QUANTITATIVE OBSERVATION FOR SPATIAL STRUCTURE OF PRECIPITATION IN QINGDAO IN RAINY SEASONS 1987-1988

Zhang Wei
Qingdao Research Center of C. R. I. R. P.
33, Fulong Mountain, Qingdao City, Shendong Province, China

Abstract
Calculating formula suited to the meteorological radar type 713 for rain intensity is derived, quantitative observing methods for horizontal and vertical structure of precipitation by using the radar are introduced, and horizontal and vertical spatial distributions of the rain intensity and normalized rain intensity in Qingdao in rainy seasons 1987-1988 are given in this paper.

1. Introduction

It is an important method of studying spatial structure of rain intensity to observe spatial structure of precipitation by using radar, and it is necessary for millimeter wave communication, remote sensing and so on to know distributive character of the rain intensity clearly. The quantitative observing results of spatial distribution of precipitation in Qingdao in rainy seasons 1987-1988 by using the meteorological radar type 713 are given in this paper.

2. Calculating formula for rain intensity

Using the 713 radar to observe the spatial structure of precipitation, the radar equation can be written as

$$Pr=\frac{c}{r^2}z \qquad (1)$$

where

$$c=\left(\frac{\pi^3}{1024\ln 2}\right)\left(\frac{PtGo^2h\theta\varphi}{\lambda^2}\right)|K|^2$$

Pt and Pr is the transmitted and received power respectively, Go is the gain of the antenna, θ and φ is the half-power beamwidth in vertical and horizontal direction respectively, h/2 is the emitted deep, λ is the wave-length, r is the detected range, $|K|$ is the constant, and z is the radar reflective factor. There is an empiric exponential relation between the radar reflective factor z and rain intensity R(mm/hr) as follows:

$$z=aR^b \qquad (2)$$

in practical measurment, the received power Pr is measured in Nr(dB) which is the maximum number of attenuate decibel, and the relationship between the Nr and the Pr is

$$Nr=10\lg\left(\frac{Pr}{Pmin}\right) \qquad (3)$$

where Pmin is the minimal distinguishable power.
Using formulae (1), (2), (3) and the 713 radar's data[1], we obtain the calculating formula for rain intensity R

$$R=\frac{1}{a^{1/b}\,10^{1.35/b}}\,r(Km)^{2/b}\,10^{Nr/10b}\qquad (mm/hr)\qquad (4)$$

In observation, we take a=200 and b=1.6 for layer-cloud rain and a=486 and b=1.37 for thundershower.

3. Observing methods

Within 200 kilometers in which the spatial structure of precipitation can be observed quantitatively, taking points at different position along a radial length in a rain cloud on the plan-position indicator, and recording the range r(Km) and the Nr(dB) corresponding to these points, we observe the horizontal structure of precipitation, therefore, the horizontal distribution of the rain intensity R is obtained by using the formula (4).

At the points on horizontal path, recording the height h in kilometers, the elevation and the Nr(dB) at different position on the range-height indicator, we observe the vertical structure of precipitation, and by using formula (4), the vertical distribution of the rain intensity R is obtained also.

Fig.1 gives the record of an observation, in Fig.1, equidistant line is shown on concentric circular and vertical line, in horizontal and vertical structure diagrammatic sketch respectively, contour line is shown on horizontal line in vertical structure diagrammatic sketch. The long of maximum circular's radius is 200 kilometers and the distances between two neighboring circulars is equal to 50 kilometers in horizontal structure diagrammatic sketch.

Fig.2 and Fig.3 is one horizontal and vertical structure diagram of precipitation respectively. The horizontal coordinate represents the distances between the radar and the observed point in Fig.2, and height between the observed point and the corresponding point at which the rain intensity is the highest on horizontal path in Fig.3, respectively, and the vertical coordinate represents the rain intensity in Fig.2 and Fig.3.

4. Spatial distributions of rain intensity

Using formula (4), the observing methods described in above paragraph and observing data recorded in rainy seasons 1987-1988, assuming that the precipitate region is symmetric about a vertical line which passes through a point located by maximum rain intensity Rm in every observation, and taking the vertical distribution of precipitation along the symmetric line as a vertical distribution of precipitation of whole precipitate region in every observation approximately, we obtain the spatial distribution of precipitation in Qingdao in rainy seasons 1987-1988.

Fig.4 and Fig.5 in which the origin represents the point located by the maximum rain intensity Rm in every observation gives the horizontal distribution of the rain intensity R and normalized rain intensity R/Rm which is the ratio R/Rm in every observation respectively.

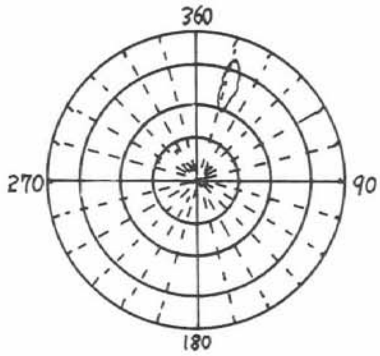
Fig.6 and Fig.7 in which the abscissa represents the height away from ground gives the vertical distribution of the rain intensity R and the normalized rain intensity R/Rm respectively.

5. Disscusion

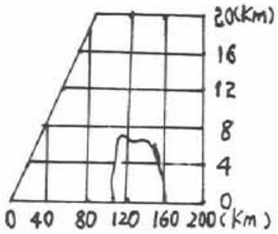
From Fig.4-7, it is obvious that neither of the horizontal and the vertical distribution of rain intensity in precipitate region in Qingdao is homogeneous, certainly, for summarizing some law on spatial distribution of precipitation in Qingdao, it is necessary to observe in a very long time and get a great deal of datum.

Reference

[1]. Data Summary, Meteorological Radar Type 713.



Horizontal structure
diagrammatic sketch



Vertical structure
diagrammatic sketch

Time: 8:05- 8:20, 18 August, 1987. Recorder: Zhang Wei

Bearing(elevation)	15° - 20°(0°)								
Distances(Km)	110	160							
Attenuation(dB)	10	10							
Height(Km)	0	0							
Attenuation(dB)	20	10							
Height(Km)	5								
Attenuation(dB)	15								
Height(Km)	6								
Attenuation(dB)	5								
Note									

Fig.1 Observation for spatial structure of precipitation

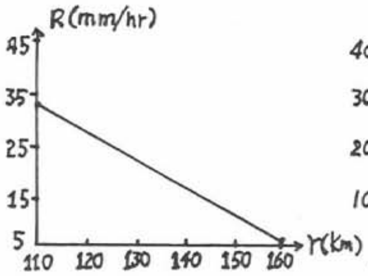


Fig.2 Horizontal structure
of precipitation

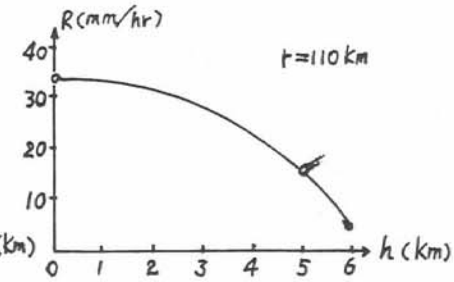


Fig.3 Vertical structure
of precipitation

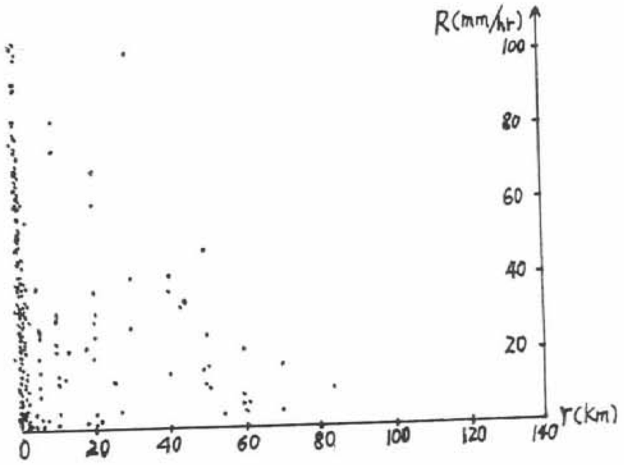


Fig.4 Horizontal distribution of rain intensity

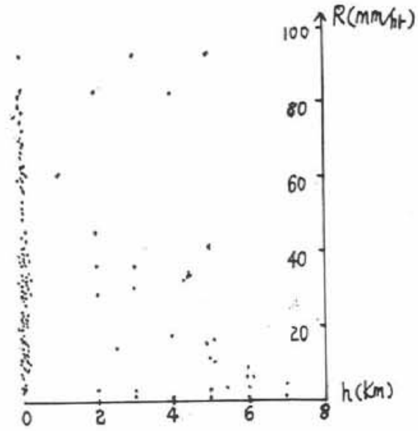


Fig.6 Vertical distribution of rain intensity

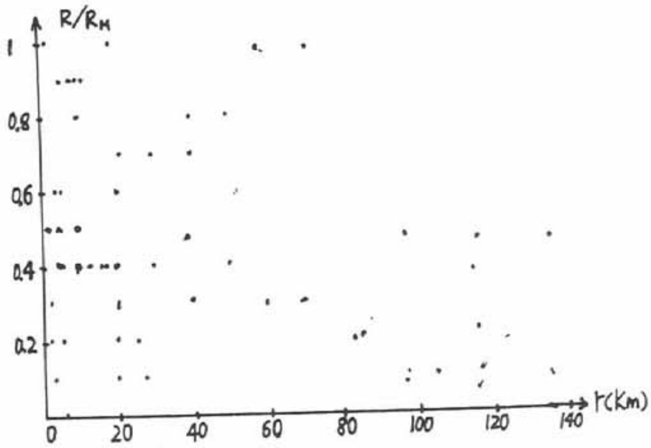


Fig.5 Horizontal distribution of normalized rain intensity

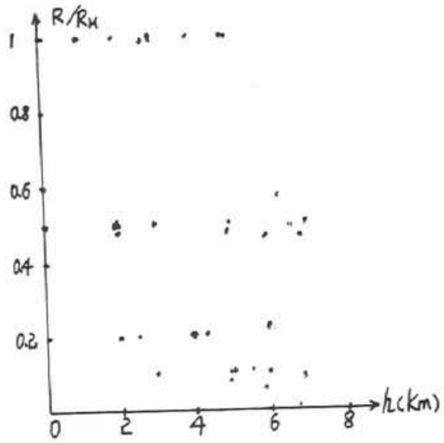


Fig.7 Vertical distribution of normalized rain intensity