Influence of Solar Magnetic Activity on the Global Climate: Correlation with Surface Temperature and Arctic Oscillation

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Introduction. The influence of solar activity variations on the global climate is verified by several studies [1, 2], and thus, it should be regarded as one of the main driving forces of climate changes especially for particular regions and periods. There is no consensus, however, on its detailed mechanisms. This is no doubt a barrier for understanding and for forecasting regional/local climate changes. We therefore intend to develop a new approach based on local and short term climate variations especially focusing on the effect of solar magnetic activity [3].

Method. In this report, we discuss correlation between monthly/seasonal values of local surface temperatures (http://data.giss.nasa.gov/gi and aa index (http://www.geomag.bgs.ac.uk/gifs/ aaindex.html).

Results and Discussion. Figure 1 shows the correlation between monthly temperatures of Sodankyla (Finland) and those of the aa index. The correlation was high between spring temperature and winter aa index. There were negative correlations for some periods. Figure 2 shows time courses of the spring (March to May, average) temperature of Sodankyla and winter (December and January, average) values of the aa index. Correlation coefficient for the period shown (1960-2001) was 0.67; which shows that 45% of the variation in the spring temperatures can be attributed to the variation of the winter aa index.

The values shown below are examples of correlation coefficients obtained for different sites for temperature measurements; strong positive correlation was found especially for Northern Europe and Eastern Europe: Finland [Jyvaskyla, 0.70: Helsinki, 0.64: Kajaani, 0.64], Sweden [Karesuando, 0.65: Haparanda, 0.64: Visby, 0.62], Norway [Oslo, 0.54], Latvia [Riga, 0.66], Russia [Murmansk, 0.65: Novgorod, 0.63: St. Petersburg, 0.59], Hungary [Szeged, 0.61: Budapest, 0.60: Pecs, 0.59], Romania [Timisoara, 0.58], Poland [Warsaw, 0.56], Germany [Hamburg, 0.45: Potsdam, 0.42], France [Paris, 0.48: Nancy, 0.23: Limoges, 0.10], Italia [Trieste, 0.45], Swiss [Zurich, 0.35], Libya [Tripoli, 0.30], UK [Waddington, 0.16], and USA [San Diego, 0.20].

Some places showed negative correlation as follows: Canada [Clyde NWT, -0.42], Greenland [Godthab Nauuk, -0.47: Egedminde, -0.46], USA [New York, -0.20], and Spain [Barcelona, -0.13].

In Japan, correlation was generally weak: e. g., Aomori, 0.25: Sapporo, 0.18: Nagoya, 0.13: Sendai, 0.06.

Thus, the surface temperature and the aa index have clear correlation in various part of the world at least during the period of 1960-2001. The spatial pattern of this correlation is very close to that of the Arctic Oscillation as a whole, which supports the result of the analysis based on gridded temperature data [3].

References.

1) D. Verschuren et al., Nature 403, 410 - 414 (2000)
2) P. Zhang et al., Science, 322, 940-942 (2008)
3) K. Itoh, 2008 Meeting of Japan Geoscience Union, No. 001303.

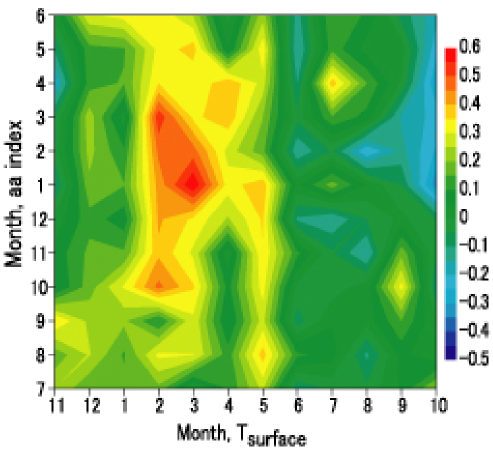

Fig.1. Month-to-month correlation between temperature and aa index (Sodaykyla, Finland).

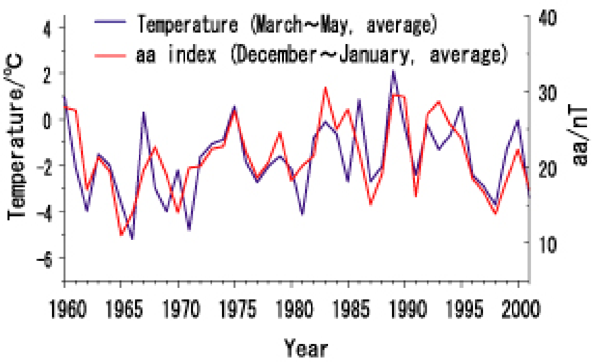

Fig.2. Correlation between spring temperature and winter aa index (Sodaykyla, Finland).