Spatial-temporal Characteristics of the Spring Drought Corresponding to Large-scale Teleconnection Pattern over the Korean Peninsula

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1. Introduction

Previous researches on spring rainfall deal mainly with spring rains and long-term variations. Byun and Lee (2002) defined the period of spring rains in the Korean Peninsula for each region. Han and Byun (2006) have proved that the temperature increase at the bottom of the Chinese Continent resulted from the temperature increase in the northern hemisphere brings the development of thermal low as well as the extension of the North Pacific anticyclone to the west, which results in the increase of the horizontal gradient and also the rainfall during the spring rainy season. However, still there is not enough research that analyzes the regional characteristics of droughts in the Korean Peninsula associated with the teleconnection of the air and long-term fluctuations. Therefore, in order to diagnose the causes and predictability of spring droughts in the Korean Peninsula, this study has conducted correlation analysis with the global air circulation patterns and also analyzed the characteristics of drought changes in the Korean Peninsula both temporally and spatially based on the teleconnection and lag-correlation patterns.

2. Materials and Methods

The rainfall data employed in this study are Global Precipitation Climatology Project (GPCP) data that deal with East Asia (100°-160°E, 20°-60°N) and contain monthly rainfall data with 2.5° × 2.5° gridded dataset. Spring (March- May) data obtained from 59 weather stations were used to analyze the characteristics of spring droughts in the basins of the Korean Peninsula (Fig. 1).

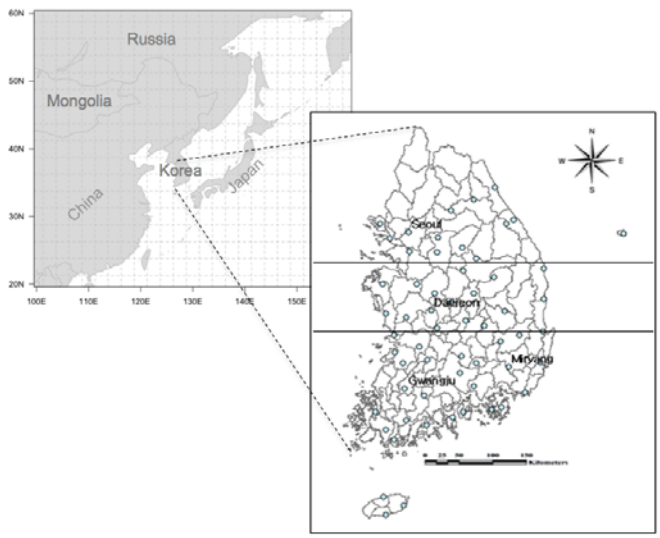

Fig 1. Spatial distribution of 59 meteorological observatories used in this study

The 59 weather stations are distributed evenly in the Korean Peninsula, and the data collection lasted for 34 years from 1979 to 2012, and they obtained the data maintaining continuity. In addition, to analyze correlation among the occurrences of droughts in East Asia, the study employed RPCA-based major teleconnection modes of air circulation in the northern hemisphere. The data used to analyze air circulation were NCEP/NCAR reanalyzed data, included geopotential heights, Outgoing Longwave Radiation (OLR), and zonal wind for each altitude from 1979 to 2012.

To investigate the fluctuations of spring rainfall in East Asia, lag-correlation analysis was conducted and primary air circulation pattern was extracted (Fig. 2), and also through Wavelet analysis, the periodicity of the selected pattern was evaluated.

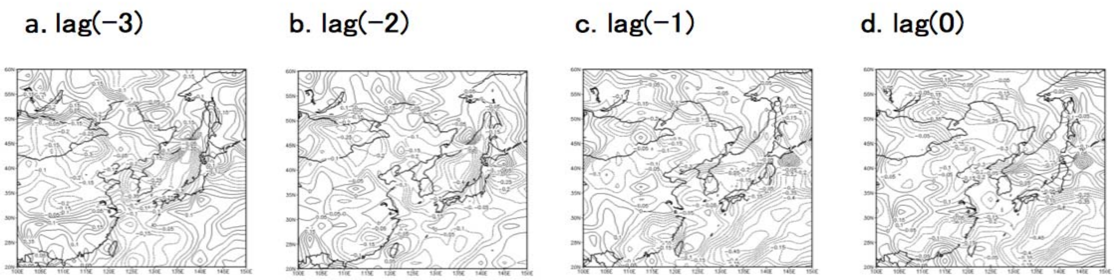

Fig. 2. Correlation coefficients between the spring GPCP precipitation (Mar-May) and large-scale teleconnection pattern (NAO) at selected time lags. Contour interval is 0.05.

3. Results and Discussion

For the result of composite analysis, in the negative NAO years, spring rainfall occurs more severely than the 30-year (1981-2010) normal; it tends to occur extensively in the entire East Asia. In contrast, during the positive NAO years, the opposite tendency is shown, and the southern area of the Korean Peninsula clearly indicates a pattern of rainfall reduction (Fig. 3). This kind of change may occur because in the positive NAO years, the North Pacific anticyclone fails to develop to the mid-latitude area in East Asia and prevents a powerful convention current from occurring in the area over 30°N including the Korean Peninsula. During the negative NAO years, however, the opposite spatial pattern is shown in general, so this means that Korea is located in the area where the convention current is active.

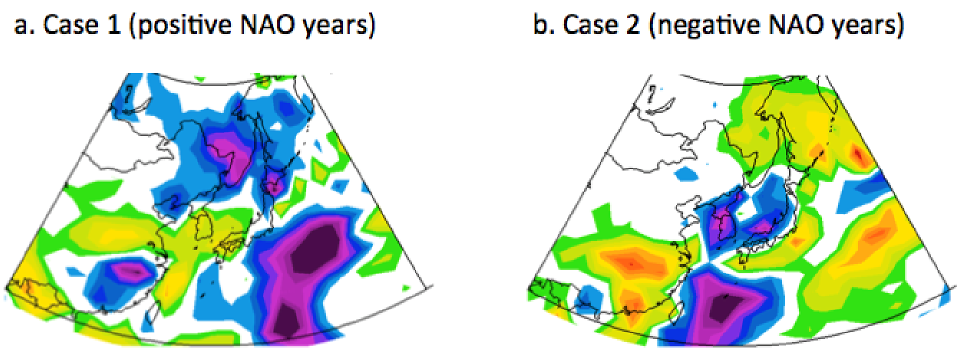

Fig. 3. Composite anomalies of spring GPCP precipitation (mm) according to different phases of teleconnection patterns.

For the result of analyzing zonal wind by the latitude gained by averaging out 120°-135°E, the longitude range that Korea belongs to, in the negative NAO years, a descending air current occurs around 30°N. In the positive NAO years, there is relatively straight current found in the Korean Peninsula; therefore, that strengthened anomaly of downdraft causes more severe droughts in the Korean Peninsula.

4. Conclusion

With the composite analysis on the positive and negative teleconnection pattern (NAO_{DJF}) selected, the study analyzed the characteristics of air circulation in connection with the temporal and spatial changes of drought frequencies over the Korean Peninsula and the variations of spring rainfall in East Asia. According to the result of analyzing correlation with the air circulation pattern of spring rainfall (March-May), the wintertime NAO index indicates statistically significant, negative lag-correlation in the northern area of China adjacent to Mongolia and the Korean Peninsula including the East Sea. It is expected that this study could provide foundational information to diagnose the characteristics of droughts in East Asia including the Korean Peninsula and develop the techniques for predicting droughts and also could be used in building practical strategies to cope with spring droughts.

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