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<th>Measurement of electrostatic charge of blowing snow particles in a wind tunnel focusing on collision frequency to the snow surface</th>
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Note: "統合的理解賞"受賞 translates to "Awards for Understanding".
1. Introduction

Blowing snow particles are known to have an electrostatic charge. This charge may be a contributing factor in the formation of snow drifts and snow cornices (Fig.1) and changing of the trajectory of blowing snow particles. These formations and phenomena can cause natural disaster such as an avalanche and a visibility deterioration (Fig.2).

There are some experimental reports on charge-to-mass ratios of blowing snow particles in the field and the wind tunnel. There are qualitatively consistent in sign, negative. But ....

Wind tunnel experiment

\[ -0.8 \sim -0.1 \text{ (μC/kg)} \]

Huge gap !

Field observation

\[ -50 \sim -10 \text{ (μC/kg)} \]

Due to difference of fetch?

in other words

\[ \text{Difference of collision frequency to the snow surface} \]

Purpose: To clarify the correlation between the collision frequency of particles to the snow surface and the negative charge accumulation to them.

2. Method

Experiments were conducted in a cryogenic wind tunnel of the Snow and Ice Research Center, NIED (Fig.3). In this experiment, we used Electrometer, Faraday-Cage and Electronic balance to measure the charge-to-mass ratios of blowing snow particles.

3. Experimental condition

- Fetch : 12 m
- Wind velocity : 4.5 ~ 7 m/s
- Air temperature : \(-20 \sim -10\)℃
- Hard snow surface
  (No particle eject from the surface)
- Spherical particle was used (Fig.4)

The collision frequency \( n \) was converted from the wind velocity using the experimental equation (Kosugi et al., 2004), as below.

\[ n = 12/(0.31U - 1.19) \]

Fetch of this experiment Wind velocity (m/s)

4. Results and Discussion

Charge-to-mass ratios \( Q \) against the collision frequency \( n \) is shown in Fig.5. The result shows that repeated collision of blowing snow particles causes negative charge accumulation to them.

\[ |\Delta Q| = 22.5\ln(n) + 15.1 \]

Enlarged view

Assuming a logarithmic relationship between the \(|\Delta Q|\): variation of \( Q \), and \( n \) (Fig.6), \( Q \) will reach roughly the same value which was obtained in the field with several hundreds collisions. For instance, \( n \) is needed approximately 200 times collisions for blowing snow particles to gain \(-30 \text{ μC/kg}\).

Fig. 6 Absolute value of the variation of \(|\Delta Q|\) against \( n \)

\[ \text{(Case of } -20\text{℃}) \]

\[ |\Delta Q| = 22.5\ln(n) + 15.1 \]

Conversion to fetch

7 m/s \(-\)196 m
6 m/s \(-\)134 m
5 m/s \(-\)72 m
4.5 m/s \(-\)41 m

5. Conclusion

Blowing snow particles accumulates negative charges with increase of collisions to the snow surface. It is suggested that the difference of the fetch is one of factors of the gaps between the field data and the wind tunnel ones.

Reference