

Study of Cloud Liquid Water Distribution under Central Asian Vortex in Xinjiang and Surrounding Central Asian Regions: Postprint

Authors: Liang Qian, bright and lustrous, Liu Qiong, Li Jiangan, Chen Yonghang, Yang Lianmei, Xin Yu, Liu Tongqiang, Huang Guan, Chen Yonghang

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Abstract

Using AIRS Version 6 Level 2 satellite data from May to September during 2003–2014 when Central Asian vortices occurred, this study analyzes the activity patterns of Central Asian vortices and the spatial distribution of cloud liquid water. The results indicate: (1) The northern-type Central Asian vortex occurred 97 times, while the southern-type occurred 88 times. The Central Asian vortex center is more likely to move southward. (2) Overall, cloud liquid water exhibits a pattern of higher values in mountainous regions and lower values in basins, exceeding $100 \times 10^{-6} \text{ kg} \cdot \text{m}^{-2}$ in the mountainous areas of the Pamir Plateau, Tianshan Mountains, and Kunlun Mountains, as well as near the Aral Sea. In the Junggar Basin, Hami Basin, and eastern Tarim Basin, values are less than $1 \times 10^{-6} \text{ kg} \cdot \text{m}^{-2}$. (3) The more southerly the path of Central Asian vortex occurrence, the lower the cloud liquid water column. Regarding cloud liquid water column, the northern vortex path exhibits higher values than the southern vortex path. These findings will provide a reference for further understanding the heavy precipitation weather system associated with Central Asian vortices.

Full Text

Preamble

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Authors and Affiliations:

LIANG Qian¹, GUANG Ying¹, LIU Qiong¹, LI Jiangan², CHEN Yonghang^{1,2}, YANG Lianmei², XIN Yu², LIU Tongqiang¹, HUANG Guan¹

¹ College of Environmental Science and Engineering, Donghua University,

Shanghai 201620, China

² China Meteorological Administration, Institute of Desert Meteorology, Ürümqi 830002, Xinjiang, China

Data Processing Notes:

Satellite data acquisition and processing involved averaging all pixel data within $0.25^{\circ} \times 0.25^{\circ}$ grid points, followed by interpolation to each grid point to generate monthly average spatial distribution maps.

Abstract

Xinjiang, China, and the surrounding Central Asian region belong to the same typical arid and semi-arid climate zone, characterized by scarce water resources and sparse surface vegetation. Sudden heavy precipitation events in this region pose significant threats to water conservancy systems. The Central Asian vortex represents the primary weather system causing heavy precipitation in Xinjiang and surrounding Central Asian areas. The precipitation process involves the transformation of water vapor and ice particles in the atmosphere, with cloud liquid water interacting with these water molecules to maintain atmospheric water budget balance.

To investigate cloud liquid water characteristics under the influence of Central Asian vortices in Xinjiang, this study utilized AIRS Version 6 Level 2 satellite data from May through September during 2003 and 2014 to analyze vortex activity patterns and the spatial distribution of cloud liquid water. In the data processing workflow, all pixel values within $0.25^{\circ} \times 0.25^{\circ}$ grid cells were first averaged, then interpolated to individual grid points for mapping monthly average spatial distributions.

The results demonstrate: (1) The Northern Vortex Type of Central Asian vortices occurred 97 times, while the Southern Vortex Type occurred 88 times. The activity center of Central Asian vortices exhibits a tendency to move southward. The monthly frequency of Northern Vortices during summer and half-year periods shows a single-peak pattern, while the Southern Vortices display a “W” shaped monthly frequency distribution. (2) Overall, cloud liquid water content tends to be higher in mountainous regions and lower in basin areas. Values exceed $100 \times 10^{-3} \text{ kg} \cdot \text{m}^{-2}$ along the Tianshan and Kunlun Mountains and in the vicinity of the Aral Sea on the Pamir Plateau, whereas content falls below $1 \times 10^{-3} \text{ kg} \cdot \text{m}^{-2}$ in the Junggar Basin, Hami Basin, and eastern Tarim Basin. This distribution pattern arises because the Himalayas and Kunlun Mountains prevent water vapor from the Indian Ocean from entering Xinjiang. (3) The more southward the vortex occurrence path, the lower the cloud liquid water content. Cloud liquid water content along the Northern vortex path is significantly higher than that along the Southern vortex path. This research could provide a new early warning index for heavy rainfall forecasting in this region.

Keywords: Central Asian vortices; southern vortex; northern vortex; movement path; monthly variation; total cloud liquid water

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

Source: ChinaXiv –Machine translation. Verify with original.