

## Global Cooling in 21st Century

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[Objectiv] To predict the climate in 21 Century

[Methods employed] Evaluating the functions to control the surface temperature of the Earth in order of potentials from high to low, 1) albedo mainly by glacier and cloud, 2) Sun activity (relative Sunspot number), 3) greenhouse gas, and Millancovich effect, we estimate the climate change in 21 Century.

[Result] Albedo is further controlled by a) Galactic cosmic ray radiation, b) Earth's geomagnetic intensity, c) aerosols derived from volcanic ash, aeolian dusts, d) aircrafts. Albedo effect is the largest; 1% cloud corresponds to 0.6K on the surface temperature of the Earth (Genda, 2008). Activity of Sun has been observed as the relative change of sunspot number for the last 400 years. Moreover, the C14 of annual ring in the old tree such as Jo-mon redwood back to 6000 years has been measured. Periodical change of Sun activity in the past is extrapolated to the future, indicating the Sun activity has just passed the maximum ca. 2 years ago. Greenhouse gas is evaluated independently for each species. Predominant role is H<sub>2</sub>O which occupies about 90-95% among greenhouse gas. CO<sub>2</sub> which has increased 1-2 ppm for the last 100 years. 1 ppm corresponds to only 0.004K, which is negligibly small, compared to the potential of cloud. The Earth is in the stage of near the end of 20,000 years cycle of Millancovich. Although the 100,000 years cycle is clearly regular for the last 400,000 years, the 20,000 years cycle does not seem to be clearly, and we are now hanging on the abrupt drop from inter-glacial to glacial period. Moreover, the role of volcanic eruption would force to cool the climate, if erupted as such a case of Pinatubo in Philippines in 1992 when 0.5K dropped during 2 years. The rapidly decreasing the Earth's geomagnetism promotes the formation of cloud as will be discussed by Terasawa (this meeting), to raise the amount of cloud in this Century. More active industrial activity in Asia particularly China and India would increase the amounts of aerosols to be nucleus of clouds, as well as the increased flight of aircrafts in 21 Century. Thus, all of key functions do work to cool the Earth, except the minor role of increasing CO<sub>2</sub> in atmosphere, though negligible.

Thus, the Earth will be cooled down in this Century, and 0.5K will be down by 2020 year. The cooling will start from the top, particularly in the continental interior such as Asia and North America. On the other hand, the oceans have stored heats by the global warming for the last 140 years. About 0.1K higher at depth range of 700m than before is measured. By this reason, the oceanic islands or nearby oceans would be less cold than within continents.