# *Observation of Giant Sea-Salt Particles from Syowa Station to the South Pole*

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It is of great interest to obtain information on the number concentration $\theta$ (per litre) of *giant sea-salt particles*, one of the most typical condensation nuclei, on the Antarctic Continent. This is an important parameter for the meteorology and geochemistry of the Antarctic Continent, which may provide information on the general circulation of the atmosphere and the chloride content in the ice field, and so on. A few observations of $\theta$ have been made over the oceans and on the continents, but no observation has yet been carried out in Antarctica and other polar regions.

Recently, TOBA (1965b) theoretically treated the vertical distribution of the giant sea-salt particles in the sea-air transitional layer. He estimated the rate of production and the distribution of particles from the above theory, and drew maps of the estimated distribution of $\theta$ over the oceans in four seasons (TOBA, 1966). However, he was not able to draw the distribution curves on the maps of the frozen sea in the area south of 55°S, due to the limitations arising from the nature of his theory.

One of the authors (KIKUCHI) made the observation of the giant sea-salt particles aboard the icebreaker FUJI over the oceans from Tokyo to Syowa Station via Fremantle, Western Australia (KIKUCHI and YAURA, 1970a). The observation values of $\theta$ showed satisfactory agreement with the theoretical values (TOBA, 1966). The mean value of $\theta$ was 1500 $l^{-1}$ in the North Pacific Ocean from Tokyo to the equator, 1200 $l^{-1}$ near the equator, and 900 $l^{-1}$ in the Indian Ocean from the equator to Fremantle. The value was relatively low, 400 $l^{-1}$ at Fremantle Sea Port located at the mouth of Swan River. From Fremantle to the ice edge $\theta$ was extremely high, 2100 $l^{-1}$, and in the regions of very close pack ice and icebergs, $\theta$ was 200 $l^{-1}$. This value was the first observed one in the region south of 55°S.

The observation was made once a day from the beginning of February 1968 to the end of January 1969 at Syowa Station (69°00′S, 39°35′E). The maximum of the

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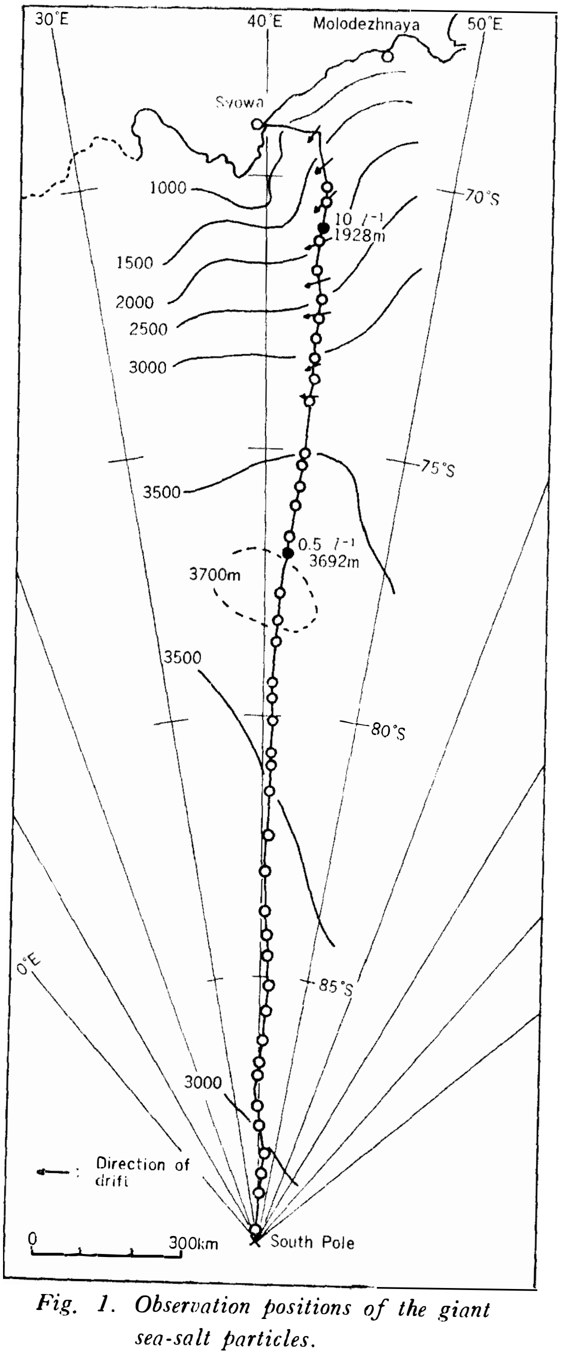


*Fig. 1. Observation positions of the giant sea-salt particles.*

monthly mean value, 100 $l^{-1}$ was observed in September. As a general tendency, the monthly mean of $\theta$ was found to vary in parallel with the number of storm days (>15 m·s$^{-1}$) per month (KIKUCHI and YAURA, 1970b).

It was planned to observe $\theta$ on the Antarctic Continent on the occasion of the JARE South Pole Traverse, and compare the results with the above described values. A hand-operated impactor (TOBA and TANAKA, 1967) was used. 30–40 $l$ of air was sampled on FARLOW's chloride reagent gelatin film (FARLOW, 1954; 1957), which was cut into pieces, each approximately 1 cm$^2$. The reagent film was processed in the caboose: water vapor was supplied in order to fully develop the white halos of silver chloride; after this, the film was coated with about 2% collodion solution to prevent further contamination by other salt particles.

The air sampling was started at St. 122 on October 9, 1968, and the sampling was carried out 42 times on the roof of a caboose on the way to the South Pole. The observational result is shown in Fig. 1. The sampling positions are shown by blank and solid circles connected with a solid line along 40°–43°E. Two solid circles show the positions at which the giant sea-salt particles were counted on the film. At St. 170 around 71°S, about 1900m above the sea, $\theta$ was 10 $l^{-1}$; at St. 530 around 77°S, about 3700m above the sea, $\theta$ was 0.5 $l^{-1}$.

The first value, 10 $l^{-1}$, seems reasonable, if one considers that the monthly mean value in November at Syowa Station was 3 $l^{-1}$ and that, judging from the direction of drift of snow, the preveiling wind near St. 170 was coming from the ocean.

Next, let us discuss the second value, 0.5 $l^{-1}$. TOBA (1965a) proposed an approximate formula for the vertical distribution of $\theta$ in the inland far from the ocean based on the results of vertical distribution observation by BYERS *et al.* (1957).

$$\theta=\gamma_0\left[\frac{1}{\lambda u+w}+\frac{1}{w}\left\{1-\exp\left(-\frac{w}{D}Z\right)\right\}\right]\exp\left(-\frac{w}{D}Z\right).$$

Here $\theta$ is the number concentration of particles, $\gamma_0$, the flux, positive downward, of particles; $\lambda$, the efficiency of impaction by ground obstacles; $u$, the uniform horizontal wind velocity; $w$, the terminal velocity of particles; $D$, the eddy diffusivity; and $Z$, the vertical coordinate positive upward. The above formula agrees with the observation result if following values are assumed; $\lambda=0.08$, $u=5\ \mathrm{m\cdot s^{-1}}$, $w=1.0\ \mathrm{cm\cdot s^{-1}}$, and $D=2\times10^5\mathrm{cm^2\cdot s^{-1}}$ (TOBA, 1965a).

Although the value of $\lambda$ is very difficult to estimate because it varies with the surface conditions of the ground, the value of $\theta$ for 3700 m is $0.6\ l^{-1}$ when the above reasonable assumed values were used for the calculation. This value agrees with the observation one.

The reason why the no particles were observed between Sts. 170 and 530 may be as follows: no particles were in the observation positions or the number of the particles was very small. When $\theta$ was very small, white halos on the gelatin film due to salt particles were difficult to distinguish from the white spots in the background. Hence, the authors did not count the particles if the number of white halos was too small (equivalent to less than 5 particles per 40 litres) and did not concentrate on an impact position.

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