TOWARD THE DEVELOPMENT OF AREAL WARNING SYSTEM OF BLOWING SNOW

by

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ABSTRACT

1. Introduction

With rapid progress of motorization, automobile transportation has come into wide use in snowy regions in Japan. But such automobile transportation sometimes suffers from the snow disaster of blowing snow especially in the northern part of Japan. To reach a solution of this snow problem, the NIED undertook a joint study of blowing snow at the Tsugaru Plain and the possibility of areal prediction of blowing snow was made clear (Higashiura *et al.*, 1993). On the basis of this result, a new project of an areal warning system of blowing snow was planned.

2. Research Plan

A five-year project was started in April of the 1993 fiscal year as the NIED's joint research study. This research intends to develop an areal warning system of blowing snow, including the prediction of the snow cloud(cumulus) motion (Fig.1).

The main subjects of this project are as follows ;

(1) Development of a dual-polarization Doppler radar and the techniques of dual Doppler radar observation (1993 -1997);
(2) Clarification of temporal and spatial variations of blowing snow(1993-1997);
(3) Development of areal warning system of blowing snow(1995-1997).

Observations are conducted at the Ishikari Plain in Hokkaido, Japan(Fig.2) where heavy blowing snow occurs every winter. The detailed structures of blowing snow near the ground are observed at the Ishikari observation site by use of snow particle counters (Sato *et al.*, 1993), visibility meter and other meteorological instruments. Areal distribution of blowing snow is measured by SPC systems (SPC-7) and their data is telemetered to the Ishikari observation site. Simultaneous observation of the cumulus structure together with the associated strong wind in the lower atmosphere are carried out with the two Doppler radars (dual observation).

To prevent the disasters caused by blowing snow such as poor visibility and abnormal snow drift, the prediction technology will be studied in this project. The movement of the gust front and the change of cumulus structure are important processes for the prediction of blowing snow.

3. New instruments prepared in the project

(1) The new SPC system (SPC-S7) has been developed by Kimura, which has a wind vane and can measure the numbers of blowing snow particles continuously with high time resolution (every 1 second or 10 seconds). It also can transfer the data through the telephone line.
(2) The new Doppler radar was completed in March, 1994 (Photo 1). This new radar has dual-polarization observation mode as well as Doppler observation mode.
(3) The computer system was introduced to achieve the on-line processing of the Doppler data. This computer system can be connected to the new Doppler radar and a nowcasting system of blowing snow, as the first step of this study, will be completed.

4. The points of this study

(1) Dual Doppler radar observation

The Doppler radar only measures the radial component of the velocity vector of falling snow flake or snow crystal in the air. The observed component $\boldsymbol{a}$ is called the Doppler velocity, which does not strictly coincide with the magnitude of the velocity vector $\boldsymbol{V}$ when the snowflake or snow crystal does not move along the

line of vision (Fig.3(a)). However, if the two Doppler radars are located at appropriate intervals, two radial components, ***a*** and ***b*** are composed to yield the correct velocity of the snowflake or snow crystal, which is nearly equal to the wind velocity (Fig.3(b)). Thus, the dual Doppler radar observation can give the precise wind field within the region where the observation ranges of the two radars overlap.

Detailed structures of downdraft and gust front associated with snow cloud will be analyzed and the dependence of blowing snow on them will be clarified.

(2) Areal observation of blowing snow by new SPC system

In the previous study at the Tsugaru Plain, we used Cyclone type collectors to investigate the areal distribution of blowing snow. Higashiura *et al.* (1993) pointed out that the magnitude of blowing snow depends on the fetch distance from the windward obstacles and on the kinds of the obstacles. But magnitudes of blowing snow were based on the accumulated mass flux for about one day. In the new study, we use the new SPC systems to obtain an instantaneous areal distribution of blowing snow. The data will be analyzed to reveal the fetch dependence and the relationship between the blowing snow and snow clouds. The position of the ground observation site relative to the snow cloud will be focused in the latter analysis.

In Japan, a strong northwesterly wind blows under the conditions of a typical winter pressure pattern. At the same time, developed snow clouds come from over the Sea of Japan and move to the inland. In such conditions, heavy blowing snow sometimes occur within 4~5 km from the seashore around the Ishikari observation area. So, the new SPC systems will be deployed near the shoreline at intervals of a few kilometers. Also they will be aligned with the prevailing wind direction so that the snow clouds will move over the neighboring sites.

5. Observation at the Ishikari Plain in 1993/4 winter

Areal investigation of blowing snow at the Ishikari Plain in Hokkaido, Japan was carried out from January 22 - 29, 1994. A single Doppler radar observation was conducted at Otaru. Snow particle counters, a visibility meter and other meteorological instruments were used at the Ishikari observation site (Photo 2). Two SPC systems were set at the Maeda sites (Photo 3, Photo 4), which were 2

km apart from each other and aligned with the prevailing wind direction. During the observation period, the time of blowing snow occurrence totaled to approximately 35 hours. The results of this winter are now under analysis. In the next winter, two SPC observation sites will be added, and the dual Doppler radar observation will be started.

References

Higashiura, M., T. Sato, A. Sato, T. Kimura, M. Maki, S. Nakai, N. Nakamura and T. Yagi. 1993. Areal investigation of drifting snow on Tsugaru Plain, Japan. Ann. Glaciol., **18**, 155-160.

Sato, T., T. Kimura, T. Ishimaru and T. Maruyama. 1993. Field test of a new snow -particle counter(SPC) system. Ann. Glaciol., **18**, 149-154.

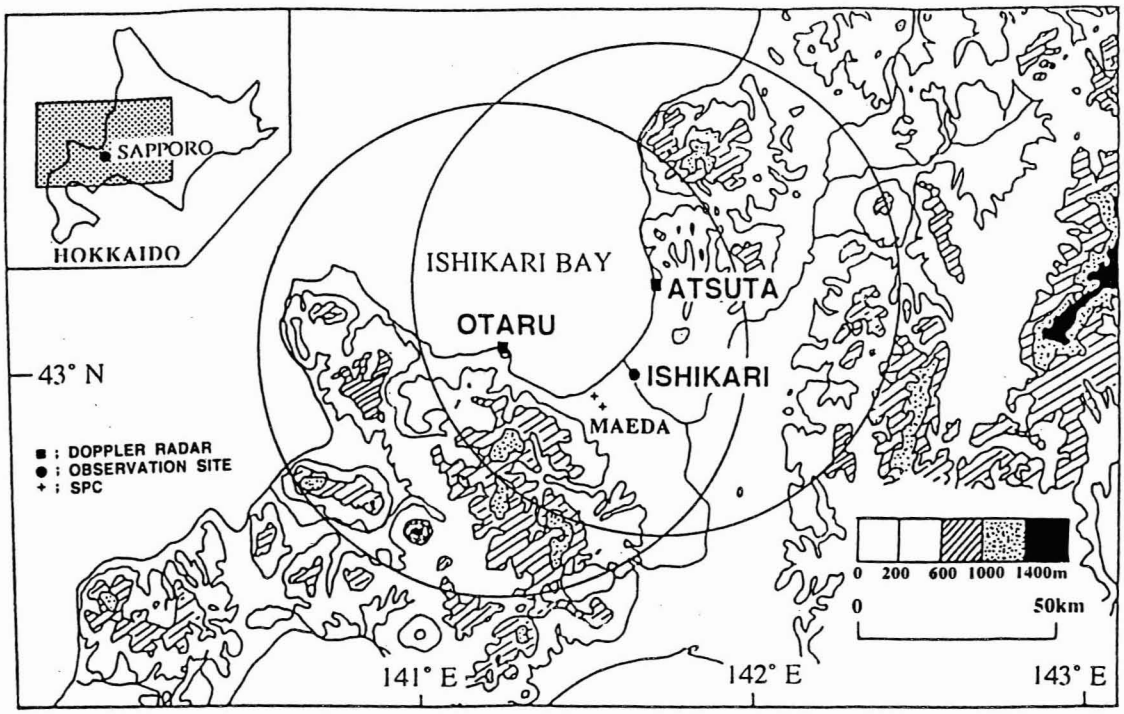

Fig.2 Topography of the Ishikari Plain and observation sites (Large circles indicate the observation range of the Doppler radars)

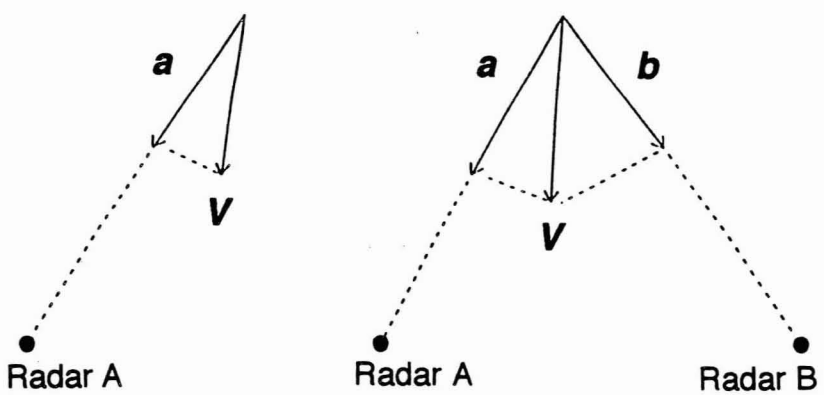

Fig.3 Schematics of the detection of wind velocity vector by the Doppler radar

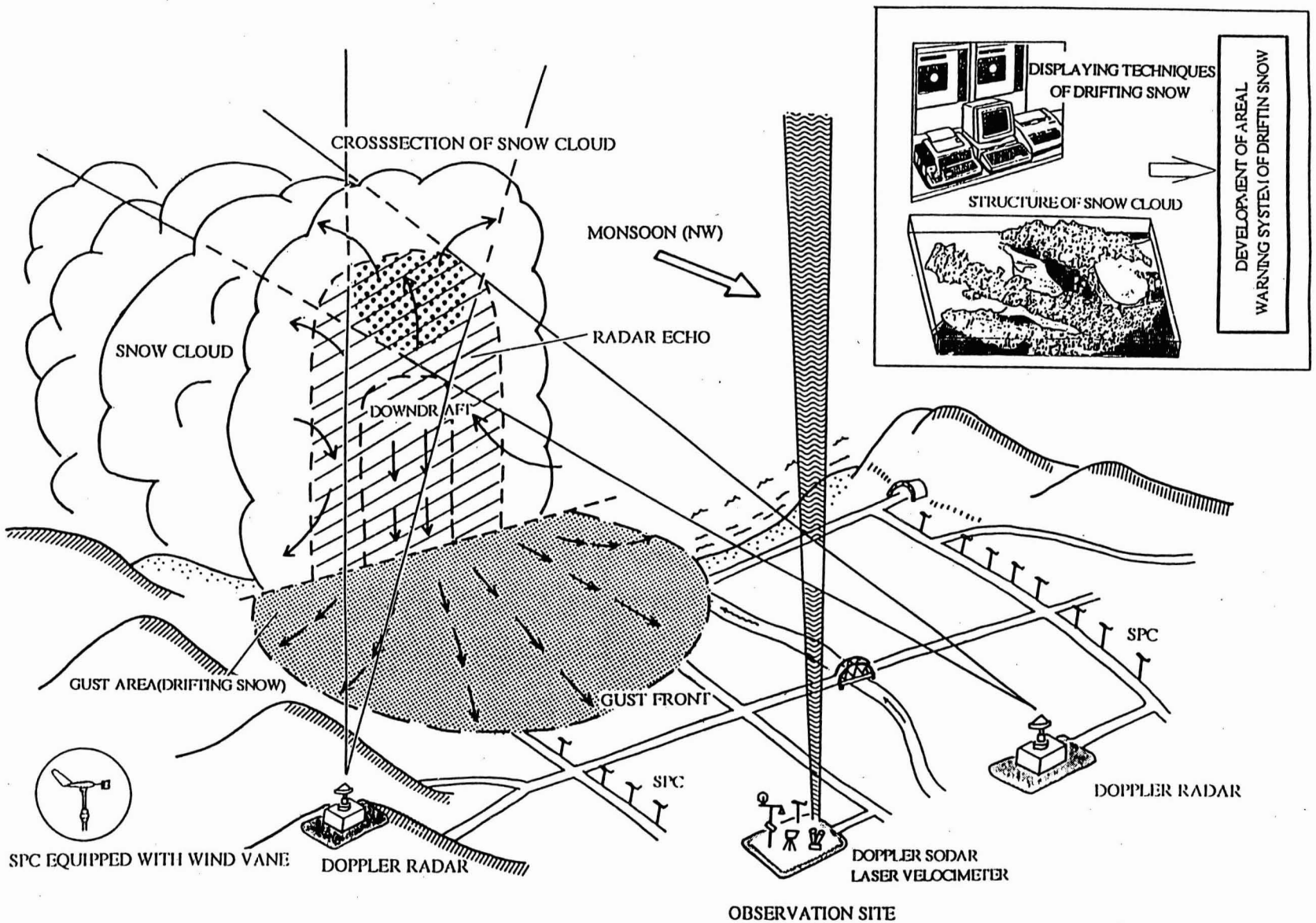

Fig.1 Schematic plan of study on the development of warning system of blowing snow

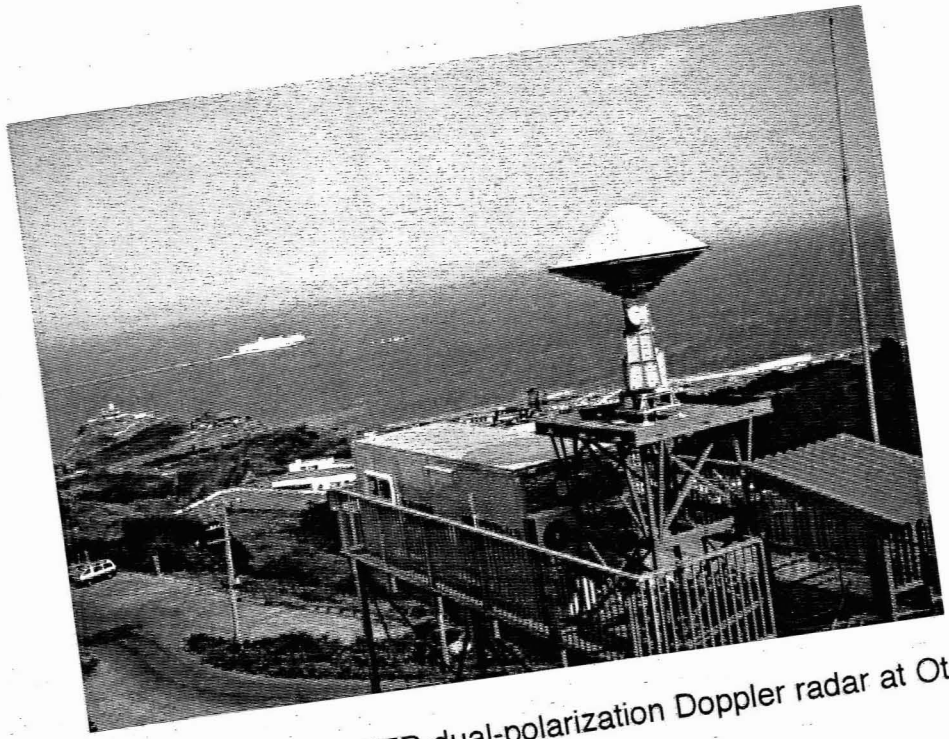

Photo 1 The new NIED dual-polarization Doppler radar at Otaru

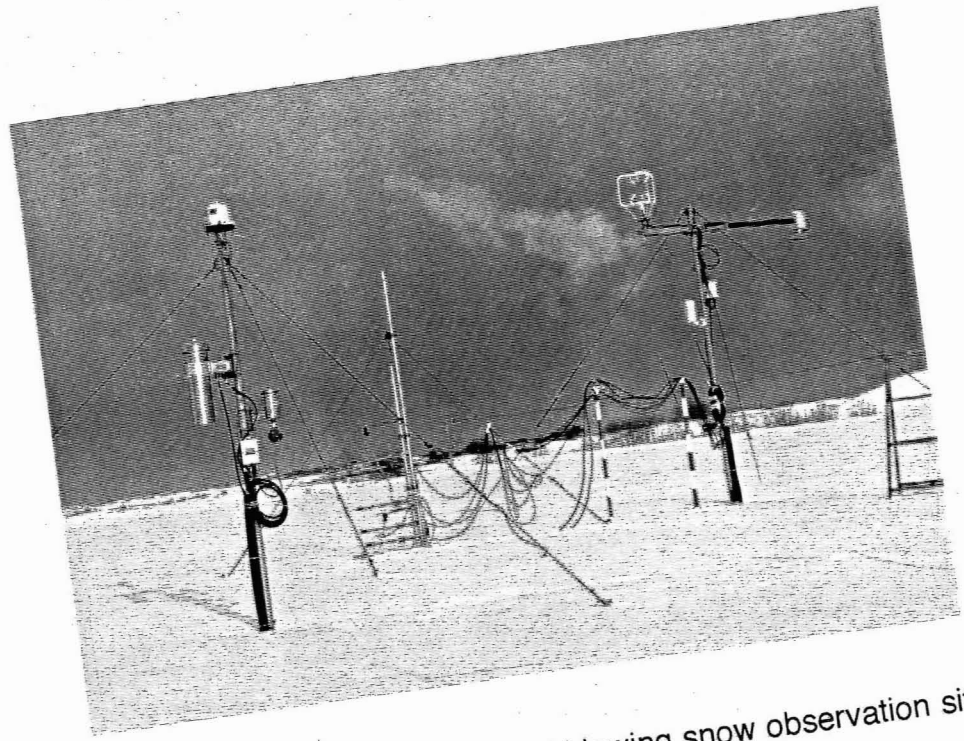

Photo 2 Sensors at the Ishikari blowing snow observation site

Photo 3 Setting up of SPC with wind vane at Maeda-A site

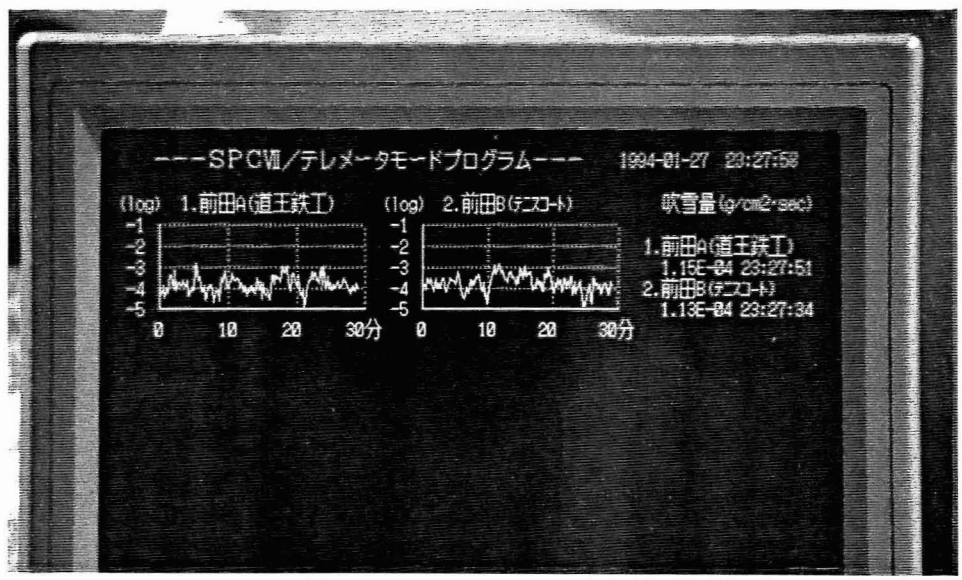

Photo 4 Real time display of blowing snow data at two Maeda sites telemetered to the Ishikari observation site