(P−12) Long-term relationship among SOI, precipitation and temperature in Fukuoka

Young-Hoon, Jin*, Akira Kawamura* and Kenji Jinno*
*Institute of Environmental Systems, Kyushu University

1. Introduction

Influence of global climate change on the local hydro-meteorological variables like precipitation and temperature has been focused with considerable interest recently. Southern Oscillation Index (SOI) which is defined as the standardized pressure difference between Tahiti and Darwin has been considered as a global driving force which is impacting to local climatic variation. Thus far, the influence of SOI on the hydro-meteorological variables has been assessed using various approaches and remarkable results for the relationship between SOI and precipitation/temperature in Fukuoka can be referred to the several researches including statistical and long-term characteristics of SOI (Kawamura et al., 2000; 2001; 2002). In the present study, based on the previous results, the phase space with 2- and 3-dimension are shown with the primary objective to assess the dynamical evolution of the relationship among SOI as a global factor and precipitation/precipitation as local factors.

2. Data Used

In the present study, we collected monthly data for SOI, precipitation and temperature in Fukuoka to display the long-term relationship among them using 2- and 3-dimensional phase space. The annual mean values were calculated and shown in **Fig. 1** with 5- and 30-year moving averaged values which can reveal the long-term variation for each data. Remarkably, there is clear increasing tendency in temperature as is seen in **Fig. 1 (c)**, mainly caused by the urbanization of Fukuoka city.

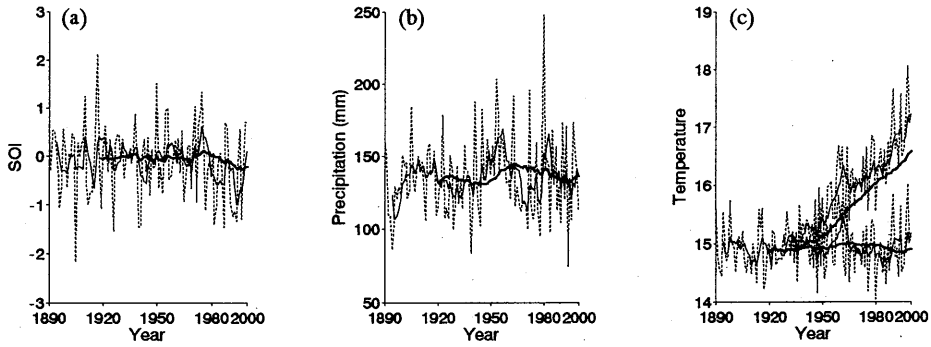

Fig. 1. Time series plots for (a) SOI, (b) precipitation and (c) temperature with annual values (dotted line), 5-year moving average (thin solid line) and 30-year moving average (thick solid line)

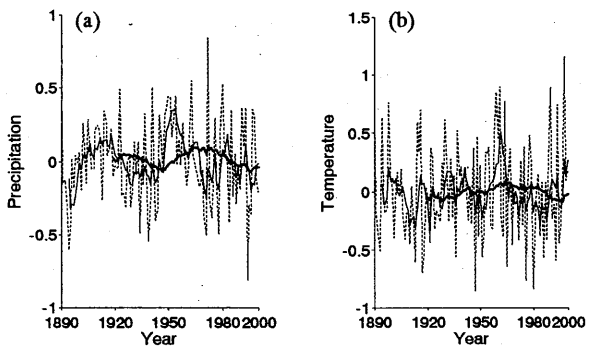

Fig. 2. Time series plots for the transformed (a) precipitation and (b) temperature

To avoid spurious relationship among the variables, all of the data should be normalized. SOI data were distributed normally but the data for precipitation and temperature showed non-normal distribution. The transformation for normal distribution was carried out in monthly basis. The cubic root transformation was applied for the normalization of precipitation and then the normalized data were standardized with mean of zero and standard deviation of one, while only the standardization was carried out to make the mean of one and standard deviation of one for the temperature data,

because the data were distributed normally after removing the trend by the least squares method in monthly basis. The transformed time series are shown in **Fig. 2 (a), (b)**.

3. Result

After making all of the data normally distributed, we put the data on the phase space to see the relationship between two variables or three variables with 30-year moving averaged values which can show the long-term relationship among them. As are seen in **Fig. 3** the long-term variation between two variables show the high correlation which has 0.49 between SOI and precipitation, -0.05 between SOI and temperature, and 0.32 between precipitation and temperature. There is statistically significant correlation between SOI and precipitation, while very low correlation between SOI and temperature. This low correlation might be affected by the assumption of linearity in removing the trend from temperature data and should be investigated in detail for further study. The long-term variation with three variables is simultaneously shown in **Fig. 4** in the 3-dimensional plot. Even though, thus far, the quantitative relationship among the variables is not clear, this result showed the first trial to reveal the interaction using phase space using three variables.

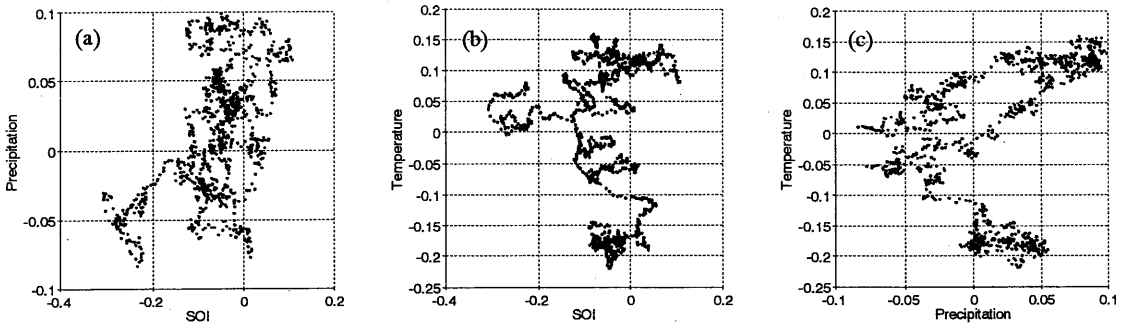

Fig. 3. Two-dimensional phase space between (a) SOI and precipitation, (b) SOI and temperature, and (c) precipitation and temperature with 30-year moving averaged values.

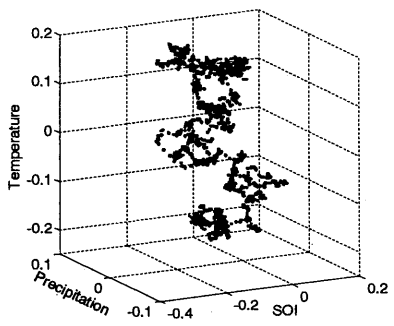

Fig. 4. Three-dimensional phase space among SOI, precipitation and temperature with 30-year moving averaged values

4. Conclusion

In the present study, we applied the phase space to display the relationship among SOI, precipitation and temperature. The 2-dimensional phase space revealed remarkable evidence there is strong relationship between SOI as global factor and precipitation as local variables which showed the significant correlation coefficient between them. As is seen in **Fig. 4**, although it is difficult to understand the dynamical evolution of the system among the variables yet, various approaches should be considered and applied to reveal how the system has been evolved dynamically as a further study.

5. Reference

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***Key words**: long-term relationship, SOI, precipitation, temperature*