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Fitting of Global Temperature Change from 1850 to 2009 Using Random Walk Model *

用随机漫步模型拟合1850年至2009年的全球气温变化

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Abstract: The random walk model was used to fit the change of global temperature. First the CRUTEM3 global mean temperature time series from 1850 to 2009 were converted to the temperature walk, and then the random walk model was used to fit the converted data and real data, respectively. The results showed that the random walk model could fit both the temperature walk and CRUTEM3 temperature, which provided an alternative approach for modeling of temperature, and suggested that the global temperature change could be mainly due to the random mechanism.

Key words: global warming, modeling, random walk, temperature change, CRUTEM3

摘要:用随机漫步模型拟合全球气温变化的CRUTEM3数据系列。首先将1850年至2009年全球的平均气温转换为气温漫步,再用随机漫步模型直接拟合。结果显示,该模型能够拟合气温漫步和CRUTEM3数据系列。这为气温建模提供了一种新的模型,并且拟合结果也表明全球气温可能是随机变化的。

关键词:全球变暖　模型　随机漫步　气温变化　CRUTEM3

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It arguably seems that the cause of change in global temperature is mainly determined by modeling because humans have no ability to create another Earth without mankind as a control to find out the real cause for the temperature change. Therefore, the factors included in the model, which fits the historical temperature and predicts recent temperature best, would be the cause for global temperature change.

If so, we noted that a very important model has not yet been used in fitting of global temperature when we were studying the potential impact of global warming on the evolution of proteins from influenza A viruses[1～4]. This model is the random walk. No matter of whether or not the random walk model can fit the temperature change, it is worthy trying because we at least can furthermore determine that the human factor is the real cause for the global warming. On the other hand, if the random walk model can fit the global temperature, then it would suggestively be one of the factors, which lead the change in global temperature.

In this study, we use the random walk model to fit the global temperature change from 1850 to 2009.

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1 Materials and methods

1.1 Data

The CRUTEM3 global mean temperature time series[5] from 1850 to 2009 were used in this study.

1.2 Temperature walk

As the temperature is recorded along the time course, the model we used is the one-dimensional random walk, which starts at zero and at each step moves by ± 1 with equal probability[6]. In other words, the simplest random walk can be considered as a sequential result of tossing a fair coin, by which we record the head as 1 and the tail as -1, and then we add the results along the time course.

For this purpose, we need to convert the temperature as a temperature walk as shown in Table 1. When the temperature at certain recording time point is higher than its previous one, we classify it as 1, otherwise we classify it as -1 (the 3rd column in Table 1), and then we add them as the random walk does (the 4th column in Table 1).

Table 1 Conversion of CRUTEM3 temperature into temperature walk and generation of random walk for global temperature from 1850 to 2009*

Year	Temperature anomaly	Temperature step	Temperature walk	Generated random Number	Random number step	Random walk
1850	−0.4250		0	0.8743		0
1851	−0.0110	1	1	0.0825	−1	−1
1852	−0.2080	−1	0	0.7623	1	0
1853	−0.3980	−1	−1	−0.8507	−1	−1
1854	0.1310	1	0	0.5626	1	0
…	…	…	…	…	…	…
2004	0.6110	−1	10	−0.2830	−1	10
2005	0.7470	1	11	−0.9581	−1	9
2006	0.6690	−1	10	0.0953	1	10
2007	0.6780	1	11	0.2311	1	11
2008	0.5280	−1	10	−0.4824	−1	10
2009	0.6380	1	11	−0.3681	1	11

* The random number is generated by SigmaPlot with the seed of 2.96622.

1.3 Generation of random walk

Actually, any computer program can generate random sequence with different seeds and we use the SigmaPlot to do this task[7]. Thus, we may consider that random mechanism can explain the temperature trend if a random walk generated by computer program is approximate to the temperature walk. Technically, the generation of random walk is quite simple: we generate random number either ranged from -1 to 1 or without limit, and then we classify a random value as 1 if it is larger than its previous one and as -1 if it is smaller than its previous one (the 6th column in Table 1). Thereafter we add these values as random walk (the 7th column in Table 1).

1.4 Searching for seed

To find a random walk that is very approximate to the temperature walk is to find a seed that can generate a random walk we want. To the best of our knowledge, there is no algorism for searching the seed, the parameter in random walk model, by converging the difference between observed data and the data produced by random walk, therefore the so-called fitting, which traditionally searches the optimum according to various algorisms, becomes to search all possible seeds in order to find out the seed that produces the random walk with the least squares between random walk and temperature walk.

1.5 Extension of random walk

Because the random walk comes from tossing of double-side coin, accordingly we expend this concept into tossing of dice, which can be not only six-side but also as many as we need. Thus we can use this multi-side dice to fit the real temperature. It is in fact somewhat simpler than the fitting of temperature walk because we need only to use any program to produce a sequential random numbers, then add them together and finally compare this random temperature with the real temperature.

1.6 Comparison

We use the least squares between temperature walk and random walk, and between random temperature and CRUTEM3 temperature to evaluate our fitting.

2 Results and discussion

Technically, the use of random walk to model either temperature walk or real temperature is not difficult, because we do not need any supercomputer to do so. Also, we have no need to include various man-made factors such as CO_2, and non-human factors, such as Sun.

Our first task is to apply the random walk model to fitting the temperature walk, and Figure 1 shows

the fitted result. As can be seen, the random walk can go through temperature walk. Thus, we say that the random walk can fit the temperature walk if the temperature walk can be considered as the temperature trend. We argue that the temperature walk can represent the temperature trend because each temperature step is the real temperature trend in comparison with previous year. Actually, the global temperature walk is going up from 1920, that is, the real temperature tends to increase from then on. This is identical with the concept of global warming.

Arguably, the temperature walk can be the trend of temperature over time due to random mechanism, which is currently considered to be at the heart of nature as demonstrated by the quantum theory. Furthermore, we suggest that the real temperature above or below the temperature walk would be attributed to various factors such as man-made factors and non-human factors.

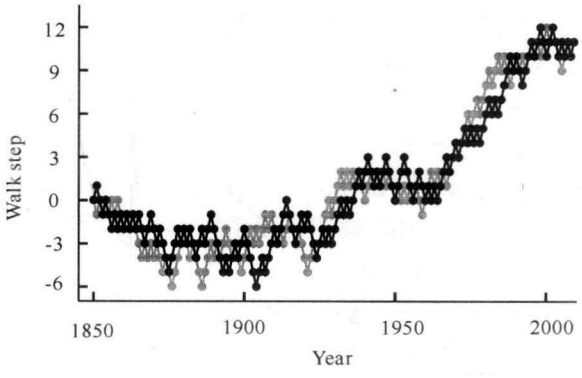

Fig. 1 Comparison of temperature walk (black) with random walk (grey) from 1850 to 2009

Seed=2.96622, sum of squares=368.

Our second task is to apply the random walk model to fit the CRUTEM3 temperature, and Figure 2 displays the result. As can be seen, the random walk model really has a perfect fit for the recorded temperature. At this moment, we have no access to the real fitted data using other climate models, thus we have no possibility to compare our fittings with theirs or to run various tests to determine the good-of-fit.

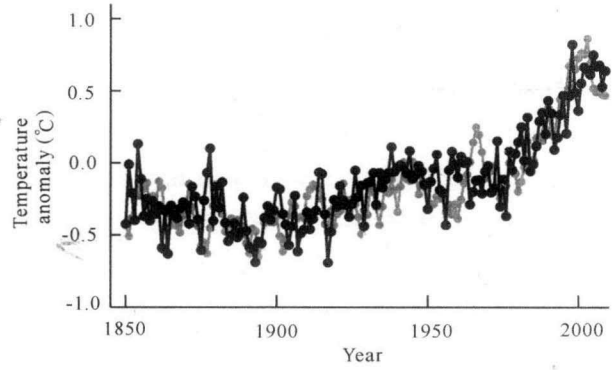

Fig. 2 Comparison of CRUTEM3 temperature (black) with random temperature (grey) from 1850 to 2009

Seed=0.14578, sum of squares=5.98342.

In conclusion, the random walk model can fit the global temperature change, which not only provide an alternative approach for modeling of temperature, but also suggest that the global temperature change could be mainly due to the random mechanism.

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