RAIN DROPLET SCALE SPECTRUM & DROP SPEED DISTRIBUTION OBSERVATION AND ITS ANALYSIS WITH DIFFERENT PRECIPITATION

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Precipitation is the result of the compositive effects of cloud microphysics process, dynamics process and various factors that influence the formation and development of precipitation[1]. The research of precipitation physics characteristic and precipitation formation mechanism requires considering both the macrophysics process and microphysics process. In the term of macroscopical characters, atmospheric circulation situation, weather system, radar echo and satellite image data can be used to analyze the precipitation process; as for microcosmic detecting, the data that collected directly by Particle Measurement System (PMS) that carried on a plane can be used in the farther research in the issues of microphysics parameters' temporal and spatial changing characters[1], like the cloud and rain droplet distribution spectra and LWC in precipitation, as well as the forming mechanism of precipitation. However, plane-born detecting can not get all of the microphysical information in cloud in every precipitation because of the influences from many factors. Because that ground raindrop spectra can be obtained easily without many limits, and also the ground raindrop spectra can show some microphysical characters in cloud, the ground raindrop spectra data is usually used to analysis the microphysical characters of precipitation.

This paper presents the study of using the optics particle spectra instrument-OTT PARSIVEL to continually detect the ground raindrop spectra in Nanjing, and doing some significant analysis of them. According to the satellite image, radar sounding data, spot cloud and weather observational data, we select raindrop spectra data from cumulus cloud and stratus cloud to discuss the characters of raindrop distribution spectra and microphysical parameters' evolving characteristic and regulation in precipitations of dissimilarity cloud.

The following charts show some particle spectra pictures that we observed in the station in Nanjing.

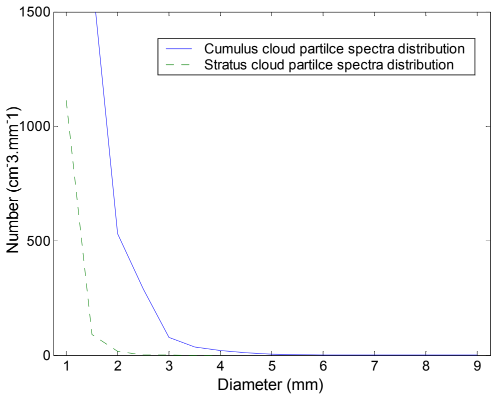
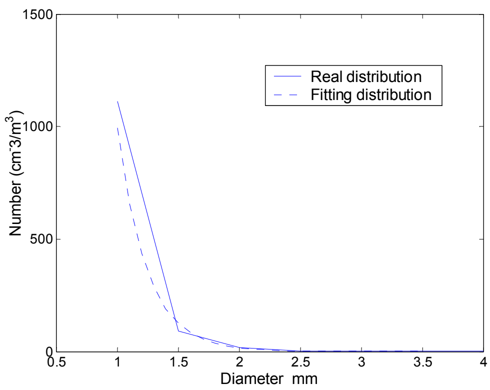
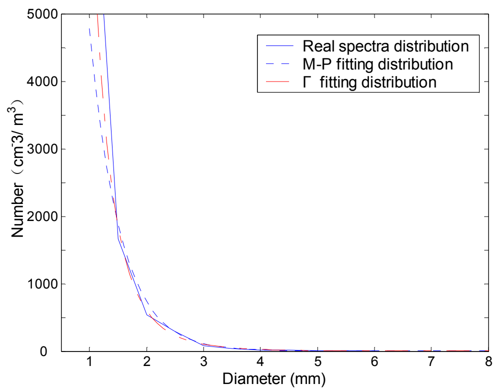


Fig1: two kind of particle spectra distribution

The particle spectra of stratus cloud precipitation is usually very narrow, and the max-diameter of the droplet is 3 mm, while the particle spectra of cumulus clouds precipitation is much broad, and the max-diameter of the droplet is 9.5 mm. The particle spectra curve of cumulus clouds precipitation is above the stratus cloud precipitation's, which means that the raindrop number density of different diameter in cumulus cloud precipitation is the largest, the stratus cloud precipitation the smallest.



a



b

Fig2: particle spectra distribution fitting of stratus cloud precipitation(a) and cumulus cloud precipitation(b)

From the charts above we can find that the particle spectra of stratus cloud precipitation fit the M-P distribute, and the fitting-curve is very close to the real particle spectra curve when the raindrop diameter is larger than 1.6 mm. On the other hand, using *M-P* distribute[3] curve to fitting the particle spectra of cumulus clouds precipitation makes big deviation, while using *Γ* distribute[4] may obviously reduce the deviation.

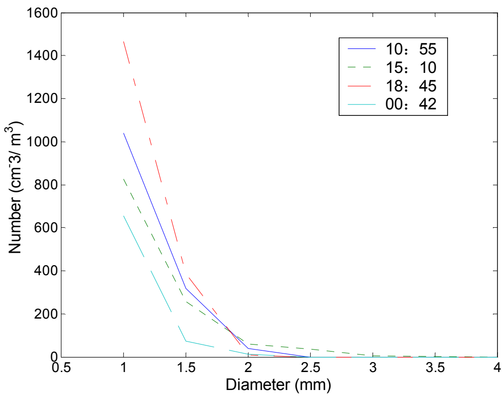


Fig3: particle spectra of different stage in one stratus cloud precipitation

Chart 3 shows some characters of precipitation at different stage in a stratus cloud precipitation. When it started to rain at 10:55, the total particle number is small, most of the droplets are little ones, the particle spectra are narrow, and the precipitation intensity is only 1.191 mm/h. When it lasted to 15:10, the intensity rose to 2.752 mm/h. There were much more large-droplet and less little ones. It might be the result of collision-coalescence between raindrops. Particle spectra became to be narrow again at 18:45, the number of little droplets increased rapidly which might because that the little ones no more depleted of collision-coalescence. As this precipitation came to over at 00:42, there is no more droplet that larger than 2 mm, the intensity was only 0.373 mm/h.

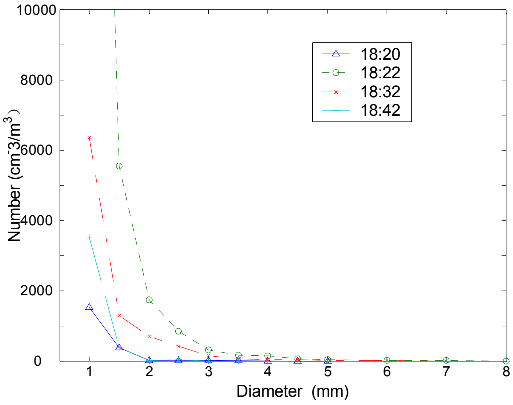


Fig4: particle spectra of different stage in one cumulus cloud precipitation

Fig4 chart shows some differences characters at different stage in a cumulus cloud precipitation. From the chart we find that at the beginning of this precipitation at 18:20, the particle number was small, about 1952/m^3 and the precipitation intensity was 3.229 mm/h. Two min later the particle number rose rapidly to 46628/m^3. The particle spectra broaden quickly, intensity rose rapidly also, and the precipitation intensity increased to 137.872 mm/h. Then the particle number decreased slowly, as well as the intensity. It was only 1.801 mm/h at 18.42 mm/h, and the precipitation finished soon.

Fig5 shows the precipitation intensity, droplet number and diameter change in by time. The intensity didn't change much, and the droplet diameter reached its max value followed by the intensity max. It is found that the particle number density, precipitation intensity and droplet mean diameter changes consistently.

From the chart below we find that the intensity of cumulus cloud precipitation changes a lot, it means that there were several precipitation centre in it, and the structure in cumulus cloud was not very uniform. When the largest-particle diameter appears the intensity also reaches its max. The instantaneous intensity max past over 162.647 mm/h, while the intensity min is only 0.013 mm/h, but the heavy instantaneous rain last a very short time. In this chart the max value of I or N value keeps consistent in the main and the max of mean diameter came out before them, that is cumulus cloud precipitation usually produce lager raindrop before the value of I or N rise.

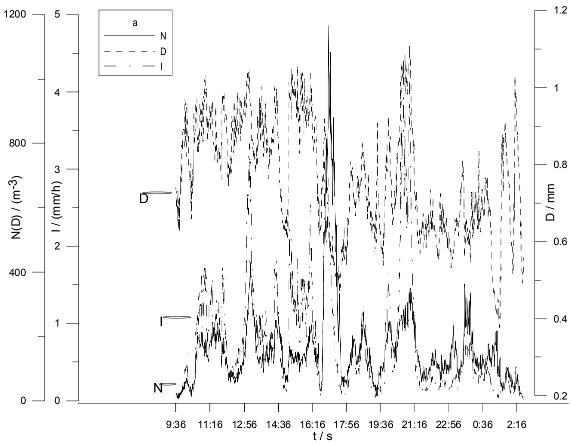


Fig5: precipitation intensity, droplet number and mean diameter in a stratus cloud precipitation change by time
(N=droplet number, D=mean diameter, I=precipitation intensity)

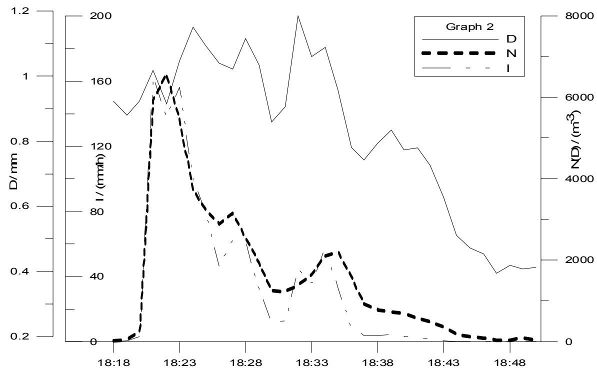


Fig6: precipitation intensity, droplet number and mean diameter in a cumulus cloud precipitation change by time
(N=droplet number, D=mean diameter, I=precipitation intensity)

From the simple analysis, we may conclude that:

1、The mean raindrop spectra of these two precipitation clouds are simply different, the particle spectra of stratus cloud precipitation is usually very narrow and the other is usually broader. The particle spectra of stratus cloud precipitation fitting the *M-P* distribution well, and using *Γ* distribution can improve the precision of curve fitting from the particle spectra of cumulus cloud precipitation.

2、The magnitude of droplet number density in stratus cloud precipitation and cumulus cloud precipitation are 10^2、$10^3/cm^3$ separately. Microphysical parameters of stratus cloud precipitation change reposefully, and the period usually last for a long time. While in cumulus cloud precipitation the microphysical parameter changes a lot by time and the precipitation always last for a short time.

3、The particle number density, precipitation intensity and droplet mean diameter changes consistently, and it is found that super raindrops always appear before the enhancement or the increase precipitation intensity.

4、There are some internal relations between the changes of number density of small raindrops, collision-coalescence and broken mechanism of large raindrops.

These studies are important for the investigations of precipitation mechanism. It may help to the work of weather modification and result evaluation in some given place, and have constructive effect to quantitative measurement of rainfall intensity by radar and provide water resources index in weather modification.

References:

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