The Effect of Repeated Activation on Depositional Ice Nuclei

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ABSTRACT

Ice nuclei collected on Millipore filters were processed at −16.6°C water saturation and resulting crystals allowed to sublime. The filters were then reprocessed. Eighty-three percent of the original sites reactivated, 17% did not, but 12% of the new crystals were located on new sites.

As part of Project METROMEX The University of Chicago Cloud Physics Group is engaged in ice nucleus measurements in the St. Louis urban atmosphere using the well-known membrane filter technique. The filters (Millipore AABG 04700) are used with a special filter holder which prevents an outer annular area from being exposed in order to give an accurate indication of background counts. The filters are processed in a special chamber where the vapor is supplied by a forced ventilation system to maintain the saturation at the filter surface. A gently flowing ice-saturated (−14.9°C) air stream is moved across the filter surface at about 2 cm s^{-1}, while the filter is cooled to a top surface temperature of −16.6°C. Under these temperatures the nuclei are exposed on the filter surface to an environment where the saturation is 100% with respect to water. During the experiment no liquid water presence was noted on the filter surface. The sample preparation follows the method of Stevenson (1968).

Several filters were processed twice to see how many of the nuclei would maintain their nucleating abilities a second time. After the first activation, the filter was photographed and placed in a cold chamber filled with desiccant, where the crystals were allowed to evaporate completely without melting in a subsaturated environment, at approximately −5°C. Although 30 min was usually sufficient for this, several hours were allotted between the first and second development, to insure the complete evaporation of the ice crystals. After the second processing, the filter again was photographed and the two photographs were compared.

Table 1 shows the results of these measurements. Ice crystals formed at the same locations during first and second processings are indicated by "repeat." Nuclei which did not activate during the second processing are listed as "missing," and "new" crystals represent those in locations where crystals were not observed in the first processing.

The data indicate that at the second activation 83% of the nuclei retained their nucleating capabilities and formed crystals at the same locations as during the first activation. Seventeen percent of the original crystal locations were blank on second processing, and crystals at "new" locations made up 12% of the second total. It is possible that some of these new sites represent nuclei not activated previously as a result of their proximity to ice crystals. According to a model of Huffman and Vali (1973), vapor depletion would strongly discourage activation within a 760 μm radius of the ice crystals; one could then expect that due to this influence, some nuclei could be "hidden" and be unable to activate. It is also possible that some of the

TABLE 1. Experimental results of repeated activation of ice nuclei on membrane filters.

	Sampling area (7.55 cm²)					Control area (8.68 cm²)				
	First	Second processing				First	Second processing			
Filter	processing	Repeat	Missing	New	Total	processing	Repeat	Missing	New	Total
190 B50	89	80	9	3	83	5	4	1	2	6
190 B65	119	99	20	19	118	6	6	0	0	6
192 H20	20	15	5	3	18	1	0	1	0	0
192 C36	5	3	2	2	5	1	0	1	2	2
194 B42	31	26	5	10	36	4	4	0	6	10
194 J62	29	25	4	2	27	10	8	2	2	10
196 H8	32	20	12	7	27	3	3	0	4	7
205 J38	16	12	4	2	14	4	4	0	1	5
205 B42	122	103	19	6	109	3	2	1	1	3

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new crystals could be due to contamination and the handling of the sample, but this is not suggested by the "control" area counts.

This study shows that the majority of the ice nuclei collected on the membrane filters were reactivated during the second processing. This suggests that if an ice crystal should evaporate in natural clouds, the remaining nucleus could be reactivated, and serve again to grow a new ice crystal by vapor deposition.

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