Influence of the Meridional Position of the East Asian Subtropical Jet on Midsummer Precipitation in Eastern Northwest China (Postprint)

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Date: 2020-01-02T00:00:00+00:00

Abstract

Using daily precipitation data from 179 meteorological stations in China compiled by the National Meteorological Information Center and NCEP/NCAR monthly reanalysis data, and based on the analysis of precipitation variation characteristics in midsummer (July, August) in eastern Northwest China from 1979 to 2017, this study utilizes the East Asian subtropical westerly jet meridional position index to focus on discussing the relationship between the meridional position variation of the East Asian subtropical westerly jet and midsummer precipitation in eastern Northwest China, with the aim of further improving the prediction level of drought and flood disasters in Northwest China. The results show that in years when the meridional position of the East Asian subtropical westerly jet center is anomalously northward, midsummer precipitation in the northern region of eastern Northwest China is above normal, while midsummer precipitation in the southern region of eastern Northwest China is below normal, and vice versa, exhibiting a north-south banded opposite distribution characteristic of the influence of meridional position variation of the East Asian subtropical westerly jet on midsummer precipitation in eastern Northwest China.

Full Text

Effect of Meridional Position of East Asian Subtropical Jet on Midsummer Precipitation in Eastern Part of Northwest China

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Abstract: Many studies have shown that the East Asian subtropical westerly jet is closely related to summer precipitation in most parts of China, but relatively few studies have focused on Northwest China. This paper uses daily precipitation data from 179 meteorological stations in China compiled by the National Meteorological Information Center, together with monthly NCEP/NCAR reanalysis data, to analyze variations in midsummer (July–August) precipitation in the eastern part of Northwest China from 1979 to 2017. Based on the East Asian subtropical westerly jet meridional position index, we examine the relationship between changes in the jet' s meridional position and midsummer precipitation in the region. The purpose is to improve prediction capabilities for drought and flood disasters in Northwest China. Results show that midsummer precipitation in the northeastern part of Northwest China was higher during abnormal years when the East Asian subtropical westerly jet center was displaced northward, and vice versa. This demonstrates that changes in the jet' s meridional position significantly affect midsummer precipitation variations in the eastern part of Northwest China.

Keywords: midsummer precipitation; climate change; East Asian subtropical jet meridional position; eastern part of Northwest China

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1 Introduction

The East Asian subtropical westerly jet is a crucial component of the atmospheric circulation system, exerting a profound influence on summer precipitation patterns across China. While numerous studies have established its relationship with precipitation in eastern and southern China, research specifically addressing its impact on Northwest China remains relatively limited. The region' s complex topography and vulnerable ecological environment make it particularly sensitive to variations in large-scale atmospheric circulation.

Previous investigations have demonstrated that the meridional displacement of the 200 hPa East Asian subtropical westerly jet correlates strongly with precipitation anomalies in the Yangtze River basin and North China. When the jet shifts northward, the rain belt typically moves northward accordingly, leading to increased precipitation in northern regions and decreased precipitation in the south. Conversely, a southward displacement of the jet results in the opposite pattern. This relationship is particularly pronounced during the midsummer months of July and August.

For Northwest China, which is characterized by arid and semi-arid climates, understanding the mechanisms linking the jet' s position to precipitation variability is essential for improving seasonal forecasting and disaster preparedness. The region has experienced significant climate changes in recent decades, with

notable trends in both temperature and precipitation. However, the role of the East Asian subtropical westerly jet in modulating these changes has not been thoroughly examined.

This study addresses this gap by analyzing the relationship between the jet' s meridional position and midsummer precipitation in the eastern part of Northwest China from 1979 to 2017. We define a meridional position index based on the 200 hPa wind field and identify abnormal years to quantify the jet' s influence on regional precipitation patterns.

2 Data and Methods

2.1 Data Sources The analysis utilizes two primary datasets: 1. Daily precipitation observations from 179 meteorological stations in China, compiled and quality-controlled by the National Meteorological Information Center 2. Monthly mean NCEP/NCAR reanalysis data for the period 1979–2017, including wind fields at 200 hPa and other relevant atmospheric variables

The study domain focuses on the eastern part of Northwest China, covering the region between 70°–120°E and 30°–50°N.

2.2 Definition of the Jet Position Index The East Asian subtropical westerly jet position index is defined based on the 200 hPa zonal wind field. The jet axis is identified as the location of maximum westerly wind speed at 200 hPa. The meridional position index is calculated by averaging the latitude of the jet core over the longitudinal range of 70°–120°E.

Abnormal years are identified when the normalized index exceeds ±1 standard deviation. This yields seven positive anomaly years (1994, 1997, 2000, 2006, 2013, 2016, 2017) and six negative anomaly years (1980, 1987, 1993, 1998, 2004, 2008).

2.3 Analysis Methods Composite analysis is applied to compare atmospheric circulation patterns and precipitation distributions between positive and negative anomaly years. Statistical significance is assessed using Student' s t-test, with differences considered significant at the 90% confidence level.

The study focuses specifically on the midsummer period (July–August) when the East Asian subtropical westerly jet reaches its northernmost position and exerts its strongest influence on precipitation patterns in Northwest China.

3 Results and Discussion

Figure 2 shows the normalized anomaly of the meridional position index of the interannual midsummer East Asian subtropical westerly jet during 1979–2017. The index exhibits pronounced interannual variability, with notable northward displacements in recent decades.

During years with positive index values (northward jet displacement), precipitation in the northeastern part of Northwest China shows significant positive anomalies. The maximum precipitation increase occurs in the region between 35°–40°N and 95°–111°E, where anomalies exceed 20% of the climatological mean. Conversely, during negative index years, the region experiences below-normal precipitation.

The mechanism involves changes in the large-scale circulation pattern associated with jet displacement. When the jet shifts northward, anomalous upper-level divergence and lower-level convergence develop over the northeastern part of Northwest China, favoring enhanced upward motion and increased precipitation. The opposite circulation pattern occurs during southward jet displacements.

These findings are consistent with previous studies linking the East Asian subtropical westerly jet to precipitation variability in other parts of China [**?**, **?**]. The results highlight the importance of the jet' s meridional position as a key predictor for midsummer precipitation in Northwest China.

4 Conclusion

The meridional position of the East Asian subtropical westerly jet significantly influences midsummer precipitation in the eastern part of Northwest China. Northward displacements of the jet are associated with increased precipitation, while southward displacements correspond to decreased precipitation. This relationship provides a valuable basis for improving seasonal prediction of drought and flood conditions in the region.

Further research should investigate the physical mechanisms linking jet position to regional circulation changes and explore the potential for incorporating this relationship into operational forecasting models.

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[Figure 2: see original paper]

Note: Figure translations are in progress. See original paper for figures.