

## Condensation Nuclei and Raindrop Spectra

DUNCAN C. BLANCHARD

*Woods Hole Oceanographic Institution*

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In a recent paper Griffith (1963) presented the hypothesis that a relation exists between the condensation nucleus concentration and the shape of the raindrop spectrum of continuous warm-front rainfall. In support of the hypothesis she presented a plot of the probable condensation nucleus count versus  $n$ . The parameter  $n$ , as stated by Griffith, "...is a function of the total number of drops and their size range. A small  $n$  results when a large total number of drops are counted, with a high percentage of them falling into the lower size intervals." Griffith feels that an inverse relation between the condensation nucleus count and  $n$  is an indication that the "...concentration of condensation nuclei affects the ultimate raindrop size distribution." On the basis of *the data that she presents and her interpretation of them*, I cannot agree with this conclusion. My arguments are presented below.

1) Griffith presents data on raindrop spectra that were obtained by a number of investigators in four different countries. How does she know that these spectra were obtained in continuous warm-front rains? In the case of the Ynyslas, Shoeburyness, and East Hill data, all obtained in England, there is no mention in Best's (1950) paper as to the cloud type. Nor is anything said about the sampling conditions encountered by Laws and Parsons (1943), who obtained their spectra in Washington, D. C. The same applies to the drop spectra reported by Marshall and Palmer (1948).

2) In her first table Griffith has classified each of the six sampling sites as either being in the country, a town, or a city. This is done in an effort to associate a surface nucleus count with each site. While the terms "country, town, or city" seem clear enough, I do not understand the criterion that is being used that enables her to class both Shoeburyness and Washington, D. C. (the site of the United States work) as towns and, therefore, to ascribe the *same* condensation nucleus count to both sites. The population of the coastal fishing village of Shoeburyness is less than 10,000 while that of Washington, D. C. is of the order (or was in 1939 when the rain samples were obtained) of half a million. Are other criteria than population being used? If so, they should be mentioned.

3) Were the raindrop spectra really obtained at the various locations given in the above-mentioned table? For example, Griffith presents the Marshall and Palmer spectra as her only example of "city" raindrop spectra. But what is the evidence that these spectra were ob-

tained in the city of Montreal? Certainly not the fact that Marshall and Palmer were at McGill University in Montreal in 1948! It seems clear from the captions in their paper that the spectra were obtained in Ottawa during the summer of 1946. And Ottawa, incidentally, has a population of less than half that of Washington, D. C. If Washington is to be classed by Griffith as a town then Ottawa must also be classed as a town. In that case Griffith's Fig. 1 would hardly suggest an inverse relation between condensation nuclei and  $n$ .

4) Assume for the moment that one were to find a good correlation in the above mentioned Fig. 1 between the condensation nucleus count in a region where rain spectra were obtained and the average  $n$  of the spectra. I would suspect that this would be fortuitous for it is *not* the condensation nucleus count at the place where the rain spectra are obtained which is of importance here. The count which *might* be of importance is that nucleus count which is representative of the air *within which the cloud forms*. As it is quite likely that the cloud that produced the rain that fell on any given spot was formed many tens of miles *upwind* of this spot, it follows that the condensation nucleus count at that spot will have no necessary correlation with that which is representative of the air within which the cloud formed.

5) There appears to be a tacit assumption on the part of Griffith that the origins of the raindrop spectra are in no way involved with the melting of snowflakes. This is unlikely. The Ottawa data, for example, probably contain many raindrop spectra that had their origin in melting snowflakes. Marshall *et al.* (1947) have found that continuous rain at Ottawa can be associated with the radar bright band, an indicator of the melting of snow to form rain. If the rain spectra have their origin in the melting of snowflakes it is hard to see how the condensation nucleus count can control the shape of the spectra. Perhaps the ice nucleus concentration should be investigated instead.

6) Data on raindrop spectra from Hawaii (Blanchard, 1953) do not agree with the Griffith hypothesis. The outstanding characteristic of the tradewind orographic showers is that many drops per cubic meter are found, with most of them at the small end of the spectrum. This, according to Griffith, would give a small  $n$  which should be associated with a high condensation nucleus concentration. But this is just what we *do not find* in Hawaii (Blanchard and Spencer, 1957). The air within which the clouds form has, on the average, a nucleus count of less than 500  $\text{cc}^{-1}$ .

I suppose one might counter this argument by saying that the Hawaiian rain spectra were not obtained during continuous warm-front rain. This is true, but I will then point to my first comment above. Are all the other spectra from warm-front rains? If not, then one must accept the Hawaiian spectra with their small  $n$  and the equally small condensation nucleus count that is associated with the tradewind air.

## REFERENCES

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