_2L(Y) \quad (2.3)$$

Further derivation shall create the vanishing of the desired function. This brings closer to the understanding of the heat equation to be treated in accordance to conditions satisfying Sturm-Liouville forms when they are considered under a particular domain which is separating distinct boundary values with the aspect of forming a particular track of heat flow resulting in a climatic change aspect.

3. Taylor Series and the Sturm- Liouville forms:

As per recent literature on similar forms to conduct analysis of heat transfer due to the climatic condition the **taylor** series plays an important role due to its interdependence of certain variables and the type of operators involved. Let us consider the variables in the form of v-velocity, a- humidity, k-temperature.

The following general form may be considered:

$$k(v,a) \cong K(0,0) + \frac{\partial k}{\partial v}|v_i|\frac{\partial k}{\partial a}|a_i| \quad (3.1)$$

For one entity to be fixed the other parameters move or differentiate infinitesimally with respect to the variable entity. In any case the function tends to vary with a precise change in one of the three entities and keeping one entity constant.

$$k_1(v) = \sum_{i=1}^{\infty} k_i l_0(v), \quad (3.2)$$

and so on.

We may consider to formulate the linear operator in lieu of the slope of the curve formed by the release of variation in the temperature.

Finally to formulate the relation of the Sturm-Liouville solvability we see the approximate relation as below when the boundary values are taken into consideration.

$$k(v,a) \cong k(0,0) + k_1h + k_2v \quad (3.3)$$

There are various further possible works that may put light on the interpolation of these theories to be excavated onto the other for similar results accordingly.

4. Effect on La Nina and other heat parameters resulting climate change:

The current work thereby focuses on the understanding of the difference of the heat waves when it comes to study of post effects of climate change due to La Nina. The modified traditional heat relation comforts an association with the solutions of the Sturm-Liouville solvability when treated with the Taylor series.

These assumptions may further give scope to a different approach to analyze the pattern fitting a particular condition.

5. Conclusion/Outcome of the research work:

- The works that involve the heat transfer over a continuous medium follows the traditional equation over the parameters chosen. (temperature, pressure and place)
- The correlation found among the two cases of the traditional relation and the taylor series gives scope to further development of analysis on the climate change aspect.
- There are other aspects of El Nino to be further treated for the similar causes that can act on the contrary to La Nina.

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