THE RECENT FEATURES OF WATER VAPOR AND ITS TRANSPORT OVER EAST-CENTRAL REGION OF NORTHWEST CHINA

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1 INTRODUCTION

Northwest of China is far away from the sea, located at the combination area of Qinghai-Tibet Plateau, Inner Mongolian, Loess Highlands, with complex terrain. Precipitation is scarce and mainly occurs in the summer, relatively rich in some mountainous and plateau areas, and its distribution is quite unevenly. The precipitation is important water source supplies in this arid and half arid area. The water vapor supply and the terrain lifting are essential condition for forming cloud precipitation. The water vapor and its transfer over the unique geography topography in the Northwestern Region have their special features, especially in the important role of orographic effects on precipitation forming. The water vapor and its transfer fluxes features, the precipitation distribution effected by the terrain are analyzed based on 5-year sounding and DEM data in this paper.

2 DATA AND METHODOLOGY

The means of water vapor and the water-vapor transfer for entire level at two times (08:00, 20:00) daily are calculated over eastern region (89°E-112°E, 30°N-46°N) of Northwest based on 40 sounding stations day-to-day data during 2001-2005 year. The surface precipitation data from 2001 to 2005 at the 212 weather observation stations are used.

Water vapor content (V) is calculated by:

$$V = \int_{h_b}^{h_t} \rho_v \Delta s dh$$

where ρ_v is water vapor density, Δs is unit area, h_t top of Integral altitude, h_b bottom of Integral altitude.

Water-vapor transfer flux ($\vec{Q}$)calculated by:

$$\vec{Q} = \int_{h_{ground}}^{h_{100}} \vec{V} \cdot \rho_v \Delta s dh = \int_{h_{ground}}^{h_{100}} (u, v) \cdot \rho_v \Delta s dh$$

3 RESULTS

3.1 Distribution of water vapor content

The water vapor contents with very similar geographical distributions change obviously for different seasons, the largest one is in summer, the second large one in spring, smaller in autumn and the smallest in winter. The water vapor is abundant in south-eastern of GANSU, southern of SHANXI province and is particularly scarce in middle of the Qinghai-Tibet Plateau and the Badanjilin Desert.

The area of water vapor content large than 8mm expands gradually and extends toward north-west from spring to summer, so as to form a “wet tongue” along Qilian mountains, except that in winter.

3.2 Transfers of water vapor

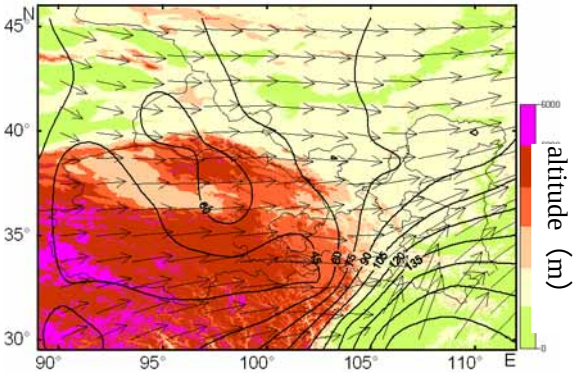

FIG.1. the contour of water vapor flux and transportation vector

It is an important factor the strong or the weak of water-vapor transfer to decide the effective precipitation formation, regarding to arid and half arid in Northwestern Region.

As show in Fig 1 and Fig 2, the water-vapor transfer in this region is mainly come from two directions, zonal transportation and meridional transportation. The zonal transportation primarily is in the west with the entire level water vapor flux less than 100Kg.cm^{-1}.s^{-1}. The more important path of water-vapor transfer is the meridional transportation in the southwest monsoon influence, from Bay of Bengal's southwest air current, with the water vapor flux more than 105Kg.cm^{-1}.s^{-1}.

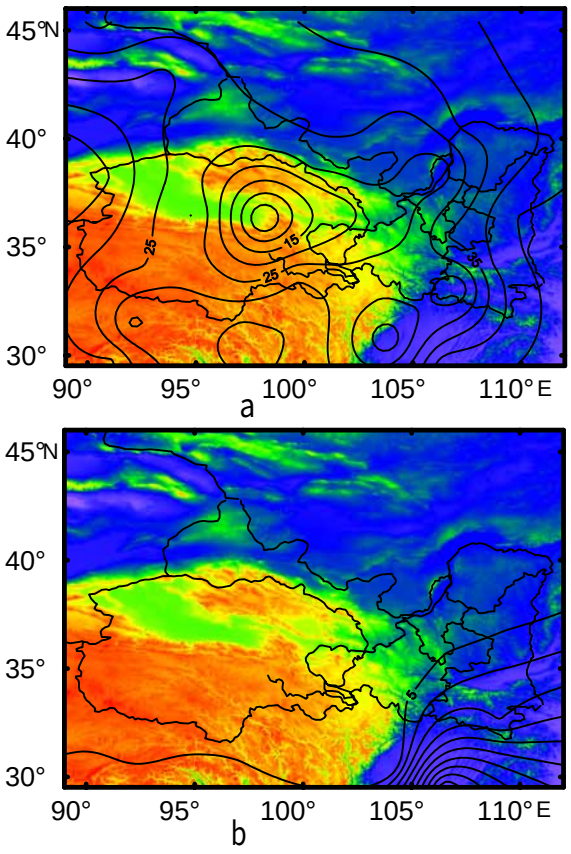

FIG.2. the mean water fluxes of zonal transportation (a) and radial transportation (b).

According to water-vapor transfer flux divergence equation:

$$\nabla \cdot \vec{Q} = \frac{1}{g}\int \nabla \cdot (\vec{V}q)dp = \frac{1}{g}\int \vec{V} \cdot \nabla q dp + \frac{1}{g}\int q \cdot (\nabla \cdot \vec{V})dp$$

the divergence of water-vapor transportation consists of water vapor advection (first part in right) and wind field divergence item (second part in right). The westerly wind average transportation is some of dry transportation because the water vapor content reduces gradually from west to east. It is not favorable to the formation of precipitation. It is well known that the effective precipitation is hardly formed if the water vapor flux does not converge. The water convergence is formed in some of region due to special landform and high mountains retarding and uplifting the incoming water vapor in west China. It finally results in precipitation formation. The positions of precipitation center and the water vapor convergence are very consistent in this area.

The water vapor transportations by zonal northwest airflow and the westerly wind airflow are the basic water vapor supply, and the powerful water vapor transported by southwest monsoon from Bay of Bengal, especially in summer, is advantageous in strengthening the precipitation intensity in this area. The zonal water vapor transportation, which the maximum value appears at 600 hPa, is the most important path in Qinghai-Tibet Plateau and its north. The meridional water transportation which concentrates below the height of 400 hPa only prevails in east Qinghai-Tibet Plain the edge and the east of the region.

4 CONCLUSIONS AND DISCUSSION

The regional water vapor and its transport features are analyzed in East-central Region of Northwest in China based on the data of recently five years. The results show that the water vapor contents from ground to upper atmosphere obviously vary with seasons and locations, and extend northwest like a “wet tongue” along Qilian mountains except that in winter. The vapor

comes mainly from zonal transport guided by west wind and meridional transport dominated by southwest current. In Qinghai-Tibe plateau, the vapor transport are mainly from southwest current in south regions and from northwest current in north regions which vapor flux value is half as many as that in east Plateau, and upper vapor transport plays a more important role. The dry vapor transport led by northwest and west current is one of primary factors. It's clearly that precipitation and uneven distribution are greatly influenced by the terrain. In the summer, the zonal vapor transport in 600hPa is the strongest, and the longitudinal vapor transport in to the east of 103°E under 600hPa is stronger than other areas.

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