Monsoonal precipitation variation in the East Asia since A.D. 1840
—Tree-ring evidences from China and Korea

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Abstract Three tree-ring rainfall reconstructions from China and Korea are used in this paper to investigate the East Asian summer monsoon-related precipitation variation over the past 160 years. Statistically, there is no linear correlation on a year-by-year basis between Chinese and Korean monsoon rainfall, but region-wide synchronous variation on a decadal-scale was observed. More rainfall intervals were 1860-1890, 1910-1925, and 1940-1960, and dry or even drought periods were 1890-1910, 1925-1940, and 1960-present. Reconstructions also display that the East Asian summer monsoon precipitation suddenly changed from more into less around mid-1920. These tree-ring precipitation records were also confirmed by Chinese historical dryness/wetness index and Korean historical rain gauge data.

Keywords: China, Korea, tree-ring precipitation reconstruction, East Asian summer monsoon precipitation.

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The main characteristic of the East Asian climate is the monsoon system. Plenty of studies have demonstrated that the Asian monsoon system plays a crucial role in the global climate system [1-4]. The Asian summer monsoon can be divided into two parts, the South Asian (Indian) monsoon and the East Asian monsoon[5,6]. Numerous studies concerning the Asian monsoon, including inter-seasonal and inter-annual variabilities, have been carried out. Recent studies indicate that the Asian monsoon system is characterized by a high rate of climate changes within all time scales. These changes are manifested by seasonal fluctuations, high inter-annual and inter-decadal variability and abrupt changes between climate regimes[7]. However, it was impossible to study climate change and annual variation on a long-term scale, because of lack of realistic long-term data which could be used to study the East Asian summer monsoon[8].

The monsoon has profound influence on the social and economic conditions of Asia which possesses over 60% of the earth’s population. In particular, the water resources in the East Asian countries depend largely on the precipitation during the summer monsoon season (from June to
late August in South Korea\cite{9}, and June to August in China\cite{10}). Summer monsoon rainfall over East Asia exhibits regional characteristics which are named with different names in different countries, such as “Mei-yu” in China and “Changma” in Korea\cite{11}. Agriculture is the traditional primary industry in the monsoon areas and the harvest is largely affected by rainfall. Unfortunately, frequent drought and flooding caused by monsoon precipitation can result in loss of lives and tremendous property damage. Therefore it is very important to recognize the behavior of East Asian summer climate in the past and to predicate possible future variations for these countries\cite{7}.

Both the Climate Variability and Predictability (CLIVAR)\cite{3} and the Past Global Changes (PAGES)\cite{4} programs emphasize the study of the variation in the Earth’s climate over the last 100 to 2000 years, which should provide a better understanding of climate variability and predictability. With its high resolution and reliability, tree-ring research has been regarded as an important technique in both programs. Tree-ring records are being combined with early instrumental records, historical documents, and other natural archives to build a yearly and seasonal history of the Earth’s climate for several centuries.

China and Korea are both impacted by the East Asian monsoon. By using traditional multivariate statistical calibration approaches and modeling, the variability of the monsoon system has been studied by scientists from both countries using instrumental climate data\cite{12,13}. Since starting GEWEX Asian Monsoon Experiment (GAME) in 1996, intensive field observations have been conducted in key regions in Asia along with long-term monitoring and modeling studies.

However, only few publications on long-term variation of the East Asian monsoon precipitation have appeared so far, mainly due to the scarcity or unavailability of datasets for longer time periods. There has been no comparative study on monsoon climate in these two countries on a long-term basis. This paper will describe monsoon precipitation variation since AD 1840 based on the tree-ring reconstructions from two countries. Annual dryness/wetness indices from Chinese historical documents, and instrumental records from traditional Korean rain gauge (scientific rainfall measurement in ancient times) are used to compare the tree-ring results.

1. Tree-ring and historical data

1.1 Tree-ring data

Three monsoonal rainfall reconstructions obtained from well replicated tree-ring chronologies of Baotou (BT) in northwest China\cite{14}, and those of Daekdam Jang (BJ)\cite{15} and Dae-Seung

\begin{thebibliography}{99}


4) PAGES, Global Palaeoenvironmental Data, IGBP PAGES Workshop Report Series 95–2, Bern, Switzerland, PAGES, 1995.

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