"*A Thousand Words*": How Shannon Entropy perspective provides link among exponential data growth, average temperature of the Earth, declining Earth magnetic field, and global consciousness.

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Abstract

The sunspot data seems to indicate that the Sun is likely to enter Maunder Minimum, then it will mean that low Sun activity may cause low temperature in Earth. If this happens then it will cause a phenomenon which is called by some climatology experts as "The Little Ice Age" for the next 20-30 years, starting from the next few years. Therefore, the Earth climate in the coming years tend to be cooler than before. This phenomenon then causes us to ask: what can we do as human being in Earth to postpone or avoid the worsening situation in terms of Earth cooling temperature in the coming years? We think this is a more pressing problem for the real and present danger that we are facing in the Earth. What we are suggesting in this paper is that perhaps it is possible to model Sun-Earth interaction in terms of Shannon entropy. Since Shannon entropy can be expressed as bits of information, then it would mean that perhaps we can do something with Earth temperature by controlling the amount of information transfer and storage in the Earth. This proposal is somewhat in resemblance with message of a 2012 movie "A Thousand words" where we shall strive to love our neighbours and nature, instead of being absorbed in a culture of less-meaningful fast-talk (starred by Eddie Murphy).[1]

Introduction

The historical recognition that the Sun warms the Earth has suggested a direct connection between the average global temperature and solar activity. Consequently, any significant changes in solar activity should result in equivalent changes in the Earth's global temperature. The literature on the solar influence on the Earth's temperature is quite extensive, indicating the importance of the problem [5].

In this regards, it is very important to note here that some reports made by climate experts have indicated that it is highly likely that the Sun will enter into a Maunder minimum in the

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[1] https://www.imdb.com/title/tt0763831/

next couple years, which will last for 20-30 years to come. Since the Sun activity highly affects Earth temperature, then it can be expected that the Earth will experience cooling, which some climatologists refer to as the Little Ice Age. This global cooling can be observed in recent extreme climate conditions such as snow storms in some regions in USA in January-February 2014 and also during this winter (January 2015). Other indication includes the fact that the Arctic Ice has increased 29% in size from 2012-2013, which indicates the coming of "global cooling" [9].

Such a global cooling phenomenon has been related to low Solar activity, as reported by Mr. John Casey (www.spaceandscience.net) and Dr. Dong Choi (www.ncgt.org). This phenomenon then causes us to ask concerning what we can do as human being in Earth to avoid the worsening situation in terms of Earth cooling temperature in the coming years.

It is well known that Shannon information entropy can reduce to the Boltzmann entropy, but we are not sure yet how temperature in thermodynamics sense can be related to the information entropy measures. Here we submit a viewpoint that it is possible to put temperature in thermodynamics sense in terms of information entropy. This result is quite new, and it is worth to be communicated to wider audience, since it affects temperature of the Earth. We expect that people start to be wiser and more efficient in using and sending information especially via online and electronic media.

Background theory on information entropy

Shannon information entropy is defined as follows [1, p.4]:

$$S = -k \sum_{i=1}^{w} p_i \ln p_i \qquad (1)$$

For the uniform distribution, then the Shannon entropy takes on its maximum value and it reduces to be Boltzmann entropy [1, p.5]:

$$S = k \ln W \qquad (2)$$

And then we conclude that both equations essentially correspond to the same process, i.e. the sending and receiving of information, provided we assume that the Earth is a large information retrieval system. Therefore we can accept that actually Boltzmann entropy is neatly related to information entropy, and therefore we can proceed further to accept that

the thermodynamics temperature of the Earth corresponds neatly to the amount of information sent and received in the Earth. Actually Boltzmann himself did not realize the full implications of his thermodynamics equation, because he did not know beforehand how the Sun activity actually corresponds to the ambience temperature of the Earth.

The correspondence between the process of information retrieval and thermodynamics entropy can be expressed as follows [2, p.6]:

$$\left| \frac{\delta Q}{dS/(\ln 2)} \right| \geq kT \,.\, \ln 2 \qquad (3)$$

where the principle is based on Clausius inequality and states that many-to-one operations like erasure of information requires the dissipation of energy. And the right hand side of the inequality is known as Landauer bound.

In other words, one should be very careful because sending and receiving useless information can affect temperature without one realizes it, although how precisely the mechanism that information can affect global temperature remains mystery. This increasing information content of the Earth has been discussed in a few papers, see for instance Hosoya-Buchert-Morita's paper [3], although they figure out the problem without connecting it with the increasing of temperature of the Earth. It is because they assume that the increasing information content is related to the Relative Information Entropy of a cosmological model containing dust matter [3]; but actually the increasing information content in the Universe corresponds strongly to the increasing use of online information in recent decades.

Shannon entropy and global temperature

According to Nicola Scafetta and Bruce West [5], Earth's short-term temperature anomalies and the solar flare intermittency are linked, and the relation can be expressed in terms of Shannon entropy, S(t):

$$S(t) = -\int_{-\infty}^{\infty} p(x,t) \ln[p(x,t)] = A + \delta \ln(t), \qquad (4)$$

Where A is constant and δ is found to be 0.67 for global temperature data between 1860-2000. However, since 2000 the global temperature shows declining change significantly caused by low Sun activity.

It should be emphasized here that Solar activity is not the only factor that affects Earth's temperature, other factors may include planetary synchronicity [6].

Moreover, it should be noted that there is a critique on the hypothesis that Solar activity affects global temperature, see for instance Gil-Alana et al. [8], nonetheless their arguments have been refuted by Scafetta in his recent paper [7].

So the conclusion is that there is nonlinear relationship between Sunspot number and Earth temperature. In the subsequent section, I will discuss a possible model in terms of Momentary Information Transfer as proposed by Runge et al.

Momentary information transfer (MIT) and source entropy

In his dissertation, Jakob G.B. Runge describes some new notions [4]. The notion of momentary information is introduced in Section 3.1.3, and momentary information transfer is explained in Section 3.4.5. The basic approach is to measure causal coupling strength (see Section 3.4.5) based on source entropy (also termed entropy rate from Shannon, 1948). The goal is to quantify the interaction between two causally linked processes as well as along causal paths and between multiple processes such as the earth's surface temperature (cooling and heating), atmosphere, moon and sun.

Climatological analysis using MIT is introduced in Appendix B. Large MIT values indicate strong coupling between Earth's surface and upper tropospheric levels, as discussed in Appendix B.3.

As an example, following Runge et al. (2012b), we compare mutual information (MI), transfer entropy (TE), the CMI defining causal links (LINK), information transfer to Y (ITY) and from X (ITX), and momentary information transfer (MIT) on an analytically tractable model of a multivariate Gaussian process: [4, p. 93]

$$Z_t = c_{XZ} X_{t-1} + \eta_t^Z$$

$$X_t = a_X X_{t-1} + \eta_t^Z$$

$$Y_T = c_{XY} X_{t-2} + c_{WY} W_{t-1} + \eta_t^Y$$

$$W_t = \eta_t^W$$

We hope that in the near future, more exact physical models will be developed to describe how information exchange can affect Earth's ambient temperature.

Further discussion

While our proposition here is somewhat simplified, here we discuss further how things are possibly linked:

Global data growth → Shannon entropy → global average temperature → Schumann resonance

For instance, some researchers have shown:

1. Global average temperature is linked to Schumann resonance

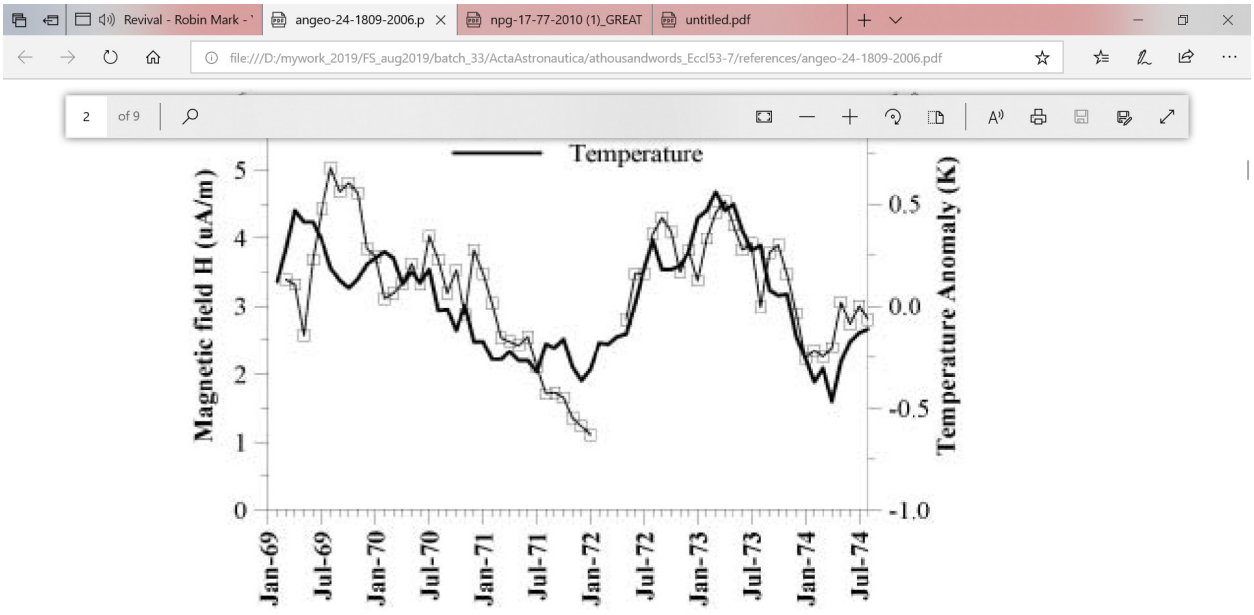

Fig. 1. Correlation between the global temperature and the intensity of Schumann resonance oscillations (adopted from Williams, 1992).

Source: ref. [12]

Note: since Schumann resonance seems to be related to human/global consciousness, we can also hypothesize that variation in Schumann resonance frequency also affects global consciousness.

2. global data is increasing exponentially, almost following Moore's law.

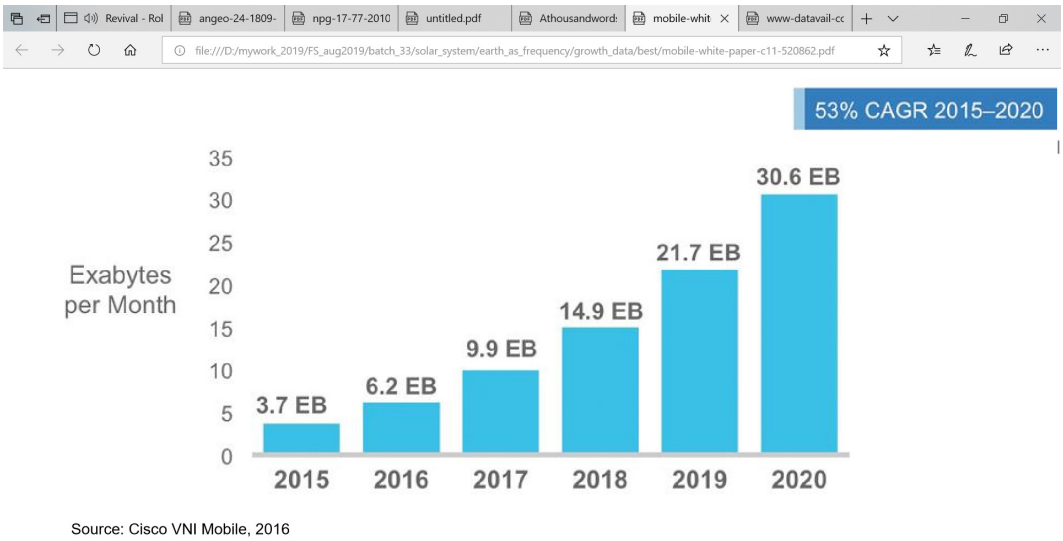

Figure 2. Source: Cisco VNI Mobile, 2016. See [10][11]

3. and Shannon entropy is also linked to variation of Earth magnetic field (using Kolmogorov or k-entropy). See ref. [13].
4. Declining Earth magnetic field is also linked to Earth climate, as emphasized by Campuzano et al. in a recent report in Plos ONE [14]:

> "The debated question on the possible relation between the Earth's magnetic field and climate has been usually focused on direct correlations between different time series representing both systems. However, the physical mechanism able to potentially explain this connection is still an open issue. Finding hints about how this connection could work would suppose an important advance in the search of an adequate physical mechanism. Here, we propose an innovative information-theoretic tool, i.e. the transfer entropy, as a good candidate for this scope because is able to determine, not simply the possible existence of a connection, but even the direction in which the link is produced. We have applied this new methodology to two real time series, the South Atlantic Anomaly (SAA) area extent at the Earth's surface (representing the geomagnetic field system) and the Global Sea Level (GSL) rise (for the climate system) for the last 300 years, to measure the possible information flow and sense between them. This connection was previously suggested considering only the long-term

> trend while now we study this possibility also in shorter scales. The new results seem to support this hypothesis, with more information transferred from the SAA to the GSL time series, with about 90% of confidence level. This result provides new clues on the existence of a link between the geomagnetic field and the Earth's climate in the past and on the physical mechanism involved because, thanks to the application of the transfer entropy, we have determined that the sense of the connection seems to go from the system that produces geomagnetic field to the climate system. Of course, the connection does not mean that the geomagnetic field is fully responsible for the climate changes, rather that it is an important driving component to the variations of the climate."

Urgent recommendation

Now we obtain that temperature of the Earth can be modeled by assuming that the Earth is a large information retrieval system, therefore Shannon information entropy can be used to represent the amount of information sent and received in the Earth. Therefore if many people send and receive information to the system without taking care to its effects to the temperature of the Earth, then the accumulative result can be dangerous to the entire system, including to the human population and environment of the Earth. Now we see that the use of online information is already increasing rapidly in recent years largely because of the Internet, and as a result it contributes to the declining temperature in this Earth.

Therefore, we urge that server administrators of the online information, including online email servers, to reduce the amount of information which are put 'online'. This action shall include reducing the amount of emails which are put online, and reserve those emails into offline databases. But this action shall be made carefully and responsibly, otherwise it may cause Ice Age again in this Earth, and also disturbance of environment stability, because of rapid decreasing of temperature.

We wrote this article very shortly because we want to emphasize that information shall be sent and received more efficiently and more responsibly. The server administrators of the online information channels shall take care too on how much emails and other information shall be kept online in order to maintain the ambience temperature to remain within the acceptable range, i.e. between 25-27 degree Celcius. Therefore we urge that

server administrators also monitor the effect of the already increasing amount of the online information and email messages in the past few days to the ambience temperature.

The effect of reducing the amount of online information can be observed and felt almost immediately, because of the entropy and temperature is transmitted immediately; it is because the Earth is intertwined to the Universe.

We recommend that all server administrators of online information channels to pray and ask for guidance from God, especially on how to maintain their online servers in a better and more effective way, in order to avoid further damage and destruction of this Earth because of rapidly increasing online information.

Furthermore, scientific journal Editors should maintain the published papers in the most efficient way possible, and do not upload too many large files if they can be kept as “optional” online. By keeping online communication at the most efficient, we can do the best to avoid the Earth magnetic field from declining further, in line with “A thousand words” spirit.

We hope this short article will be read in front of other physicists and also in front of all server administrators of online information channels, including Yahoo!, Google, Hotmail and other large email servers.

Concluding remarks

The sunspot data seems to indicate that the Sun is likely to enter Maunder Minimum, then it will mean that low Sun activity may cause low temperature in Earth. If this happens then it will cause a phenomenon which is called by some climatology experts as “The Little Ice Age” for the next 20-30 years, starting from this year (2015). Therefore, the Earth climate in the coming years tend to be cooler than before. This phenomenon then causes us to ask: what can we do as human being in Earth to postpone or avoid the worsening situation in terms of Earth cooling temperature in the coming years? I think this is a more pressing problem for the real and present danger

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We hope that in the near future, more exact physical models will be developed to describe how information exchange can affect Earth’s ambient temperature.

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(There are of course many references on the subject of Shannon entropy, but there are only very few papers which clearly address this subject of increasing temperature of the Earth because of increasing use of information. We mention here only a few references.)

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