跳躍回数に着目した吹雪粒子の電荷測定

大宮哲[1]、佐藤篤司[2]
[1] *北海道大学 環境科学院*
[2] *防災科学技術研究所 雪氷防災研究センター*

Measurement of electrostatic charge of blowing snow particles focusing on collision frequency to the snow surface

Satoshi OMIYA[1] and Atsushi SATO[2]
[1] *Graduate School of Environmental Science, Hokkaido University*
[2] *Snow and Ice Research Center, NIED*

1. Introduction

Blowing snow particles are known to have an electrostatic charge. The charge is thought to be a factor of electrical noise in electronic signals such as in polar region. Electric force on the particles change own trajectory, and it should affect the redistribution of snow cover. In addition, this electrostatic charge may be a contributing factor in the formation of snow drifts and snow cornices (Fig.1). These formations may cause natural disaster such as an avalanche, and obstruct transportation during winter season. Therefore, charging phenomenon of the blowing snow particles is an important issue in terms of not only precise understanding of the blowing snow particle motion but disaster prevention.

The primary factor of charge accumulation to the blowing snow particles is thought to be due to repetition of frictional collisions with the snow surface. In previous measurements of electrostatic charge of blowing snow particles, charge-to-mass ratios measured in the field were approximately –50 to –10 μC/kg (Wishart, 1968 and Latham and Mason, 1970), and in the wind tunnel was approximately –0.8 to –0.1 μC/kg (Maeno et al., 1985). While there were qualitatively consistent in sign, negative, there were huge gaps quantitatively between them. One reason of those gaps is speculated to be due to differences in fetch. In other words, the difference of the collision frequency of snow particles to the snow surface has caused the gaps. But it is merely a suggestion and that has not been confirmed yet. The purpose of this experiment is to measure the charge of blowing snow particles focusing on the collision frequency and clarify the relationship between them.

Fig.1 Snow cornice

2. Method

Experiments were carried out in the cryogenic wind tunnel of Snow and Ice Research Center, NIED (Fig.2). In this experiment, blowing snow was created using automatic particle seeder (Fig.4), over the hard snow surface, which prevents the erosion and the generation of new snow particles from the surface. A Faraday cage, an electrometer (Fig.3) and an electric balance were used to measure the charge-to-mass ratios of blowing snow particles.

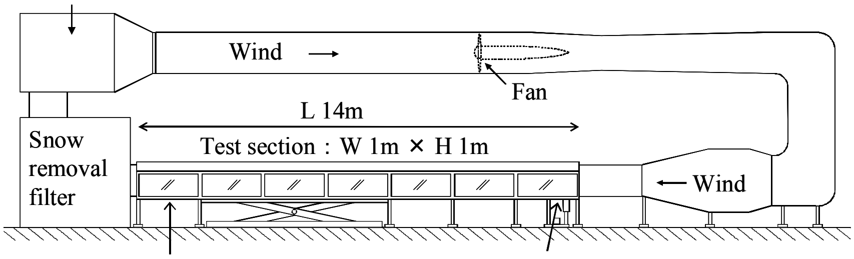


Fig.2 Schematic of wind tunnel

Fig.3 Faraday cage (left)
Electrometer (right).

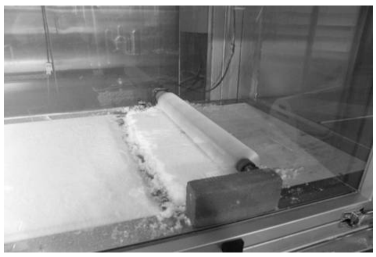


Fig.4 Automatic particle seeder

3. Experimental condition

The experimental conditions are listed below,

- Fetch・・・・12 m
- Wind velocity・・・・4.5 to 7m/s
- Air temperature・・・・-20 to -10℃
- Hard snow surface
- Particle shapes・・・・2 types
  (Spherical and dendritical particles shown in Fig.5)

The collision frequency of snow particle was controlled by changing the wind velocity under the fixed fetch. Here, following experimental equation obtained by Kosugi et al. (2004) was used.

$$L = 0.31U - 1.19$$

(L: saltation length (m)
U: wind velocity (m/s))

3. Results

Measured charge-to-mass ratio Q against the n: collision frequency of snow particles to the snow surface is shown in Fig. 6 (case of the spherical particles). Fig.7 is enlarged view of dashed portion of Fig.6. These results show that repeated collision of blowing snow particle causes negative charge accumulation to them. A similar tendency was confirmed also in the case of dendritical particles. As a result, it is suggested that the difference of the fetch is one of the factors of the gaps between the field measurement values and the wind tunnel ones.

4. Discussion

Relationship between the absolute value of variation of Q and the collision frequency n are shown in Fig.8, for a case of spherical particles and –20℃. Assuming a logarithmic relationship between them, Q will reach roughly the similar value which was obtained in the fields with several hundreds collisions. For instance, fetch is needed approximately 200 times collisions for blowing snow particles to gain –30 μC/kg: median value observed in the fields. In case of wind velocity of 7m/s and 6m/s, it is equivalent to the fetch of 196 m and 134m, respectively.

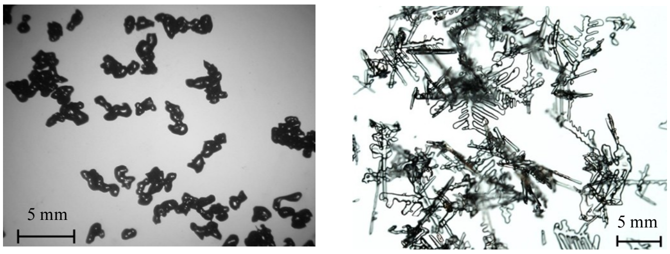
References

Kosugi et al.: Dependence of drifting snow saltation length on snow surface hardness. Cold Reg. Sci. Technol., 39, 133-139, 2004.

Latham and Montagne: The possible importance of electrical forces in the development of snow cornices. Journal of Glaciology, 9, 57, 375-384, 1970.

Maeno et al.: Wind-tunnel experiment on blowing snow. Ann. Glaciol., 6, 63-67, 1985.

Wishart: Electrification of Antarctic drifting snow. Proc. Int. Symp. Antarctic Glaciological Exploration, Hanover, 316-324, 1968.



Spherical particle Dendritical particle

Fig.5 Snow particles used in this experiment

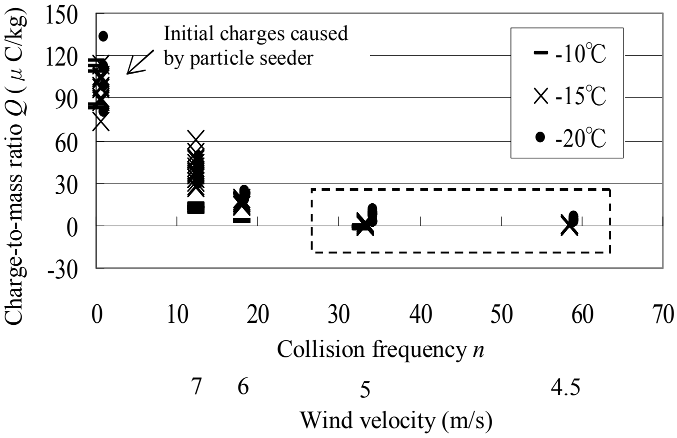


Fig.6 Charge-to-mass ratio Q against the collision frequency n. (Case of spherical particles)

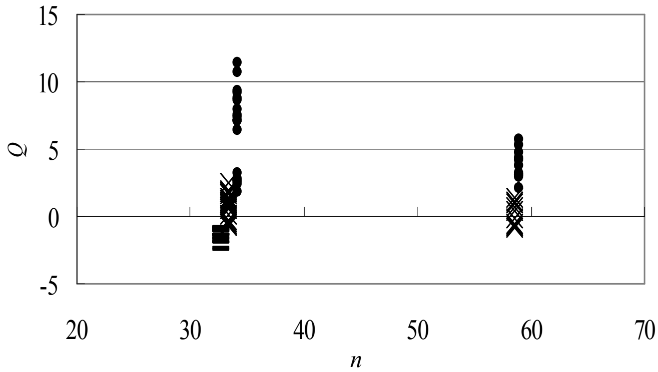


Fig.7 Enlarged view of dashed portion of Fig.6.

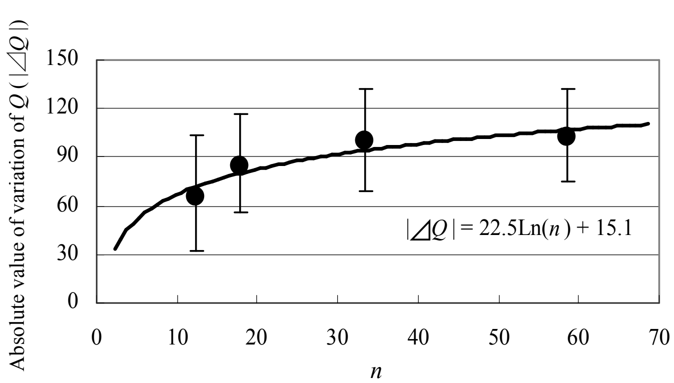


Fig.8 Absolute value of variation of Q against n. (Case of spherical particles, −20℃)