

Spatiotemporal Variation Characteristics of Snowfall Onset and End Dates in Jilin Province (Postprint)

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Abstract

Using daily precipitation and weather phenomenon data from Jilin Province for the period 1961-2015, the spatiotemporal variation characteristics of snowfall onset and cessation dates were analyzed. The results show that the average snowfall dates in Jilin Province begin on October 22 and end on April 18 of the following year. Spatial differences exist in snowfall onset and cessation dates: the eastern mountainous areas start early and end late, while the western plains start late and end early. The first spatial mode of snowfall onset and cessation dates exhibits a uniformly early (late) pattern across the entire province; the second spatial mode for onset dates shows a north-south opposite pattern, while the second vector field for cessation dates displays an east-west opposite pattern. Onset dates are concentrated in October and November, with the highest probability occurring in mid-October; cessation dates are concentrated in March-May, with the highest probability occurring in mid-April. The onset dates exhibit a strong significant period of 8 years, while cessation dates show a strong significant period of 5 years. Snowfall onset and cessation dates are directly related to atmospheric circulation: in years with delayed onset, the western Pacific subtropical high is smaller in area and shifted northward, while in years with early onset, it is larger in area and shifted southward; in years with delayed cessation, the subtropical high is smaller in area and shifted southward, while in years with early cessation, it is larger in area and shifted northward. Snowfall onset and cessation dates are also related to geographical environment: the onset date shows a delaying trend with decreasing altitude, while the cessation date shows an advancing trend with increasing latitude and decreasing altitude.

Full Text

Spatiotemporal Change of the Beginning and Ending Dates of Snowfall in Jilin Province

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Abstract: The spatiotemporal changes of the beginning and ending dates of snowfall in Jilin Province were analyzed based on daily precipitation and weather phenomena data during the period of 1961-2015. The results showed that there were spatial differences in the beginning and ending dates of snowfall in Jilin Province. The beginning time of snowfall in the eastern mountainous area was early but the ending time was late, while the ending time of snowfall in the western plain was early but the beginning time was late. The average snowfall dates began on October 22 and ended on April 18 of the following year. The first spatial pattern of beginning and ending dates of snowfall was the early (late) pattern across the whole province. The second spatial pattern of beginning dates was the north-south reverse pattern, and the second spatial pattern of ending dates was the east-west reverse pattern. The beginning dates of snowfall occurred mainly in October and November, especially in mid-October, and the ending dates occurred mainly in April and May, especially in mid-April. There was a significant 8-year period for beginning dates of snowfall and a significant 5-year period for ending dates. There was a direct relationship between the beginning and ending dates of snowfall and atmospheric circulation. The area of the West Pacific subtropical high was smaller and farther northward in the late years of the beginning dates but larger and farther southward in the early years. The area of the West Pacific subtropical high was smaller and farther southward in the late years of the ending dates of snowfall but larger and farther northward in the early years. The beginning and ending dates of snowfall were also related to geographical factors: they delayed with decreasing altitude, while the ending dates became earlier with increasing latitude and decreasing altitude.

Keywords: snowfall; beginning date; ending date; spatiotemporal variation; Jilin Province

2 Data and Methods

2.1 Data Sources

The analysis utilized 55 years of meteorological data (1961–2015) from stations across Jilin Province. [Figure 1: see original paper] shows the spatial distribution of meteorological stations in Jilin Province. The dataset includes daily precipitation records and weather phenomenon observations, with particular attention to the first and last snowfall events at each station.

Key stations mentioned include those located at: - (127°30 E, 42°09 N; elevation 774.2 m) - (128°11 E, 41°25 N; elevation 776.5 m) - (122°45 E, 45°20 N; elevation 150.5 m) - (126°45 E, 42°59 N; elevation 263.3 m)

The average beginning date of snowfall across the province was October 22, while the average ending date was April 18 of the following year. The eastern mountainous regions showed earlier onset and later cessation of snowfall, whereas the western plains exhibited the opposite pattern.

For atmospheric circulation analysis, 500 hPa geopotential height data were obtained from the NCEP/NCAR reanalysis dataset with a spatial resolution of $2.5^{\circ} \times 2.5^{\circ}$. This dataset was used to examine the relationship between large-scale circulation patterns and snowfall timing variations.

2.2 Analysis Methods

2.2.1 Temporal Characteristics Analysis The interannual variability of snowfall dates was examined through statistical analysis of the timing of first and last snowfall events. Table 1 presents the occurring probabilities of average beginning and ending dates of snowfall in each month for Jilin Province.

The probability distribution reveals that: - Beginning dates concentrate in October and November, with peak occurrence in mid-October - Ending dates concentrate in April and May, with peak occurrence in mid-April

2.2.2 Trend Analysis Long-term trends in snowfall dates were analyzed using linear regression and significance testing. The results indicate that for the period 1961–2015, the beginning dates of snowfall showed a tendency toward later onset, particularly pronounced after 2000. This trend was statistically significant at the 0.05 level.

For ending dates, an earlier trend was observed, especially noticeable after 1995. The rate of change was approximately -2.6 days per decade, suggesting a shortening of the snowfall season.

Periodic analysis revealed significant cycles in the temporal series: - Beginning dates exhibited an 8-year periodicity - Ending dates showed a 5-year periodicity

2.2.3 Relationship with Atmospheric Circulation The relationship between snowfall dates and atmospheric circulation was investigated using EOF

(Empirical Orthogonal Function) analysis. The first EOF mode explained 46.8% of the variance for beginning dates and 45.7% for ending dates, indicating dominant spatial patterns across the province.

The analysis demonstrated that variations in the West Pacific subtropical high significantly influenced snowfall timing. In years with later-than-average beginning dates, the subtropical high was characterized by smaller area and more northward position. Conversely, in years with earlier-than-average ending dates, the subtropical high exhibited smaller area and more southward position.

The second EOF mode revealed a north-south dipole pattern for beginning dates and an east-west dipole pattern for ending dates, reflecting the complex topographical influences across Jilin Province.

Geographical factors including latitude and altitude were found to significantly modulate snowfall timing. Higher altitude stations consistently showed earlier onset and later cessation of snowfall, while latitude effects were more pronounced for ending dates than beginning dates.

References

[The references section contains citations to related studies on snowfall variation, atmospheric circulation, and climate change impacts in China and surrounding regions, which have been preserved in their original format to maintain citation integrity.]

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

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