How to effectively protect the Earth from global warming by means of advanced Sunlight Shield Equipment

H. Murakami[1]

Abstract —Lots of studies are proceeding in the world to prevent global warming. The author has proposed a set of Sunlight Shield Equipment composed of a flat balloon of which surface has a mirror function. When the Sunlight Shield Equipment is set in the stratosphere, its surface reflects sunlight to space. Temperature of the Earth could be controlled by controlling an amount of sunlight energy which the Earth receives from the sun. In order to decrease sunlight energy by one percent, it is required that a large number of the Sunlight Shield Equipment should be evenly distributed, set and operated in the stratosphere over the Earth. When the area of a set of the Sunlight Shield Equipment is equal to 0.5 square kilometer, about ten million sets of the Sunlight Shield Equipment are necessary, and a huge amount of cost is required. In this case, the gross area of ten million sets of the Sunlight Shield Equipment is equal to about 5.1×10^6 square kilometers. Therefore, it is desired that a mean value of the Earth temperature decreases more effectively. This paper proposes a set of advanced Sunlight Shield Equipment, and clarifies its effective operation.

Keywords —global warming prevention, Sunlight Shield Equipment, CO_2, temperature decrease of the Earth

1 Introduction

The Earth is getting warmer. The temperature of the Earth depends on an amount of sunlight energy received by the Earth. In order to prevent global warming, Sunlight Shield Equipment composed of a flat balloon has been proposed by the author. Balloon's surface of the Sunlight Shield Equipment has a mirror function. When the Sunlight Shield Equipment is set in the stratosphere, its surface reflects sunlight to space.

When one percent of sunlight energy which the Earth receives from the sun is reflected to space by a large number of the Sunlight Shield Equipment, a mean value of the Earth temperature decreases by about one degree centigrade.

For decreasing sunlight energy by one percent, it is required that a large number of the Sunlight Shield Equipment are evenly distributed, set and operated in the stratosphere over the Earth. When the area of a set of the Sunlight Shield Equipment is equal to 5 square kilometers, about one million sets of the Sunlight Shield Equipment are necessary, of which gross area is equal to about 5.1×10^6 square kilometers. In such a case, huge amount of cost is required. Therefore, an effective operation of the Sunlight Shield Equipment is desired.

This paper proposes a set of advanced Sunlight Shield Equipment, and its effective operation.

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2 Typical setting of the Sunlight Shield Equipment

2.1 An example of Sunlight Shield Equipment

An example of Sunlight Shield Equipment is shown in Figure 1. The Sunlight Shield Equipment is composed of a flat balloon with the following three main functions, which, however, does not have an attitude control function. The first function is a reflection function. By this function, sunlight, which a surface of the Sunlight Shield Equipment receives from the sun, is reflected to space. The second function is a float function. By this function, it is possible to float the Sunlight Shield Equipment itself in the air. The last function is a movement function. By this function, it is possible to move the Sunlight Shield Equipment itself in the air. The surface area of the Sunlight Shield Equipment is about 0.5 square kilometer. There could be a variety of sizes of the Sunlight Shield Equipment.

A large number of the Sunlight Shield Equipment are set in the stratosphere horizontally. A reflection direction of sunlight depends on a sunlight direction, and an amount of reflected sunlight depends on a setting position of the Sunlight Shield Equipment. The total amount of reflected sunlight by the Sunlight Shield Equipment is large in quantity. It is dependent on the amount of required mean temperature decrease.

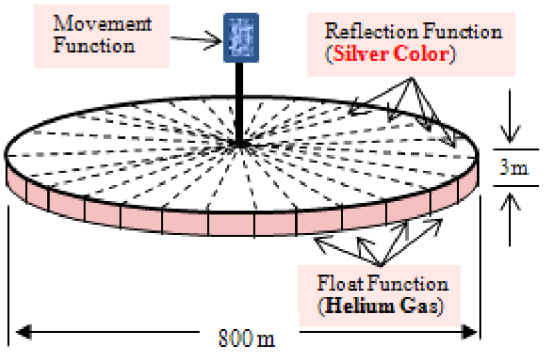

Figure 1. An example of the Sunlight Shield Equipment

The total cost of the Sunlight Shield Equipment is huge. Therefore a gross area of the Sunlight Shield Equipment should be as small as possible from a cost point of view.

Operation of the Sunlight Shield Equipment requires small energy for moving itself or telecommunication. The Sunlight Shield Equipment does not emit CO_2, because it does not use oil for its operation.

2.2 Evenly setting of Sunlight Shield Equipment (Case A)

The total area of the Earth's surface is about 5.1×10^8 square kilometers. Case A shows that many sets of the Sunlight Shield Equipment shown in Figure 1 are set evenly over the Earth as shown in Figure 2. In case A, the gross area of the Sunlight Shield Equipment is equal to about 5.1×10^6 square kilometers, in order to reflect 1 % of the sunlight energy received by the Earth. If the Sunlight Shield Equipment as shown in Figure 1 is applied, ten million sets of the Sunlight Shield Equipment are required.

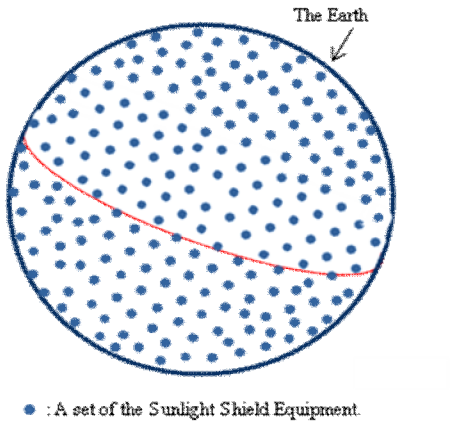

Figure 2. A large number of the Sunlight Shield Equipment set evenly over the Earth.

When a large number of the Sunlight Shield Equipment reflect 1 % of the sunlight energy received by the Earth, a mean value of the Earth temperature decreases by about one degree centigrade.

Case A has great advantage in that it does not make a serious issue of climate changes, because that the Earth temperature decreases evenly. Case A assumes that the sun radiates 99 % of sunlight energy. As a result, the Earth can maintain almost the same temperature as the usual climate, or specifically about one centigrade lower than a case without the Sunlight Shield Equipment.

In case A, a mean temperature decrease of the Earth is estimated under the assumption that the Earth is a black body with one air layer.

2.3 Concentrated setting of Sunlight Shield Equipment (Case B)

Case B shows that a large number of the Sunlight Shield Equipment shown in Figure 1, are set within a band area of 3000km width over the equator as shown in Figure 3, and are not set in the other area.

In Case B, the Sunlight Shield Equipment can efficiently reflect sunlight to space, because an angle between sunlight direction and surface direction of the Sunlight Shield Equipment is about 90 degrees during daytime. Therefore the band area is cooled down, but the area except the band area is not cooled down by the Sunlight Shield Equipment directly.

Therefore in Case B, the gross area of the Sunlight Shield Equipment is equal to about $0.25\pi\times5.1\times10^6$ square kilometers, in order to reflect 1 % of the sunlight energy received by the Earth. When the Sunlight Shield Equipment as shown in Figure 3 is

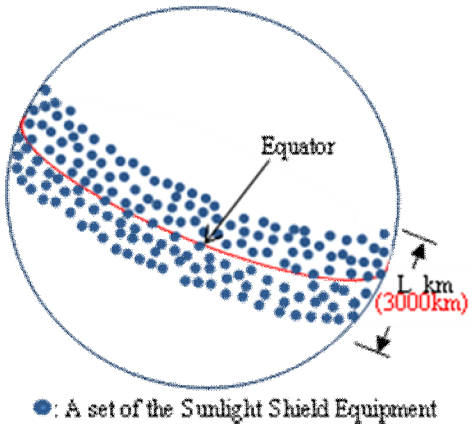

Figure 3. A large number of the Sunlight Shield Equipment set within a band area of 3000km width over the equator.

applied, about 7.9 million sets of the Sunlight Shield Equipment are required. The cost of the Sunlight Shield Equipment in this case is about 79 % of it in Case A. This lower cost is an advantage of Case B over Case A.

In Case B, a reflection rate in the band area is about 3 %. Thus the band area is cooled down by a large number of the Sunlight Shield Equipment directly, and a mean temperature value of the band area could decrease by about 2 centigrade. In the outside of the band area, a reflection rate is zero. But the outside area, which is not directly cooled down, is also cooled down indirectly by an ocean current, general circulation and so on. Therefore climate of many areas is affected and changed, which sometimes may cause serious problems such as change of westerly. This climate change is a disadvantage of Case B.

Climate changes may be useful in that weaker hurricanes could be born, because a hurricane growing area included in the band area is cooled down.

3 Effective setting of the Advanced Sunlight Shield Equipment

3.1 Proposal for the Advanced Sunlight Shield Equipment

A set of advanced Sunlight Shield Equipment with the Attitude Control Function is proposed. The advanced Sunlight Shield Equipment is made by adding the Attitude Control Function to the Sunlight Shield Equipment. An example is shown in Figure 4. The Attitude Control Function is composed of three electric propellers as shown in Figure 4.

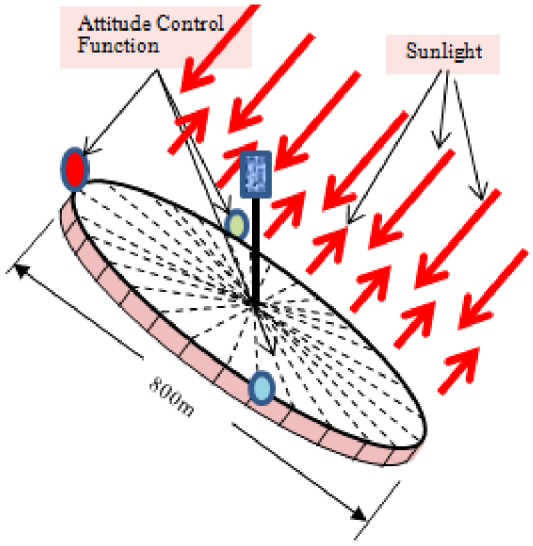

Figure 4. An example of the advanced Sunlight Shield Equipment with an attitude Control Function.

A central propeller of three electric propellers pulls up the advanced Sunlight Shield Equipment itself under the control of a remote control centre on the ground. Right and left electric propellers control a direction of the advanced Sunlight Shield Equipment under the control of the remote control centre.

Then the Attitude Control Function controls the surface angle of the advanced Sunlight Shield Equipment, and keeps a direction of the surface toward the Sun, as shown in Figure 4 and Figure 6.

The Attitude Control Function controls the attitude of the Advanced Sunlight Shield Equipment so that an angle θ between the surface of the advanced Sunlight Shield Equipment and sunlight line may become about 90 degrees. Then the Attitude Control Function adjusts a slope to be β degrees of the advanced Sunlight Shield Equipment according to a setting position.

This Attitude Control Function does not require high level of accuracy. Because even if some sets of the Advanced Sunlight Shield Equipment have about 10 degrees errors, the total reflected sunlight energy might not be changed to a greater extent. Even if some sets of the advanced Sunlight Shield Equipment are broken, they do not make serious issues. The Sunlight Shield Equipment with some degrees error due to the attitude control can reflect almost all of sunlight energy to space. Reflection efficient of the advanced Sunlight Shield Equipment is more than about 90 %, when the slope of β

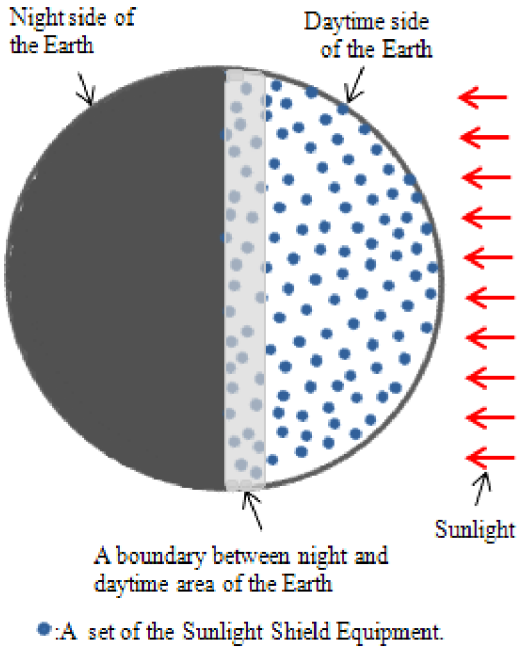

Figure 5. A boundary between night and daytime area of the Earth where reflection efficient of the advanced Sunlight Shield Equipment is less then 90 %.

degrees is adjusted in between 20 and 90 degrees. When the reflection efficient of a large number of sets is less than about 90 %, it might be necessary to slightly increase the number of the advanced Sunlight Shield Equipment.

The Attitude Control Function could not control the slope of β, when it is less than 20 degrees. In this case, reflection efficient of the advanced Sunlight Shield Equipment is less than 90 %.

In a boundary between night and daytime area of the Earth, as shown in Figure 5, reflection efficient of the advanced Sunlight Shield Equipment is less than 90 %. The boundary between night and daytime area occupies about 17 % of all the surface of the Earth. Therefore 17 % sets of the advanced Sunlight Shield Equipment have more than 10 % loss of reflection sunlight energy.

If it is necessary to precisely evaluate a total reflection amount by the advanced Sunlight Shield Equipment, the advanced Sunlight Shield Equipment should be actually manufactured and experimented. This loss should be taken into account, and sets of the advanced Sunlight Shield Equipment should be increased to compensate the loss.

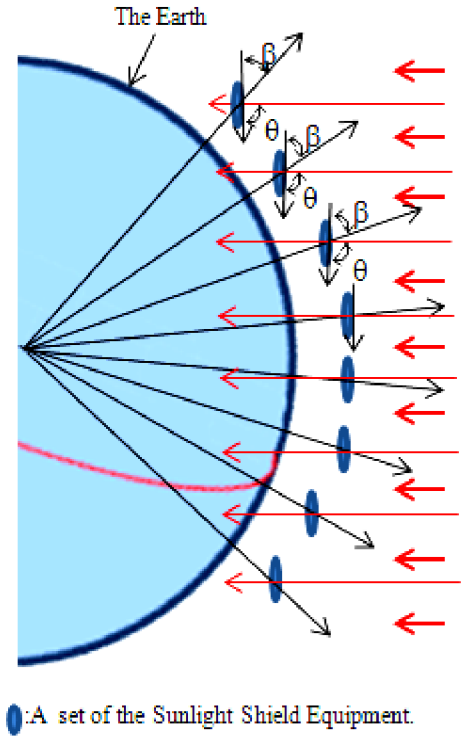

Figure 6. An attitude operation example of the advanced Sunlight Shield Equipment over the Earth.

3.2 Evenly setting the advanced Sunlight Shield Equipment (Case C)

Case C shows that a large number of the advanced Sunlight Shield Equipment are evenly set over the Earth. Case C uses the advanced Sunlight Shield Equipment. On the other hand Case A or Case B uses the Sunlight Shield Equipment. Case C has advantages over Case A and Case B from the cost and climate issue point of view.

In Case C, the gross area of the Sunlight Shield Equipment is equal to about $0.5\times5.1\times10^6$ square kilometers, so that a large number of the advanced Sunlight Shield Equipment reflect 1 % of sunlight energy received by the Earth.

If the Sunlight Shield Equipment as shown in Figure 6 is applied, in order that a large number of the advanced Sunlight Shield Equipment can reflect 1 % of sunlight energy, about 5 million sets of the advanced Sunlight Shield Equipment are required, which covers about 50 % of the gross area of Case A. The about 50 % area of Case A means that the cost in Case C is equal to bout one half of it in Case A, because the Attitude Control Function cost is negligibly small, compared with it of the advanced Sunlight Shield Equipment. This cost in Case C is an advantage over Case B or Case A.

When a large number of the advanced Sunlight Shield Equipment are evenly set over the Earth, the Earth is cooled down evenly. Therefore, they do not make climate changes. No climate change in Case C is advantage over Case B.

4 CONSIDERATION

(1) The advanced Sunlight Shield Equipment is a tool which reflects sunlight to space to cool down anything under it. This tool could be useful for cooling down the temperature of too hot areas of the Earth in summer.

(2) There are many applications of the advanced Sunlight Shield Equipment for dealing with climate issues. For example, if an area, where a hurricane is born, is cooled down by the advanced Sunlight Shield Equipment, the energy of the hurricane could get smaller.

(3) The Attitude Control Function can control an attitude of the advanced Sunlight Shield Equipment. When it is not desired that the advanced Sunlight Shield Equipment reflects sunlight, the Attitude Control Function controls the advanced Sunlight Shield Equipment using a control signal transmitted from a remote centre to change an attitude of the advanced Sunlight Shield Equipment not to reflect sunlight.

5 CONCLUSION

(1) The advanced Sunlight Shield Equipment with the Attitude Control Function is proposed, which could be applied to preventing global warming.
(2) In Case C, when the advanced Sunlight Shield Equipment is applied to preventing global warming, it is clarified that no big climate changes are not caused.
(3) In Case C, the required number of the advanced Sunlight Shield Equipment is one-half of it in Case A, so that many sets of the advanced Sunlight Shield Equipment reflect 1 % of the sunlight energy.
(4) The advanced Sunlight Shield Equipment is a useful tool for cooling down areas under it, which solves climate issues.

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