

The Formation of Ice Crystals in the Air and Their Development

— On Small Ice Crystals (IV) —

by

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Abstract

Ice crystals in the air [1] [2] [3] (Diamond dust) are formed in the lower atmosphere. In this report we explain the atmospheric conditions under which ice crystals are formed, first from data by radio-sonde and second from weather charts.

1. The relation between ice crystals in the air and the temperature in the lower atmosphere

We analyzed the data by radio-sonde on the day when ice crystals were observed. The temperature below the altitude of 1,000 meters is related to the formation of ice crystals. The observed value by radio-sonde at Hailar ($49^{\circ}13'N$, $119^{\circ}44'E$) is shown in Figs. 1, 2 and 3; the average in January and February is shown, too. As perceived in these figures a conspicuous inversion layer exists near the ground on the day when ice crystals in the air are formed.

Ice crystals are observed, as mentioned above, mostly below $-22^{\circ}C$ near the ground and rarely above $-19^{\circ}C$.

From this fact, we can draw a conclusion that ice crystals in the air are formed below the altitude of 400 meters above the ground. Ice crystals are observed even when it is cloudless. Though sun pillars and a mock sun are seen with ice crystals, the altitude of the formation is low. When ice fog is observed, the upper base is less than 100 meters high. Ice crystals and ice fog are of the same kind. Ice crystals and snow flakes are sometimes formed in the smoke from trains. In that case their altitude is around 50 meters.

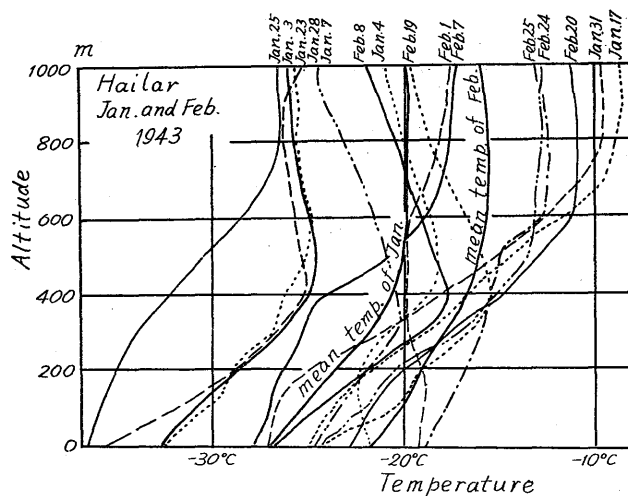


Fig. 1. State curves of 15 days at Hailar weather station. (In these days ice crystals in the air were observed at the station. Mean state curves of Jan. and Feb. 1943 are shown.)

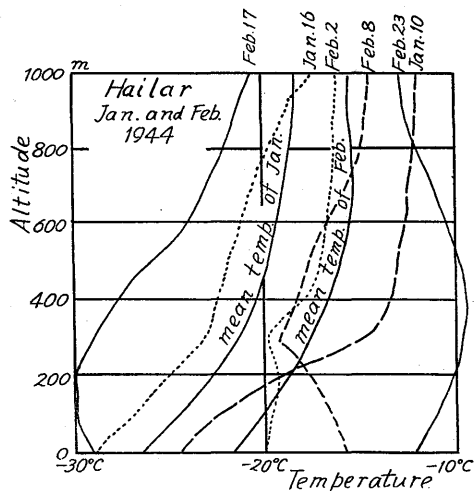


Fig. 2. State curves of 6 days at Hailar weather station. (In these days ice crystals in the air were observed. Mean state curves of Jan. and Feb. 1944 are shown.)

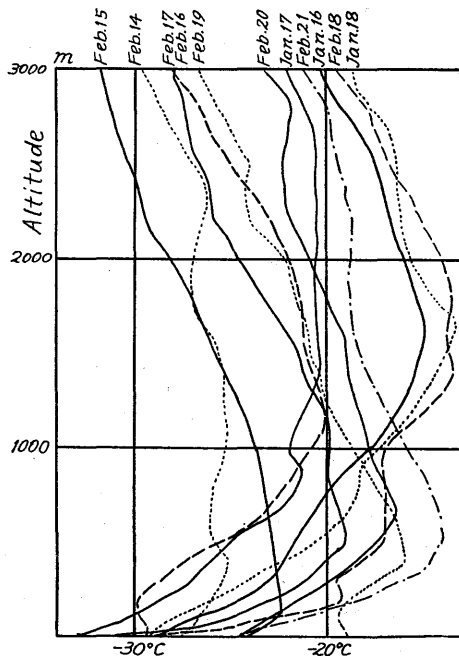


Fig. 3. State curves of 11 days at Hailar weather station. (In these days ice crystals in the air were observed.)

Fig. 3 shows that ice crystals of combined hexagonal prism with pyramid at one end fell on February 14th, and crystals of hexagonal prism and combined hexagonal prism on February 15th. These crystals were akin to show, and no conspicuous inversion existed. In other cases we observed inversion. A layer of comparatively higher temperature, which contained aqueous vapour, lay above the inversion layer.

The atmosphere is stable and calm when an inversion layer exists, and also ice crystals are observed even when it is windy.

2. Observation by weather charts

We collected the data from 13 weather stations in order to investigate the weather in which ice crystals in the air were observed in the following table.

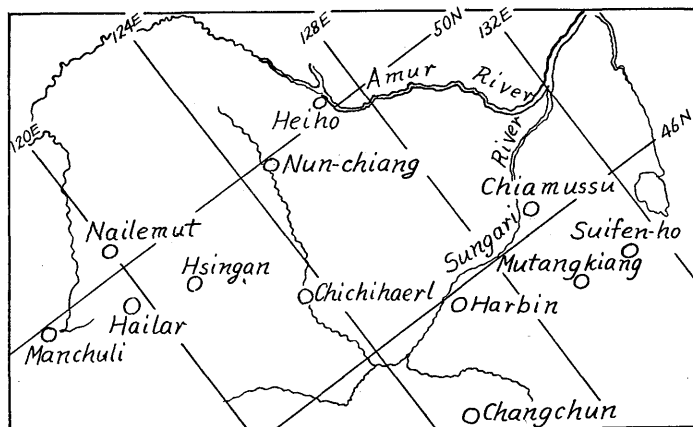


Fig. 4. Northern part of Manchoo.

Station	Manchuit	Hailar	Nailemut	Hsingan	Nan-chiang	Heiho	Harbin	Changchun	Chiamussu	Mutanbiang	Suifen-to	Tunghua	Tolun
	a p	a p	a p	a p	a p	a p	a p	a p	a p	a p	a p	a p	a p
January 1941													
1	↔	↔											
2			↔	↔									
3			↔	↔									↔
4			↔	↔						↔		↔	↔
5			↔	↔									↔
6				↔	↔								↔
7				↔	↔				↔	↔			
8				↔	↔						↔		
9	↔	↔	↔	↔	↔					↔			
10	↔	↔		↔	↔				↔	↔		↔	
11	↔		↔	↔						↔			
12		↔	↔	↔							↔	↔	
13			↔	↔								↔	
14		↔	↔	↔								↔	↔
15			↔	↔							↔	↔	↔
16			↔	↔									
17												↔	↔
18													↔
19				↔	↔								↔
20				↔	↔			↔					
21			↔	↔	↔			↔		↔			
22			↔	↔							↔		
23			↔	↔						↔			
24			↔	↔		↔					↔		
25		↔	↔	↔	↔								↔
26	↔	↔	↔	↔						↔	↔		↔
27			↔	↔									
28		↔	↔	↔		↔	↔			↔	↔		
29		↔	↔	↔			↔				↔	↔	
30		↔	↔	↔			↔	↔		↔			
31			↔	↔									↔
February 1941													
1			↔	↔								↔	↔
2			↔	↔								↔	↔
3			↔	↔								↔	↔
4		↔		↔	↔							↔	↔
5								↔	↔				
6													
7													↔
8		↔	↔	↔	↔							↔	
9		↔	↔	↔	↔								↔
10	↔	↔	↔	↔	↔								↔
11			↔	↔	↔								
12			↔	↔	↔								
13	↔	↔	↔	↔	↔								
14	↔	↔	↔	↔	↔							↔	↔
15	↔	↔	↔	↔	↔						↔		
16			↔	↔								↔	
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20		↔	↔	↔	↔						↔		
21		↔	↔	↔	↔						↔		
22			↔	↔									↔
23											↔		
24	↔										↔		
25											↔		
26			↔	↔	↔						↔		
27													
28			↔	↔							↔		

The weather stations are shown in Fig. 4. There were many observations in Nailemut and Hsingan but a few in Changchun and Chiamusu. Ice crystals in the air were observed periodically as given in Table 1. The following cases are the weather types in which ice crystals are *not* observed.

- a) When a Manchurian cyclone is passing through.
- b) In the rear of a migratory anti-cyclone.
- c) When an anti-cyclone overlies the southern part.

On the contrary, ice crystals are frequently observed in the other weather types: Siberian anticyclone, Japan Sea cyclone, and Manchurian anti-cyclone and so on. And the spot where ice crystals are observed is moving from west to east.

3. The formation of ice crystals and their development.

According to the foregoing explanation, the conditions under which ice crystals are formed are as follows :

- a) When the temperature is below -19°C .
- b) When an inversion layer exists in the lower atmosphere.
- c) When the atmosphere contains considerable amount of moisture.
- d) According to certain topographic conditions.

Ice crystals are, it may be thought, the incipient stage in the process of snow crystal formation, but it is not confirmed in detail. And they are also formed under just the same atmospheric condition as cirrus cloud.

4. Freezing nuclei

Freezing nuclei are necessary as centers of ice crystals. The research concerning them, however, will not be accomplished without electron microscopical observation. The larger ones of artificial smoke particles are not likely to act as the freezing nuclei of ice crystals in the air, since the larger ones come down as they are.

References

- [1] Iroo, K, 1951: Phenomena of Ice Crystals in the Air. Pap. Met. Geophy., 2, p. 67.
- [2] " 1953: Forms of Ice Crystals in the Air. Pap. Met. Geophy., 3, p. 207.
- [3] " 1953: Size, Mass and Some Other Properties of Ice Crystals in the Air. Pap. Met. Geophy., 3, p. 297.