

# Analysis of Rain, Snow and Freezing Weather Process in the Middle and East of China from January 25 to 29, 2022

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**Abstract:** This study used data from the National Meteorological Information Center of China, National Centers for Environmental Prediction of the United States, and others in late January 2022. The main analysis is of the circulation situation and precipitation profile for late January 2022. The main influencing factors are: 1) cold air brought by a high-altitude trough to the south. 2) The prolonged convergence of cold and warm air currents. 3) Warm and humid airflow climbing at lower levels. The result led to widespread snow and rain and freezing weather in east-central China from 25th to 29th January 2022. Blizzards to heavy snowfall were reported in Henan, Hubei, and Hunan.

**Keywords:** High-Altitude Trough; Blizzard; Heavy Snowfall; South Branch Trough

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## 1. Introduction

From January 25<sup>th</sup> to 29<sup>th</sup>, 2022, there was a rainy and snowy weather process in the middle and east of China. The strongest period occurred from the night of the 27<sup>th</sup> to the day of the 29<sup>th</sup> and it ended on the 30<sup>th</sup>. The rain and snow weather process has a wide range of influence and strong intensity. The rain and snow center were in the south. Heavy snow occurred in Henan, Hubei, Anhui, Hunan, and other places. And freezing rain occurred in Guizhou and Hunan.

The snowfall is beneficial to alleviating the drought in some southern regions and promoting agricultural production, but it has an adverse impact on the urban operation and energy supply.

Affected by the rise of air temperature, the sustainability of China's freezing weather process is weakened, and the scope of influence is reduced. This leads to a reduction in the frequency of large-scale sustained freezing weather processes, which are prone to processes with shorter duration and smaller impact ranges Wang (2014). The freezing weather process in Hunan in the center of China is influenced by the weather situation. In the weather situation, there exists a strong cold air blow to the south from Lake Baikal in the north and it influenced the middle and lower reaches of the Yangtze River and the middle and high latitudes of Central Asia as two troughs and a ridge Zhao et.al (2019). The occurrence of freezing rain and snow weather in Guiyang is related to the interaction of 500 hPa blocking high in the middle and high latitudes, the jet stream in the southern branch trough, the subtropical front in the low latitudes, and the low-level southwest low-level jet stream Luo & Zhang (2022). It is concluded from the study that there is an inversion layer at the temperature of 800 hPa~700 hPa and whether the temperature of the inversion layer is greater than 0 degree is one of the key conditions to determine the phase state of precipitation. During the freezing rain, the convergence center of water vapor is concentrated in the middle and low layers, while the height of upward development of the high humidity area during the snowfall is much higher than that of the freezing

rain. When freezing rain and snowfall occur, the subsidence movement of cold air near the ground is shown, and the ascending movement is stronger when snowfall occurs Luo & Zhang (2022).

Winter weather conditions lead to snowfall and extremely low temperatures. Such weather conditions do harm to the normal life of society and the social economy Allison & Melissa (2020). The statistical validity of the research results was confirmed by the statistical significance test. With the decrease in cold temperature, the number of passenger cars and trucks is expected to decrease significantly. Compared with trucks, the decline of passenger cars is larger Hyuk et.al (2013). Determining the reliability of the precipitation index at specific stations such as Albany can enable meteorologists in other regions of the country to compare the weather type, precipitation, and thickness in their prediction areas Allison & Melissa (2020).

Previous studies have some limitations in data and methods. This study uses the latest data and more accurate analysis methods. Analyze weather conditions by analyzing weather charts. This study introduces the latest research on rain, snow, and freezing weather processes in the middle and east of China.

## **2. Data And Methods**

### **2.1 Data**

This study is relative to the surface weather observation data about the station in the middle and east of China coming from the National Meteorological Information Center of China. The climate background information about the rainstorm and snow weather comes from the climate system detection of the National Climate Center of China. National Centers for Environmental Prediction (NCEP) of the United States reintroduces the numerical model to integrate the actual data and coordinate the wind field and pressure field.

### **2.2 Methodology**

This study uses the dynamic analysis method and the extrapolation analysis method of the weather system. One of the extrapolation methods is to assume that the moving speed or intensity of the system basically does not change with time. Currently, the moving distance or intensity of the system is in a linear relationship with time. The extrapolation method is based on this linear relationship. This extrapolation method is called isokinetic extrapolation. The other is to assume that the change of the moving speed or intensity of the system is close to the constant acceleration state. Currently, the moving distance of the system or its intensity is in a curvilinear relationship with time. Their acceleration should be considered when extrapolating, so this extrapolation method is called accelerated extrapolation. Using the distribution characteristics of the height change caused by the past movement and change of the air pressure system, the method of predicting the future movement and change of the system through the kinematic formula is called the kinematic method. This method is also an extrapolation method in essence, which has limitations.

## **3. Results And Analysis**

### **3.1 Analysis of Circulation Situation and Precipitation**

It can be seen from the circulation situation of Euro-Asia in the middle and high latitudes in late January 2022 (Fig. 1) that the high-pressure ridge near Baikal Lake develops strongly northward. It is obvious that the meridional direction of the circulation increases and the northerly airflow in front of the ridge is strong, which is conducive to guiding the polar cold air southward along the east road to affect China. Then the south side of the ridge area continues to split, and the short wave moves eastward and affected China along the west road. The contour lines in the middle and low latitudes are dense, and the south branch front area is relatively strong. The southwest airflow in front of the south branch trough continuously transports the water vapor in the Bay of Bengal to China, and the cold and warm air frequently meet in the central and eastern regions.

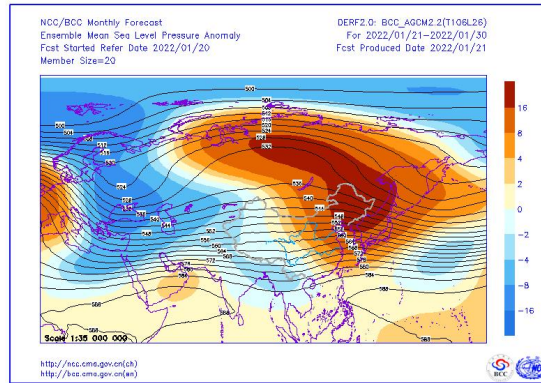


Figure 1 The 500 hPa geopotential height field in late January 2022.

This circulation situation is conducive to bringing a large-scale rain and snow freezing process to the middle and east of China, resulting in more precipitation in the middle and east of China. Henan, Hubei, Anhui, and Hunan are the center of the heavy snow. Hunan and Guizhou occurred freezing rain (Fig. 2).

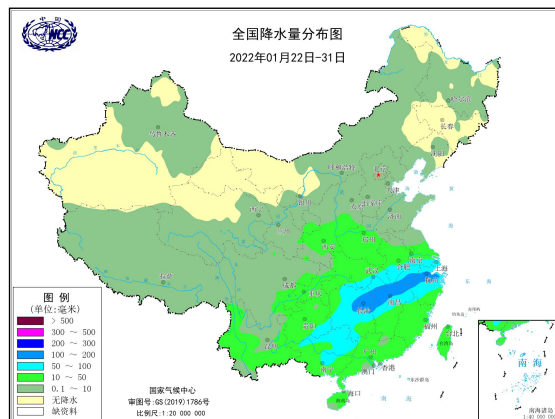


Figure 2 Cumulative precipitation in late January 2022.

### 3.2 Analysis Of Weather Situation In The Precipitation Process

From January 25<sup>th</sup> to 29<sup>th</sup>, large-scale rain, snow, and freezing weather occurred in the middle east of China. Moderate to heavy snowfall in the center and south of Shaanxi, southwestern Shanxi, western and southern Henan, Hubei, northern Hunan, northern Jiangxi, most of Anhui, northern Zhejiang, and southwestern Jiangsu. Blizzard occurred in southern Henan, the north and center of Hubei, northeastern Hunan, northern Jiangxi, southern Anhui, and northwestern Zhejiang. Localized precipitation more than 50mm in the above areas. The accumulated precipitation in the north and west of Zhejiang, the north of Jiangxi, and the northeast of Hunan exceed 100 mm (Fig. 2).

In this process, the cold air from the north was guided by the high trough to the south, the deepening of the south branch trough to the east, and the strengthening of the subtropical high to the west. The upper shortwave trough overlaps with the south branch trough in the same position, and the southwest warm and humid airflow in front of the trough is strengthened. At the same time, with the development of the low-level shear line, the cold and warm air flows converge in the middle and lower reaches of the Yangtze River for a long time; The easterly airflow near the ground forms a cold pad, and the warm and humid airflow climbs on the low-level cold pad. This has caused continuous low-temperature rain and snow in the middle and lower reaches of the Yangtze River in China.

At 08:00 on January 25<sup>th</sup>, the front of the surface cold front was in the middle of north China to the north of Shaanxi (Fig. 3), and the low-pressure inverted trough developed from the southeast of northwest China to the southwest (Fig. 3). he

water vapor was transported to the south of Gansu and the central and southern part of Shaanxi along the low-level southeast air flow (Fig. 4) and intersected with the cold air in the north.

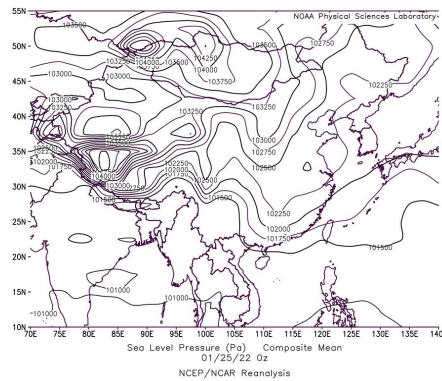


Figure 3 Sea level pressure field at 08:00 on January 25<sup>th</sup>, 2022.

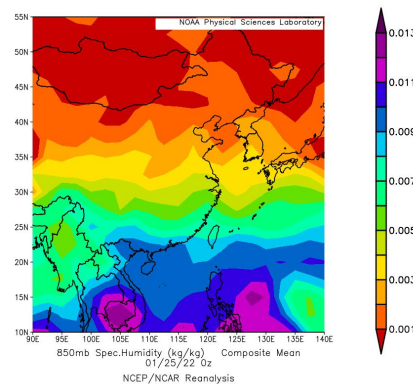


Figure 4 The 850 specific humidity at 08:00 on January 25<sup>th</sup>, 2022.

At 20:00 on January 25<sup>th</sup>, the cold front on the ground in the northern region advanced southwards. In the southern region, as the southern trough deepened and moved eastward, the pre-trough forcing was conducive to the development of southwestern low-level jets. Water vapor channels at 700 hPa were established from the Bay of Bengal to southwest China and northern Jiangnan via the central south Peninsula, in conjunction with warm and wet shear formation at 850 hPa. Moisture accumulates near the shear line, resulting in moderate to heavy rainfall in southern Hubei and northern Hunan.

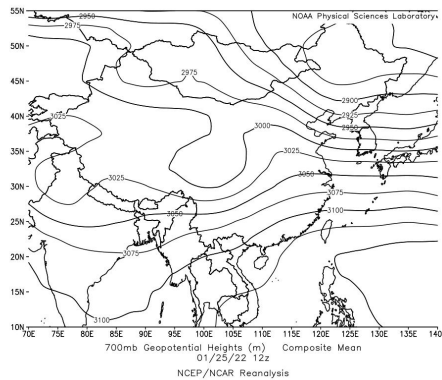


Figure 5 The 700 hPa geopotential heights at 20:00 on January 25<sup>th</sup>, 2022.

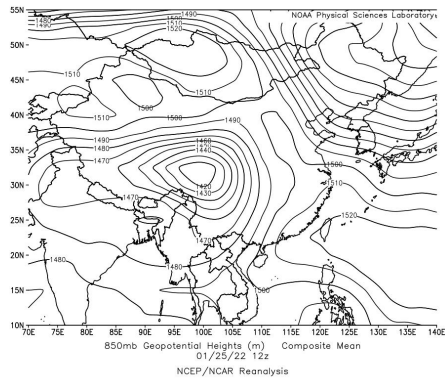


Figure 6 The 850 hPa geopotential heights at 20:00 on January 25<sup>th</sup>, 2022.

At 08:00 on January 26<sup>th</sup>, the 700 hPa low-level jet developed northward (Fig. 7), and the 850 hPa low-level warm horizontal wind shear developed eastward (Fig. 8). Heavy rainfall mainly occurred on the south side of the 850 hPa shear line and the left side of 700 hPa jet stream axis. The strong convergence ascending movement in this region provided a good dynamic condition for precipitation. The surface cold front gradually advanced to the Jianghuai region and Jiangnan region. The warm humid airflows climbed on the cold mat formed by the easterly airflow (Fig. 9). The above weather situation led to small to moderate snow in Shaanxi, Henan, Hubei, Anhui, and other places.

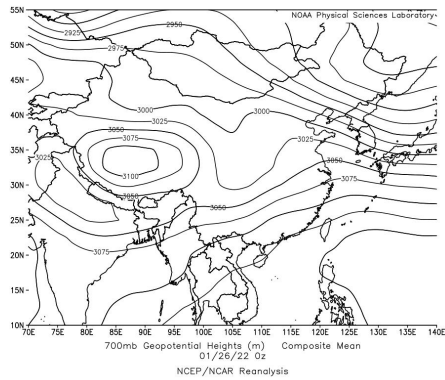


Figure 7 The 700 hPa geopotential heights at 8:00 on January 26<sup>th</sup>, 2022.

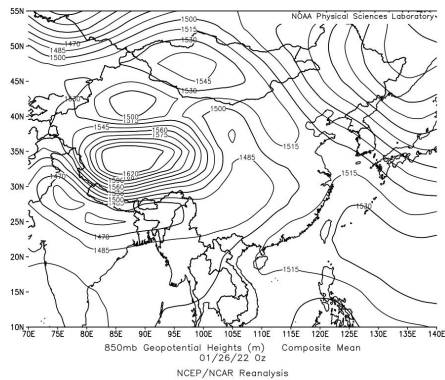


Figure 8 The 850 hPa geopotential heights at 8:00 on January 26<sup>th</sup>, 2022.

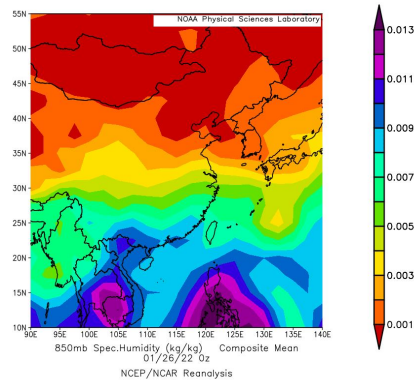


Figure 9 The 850 hPa specific humidity at 8:00 on January 26<sup>th</sup>, 2022.

At 08:00 on January 27<sup>th</sup>, the ground cold front advanced to the front line along the Yangtze River. The 850 hPa in the lower layer changes from warm shear to cold shear (Fig. 10). The warm and humid airflow in the south was active and the water vapor is abundant. The specific humidity of 850 hPa was above  $4\text{g}\cdot\text{kg}^{-1}$  (Fig. 11), which was conducive to the maintenance of rain and snow weather. Heavy rainfall occurred on the south side of the shear, and heavy rain occurred in Hunan and Jiangxi. The south pressure of 850 hPa temperature  $-4^{\circ}\text{C}$  line was relatively slow, and the area to the north of  $-4^{\circ}\text{C}$  line was dominated by pure snow. The snowfall was basically maintained in the north of the Yangtze River.

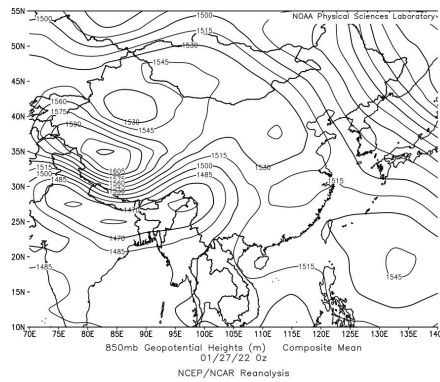


Figure 10 The 850 hPa geopotential height at 8:00 on January 27<sup>th</sup>, 2022.

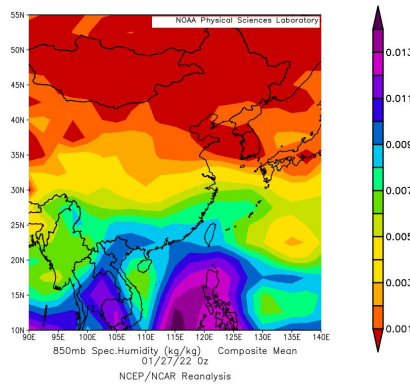


Figure 11 The 850 hPa specific humidity at 8:00 on January 27<sup>th</sup>, 2022.

At 08:00 on January 28<sup>th</sup>, the 850 hPa temperature  $-4^{\circ}\text{C}$  line gradually pressed south to the north of Jiangnan (Fig.12).

Along the river and in the south of the Yangtze River, there had been rained to sleet or pure snow, with a wide range of snow and a large intensity of snow.

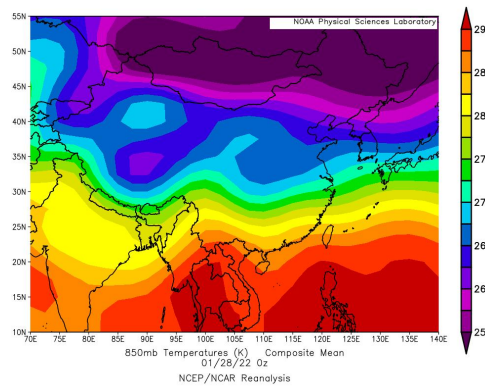


Figure 12 The 850 hPa air temperature at 8:00 on January 28<sup>th</sup>, 2022.

At 08:00 on January 30<sup>th</sup>, it moved out with the fluctuation of the south branch. Most parts of China were controlled by the upper northerly airflow, and the rain and snow weather were temporarily suspended.

## 4. Conclusion

In the second half of January 2022, heavy rain and snowstorms were reported in the center and east of China.

On the 25<sup>th</sup>, moderate to heavy rain fell in southern Hubei and northern Hunan; At 08:00 on the 26<sup>th</sup>, light to moderate snow fell in Henan, Hubei, and Anhui; At 08:00 on the 27<sup>th</sup>, snowfall occurred north of the Yangtze River, with heavy rain in Hunan; On the 28<sup>th</sup>, the rain turned to sleet in northern Jiangnan. Until 08:00 on the 30<sup>th</sup>, the rain and snow were suspended.

This weather process is mainly due to the combined effects of the high trough guiding cold air from the north southward and the deepening eastward shift of the southern branch trough in conjunction with the strengthening of the subtropical high pressure extending westward. The eastward airflow near the ground formed a cold cushion, and the warm and humid airflow climbed on the lower cold cushion, causing persistent low-temperature rain and snow in the middle and lower reaches of the Yangtze River in China.

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