Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MIS22-01 Room:102B Time:May 20 09:00-09:15

Spring and autumn temperatures deduced from phenology in Kyoto and Yedo, and their correspondence with solar variation

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The changes in springtime (March) and autumn (October) temperatures were reconstructed applying data for cherry blossoms and maple leaves' autumn-tints phenologies, respectively. Phenological data series in Kyoto and Yedo (Tokyo) were obtained from many old diaries. From many archives, the dates on which phenophase was observed or viewing parties were held, were acquired as noted phenological records.

The full blossoming dates of a native cherry tree species, *Prunus jamasakura*, were applied to reconstruct March mean temperatures in Kyoto and Yedo. Cherry blossom phenological data for 823 years (scattered from 812 to 2011 A.D.) in Kyoto and for 207 years (scattered from 1636 to 1905 A.D.) in Yedo are now available, respectively. Calibration enabled accurate estimation of March temperatures in the instrumental period. The reconstructed March temperature series in Kyoto suggests the presences of a warm period in the 10th century (around 7 degree C, warmer than the present normals of 6.6 degree C, after subtracted the urban warming bias) and four cold periods of 1330-50, 1520-50, 1670-1700 and 1825-30. These cold periods coincided with the less extreme period of solar activity, known as the Wolf, Spoerer, Maunder and Dalton minima. Each cold period has time-lag of climate response of a few ten years to corresponding minimum of solar variation.

Reconstructed March mean temperature series in Yedo since the 17th century shows a similar pattern to that in Kyoto. Especially, two cold periods in the late-17th and in early-19th centuries in both cities clearly appeared in each reconstructed temperature series. The spring temperatures in Maunder and Dalton minima in Kyoto were almost the same, while those in Yedo showed 1 degree C difference. In Yedo, the estimations in Maunder minimum were about 4 degree C, 1 degree C colder than those in the Dalton minimum.

Another attempt to reconstruct October mean temperature in Kyoto was made by applying of phenological data for autumn-tints of maple (*Acer* spp.) leaves, which were available for 478 years after 1200 A.D. Autumn temperature series partially showed similar pattern to springtime temperature series. A cooling trend over the 15th-16th centuries was commonly detected in October and March temperature series, however, October temperature change preceded March temperature change by about 10 years. It suggests that the time-lag of climate response of October temperature in Kyoto to the solar variation might be smaller than that of March temperature.

This research was partially supported by the Ministry of Education, Science, Sports and Culture, Grant-in-Aid for Scientific Research (C), 23501247, 2011-2013.

Keywords: Climate reconstruction, Phenology, Cherry bloosom, Autumn-tints of maple, Solar variation

Japan Geoscience Union Meeting 2013
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MIS22-02 Room:102B Time:May 20 09:15-09:30

Annual reconstruction of East Asian summer monsoon variability using tree ring stable carbon isotope in Yakusugi cedar

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Understanding the paleoclimate based on the high-precision reconstruction of the best proxies is essential to predict future climate change. It has been known that stable carbon isotope in tree rings formed in high humidity area is a proxy for the actual sunshine duration during the tree ring formation. We reconstructed 1629 year record of the actual sunshine duration in Yakushima island in Summer from the stable carbon isotope of the annually resolved tree rings using the Yakusugi cedar (Cryptomeria japonica) grown in Ishizuka area where we identified that the humidity has been the highest at about 100% in Summer. As a result, it is found that the actual sunshine duration in summer is smaller than average in Medieval Warm Period (MWP), while it is higher than average in Little Ice Ages (LIA). Since the actual sunshine duration in Yakushima Island is sensitive to East Asian Summer Monsoon (EASM), it is indicated that EASM activity was stronger than average in MWP and is weaker than average in LIA. We will discuss the relationship between EASM and actual sunshine duration in Yakushima island.

Keywords: tree ring, stable isotope, East Asian summer monsoon

Japan Geoscience Union Meeting 2013
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MIS22-03 Room:102B Time:May 20 09:30-09:45

Influence of solar wind on the climate ? a mechanism containing stratospheric ozone

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We recently have shown large correlation between solar parameters and temperature of atmospheric layers although its mechanism is still unknown. Here, we reexamine relevant mechanisms proposed so far, and show that a mechanism containing stratospheric ozone can give a reasonable explanation.

The solar wind particles finally enter the atmosphere, and produce NOx etc., and hence, decompose ozone molecules. The resultant ozone concentration decrease will reflect on the changes in the stratosphere heating due to UV absorption. This can influence the global climate/weather pattern through the changes in the stratosphere temperatures. The solar wind thus can influence the atmospheric circulations and temperatures.

Keywords: solar wind, climate, stratospheric ozone, NOx

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MIS22-04 Room:102B Time:May 20 09:45-10:00

Influnce of solar wind on stratospheric ozone

Takahito Arataki[1*], Kiminori Itoh[1]

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Using the aa index as a measure of solar wind intensity, correlation with the amount of stratospheric ozone was examined. The northern temperate and polar regions showed relatively large positive correlation between December aa index and January ozone amount. The southern temperate region showed weak anticorreltion, and the equatorial region showed virtually no correlation. Solar wind particles may decompose ozone molecules through NOx production, but the positive correlation observed may show the redistribution of ozone due to the influence of the solar wind.

Keywords: solar wind, stratospheric ozone, correlation

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MIS22-05 Room:102B Time:May 20 10:00-10:15

22-year cycles of cosmic rays at the Maunder Minimum

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Due to the weakened solar magnetic activity and consequent change in the heliospheric environment, flux of the galactic cosmic rays incident to the earth had characteristic time variability at the Maunder Minimum (AD1645-1715). Drift effect played an important role in the transport of cosmic rays in the heliosphere, and hence the Hale 22-yr cycles were intensified during the time. Such a characteristic variation of cosmic rays enable us to also understand the cosmic ray-climate connection. In this paper, we report the detailed features of cosmic ray variation revealed by the high precision measurements of carbon-14 and beryllium-10.

Keywords: solar activity, heliosphere, cosmic rays, cosmogenic nuclides, climate variation

Japan Geoscience Union Meeting 2013
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MIS22-06 Room:102B Time:May 20 10:15-10:30

Global spatial distribution of climate response to the cosmic ray intensifications during the Maunder Minimum

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Solar variability as sunspot intensity and solar magnetic activity influence climate. Here we focus on the Hale solar magnetic cycles and their subsequent characteristic enhancements of GCR flux during the Maunder Minimum (AD 1645-1715) in order to distinguish the effect of GCR from the other external forcing factors as Total Solar Irradiance or Ultra Violet.

In our previous study, we revealed that humidity conditions in central Japan and air temperature conditions in Greenland were synchronized to the rapid intensification of GCR flux at the solar cycle minima of negative magnetic polarity during the Maunder Minimum. In order to investigate the spatial distribution of climate response (air temperature, precipitation, etc.) to GCR enhancements from a global perspective, we analyzed annual paleoclimate data from more than 50 sites around the world using the NOAA database for the Maunder Minimum. We separated the AD 1632-1735 into four periods based on the solar magnetic cycle and we superimposed each of the cycle to obtain a compile signal in order to compare with GCR.

Preliminary results of the analyses of 30 data sets showed that air temperature and humidity conditions in East Asia were cold and wet at the solar cycle minima of negative magnetic polarity. There were also cold signals in Western North America, which were synchronized to solar magnetic cycles. However, no distinct climate responses were found in the other regions as South America and Australia. These results suggest that climate response to GCR intensification has complex spatial pattern, but more analyses are required to confirm. In this paper, we report the more detailed results of our analysis.

Keywords: Solar Magnetic Activity, Galactic Cosmic Ray, The Maunder Minimum

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MIS22-07 Room:102B Time:May 20 11:00-11:15

Climate change during the geomagnetic polarity reversals: paleoecological evidence

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[1]KURCIS, [2]Museum of Nature and Human Activities, [3]University of Arizona, [4]University of Hyogo

Observed correlation between galactic cosmic ray (CR) flux and cloud cover suggests that variations in geomagnetic field intensity could change climate through modulation of CR flux. This hypothesis has never been tested using robust geological evidence. Here we present a new record of climate cooling that coincided with a large decrease in field intensity during the Matuyama-Brunhes and Lower Jaramillo geomagnetic polarity reversals. The cooling event cannot be attributed to orbital forcing because it occurred across an interglacial sea-level highstand. The geomagnetic field intensity seems to influence global climate through the modulation of CR flux at variable timescales. The effect can be observed in multiple climatic parameters.

Keywords: cooling, geomagnetic reversal, cosmic ray, paleoclimate, paleoceanography, paleomagnetism

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MIS22-08 Room:102B Time:May 20 11:15-11:30

Reproducibility of laboratory experiment for verification of cloud condensation nucleation by cosmic rays

Asami Suzuki[1*], Kimiaki Masuda[1], Yoshitaka Itow[1], Takashi Sako[1], Yutaka Mathumi[1], Tomoki Nakayama[1], Kanya Kusano[1]

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It is said that there is the correlation between the solar activity and earth climate.
However, a mechanism of the correlation is still not understood.
One of hypotheses for the mechanism is that an amount of cloud changes in connection with the cosmic-ray intensity which is influenced by the solar activity as indicated by the observation of good correlation between cosmic-ray intensity and the amount of low clouds.
The ion-induced nucleation model is considered as a model to explain this mechanism.
New particle is created efficiently in the atmosphere, with atmospheric ions produced by cosmic rays and finally this particle grows to the size of cloud condensation nucleus .
In order to verify the hypothesis the gas with the atmospheric composition is irradiated with ionizing radiation.
In this study, a verification experiment is conducted in a laboratory with a reaction chamber, flow control of clean air, H_2O, O_3 and SO_2, and irradiation of UV light and beta-rays as an ion source.
We will show a relation between aerosol concentration and ion density , and it is reproducibility.

Keywords: cosmic ray, cloud, cosmoclimatology, cloud condensation nuclei

Japan Geoscience Union Meeting 2013
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MIS22-09 Room:102B Time:May 20 11:30-11:45

Synchronization between thunderstorm activities and solar parameters

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Relationship between thunderstorm/cloud activities and solar parameters are examined based on lightning measurement by Global ELF observation Network (GEON) and Outgoing Longwave Radiation (OLR) intensity. A correlated analysis between the number of the lightning strokes, cloud variation in the tropical regions, and solar parameters was examined, focusing the variation around one month periodicity. It was found that the number of lightning stokes in the Maritime Continent (MC) varies with about month periodicity in the period from February to June 2004 and shows positive correlation (R= ?0.8) with OLR in the Western Paci?c Warm Pool (WPWP). That is, when thunderstorm activity in the MC is enhanced, the OLR in WPWP becomes large, meaning less cloud amount. On the other hand, OLR in the central Africa shows negative correlation with the number of lightning stokes in the MC in that period (R= ?-0.7). Furthermore, in the central Africa OLR seems to re?ect the number of lightning strokes, showing good correlation between them. This implies that the activities of thunderstorms both in the central Africa and in the MC oscillate in the same phase. Such a synchronization of thunderstorms or cloud amount in global scale without phase difference has not been reported. These observational facts may lead to consideration of solar activit, whose variation in the present period (Feb-Jun 2004) shows good correlation with OLR variations.

Keywords: lightning, thunderstorm, global, synchronization, solar activity

Japan Geoscience Union Meeting 2013
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MIS22-10 Room:102B Time:May 20 11:45-12:00

Faint Young Sun Paradox: the astrophysical viewpoints

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In this talk, we will discuss the faint young sun paradox from the astrophysical view points. The earth's temperature at the birth time of life (3.5 Gyear before) is believed to be lower than the freezing temperature, because the sun is darker than the present which is predicted by the standard star evolution theory. To solve this paradox, we will discuss the possibility of 5% massive sun at the birth time of life. If the solar mass is 5% heavier than the current sun, this paradox can be solved. The current solar mass loss is very low. Thus we need 1000 times mass loss around ~3.5Gyear before, because the sun should be reduce the 5% mass during 3.5Gyear. We will discuss the possibility of efficient mass loss by the solar wind and coronal mass ejection.

Keywords: Sun, mass loss, climate, faint young sun paradox

Japan Geoscience Union Meeting 2013
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MIS22-11 Room:102B Time:May 20 12:00-12:15

Nebula Winter

Toshikazu Ebisuzaki[1*], Ryuho Kataoka[2], Shigenori Maruyama[2]

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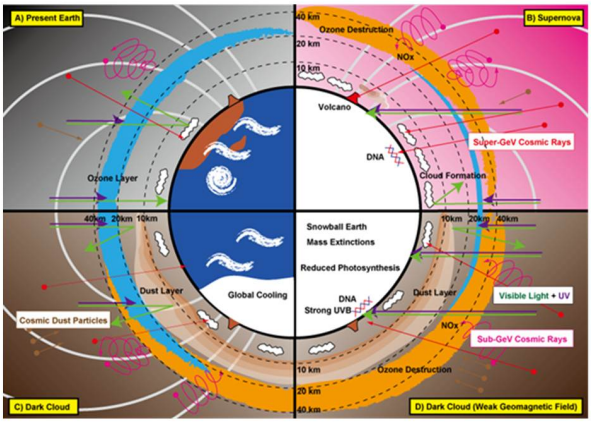
Encounters with nebulae, such as supernova remnants and dark clouds in the galaxy, can lead to an environmental catastrophe on the Earth through the negative climate forcings and destruction of the ozone layer by enhanced fluxes of cosmic rays and cosmic dust particles. A resultant reduction in primary productivity leads to mass extinctions through depletion of oxygen and food starvation as well as anoxia in the ocean. The model shows three levels of hierarchical time variations, caused by supernova encounters (1-10 kyrs), dark cloud encounters (0.1-10 Myrs), and starbursts (˜100 Myrs), respectively.

This Nebula Winter model can explain the catastrophic phenomena such as snowball Earth events, repeated mass extinctions, and Cambrian explosion of biodiversities which are happened in the late Proterozoic era through the Cambrian period. Late Neoproterozoic snowball Earth event covers a time range of ca. 200 Myrs long spanning from 770 Ma to the end of Cambrian period (488 Ma) with two snowball states called Sturtian and Marinoan events. Mass extinctions occurred at least eight times in this period, synchronised with large fluctuations in delta13C of carbonates in the sediment. Each event is likely to correspond to each nebula encounter. In other words, the late Neoproterozoic snowball Earth and Cambrian explosion are possibly driven by a starburst, which took place around 0.6 Ga in the Milky Way Galaxy. The evidences for Nebula Winter can be obtained from geological records in sediment in the deep oceans at those times.

Keywords: Dark Cloud, Supernova Remnant, Snowball Earth, Mass Extinction, Cosmic Dust, Cosmic Rays



Japan Geoscience Union Meeting 2013
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MIS22-12 Room:102B Time:May 20 12:15-12:30

K/T(Pg) boundary : A new proposal of collision of Dark Cloud.

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The Earth has undergone mass extinction five times over the course of 600 Ma in Phanerozoic eon. Alvarez et al. (1980) first pointed out that an impact of an extraterrestrial body causes Cretaceous-Tertiary extinction at 65 Ma. Although they also studied the possibility of supernova explosion in the same paper, they conclude that it is unlikely because the 191Ir/193Ir ratio is consistent with solar abundance. In fact, Chicxulub crater in Mexico is thought to be the cause of the Cretaceous-Tertiary extinction (e.g., Schulte et al. 2010). However the recent studies revealed that the asteroid impact has several difficulties to explain the extinction event.

First of all, the solid particles and sulphate launched by the asteroid impact are settled down in relatively short time-scale and the climate forcing from them become negligible after ten years from the impact (Kring et al., 1996). It seems rather difficult to achieve a complete extinction of dinosaurs by just one event with such a short period less than few years. In addition the earth has undergone several asteroid impacts such as Manicouagan crater, however these impact has not caused the mass extinction. Second, the diversities of the species, such as dinosaur, ammonaite, and foraminifer, living in the Cretaceous period start to decrease in their bio-diversities well prior to the K/Pg boundary (Sloan et al.,1986; House, 1989; 1993, Thomas, 1990). Furthermore, Zachos et al. (1989) pointed that the substantial reduction in oceanic primary productivity persisted for 0.5 Myr before the carbon isotope gradient was gradually re-established. In addition, the stable isotope and preservational data indicate that environmental change, including cooling, began at least 200 kyr before the Cretaceous-Tertiary boundary, and a peak warming of 3 degree in Celsius occurred 600 kyr after the boundary event. This cooling climate and the reduction of reduction in primary productivity that started 200 kyr before the boundary and last for at least 0.7 Myr, cannot be explained by the direct consequence of an asteroid impact.

In order to explore the real reason of this mass extinction at the K/Pg boundary, we studied the data of Iridium in the deep sea sediment around the K/Pg boundary and found a broader component of a significant enhancement in Iridium density around the central peak, which probably correspond to the asteroid impact. The width of this broad component, which is difficult to explain by mixing or remobilization after an instantaneous deposition (Hull et al., 2010). This broader component in Iridium could be caused by an increased flux of cosmic dusts due to the encounter to a dark cloud across. The sunscreen effect of cosmic dust in stratosphere may lead a global cooling (Pavlov et al. 2005). The flux of sub-GeV component of cosmic rays increased by a large factor due to the dense molecular gas from dark cloud to lead the destruction of ozone layer (Kataoka et al. 2012). Such an environmental catastrophe, which continued several ten Myears, may be the real reason of the mass extinction at K/Pg boundary.

The asteroid impact at K/Pg may also be one of the consequences of the dark cloud; encounter with a giant molecular cloud is well massive to perturb the orbit of asteroid/comet by its gravitational potential to lead an asteroid/comet shower. In fact, there is increasing evidence that the end of the Cretaceous experienced multiple impacts. A few craters are reported in late Maastrichian stage. In addition, K/Pg and late Maastrichtian Ir and Platimun Group Elements (PGE) anomalies have been reported from Oman (Ellwood et al. 2003). Another impact may have occurred in the early Danian as suggested by Ir and PGE anomaly patterns (e.g., Stuben et al. 2002). The multiple impacts may be induced by a dark cloud encounter. Of course, some of the Ir and PGE anomalies mentioned above can be directly caused by the accretion of the cosmic solid particles from the dark cloud itself.

Keywords: mass extinction, dark cloud, K/T(Pg) boundary, dust, asteroid impact, deep sea