Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

MIS024-P01 Room:Convention Hall Time:May 25 10:30-13:00

Could properties and the effect on climate

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The existence of clouds causes great uncertainty for predicting the climate change. Clouds reflect the solar radiation to cool the earth-atmosphere system, while they absorb the infrared radiation from the system to heat it. The net effect on climate depends on cloud properties such as optical characteristics, cloud cover rate, and cloud height. Since these cloud properties are determined through the microphysical processes of a few micron-scale cloud droplets, it is difficult to estimate net cloud effect precisely. Also, according to the recent hypothesis that galactic cosmic rays at the earth affects microphysical process, the cloud properties are the key to understand the climate, especially to understand the mechanism that connects cosmic phenomena and climate. In this study we numerically estimate the effect on climate as induced by the variation of parameters that affect optical characteristics, such as droplet radius and liquid water contents. We also evaluate the effect of macro parameters, such as cloud cover rate and cloud height. As a result, it is found that the optical characteristics do not significantly affect climate. We therefore conclude that the cloud cover rate is a dominant factor for the climate change by cosmic ray intensity variation.

Keywords: Cosmic ray, Cloud, Climate, Modeling

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Statistical analyses of solar activity and climate change

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Introduction

There are a lot of studies about the relationship between the solar activity and the climate change, and various theories have been proposed. However, there is no definite theory. Then, the purpose of this study is to find how the solar activity influences Earth's climate.

Analysis

We compared the annual mean global temperature, precipitation, sea surface temperature and amount of low cloud with the sunspot number. The data of the sunspot number that we used are provided by Solar Influences Data Analysis Center (SIDC).

Result

The correlations were not significant when we compared the annual mean global temperature, precipitation, sea surface temperature and amount of low cloud with the sunspot number. About the amount of the low cloud, our result is the same as Svensmark's (Svensmark, 2000) between 1983 to 1991 and 1998 to 2009, i.e. these inversely correlated. However, from 1991 to 1998, our result is not the same as Svensmark's.

Conclusion

The correlation of the sunspot number and the annual mean global temperature, precipitation, sea surface temperature and amount of low cloud was not significant. As for the Svensmark's theory, our result partly consisted of his theory, but partly contradicted his.

Keywords: solar activity, climate change, cosmic ray, cloud amount, statistical analyses, correlation

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Influence of solar magnetic activity on climate ? comparison between different geomagnetic activity indices

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Introduction. The relation between the aa index and surface temperatures has been long reported, but it is a kind of mystery in a sense that its mechanism is unknown, and hence, has been regarded as unconvincing. We, however, recently showed that a local-based short-term approach is useful to elucidate the relation [1]. For instance, winter aa index has high positive correlation with spring surface temperature of Scandinavian regions, and high negative correlation with southern regions of Greenland. We explained this result considering the participation of the Arctic Oscillation.

In this report, we consider geomagnetic indices other than the aa index, and show the possibility of similar observations. Furthermore, we use solar wind data to make further discussions.

Method. Geomagnetic indices used are, the aa index, the AE index, the ap index, the Dst index etc. By utilizing the open data base such as OMIN 2 [2], the relations between these indices and between the indices and the surface temperature data were examined.

Moreover, BV^2 that is calculated from solar wind magnetic field B and solar wind speed V, and P_{alpha} calculated as energy extracted from the solar wind [3], are utilized for the correlation studies.

Results and discussion.

It was observed, for instance, that daily changes of ap and AE were well correlated. Correlations between the geomagnetic indices and solar wind parameters such as BV^2 and P_{alpha} were high as well. Thus, different geomagnetic indices should show correlations against the surface temperatures. In fact, for instance, ap (January) and Dst (January) shows high correlation with the surface temperature (March) of Sodankyla, Finland as high as the case for the aa index.

AE is a measure of the Aurora electro jet, and Dst is a measure of the equatorial ring current, and thus, the hourly time course of their changes are different [4, p. 59]. However, considering that the magnetic field changes such as AE, aa and ap due to currents in the ionosphere are linearly correlated with P_{alpha} [3] and that Dst is proportional to the energy accumulated in the magnetosphere [4, p. 172], we consider it reasonable that the difference between the geomagnetic indices becomes small when daily and/or monthly average data were concerned.

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Keywords: geomagnetic activity index, temperature, solar wind, correlation

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Raison d etre of simple climate models

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Now that GCM simulations using high-performance supercomputers are at the height of prosperity, is there any ’raison d’etre’ in simple climate models that can be simulated by reasonable-priced PCs? The heat transfer model devised by Kleidon for explaining the Maximum Entropy Production (MEP) principle seems to be one of the proper examples to answer this philosophical question[1]. Generally speaking, the simplification of mathematical models has a merit to ease capturing the essence of phenomena. For example, it has been well known that dissipative structures characterized by low entropy can emerge spontaneously in open systems maintained in the state of far from equilibrium. Then, the Kleidon’s heat transfer model is thought to contain all the elements indispensible for the formation of dissipative structures. To be concrete, these elements include heat or energy sources, space to dump degraded heat and materials, temperature gradient for heat flow, and so on. These are also necessities for dissipative structures other than atmospheric convection. There exist uncountable dissipative structures with low entropy on the Earth such as various types of lives and human societies. Energy sources that drive human societies are mineral resources and fossil fuel such as coal, oil and natural gas as well as the sun. Space to abandon disused goods is natural environment on the Earth or outer space. Moreover, freshness (the reciprocal of degradation) of the product would correspond to the temperature in the Kleidon’s model. That is, new products have high temperature (freshness), while the temperature of exhausted products is low. Then, entropy in human societies could be defined as the division of the quantity of resources and energy used in production by freshness. In this session, we survey the application of the MEP theory to ecology, sociology and economics, redefining variables or parameters used in the Kleidon’s model. Another theory well known in this field is the Bejan’s constractal theory[2]. Last year, the MEP vs. constructal dispute has occurred as for which theory is more fundamental[3],[4],[5], which will be discussed also in this session.

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Keywords: Principle of Maximum Entropy Production (MEP), Temperature, Constructal theory, Dissipative structure, Heat transfer model

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Plant phenological change in Korea and its relation to air temperature and circulation

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Plant phenology, the study of the timing of recurring biological phenophases such as budding, flowering, and leaf colouring provides useful information for environmental monitoring because of the capability of detecting changes and correlating climatic parameters with natural ecosystems. It also can provide a mean whereby the general public can get motivated to contributing to monitoring and discussing climate changes issues because of the simplest method to observe and the simple concept to understand. Therefore, phenological observations of tree developmental stages are the most effective impact indicators of climate change.

In the present study, the plant phenological change in Korea was analyzed and related to air temperature and atmospheric circulation. The budding and flowering dates of five spring species, forsythia (*Forsythia koreana*), azalea (*Rhododendron mucronulatum*), cherry (*Prunus yedoensis*), peach (*Prunus persica*) and pear tree (*Pyrus pyrifolia*) from 1960 to 2009, and the beginning and peak dates of leaf colouring of two autumn species, ginkgo (*Ginkgo biloba*) and maple (*Acer palmatum*) from 1989 to 2009 used in this study. The increase in mean air temperature from February to March of 0.5 degrees Celsius per decade over last 50 years (1960-2009) led to earlier phenophases of spring by 1.7 to 2.6 days per decade. In contrast to these, the autumn phenophases of plant were significantly delayed by 2.4 to 3.4 days per decade for the short period 1989-2009. The observed trends in plant phenology in Korea corresponded well with changes in air temperature. Spring phenophases advanced by 3.2 to 3.9 days with the increase of air temperature of 1 degree Celsius from February to March, whereas warming in October by 1 degree Celsius caused a delay in the autumn phenophases by 1.4 to 2.8 days. The spring phenological phases also had high correlation with Siberian High intensity and Arctic Oscillation (AO) in late-winter and early-spring (February-March). These results suggest the possibility of using the air temperature, as well as AO-index and Siberian High for predicting phonological dates of plant.

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Keywords: phenology, climate change, temperature, AO, Siberian High