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Influence of the solar magnetic activity on the global climate (3): based on correlations between Arctic oscillation and

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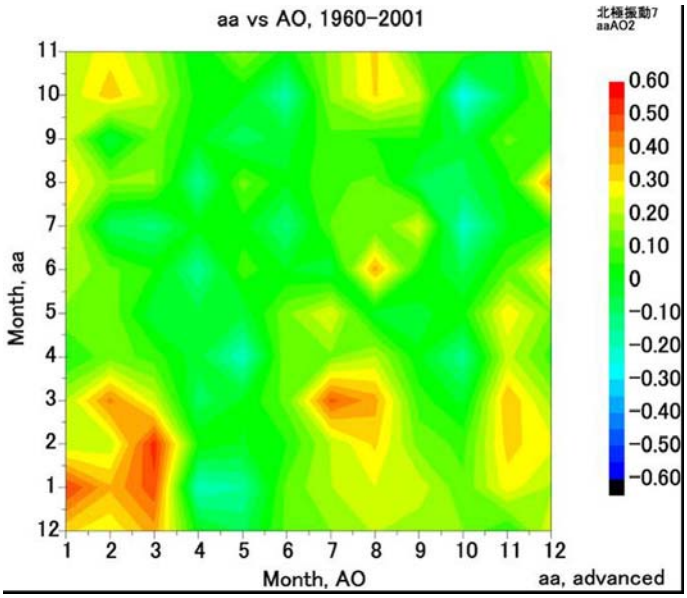

It is important to elucidate contributions of natural as well as anthropogenic factors affecting climate changes in order to discuss present/future environmental policies. The globally averaged temperatures can be a convenient metric to evaluate the effect of anthropogenic CO2 because the concentration of CO2 tends to be homogeneous due to the long lifetime of CO2 and global scale convection. However, other approaches are required when the effect of other factors are examined. In particular, when we consider that local and short-term meteorological variations have a large influence on the environmental policies, local-based approaches are important also for climate factors.

We examine here solar activity changes as a natural factor. There have been a number of discussions on the sun as a cause of climate changes, but due to a tendency that too many phenomena were attributed to the solar changes, the effect of the sun has ironically become doubtful for researchers.

Recently, however, it has been shown that lake depth (Verschuren et al., 2000) and Asian monsoon strength (Zhang et al., 2008) had significant correlation with the solar activity changes. Although these results are important, mechanisms behind them are not clear yet. For example, it is difficult to explain the large climate changes in terms of solar luminosity changes, because the change in the solar luminosity appears to be small: only around 0.1% associated with the Schwabe cycle as well as long-term variations. This fact requires us to consider other aspects of the solar activity such as changes in UV radiation and solar magnetic activity.

Thus, we pay attention to the influence of the solar magnetic activity changes on the climate changes of local and short-term scales [1, 2]. We have employed monthly surface temperature data of meteorological stations (GISS NASA), and examined their correlations with solar magnetic activity metrics (aa index, typically). It was found, for instance, that special distribution of correlation coefficient (correlation map) for the combination of the aa index and the surface temperature was very close to that for the combination of the Arctic oscillation (AO) and the surface temperature, for the period of 1960-2001 where sufficient number of surface station data were found. Thus, it was concluded that solar magnetic activity changes affect the surface temperatures through the AO.

Furthermore, it was found that the correlation was large between winter aa index and spring

surface temperature (e.g., at Northern Europe), while the correlation was large between winter AO index and winter surface temperature (e.g., at Siberia area) [1, 2]. This shows a complicated mechanism is working.
Figure 1 shows the correlation between the aa index and the AO index at monthly data basis. The correlation is strong for the combination of January-January and February-March. Since it appears reasonable that the AO (i.e., not the solar magnetic activity) directly affect the surface temperature, the aa index in winter influences on the surface temperature through the winter AO as well as through the spring AO.
The result above gives an important hint to discuss climate patterns other than the AO as well. For instance, El Nino and the AO reportedly show weak correlation. That is, the spring AO appears to affect the onset of El Nino. According to Fig. 1, the spring AO is affected by the winder aa index; hence, the onset of El Nino is affected by the winter aa index through the spring AO. Thus, the influence of the solar magnetic activity on the climate appears to take place through various paths.

1) K. Itoh, Influence of solar magnetic activity on the global climate (1): relations with local surface temperature and Arctic oscillation, Jpn. Geophys. Union Meeting 2008.
2) K. Itoh, Influence of Solar Magnetic Activity on the Global Climate (2): Correlation with Surface Temperature and Arctic Oscillation, Jpn. Geophys. Union Meeting 2009.

Keywords: Solar magnetic activity, Arctic oscillation, surface temperature, precipitation, El Nino