OBSERVATIONS ON THE SHAPES OF SNOW CRYSTALS IN THE SUMMER SEASON IN MIZUHO PLATEAU, ANTARCTICA

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Abstract: Snow crystal observations in Mizuho Plateau, Antarctica, during the 1981 austral summer revealed the following: The shapes of single bullet and combination of bullets were frequently observed, and because of their large mass, these crystals are considered to be the major contributor to the snow accumulation in this area.

Long solid column crystals were found within the surface air temperature range from −42°C to −56°C, when the air temperature at the inversion top was from −38°C to −43°C. The mean length of *c*-axis of these crystals was 287 μm and the maximum length was 1.2 mm. The mean value of the axial ratio (*c*/*a*) of the crystals was 18 and the maximum value was 70.

Only a few scalene hexagonal, triangular and square form crystals were detected in the inland.

1. Introduction

Observations of snow crystals have been carried out at a few places in Antarctica (SHIMIZU, 1963; KIKUCHI, 1969, 1970; KIKUCHI and YANAI, 1971; KIKUCHI and HOGAN, 1976a, b; OHTAKE and INOUE, 1980).

As one of the activities of POLEX-South (Polar Experiment in the Antarctic) (KUSUNOKI, 1981), oversnow traverses in Mizuho Plateau in 1981 were conducted by JARE-22 (the 22nd Japanese Antarctic Research Expedition) for the observations of surface and upper-air weather, and related glaciological phenomena. This paper describes the shapes of snow crystals observed by means of replication method during the traverses in the summer season.

2. Observation

Figure 1 shows the positions where the observations of snow crystals were made during the austral summer of January–February, and from September to December in 1981. Station V142 (72°32′18″S, 51°57′21″E) at the farthest inland point in Fig. 1 is located on the highland (3076 m above sea level) about 600 km from the coast.

Snow crystals were collected by sedimentation and were replicated on glass slides coated with 0.5–1% Formvar solution. The shapes of snow and ice crystals on these glass slides were examined by means of photomicrographs. Many of old round particles of drifting snow were seen, but only distinct crystals were picked up here.

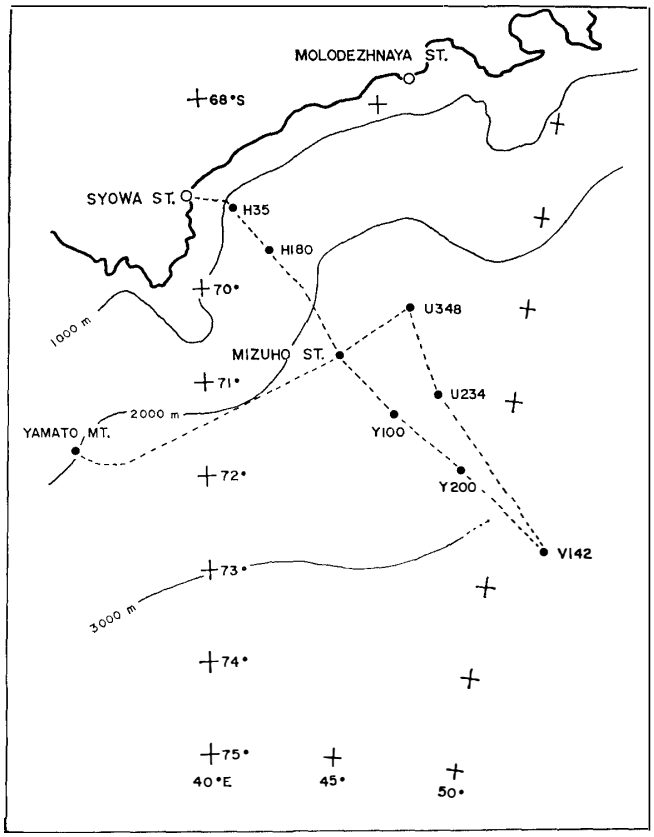


Fig. 1. Observation positions of snow crystals in Mizuho Plateau (solid circles show the positions).

3. Shapes of Snow Crystals

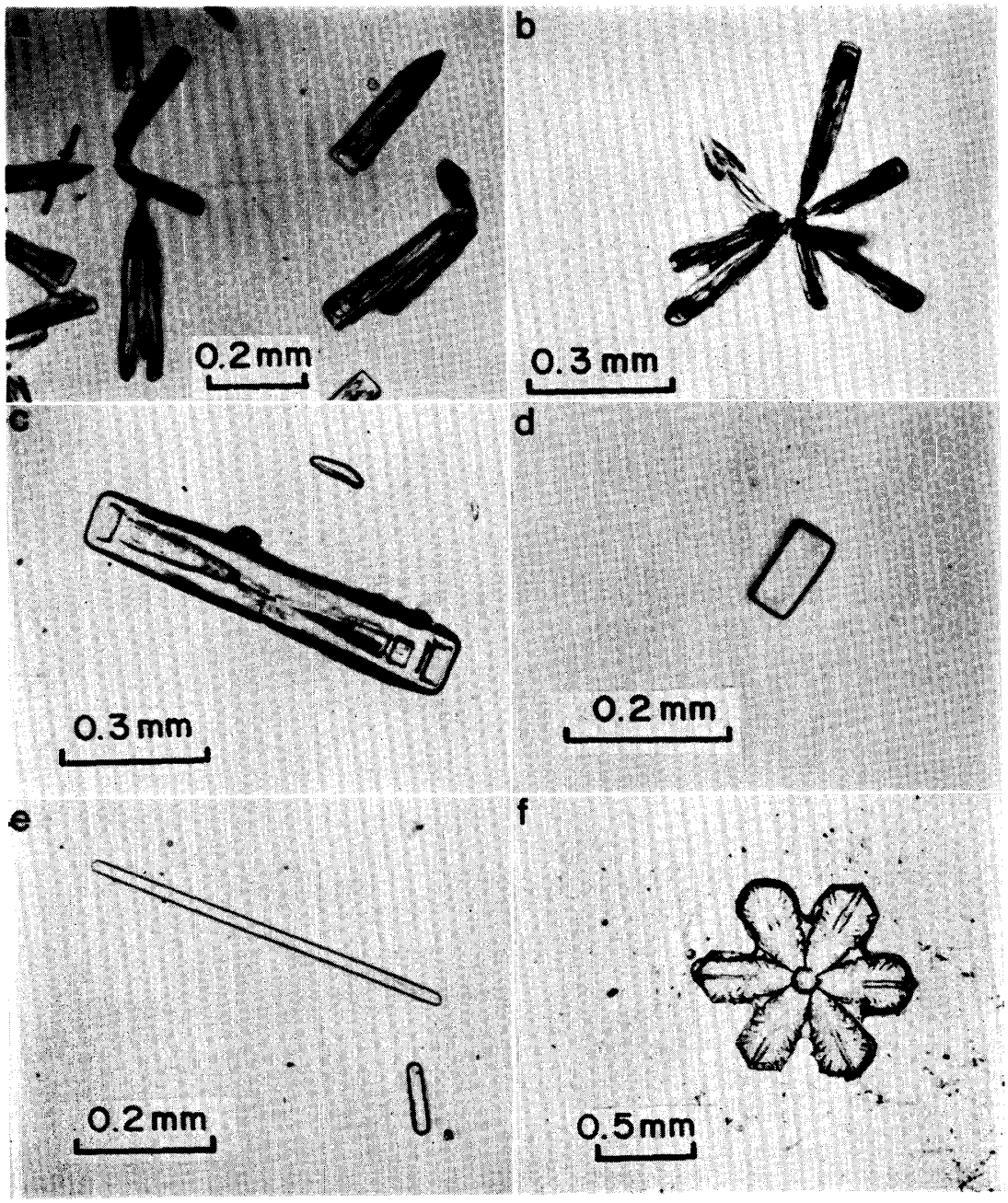
The result of observations is shown in Table 1. The snow crystals are divided

Table 1. Data of snow crystals collected in Mizuho Plateau.

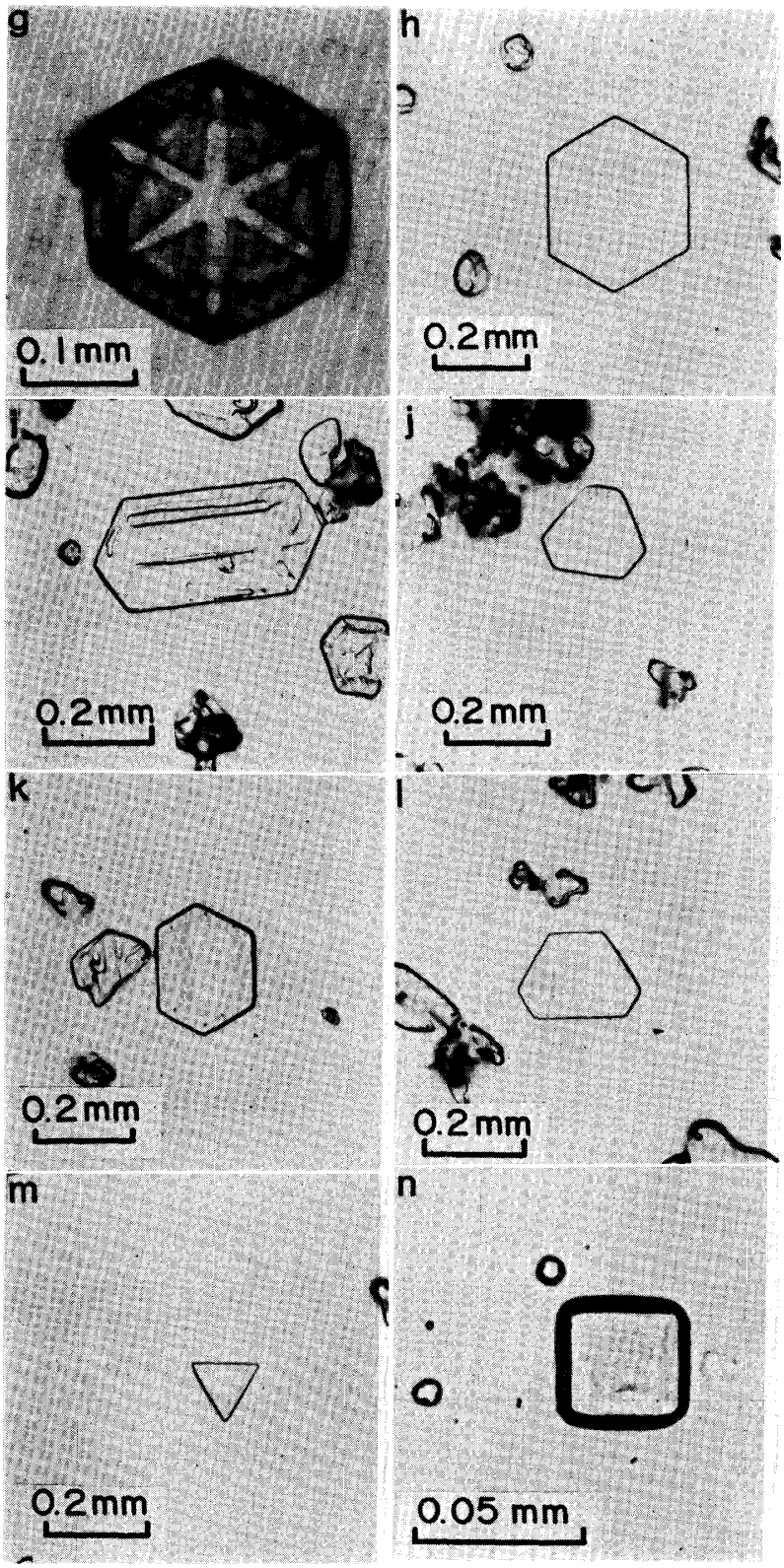
Station	Observed date	Number of sampling time	Number of observed time of each crystal (1)	(2)	(3)	(4)	(5)	(6)
H35	Jan. 8, 1981	1					1	
H180	Jan. 9, 1981	1					1	2
Mizuho St.	Jan. 16, 1981	1					1	
	Feb. 26, 1981	1	1					
	Nov. 21–Dec. 4, 1981	9	5	2	4		5	4
Y100	Sep. 30, 1981	5	5	5			2	2
	Oct. 3, 1981	1	1		1		1	
Y200	Oct. 8, 1981	1	1					
V142	Oct. 13–29, 1981	51	29	31	25	22	13	3
U234	Nov. 7–11, 1981	9	7	1	3		7	
U348	Nov. 15–19, 1981	6	3	2	3		5	1
Yamato Mt.	Dec. 14–19, 1981	7	1		2		7	
Total		93	53	41	38	22	43	12

Note: (1): single bullet, (2): combination of bullets (or columns), (3): single column, (4): long solid column, (5): hexagonal plate and (6): others.

into six groups. The total number of sampling was 93. As seen in Table 1, single bullet, combination of bullets (or columns), single column and hexagonal plate were frequently observed. The dominant shapes of crystals were single bullet (Fig. 2a) and combination of bullets (Fig. 2b) (or columns). In view of their large number and large mass, it can be said that these crystals are the major contributor to the snow accumulation on the plateau (SATOW *et al.*, 1977). It can be considered that most of single bullets are a result of disintegration of the combination of bullets during their descent, judging from the high frequency of simultaneous occurrence of the both



Figs. 2 (a–f). Typical shapes of snow crystals observed during the 1981 austral summer in Mizuho Plateau (to be continued).



Figs. 2 (g–n). Typical shapes of snow crystals observed during the 1981 austral summer in Mizuno Plateau.

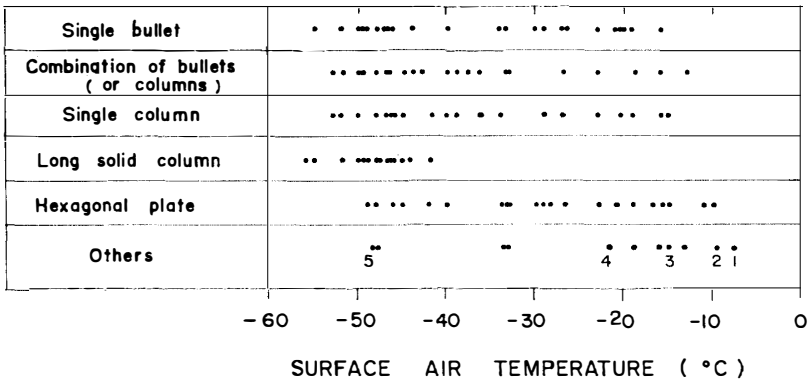


Fig. 3. Description of snow crystals with the surface air temperature (in the lowest column, 1: crystal with sectorlike branches, 2: ordinary dendritic crystal, 3: plate with sectorlike extensions, 4: triangular crystal, 5: square form crystal).

crystals and from the report by KIKUCHI (1968). Single column crystals (Figs. 2c and 2d) are also observed frequently and have an extended range of size. It was more common to find minute hexagonal plate crystals (Figs. 2g and 2h) throughout the observation area. A few scalene hexagonal plates (Figs. 2i–2l) were once discovered at St. U348. At Syowa Station near the sea, crystal shapes frequently observed in falling snow were also bullet, combination of bullets and column (KIKUCHI, 1969).

In Fig. 3, all shapes are plotted against the surface air temperature when they were observed. As for the crystals except for long solid column, the surface air temperature is in a wide range, as seen in Fig. 3. Long solid column crystals (Fig. 2e) were found at St. V142. Although the discussion by the surface air temperature only is dangerous, it is noted in Fig. 3 that long solid columns are concentrically found within the temperature between $-42°$ and $-56°C$, when the air temperature at the inversion top was from $-38°$ to $-43°C$ according to radiosonde observations at St. V142. On the other hand, SHIMIZU (1963) reported that a "long prism" snow crystal was discovered within the temperature range from $-30°$ to $-45°C$ at Bird Station. According to the observations at the South Pole Station by OHTAKE and INOUE (1980), it was reported that pencil-shaped and triangular crystals formed near the surface, under clear skies and during extremely low temperatures, $-50°C$ or below, at the lowest part of the atmosphere.

Others in Table 1 and Fig. 3 contain crystal with sectorlike branches (Fig. 2f) at St. H180, ordinary dendritic crystal at St. H180, plate with sectorlike extensions at Mizuho Station, triangular crystal (Fig. 2m) at St. U348, square form crystal (Fig. 2n) at St. V142, "peculiar shaped" snow crystal (KIKUCHI, 1970) and crossed plates, but these crystals are very few in the present ovservations.

OHTAKE and INOUE (1980) reported that triangular crystals and pencil crystals occurred under similar conditions. In the present case, triangular crystals are not found simultaneously with long solid columns, and are discovered at the surface air temperature of $-23°C$ (see Fig. 3).

As expected, large snow crystals of dendritic shape, crystal with sectorlike branches and plate with sectorlike extensions were observed at much higher temperature, as seen in Fig. 3.

4. Length of *c*-axis and Axial Ratio (*c*/*a*) of Long Solid Columns

Long solid columns were found at the rate of 43% among 51 sampling times at St. V142 in October 1981 (Table 1). The total number of these crystals examined on the glass slide was 40. The frequency of the length of *c*-axis and the axial ratio (*c*/*a*) of the crystals are shown in Tables 2 and 3, respectively. The mean length of *c*-axis and the mean axial ratio (*c*/*a*) were 287 μm and 18, respectively. The maximum values of the length of *c*-axis and the axial ratio were 1.2 mm and 70, respectively. On the other hand, the crystal with a large value of axial ratio of 200 was observed at the South Pole (OHTAKE and INOUE, 1980).

Table 2. Number of long solid columns with the length of c-axis.

Length of *c*-axis	– 50 μm	– 100 μm	– 200 μm	– 500 μm	– 1 mm	1 mm –	Total
Number	0	4	14	15	6	1	40

Table 3. Number of long solid columns with the axial ratio (c/a).

Axial ratio (*c*/*a*)	5 – 10	– 15	– 20	– 25	– 30	– 35	– 50	50 –	Total
Number	8	14	5	7	2	3	0	1	40

5. Concluding Remarks

Observations on the shapes of snow crystals, carried out in the 1981 austral summer season in Mizuho Plateau, are summarized below.

Near the coast where the temperature is warmer, large snow crystals were observed, their shapes being dendritic crystal, plate with sectorlike extensions, and crystal with sectorlike branches. Only a few scalene hexagonal, triangle-shaped and square form crystals were detected in the inland. Throughout the present area, single bullet and combination of bullets are the most common crystals and they substantially contribute to snow accumulation because of their large number and mass. But the hexagonal plates which are also observed frequently cannot be the major contributor to the snow accumulation because of their small mass.

Long solid columns were observed at St. V142 within the surface air temperature range from $-42°$ to $-56°$C, under the inversion layers with the maximum temperature from $-38°$ to $-43°$C. The mean length of *c*-axis and the mean axial ratio (*c*/*a*) of these crystals were 287 μm and 18, and the maximum values were 1.2 mm and 70, respectively.

Acknowledgments

The author wishes to express his sincere thanks to the members of the wintering party of JARE-22, specially the traverse party led by Mr. J. INOUE, a member of POLEX-South, for their pleasant co-operation.

References

KIKUCHI, K. (1968): On snow crystals of bullet type. J. Meteorol. Soc. Jpn., **46**, 128–132.

KIKUCHI, K. (1969): Unknown and peculiar shapes of snow crystals observed at Syowa Station, Antarctica. J. Fac. Sci., Hokkaido Univ., Ser. 7, **3**, 99–116.

KIKUCHI, K. (1970): Peculiar shapes of solid precipitation observed at Syowa Station, Antarctica. J. Meteorol. Soc. Jpn., **48**, 243–249.

KIKUCHI, K. and HOGAN, A. W. (1976a): Properties of diamond dust type ice crystals observed in summer season at Amundsen-Scott South Pole Station, Antarctica. J. Meteorol. Soc. Jpn., **57**, 180–190.

KIKUCHI, K. and HOGAN, A. W. (1976b): Snow crystal observations in summer season at Amundsen-Scott South Pole Station, Antarctica. J. Fac. Sci., Hokkaido Univ., Ser. 7, **5**, 1–20.

KIKUCHI, K. and YANAI, K. (1971): Observation on the shapes of snow crystals in the South Pole region in the summer. Nankyoku Shiryô (Antarct. Rec.), **41**, 34–41.

KUSUNOKI, K. (1981): Japanese Polar Experiment (POLEX) in the Antarctic in 1978–1982. Mem. Natl Inst. Polar Res., Spec. Issue, **19**, 1–7.

OHTAKE, T. and INOUE, M. (1980): Formation mechanism of ice crystal precipitation in the antarctic atmosphere. Proc. Int. Conf. Cloud Physics, Clerment-Ferrand, France, July 1980, 221–224.

SATOW, K., HIGUCHI, K. and KATO, K. (1977): Observations of snow crystals and $\delta^{18}O$ of surface snow at Mizuho Plateau, East Antarctica. Collection of contributions presented at CPM sessions, Joint JAGA/IAMAP Assembly, Seattle, 55–59.

SHIMIZU, H. (1963): "Long prism" crystals observed in precipitation in Antarctica. J. Meteorol. Soc. Jpn., **41**, 305–307.

(*Received April 11, 1983; Revised manuscript received June 13, 1983*)