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Cause and countermeasure of global climate change and alternation of glacial and interglacial periods

Cui-Xiang Zhong

Jiangxi Normal University, Nanchang 330022, China

Email address

cuixiang_zhong@sohu.com

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Abstract

Many scientists are skeptical about that the emission of greenhouse gases is the primary factor in global climate change, and they believe natural driving is the main factor for global climate change, but they haven't found such a convincing natural driving force yet. So the author has researched deeply into various natural forces that could affect climate change,and found that volcanism can obviously alter the orbit of the Earth and therefore is another key factor for climate change. This research mainly includes the derivation of a formula on volcanic eruption changing the earth's revolution speed and another formula on the earth's revolution speed variation causing the Earth's orbital transfer. According to these formulas, through computer's high precision computation, the author found that volcanic eruptions at a certain scale can indeed cause the Earth's orbital variation, thus causing global warming or cooling, even making the Earth enter an interglacial period or a glacial period. Hence, this research has solved the cause-problem of global warming as well as the cause-problem of the alternation of glacial and interglacial periods, and also found the corresponding strategies.

1. Introduction

The globe has experienced obvious climate change since the late 19th century. Earth's mean surface temperature has increased by about 0.8 °C (1.4 °F), with about two-thirds of the increase occurring since 1980. The effects of an increase in global temperature include a rise in sea levels and a change in the amount and pattern of precipitation, as well a probable expansion of subtropical deserts. Warming is expected to be strongest in the Arctic and would be associated with the continuing retreat of glaciers, permafrost and sea ice. Other likely effects of the warming include a more frequent occurrence of extreme-weather events including heat waves, droughts and heavy rainfall, ocean acidification and species extinctions due to shifting temperature regimes. Effects significant to humans include the threat to food security from decreasing crop yields and the loss of habitat from inundation [1]. Global warming and its serious effects have aroused world-wide attention, and the issue of global warming is now extensively debated around the world [6].

In order to effectively deal with global climate change, we should first find out the real cause for it, and then decide the corresponding effective strategy. Warming of the climate system is unequivocal, and many people believe that it is primarily caused by increasing concentrations of greenhouse gases produced by human activities such as the burning of fossil fuels and deforestation. But this conclusion has caused a lot of controversy in scientific circles. Many experts represented by NIPCC have refuted this view with plenty of evidence, and they believe natural driving is the main factor for global climate change, but they haven't found such a convincing natural driving force yet [5]. So the author has researched deeply into various natural forces that could affect climate change,and found that volcanism can obviously alter the orbit of the Earth and therefore is another key factor for climate change.

2. Cause of Climate Change

According to the existed research results, factors that can shape climate include solar output, Earth's orbital variations, volcanism, magnetic field strength, ocean variability, and human influences.

(1) Orbital variations: Slight variations in Earth's orbit lead to changes in the seasonal distribution of sunlight reaching the Earth's surface and how it is distributed across the globe. There is very little change to the area-averaged annually averaged sunshine; but there can be strong changes in the geographical and seasonal distribution.

In addition, the author newly found that the variation of Earth's orbit influences climate also through the following two ways: when the Earth's orbit is reduced, the Earth's revolution speed is increased, making both the friction between the air and the ground surface (such as iceberg surface) and the friction between the water and seafloor intensified, therefore causing global warming (such as iceberg melting); when the Earth's orbit is extended, the Earth's revolution speed is decreased, making both the friction between the air and the ground surface and the friction between the water and seafloor weakened, therefore causing global cooling.

In short, the orbital variations have a large impact on climate and are notable for their correlation to glacial and interglacial periods [4].

(2) Solar output: Since 1978, output from the Sun has been precisely measured by satellites. These measurements indicate that the Sun's output has not increased since 1978, so the warming during the past 30 years cannot be attributed to an increase in solar energy reaching the Earth [11].

(3) Volcanism: Volcanic eruptions release gases and particulates into the atmosphere. Eruptions large enough to affect climate occur on average several times per century, and cause cooling (by partially blocking the transmission of solar radiation to the Earth's surface) for a period of a few years [3,8].

(4) Magnetic field strength and Ocean variability: Some recent (2006+) analysis suggests that global climate is also correlated with the strength of Earth's magnetic field [2] and ocean variability [2].

(5) Human influences: Climate changes are in part caused by human activities [6,9]. Of most concern in these anthropogenic factors is the increase in CO_2 levels due to emissions from fossil fuel combustion, followed by aerosols (particulate matter in the atmosphere) and cement manufacture. Other factors, including land use, ozone depletion, animal agriculture and deforestation, are also of concern in the roles they play - both separately and in conjunction with other factors - in affecting climate, microclimate, and measures of climate variables.

From above，it can be seen that at present some people tend to believe the emission of greenhouse gases is the primary factor in global warming. But many scientists are skeptical about this viewpoint, they have refuted this view with plenty of evidence, and they believe natural driving is the main factor for global climate change. The IPCC Fourth Assessment Report (AR4) also acknowledged uncertainties in assessing global warming [6]. Many researchers have found volcanic activity is another important factor for climate change, and the climate effect caused by volcanic eruption can be greater than that caused by green house gases to a certain degree. Their arguments are as follows: volcanic eruptions may inject a lot of volcanic ash and gases into the stratosphere, which causes the reduction of solar radiation, and further results in lowering the temperature at the Earth's surface for periods of one to three years. The examples they often gave are the eruption of Mount Pinatubo in 1991 and the eruption of Mount Tambora in 1815. However, there are also some researches showing that much larger eruptions, known as large igneous provinces, occur only a few times every hundred million years, but may cause global warming and mass extinctions. It is thus clear that scientists haven't been able to determine whether a volcanic eruption causes global warming or cooling, so they haven't found the real cause of volcanic eruption leading global climate change.

In fact，the author's recent research shows that the real cause of large volcanic eruption leading climate change is that these volcanic eruption can obviously alter the orbit of the Earth, finally causing climate change, therefore volcanism is another key factor for climate change. This theory can be narrated separately as follows:

(1) Extend "the principle of satellite orbit variation" to the computation model of the Earth's orbital variation, including the derivation of a formula on the earth's revolution speed variation causing the Earth's orbital variation [12].

This work can be divided into the following two cases.

(1.1) Speeding up the Earth's revolution enlarges the Earth's orbit

Assume the Sun's mass is M_s and the Earth's mass is M, and also the Earth moves around the Sun in a circular orbit of radius r_1 to do uniform circular motion, as is shown in Fig.1,

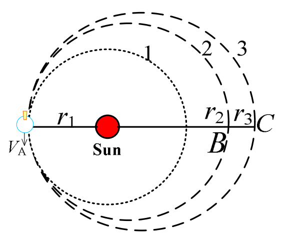


Fig. 1. *Speeding up Earth's revolution enlarges the Earth's orbit*

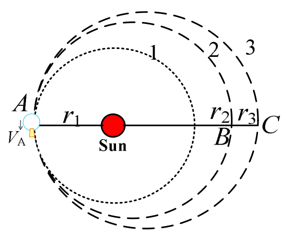


Fig. 2. *Decelerating Earth's revolution reduces the Earth's orbit*

then the Earth's rotation speed $V_1=\sqrt{\frac{GM_s}{r_1}}$. If the Earth at position A is accelerated by a pushing force, the Sun's gravitation pull on the Earth is less than the centripetal force required by the Earth's uniform circular motion around the Sun, thus do centrifugal motion to enter an elliptic orbit. So we can assume that when the Earth's orbital speed at point A is increased from V_1 to V_{A2}, it can enter elliptical orbit 2 whose perihelion distance is r_1 and aphelion distance is r_2. According to the law of conservation of mechanical energy, when Earth moves from perihelion A to aphelion B, we have

$$\frac{1}{2}MV_{A2}^2=\frac{1}{2}MV_B^2+\Delta E_p \tag{1}$$

$$\Delta E_p=\int_{r_1}^{r_2}\frac{GMM_s}{r^2}dr=GMM_s\left(\frac{1}{r_1}-\frac{1}{r_2}\right) \tag{2}$$

According to Kepler's second law, we also know

$$\frac{1}{2}V_{A2}\bullet\Delta t\bullet r_1=\frac{1}{2}V_B\bullet\Delta t\bullet r_2 \tag{3}$$

From Eq.(1)～Eq.(3), we can deduce the following formula:

$$V_{A2}=\sqrt{\frac{2r_2}{r_1+r_2}}\sqrt{\frac{GM_s}{r_1}}=\sqrt{\frac{2r_2}{r_1+r_2}}V_1 \tag{4}$$

Similarly, in order to make the earth in a circular orbit of radius r_1 enter elliptical orbit 3 whose perihelion distance is r_1 and aphelion distance is r_3, the Earth's orbital speed at point A should be increased from V_1 to V_{A3} :

$$V_{A3}=\sqrt{\frac{2r_3}{r_1+r_3}}\bullet\sqrt{\frac{GM_s}{r_1}}=\sqrt{\frac{2r_3}{r_1+r_3}}V_1 \tag{5}$$

From Eq.(4)～Eq.(5),we can deduce the following formula:

$$V_{A3}=\sqrt{\frac{r_1+r_2}{2r_2}}\bullet\sqrt{\frac{2r_3}{r_1+r_3}}\bullet V_{A2}=\sqrt{\frac{r_3(r_1+r_2)}{r_2(r_1+r_3)}}\bullet V_{A2} \tag{6}$$

$$V_{A3}-V_{A2}=\left(\sqrt{\frac{r_3(r_1+r_2)}{r_2(r_1+r_3)}}-1\right)\bullet V_{A2} \tag{7}$$

i.e. if the Earth's orbital speed V_{A2} at perihelion A of elliptical orbit 2 is increased by $\left(\sqrt{\frac{r_3(r_1+r_2)}{r_2(r_1+r_3)}}-1\right)\bullet V_{A2}$, then the Earth can be transferred from elliptical orbit 2 to orbit 3.

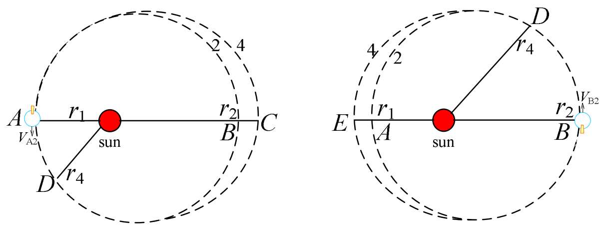
For example, now the earth moves in an elliptical orbit whose perihelion distance r_1= 147098074000 m and aphelion distance r_2= 152097701000 m, and the Earth's orbital speed at perihelion is V_{A2}= 30287 m/s. In order to make the Earth be transferred from the current elliptical orbit to an extended elliptical orbit of aphelion distance $r_3=r_2+0.02$m, the Earth's orbital speed at perihelion should be increased by 9.75134e-10 m/s.

Generally, as is shown in Fig. 3(a), for any point D on semi-elliptic orbit 2 starting from perihelion A to aphelion B, assume the Earth's orbital speed at point A and point D are V_{A2} and V_D respectively, the distance between D and the Sun is r_4, then according to Kepler's second law, we have

$$V_{A2}\bullet r_1=V_D\bullet r_4 \tag{8}$$

If the Earth's orbital speed at point D is increased by a propulsive force, making V_D become V_4, then the Earth is transferred to a larger elliptic orbit marked as 4. Since the perihelion distance of the elliptic orbit is invariant, its aphelion distance must be increased. Assume when the Earth's orbital speed at point A of orbit 2 is increased from V_{A2} to V_{A4}, the Earth can also enter orbit 4, then

$$V_{A4}\bullet r_1=V_4\bullet r_4 \tag{9}$$



(a) aphelion distance is increased (b) perihelion distance is increased

Fig. 3. *The Earth's orbit is extended due to the increase of speed*

From Eq.(8) and Eq.(9), we can obtain

$$V_{A4}-V_{A2}=\frac{r_4}{r_1}(V_4-V_D) \tag{10}$$

$$V_4-V_D=\frac{r_1}{r_4}(V_{A4}-V_{A2}) \tag{11}$$

i.e., if an increase as much as ΔV in the Earth's orbital speed at point A of orbit 2 can make the earth be transferred to orbit 4, then only an increase as much as $\frac{r_1}{r_4}\Delta V$ ($\frac{r_1}{r_D}<1$) in the Earth's orbital speed at point D of orbit 2 is required to make the earth be transferred to orbit 4. Hence, the probability of an increase in the Earth's orbital speed causing an extension of the Earth's orbit is large.

Similarly, as is shown in Fig. 3(b), for any point D on semi-elliptic orbit 2 starting from aphelion B to perihelion A, if the Earth's orbital speed at point D is increased by a propulsive force, then the Earth is transferred to an elliptic orbit (marked as 4) with longer perihelion distance.

(1.2) Decelerating the Earth's revolution reduces the Earth's orbit

As is shown in Fig.2, if the Earth's orbital speed at perihelion A of elliptical orbit 3 is decreased from V_{A3} to V_{A2}, then the Earth can be transferred from elliptical orbit 3 to elliptical orbit 2. From Eq.(6), we obtain

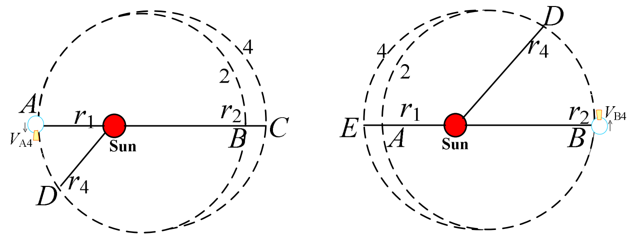
$$V_{A3}-V_{A2}=\left(1-\sqrt{\frac{r_2(r_1+r_3)}{r_3(r_1+r_2)}}\right)\bullet V_{A3} \tag{12}$$

i.e. if the Earth's orbital speed V_{A3} at perihelion A of elliptical orbit 3 is decreased by $\left(1-\sqrt{\frac{r_2(r_1+r3)}{r_3(r_1+r2)}}\right)$•$V_{A3}$, then the Earth can be transferred from elliptical orbit 3 to orbit 2.

For example, now the earth moves in an elliptical orbit whose perihelion distance r_1= 147098074000 m and aphelion distance r_2= 152097701000 m, and the Earth's orbital speed at perihelion is V_{A3}= 30287 m/s. In order to make the Earth be transferred from the current elliptical orbit to a contracted elliptical orbit of aphelion distance r_3=r_2-0.02m, the Earth's orbital speed at perihelion should be decreased by 9.78497e-10 m/s.

Generally, as is shown in Fig. 4(a), for any point D on semi-elliptic orbit 4 starting from perihelion A to aphelion C, assume the Earth's orbital speed at point A and point D are V_{A4} and V_D respectively, the distance between D and the Sun is r_4, then according to Kepler's second law, we have

$$V_{A4}•r_1=V_D•r_4 \tag{13}$$



(a) aphelion distance is decreased (b) perihelion distance is decreased

***Fig. 4.** The Earth's orbit is contracted due to the decrease of speed*

If the Earth's orbital speed at point D is decreased by a reverse-thrust force, making V_D become V_2, then the Earth is transferred to a smaller elliptic orbit marked as 2. Since the perihelion distance of the elliptic orbit is invariant, its aphelion distance must be decreased. Assume when the Earth's orbital speed at point A of orbit 4 is decreased from V_{A4} to V_{A2}, the Earth can also enter orbit 2, then

$$V_{A2}•r_1=V_2•r_4 \tag{14}$$

From Eq.(13) and Eq.(14), we can obtain

$$V_{A4}-V_{A2}=\frac{r_4}{r_1}(V_D- V_2) \tag{15}$$

$$V_D- V_2=\frac{r_1}{r_4}(V_{A4}-V_{A2}) \tag{16}$$

i.e., if a decrease as much as ΔV in the Earth's orbital speed at point A of orbit 4 can make the earth be transferred to orbit 2, then only a decrease as much as $\frac{r_1}{r_4}\Delta V$($\frac{r_1}{r_4}$<1) in the Earth's orbital speed at point D of orbit 4 is required to make the earth be transferred to orbit 2. Hence, the probability of a decrease in the Earth's orbital speed causing a contraction of the Earth's orbit is large.

Similarly, as is shown in Fig. 4(b), for any point D on semi-elliptic orbit 4 starting from aphelion B to perihelion E, if the Earth's orbital speed at point D is decreased by a reverse-thrust force, then the Earth is transferred to an elliptic orbit (marked as 2) with shorter perihelion distance.

(2) Extend "the principle of rocket flight" to the computation model of volcanic eruption changing Earth's revolution speed, and derive a formula on volcanic eruption changing the earth's revolution speed [13].

This work can be divided into the following two cases.

(2.1) Reverse-thrust volcanic eruptions decrease the Earth's orbital speed

As is shown in Fig.2 and Fig.5, during the Earth's revolution around the Sun, when a volcano continuously erupt and send a huge amount of material into the stratosphere with great speed towards the tangential direction of the Earth's revolution, which can produce a tremendous resistance to the Earth, decreasing the Earth's orbital speed. Hence, we can employ the principle of rocket flight to calculate the negative increment of the Earth's orbital speed.

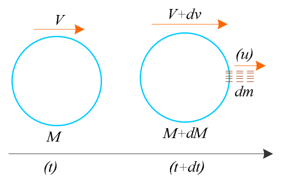


***Fig. 5.** Reverse-thrust volcanic eruptions decrease the earth's orbital speed*

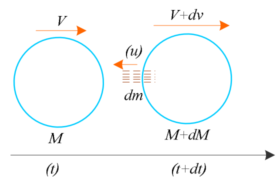


***Fig. 6.** Forward-thrust volcanic eruptions increase the earth's orbital speed*

At a given instant t, let the mass of the Earth be M and its speed be v, then during the period from time t to time t+dt, the volcanoes erupted substance of mass dm, the velocity of these substances erupted from the Earth be u, making the Earth's speed increase dv. Therefore, at the time t+dt, the mass of the Earth is M+dM, its speed is v+dv, the mass of the erupted substances is dm (if dt is very small, such as dt≤1s, these substances can be regarded separated substances flying in the air) and the speed of these substances is (v+dv+u). Since the Sun's gravitation pull on the Earth and the centrifugal force produced by the Earth's revolution around the Sun had the same size but opposite directions, the resultant external force exerted on the Earth is zero, therefore according to theorem of momentum, we have

$$Mv=[M+dM](v+dv)+dm(v+dv+u)]$$

Notice that dM=-dm, we have

$$dv=u*dM/M$$

Let v=v_i and M=M_i when t=t_i, during the period from time t_i to time t_j the volcanoes erupted some substances, then at instant t_j, v=v_j and M=M_j , therefore we obtain

$$\int_{v_i}^{v_j} dv = u\int_{M_i}^{M_j} dM/M \rightarrow v_j-v_i=-u\ln(M_i/M_j)$$

Let the ratio of the mass of the entire Earth to the remaining mass after the first second of volcanic eruption be N_1, the ratio of the remaining mass to the remaining mass after the second second of volcanic eruption be N_2, and so on. Let u_i be the speed of the substances erupted from the Earth in the i-th second of volcanic eruption, and v_i be the speed of the Earth after the i-th second of volcanic eruption, then

$$v_1-v_0=-u_1\ln(N_1),\ v_2-v_1=-u_2\ln(N_2),\ v_3-v_2=-u_3\ln(N_3),\ \bullet\bullet\bullet\bullet\bullet\bullet,\ v_k-v_{k-1}=-u_k\ln(N_k)$$

Generally, we can think that $u_1= u_2=\bullet\bullet\bullet=u_k =u$ and $N_1= N_2=\bullet\bullet\bullet=N_k= N$ for some positive number u, N, so

$$v_k- v_0=-ku\ln(N)$$

In the calculation of volcano activity, we should refer to statistical data. There are 1500 more active volcanoes around the world, and out of these volcanoes, 50~80 volcanoes erupt every year. The famous Vesuvius volcano in history could spew volcanic substances at the rate of 1.54321 million tons per second. Stromboli volcano in Italy has been in almost continuous eruption for hundreds of years. The well-known Vulcanian eruption is a type of explosive eruption that can eject volcano substances with a speed greater than 350m/s. Just as the volcanoes discovered by Voyager 1 on Jupiter's satellite, Io, whose velocity of spewing volcano substances could reach 1000m/s, many volcanoes on the Earth are also very violent. Their eruptions could eject a cloud of stones, ash and fumes to a height of dozens of miles. The Moon is formed by this kind of “volcano cloud” moving around the Earth. This shows that the velocity of some erupted matter can reach the first cosmic velocity, which is 7.9 km/s.

Volcanic eruption has relation with time. For the same region, before dawn, the temperature is usually lower than other time of a day, it is easy to form raindrops, so the probability of rain in this period is larger than that in other periods. When the rainfall is large enough, the rainwater can permeate through crust cracks into volcano’s magma chambers, causing violent volcanic eruptions or earthquakes. Hence, for the same region, the probability of volcanic eruption before dawn is larger than that in other periods. In addition, the direction of volcano ejection occurring between 3:00 am and 7:00 am almost coincides with the direction of the Earth’s revolution, therefore decreasing the Earth’s revolution.

Since some volcano groups have several volcanoes erupting simultaneously, we can moderately assume when the Earth approaches its perihelion,a volcano group ejects 1.54321e9 kg per second (which amounts the ejecta mass of a Vesuvius volcano per second), and the ejection velocity is 350 m/s, then after 4 hours of continuous eruption, the Earth’s orbital speed can be decreased by 1.1191e-9 m/s (＞9.78497e-10 m/s), making the Earth be transferred to a contracted elliptical orbit whose aphelion distance is 0.02m shorter than that of the previous orbit.

Just as what Eq.(15) and Eq.(16) shows, a volcanic eruption of the same scale occurring at any point D on the semi-elliptic orbit from perihelion A to aphelion C can produce almost the same effect on the decrease of the Earth’s orbital speed， therefore produce almost the same effect on the variation of the Earth’s orbit. Hence, the probability that the Earth’s orbit changes fifty times along this long semi-elliptic orbit is very high. So it’s very natural that the aphelion distance is deceased by 1 m in a year due to the variation of the Earth’s orbit. In the course of one hundred years, it’s very natural that the aphelion distance is deceased by 100 m due to the variation of the Earth’s orbit; meanwhile, it’s also very natural that the perihelion distance is deceased by 100 m due to the variation of the Earth’s orbit. So it is no wonder that the Earth’s surface temperature has been increased by 0.8 ºC. Similarly, table 1 also shows some other data about the Earth’s orbital variation corresponding to different scales of volcanic eruptions.

Table 1. *Earth’s orbit contraction caused by different scales of volcanic eruptions*

eruption velocity(m/s)	**erupted mass per second (kg/s)**	**eruption duration at a time (h) ×number of times**	**yearly decrease of Earth’s aphelion distance (m)**	**centennial decrease of Earth’s aphelion distance (m)**
350	1.54321e9	4×50	≥0.020×50	≥100
500	1.54321e9	4×40	≥0.025×40	≥100
1000	1.54321e9	4×20	≥0.05×20	≥100
2000	1.54321e9	4×10	≥0.1×10	≥100
3200	1.54321e9	2×10	≥0.1×10	≥100
7900	1.54321e9	2×4	≥0.25×4	≥100
7900	1.54321e9	2×8	≥0.25×8	≥200

(2.2) Forward-thrust volcanic eruptions increase the Earth’s orbital speed

As is shown in Fig.1 and Fig.6, during the Earth’s revolution around the Sun, when a volcano continuously erupt and send a huge amount of material into the stratosphere with great speed contrary to the tangential direction of the Earth’s revolution, it can produce a tremendous impetus on the Earth, increasing the Earth’s orbital speed. Hence, we can also employ the principle of rocket flight to calculate the increment of the Earth’s orbital speed.

At a given instant t, let the mass of the Earth be M and its speed be v, then during the period from time t to time t+dt, the volcanoes erupted substance of mass dm, the velocity of these substances erupted from the Earth be u, making the Earth’s speed increase dv. Therefore, at the time t+dt, the mass of the Earth is M+dM, its speed is v+dv, the mass of the erupted substances is dm (if dt is very small, such as dt≤1, these substances can be regarded separated substances flying in the air) and the speed of these substances is (v+dv-u). Since the Sun's gravitation pull on the Earth and the centrifugal force produced by the Earth’s revolution around the Sun had the same size but opposite directions, the resultant external force exerted on the Earth is zero, therefore according to theorem of momentum, we have

$$Mv=[M+\mathrm{d}M](v+\mathrm{d}v)+\mathrm{d}m(v+\mathrm{d}v-u)]$$

Notice that $\mathrm{d}M=-\mathrm{d}m$, we have

$$\mathrm{d}v=-u*\mathrm{d}M/M$$

Let $v=v_i$ and $M=M_i$ when $t=t_i$, during the period from time t_i to time t_j the volcanoes erupted some substances, then at instant t_j, $v=v_j$ and $M=M_j$, therefore we obtain

$$\int_{v_i}^{v_j} dv = -u \int_{M_i}^{M_j} dM / M \;\rightarrow v_j - v_i = u\ln(M_i / M_j)$$

Let the ratio of the mass of the entire Earth to the remaining mass after the first second of volcanic eruption be N_1, the ratio of the remaining mass to the remaining mass after the second second of volcanic eruption be N_2, and so on. Let u_i be the speed of the substances erupted from the Earth in the *i*-th second of volcanic eruption, and v_i be the speed of the Earth after the *i*-th second of volcanic eruption, then

$$v_1-v_0=u_1\ln(N_1),\ v_2-v_1=u_2\ln(N_2),\ v_3-v_2=u_3\ln(N_3),\ \bullet\bullet\bullet\bullet\bullet\bullet,\ v_k-v_{k-1}=u_k\ln(N_k)$$

Generally, we can think that $u_1= u_2=\bullet\bullet\bullet=u_k =u$ and $N_1= N_2=\bullet\bullet\bullet=N_k= N$ for some positive number *u, N*, so

$$v_k- v_0=ku\ln(N)$$

Volcanic eruption has relation with time. For the same region, in the daytime, the temperature is high, air movement is active, so it is difficult to form raindrops; while at night, the temperature is low, then it is easy to form raindrops. So the probability of rain at night is larger than that during the day. When the rainfall is large enough, the rainwater can permeate through crust cracks into volcano's magma chambers, causing violent volcano eruptions or earthquakes. Hence, for the same region, the probability of volcanic eruption at night is larger than that in the daytime. In addition, volcanic eruption occurring between 4:00 pm and 8:00 pm spouts substance almost in the opposite direction to the Earth's revolution, therefore increasing the Earth's orbital speed.

Since some volcano groups have several volcanoes erupting simultaneously, we can moderately assume when the Earth approaches its perihelion,a volcano group ejects 1.54321e9 kg per second (which amounts the ejecta mass of a Vesuvius volcano per second), and the ejection velocity is 350 m/s, then after 4 hours of propulsive eruption, the Earth's orbital speed can be increased by 1.1191e-9 m/s (＞9.75134e-10 m/s), making the Earth be transferred to an extended elliptical orbit whose aphelion distance is 0.02m longer than that of the previous orbit.

Just as what Eq.(10) and Eq.(11) shows, a volcanic eruption of the same scale occurring at any point D on the semi-elliptic orbit from perihelion A to aphelion C can produce almost the same effect on the increase of the Earth's orbital speed， therefore produce almost the same effect on the variation of the Earth's orbit. Hence, the probability that the Earth's orbit changes fifty times along this long semi-elliptic orbit is very high. So it's very natural that the aphelion distance is increased by 1 m in a year due to the variation of the Earth's orbit. In the course of 100,000 years, it's very natural that the aphelion distance is increased by 100 km due to the variation of the Earth's orbit; meanwhile, it's also very natural that the perihelion distance is increased by 100 km due to the variation of the Earth's orbit. This would make the Earth enter a little ice age. In the course of 1,000,000 years, it's very natural that the aphelion distance is increased by 1000 km due to the variation of the Earth's orbit; meanwhile, it's also very natural that the perihelion distance is increased by 1000 km due to the variation of the Earth's orbit. This would make the Earth enter a great ice age.

Similarly, table 2 also shows some other data about the Earth's orbital variation corresponding to different scales of volcanic eruptions.

Table 2. *Earth's orbit extension caused by different scales of volcanic eruptions*

eruption velocity(m/s)	erupted mass per second (kg/s)	eruption duration at a time (h) ×number of times	yearly increase of Earth's aphelion distance (m)	a hundred millennial increase of Earth's aphelion distance (km)
350	1.54321e9	2×10	≥0.01×10	≥10
350	1.54321e9	2×100	≥0.01×100	≥100
350	1.54321e9	4×50	≥0.02×50	≥100
500	1.54321e9	4×40	≥0.025×40	≥100
1000	1.54321e9	4×20	≥0.05×20	≥100
2000	1.54321e9	4×10	≥0.1×10	≥100
3200	1.54321e9	2×10	≥0.1×10	≥100
7900	1.54321e9	2×4	≥0.25×4	≥100
7900	1.54321e9	2×8	≥0.25×8	≥200

3. Conclusions

The issue of global climate change is now extensively debated around the world. Although some people have accepted with half-believing and half-doubting the view that the emission of greenhouse gases is the primary factors in global climate change, many scientists are skeptical about this view, they have refuted this view with plenty of evidence and believed natural driving is the main factor for global climate change. The author's recent research also shows that although greenhouse gases can cause short-term warming in some local areas, volcanism can obviously alter the orbit of the Earth and therefore is another key factor in climate change. When the Earth's revolution speed is increased by volcanic eruption, the Earth's orbit is extended, causing global cooling; when the Earth's revolution speed is decreased by volcanic eruption, the

Earth’s orbit is reduced, making global warming. It’s thus clear that global warming and cooling are both natural phenomena, and they occur alternately. Therefore we can find the corresponding strategy excavating global warming is to make some violent volcanoes erupt towards evening, and the corresponding strategy excavating global cooling is to make some violent volcanoes erupt at dawn. We are no longer afraid the arrival of the world’s end caused by climate change.

References

[1] Changnon, Stanley A.; Bell,Gerald D. 2000. *El Nino,1997-1998:The Climate Event of the Century*. London: Oxford University Press.

[2] Courtillot, Vincent; Gallet, Yves; Le Mouël, Jean-Louis; et al. 2006. Are there connections between the Earth's magnetic field and climate?. Earth and Planetary Science Letters, 253 (328–339): 620.

[3] Diggles, Michael. 2006. The Cataclysmic 1991 Eruption of Mount Pinatubo, Philippines. U.S. Geological Survey Fact Sheet 113-97.

[4] Gale, Andrew S.1989. "A Milankovitch scale for Cenomanian time". Terra Nova, 1(5): 420.

[5] Ge Quan-sheng, Wang Shao-wu, Fang Xiu-qi. 2010. An uncertainty analysis of understanding on climate change. Geographical Research, 29(2):192-203.

[6] IPCC.2007. *Climate Change 2007: Synthesis Report* (*Summary for Policymakers*). Cambrige University Press, 2007: 2-22.

[7] IPCC.2007. *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the International Government Panel on Climate Change*. Cambridge,UK and New York:Cambridge University Press.

[8] Oppenheimer, Clive. 2003. Climatic, environmental and human consequences of the largest known historic eruption: Tambora volcano (Indonesia) 1815. Progress in Physical Geography, 27 (2): 230.

[9] Sagan, C.; Chyba, C. 1997. The Early Faint Sun Paradox: Organic Shielding of Ultraviolet-Labile Greenhouse Gases. Science, 276 (5316): 1217–21.

[10] Wignall,P. 2001. Large igneous provinces and mass extinctions.Earth-Science Reviews, 53: 1.

[11] Willson, Richard C.; Hugh S. Hudson. 1991. "The Sun's luminosity over a complete solar cycle". Nature, 351 (6321): 42–44.

[12] X.P. Mao. 2012. Let students understand the problem of satellite orbit transfer through instance calculation. Physics Teacher, 33(4):53 (in Chinese).

[13] Zhang San-hui.2008. *University Physics—Mechanics,Thermodynamics*. Beijing:Tsinghua University Press.