No.13　Water Circulations－2

Around 4.6 millions years ago, a primordial solar nebula began to shrink and most of the mass of nebulae was drawn to the sun, which is the center of the nebula (the mass of the sun is 330 thousands times as that of the earth). Nine planets, including the earth, that circulate around the sun were formed by a little amount of dusts that were not drawn to the sun.

As being called “a planet of the water,” the two-thirds of the surface of the earth is covered with water. There are hundreds of billions of stars in a vast space area, of which the Galactic System has more than 100 billions of stars, and the earth is the only one that possesses affluent of fluid water.

Why does fluid water, including the seawater, exist only on the earth?

There are several necessary conditions that water can exist on the earth (Kitano, Yasushi: “Science of the Water”).

Firstly, there were affluent hydrogen and oxygen in the primordial solar nebula, both of which are components of the water.

Current development of space science proved that, by cosmic abundance, affluent hydrogen and oxygen had existed in the space. Therefore, water molecules were easily synthesized.

Secondary, the distance from the earth to the sun should have an appropriate length

If the earth were located too far from the sun like the Mars, the surface temperature would be at –60 ^{o}C and no fluid water could exist. If the earth were located too near like the Venus, the temperature would be at 500 ^{o}C and the water would evaporate and immediately decompose to the hydrogen gas and the oxygen gas. Then hydrogen gas would be gone to the space. Therefore, no water could exist in the Venus. On the contrary, the earth is located on the appropriate distance from the sun, which keeps the average temperature of the earth around 15 ^{o}C. Therefore, the water can exist on the earth with three different conditions, the fluid water, ice/snow, and vapor.

Thirdly, there is an appropriate attractive force on the earth

The water evaporates by the energy from the sun and, on the upper air where the temperature is low, it turns into ice and snow/rain. Ice and snow/rain then return to the surface of the earth drawn by attraction of the earth. If the earth were lighter, its attractive force would be smaller and water vapor would be gone to the space. If the earth were bigger and had more attractive force, light gases, such as hydrogen and helium gases would be held inside the gravity sphere and the earth would be covered with those gases. Therefore, the water can exist on the earth because the appropriate attraction force lets hydrogen and helium gases go to the space and keep the water vapor inside.

Fourthly, the atmosphere includes an appropriate amount of the greenhouse effect gas

0.03 % of carbon dioxide and 1 % of water vapor, both of which are included in the atmospheric composition, mainly keep the average temperature of the earth 15 ^{o}C. Organisms have formed this atmosphere spending for more than 3.7 billions years from the primordial atmosphere which was less than 30 pressures and consisted of 97 % of carbon dioxide. If organisms fixed extra carbon dioxide or all water vapor in the atmosphere became the fluid water, there would be no greenhouse effect. The average temperature would be –18 ^{o}C and the fluid water would freeze. Therefore, no organisms would be able to survive in this environment.

Water cannot exist on the earth if either one or more conditions lack. Because of the series of fractions of chances as small as one-quintillionth, water can exist on the earth, which made possible for a great variety of organisms to live. This is indeed the “water of life.”

The total amount of water on the earth is 1360 x 10^6 billions tons. 97.2 % of the total exists in the ocean. Of the rest 2.8 %, 2.15 % is glaciers and icebergs, 0.62 % as groundwater, 0.017 % in lakes, 0.01 % in the air, and only 0.0001 % in rivers, where human beings use the most.

The water circulates in a fixed period of retention period, changing into vapor, fluid water, and ice. For example, the average retention period of water in glaciers is 15,000 years, in the ocean is 4,000 years, in rivers is 14 days, and in water vapors in the air is 10 days. The water circulates in those places and ultimately returns to the ocean, which is also the starting point of the global water circulation.

However, the water circulation system which has been stable begins to be disrupted because of rapidly increased human' s activities.

We will know how big the influence of the corruption of circulation systems is if we assume extremely situations. For example, most of the fresh water exists in glaciers and icebergs, 80 % of which exists in the South Pole. If these glaciers and icebergs melted away to the water, the water level of the ocean would rise by 50 m.

For another example, the average rainfall on the earth is assumed to be 1,000 mm (or 1 m) per year. In the normal situation, the same amount of water evaporates from the ocean and circulates. However, if the water evaporated but did not circulate, the ocean would be dried up in 3,800 years, less than 4,000 years (the average depth of the ocean is 3,800 m). On the contrary, if there were rainfall but no evaporation, the water level would rise by 100 m in 100 years and more than 50 % of the land would sink into the ocean.

Of course, those are extreme cases. However, as mentioned in the previous article (No.12), the ice in the South and North Poles are getting melted and glaciers in various areas are getting decreased faster than before. Moreover, there are more cases than before that major rivers in the world are dried up before flowing into the sea, which causes the shortage of the water in rivers, on which people mostly rely. Those phenomena are signs that the water circulation is getting corrupt.

Climate changes are serious problems because the abnormal weathers occur in the local levels. In the desert area, the water evaporation is accelerated and in the areas with a much rainfall, such as tropical rainforests, a local downpour occurs more frequently than before.

In the end, the water level of the ocean rises because ice sheets melt and ice shelves are getting corrupted in the South Pole.

Ice sheets in the South Pole used to have a thick and plump shape. Along with the end of the glacial period, ice sheets became smaller. The surface area of ice sheets is approximately 1,400 km^2, which is 37 times as big as that of Japan and 10 times of ice sheets in Greenland. The thickness of ice is about 2,000 m and if all of ice sheets melt away, the water level of the ocean will rise by 8 m. Moreover, if the density of CO_2 becomes twice as much as before, the temperature will rise by more than 2 ^oC in low/middle latitude areas and more than 7 ^oC in the polar regions. This implies that the polar region is more affected the influence of global warming than other areas. The rise of the seawater temperature speeds the melting of ice shelves and the thermal expansion of the ocean and its buoyancy will cause the corruption of ice shelves.

Statistical Information

Amount of water necessary to produce 1 kg of grain: 1 tons

Amount of 1) grain and 2) water to produce 1 kg of pork: 1) 4 kg, and 2) 4 tons

Amount of 1) grain and 2) water to produce 1 kg of beef: 1) 4 7g, and 2) 7 tons

Total amount of the water uses in the world: 5 trillions tons

For the agriculture: 65%	(3,250 billions tons)
➢ Grains for food: 24%	(1,210 billions tons)
➢ Grains for feed: 13 %	(650 billions tons)
➢ Others: 29 %	(1,450 billions tons)
For the industry: 25 %	(1,250 billions tons)
For the living: 9%	(450 billions tons)

“Nowadays we live in affluent circumstances while plunging our hands in the pockets of our children and grandchildren without asking them and taking out their properties.” (Margaret Thatcher, former British Prime Minister)