Method for Calculating the Amount of Accumulated Snow Transported during a Single Blizzard

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1. Introduction

Background to the study

Approximately 140 vehicles were trapped in accumulated snow on National Route 274 in Naganuma near Sapporo on February 23 and 24, 2008.

More than 100 vehicles stalled in the Kushiro/Nemuro district on March 31 and April 2, 2008.

How often do such blizzards occur?

Purpose of the study

■Indexes to represent blizzard intensity

- Maximum amount of accumulated snow (Fukuzawa et al., 2000)
- Frequency of blizzards (Ishimoto, 1987)

} Blizzard intensity for the year

➢ **There are no indexes to represent the intensity of a single blizzard.**

■Purpose of the study

Development of an **index to represent the intensity of a single blizzard**

- A single blizzard was defined.
- The total transport rate of blowing snow during a single blizzard were calculated for the aforementioned cases.
- The probability period for replication of the total transport rate of blowing snow was found.

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2. Study Method

Relationship between the transport rate of blowing snow Q and wind velocity

Definition of the transport rate of blowing snow Q:

Mass of snow blown particles that passes through a particular unit width perpendicular to the wind direction during a fixed time [g/(ms)]

Relation between the transport rate of blowing snow Q and wind velocity (Kobayashi D. (1972))

$Q=0.03V_1^3$ [g/(ms)] ・・・(1)

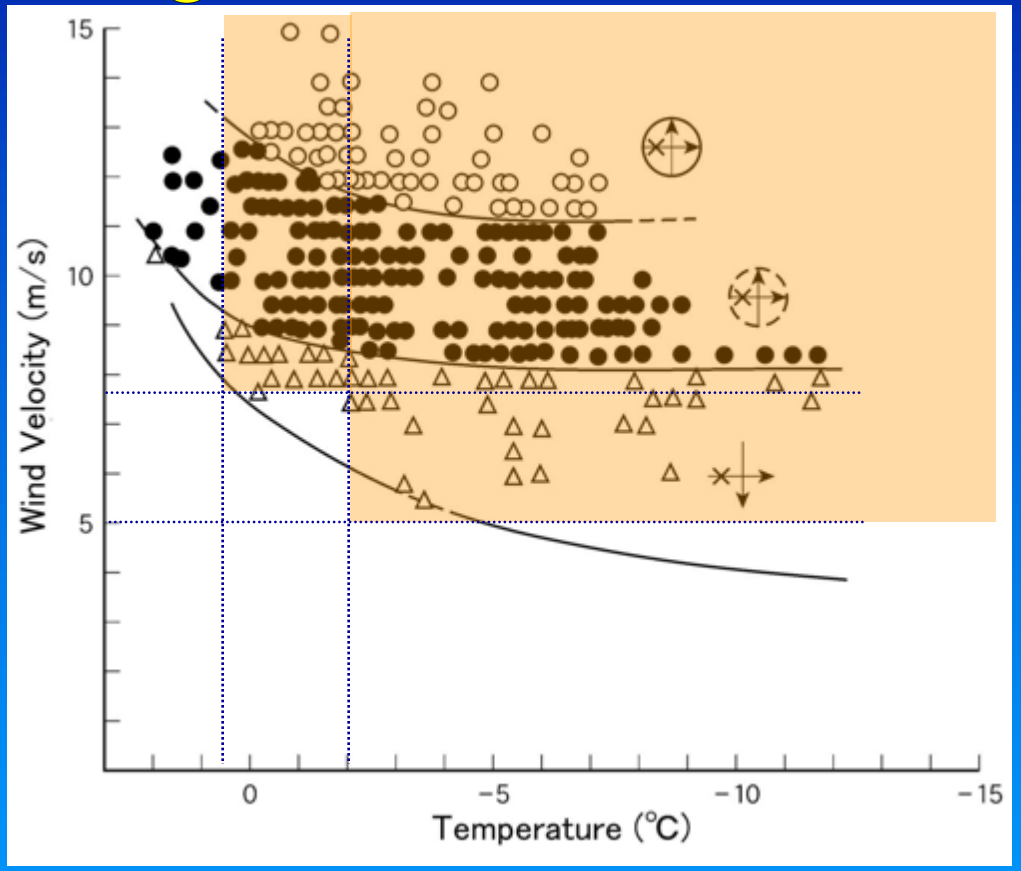
Where, V_1 is the wind velocity at a height of 1 m.

Conditions required for the occurrence of blowing snow

- Conditions required for the occurrence of blowing snow during snowfall (Takeuchi et al., 1986)
- Blizzard conditions were assumed when either set of the following criteria were satisfied:

1: **An air temperature of < -2° C, a wind velocity of > 5.0 m/s and a snow depth of > 1 cm**

2: **An air temperature of < 0.5° C, a wind velocity of > 7.5 m/s and a snow depth of > 1 cm**



△ : **low drift snow**
● : **intermittent high drift snow**
○ : **continuous high drift snow**

Definition of a single blizzard

Conditions required for blowing snow occurrence

1. An air temperature of < -2° C, a wind velocity of > 5.0 m/s and a snow depth of > 1 cm
2. An air temperature of < 0.5° C, a wind velocity of > 7.5 m/s and a snow depth of > 1 cm

- A blizzard was considered to have ended when the above necessary conditions for blowing snow occurrence were not satisfied for six consecutive hours.
- The period between the start and end of a blizzard was defined as a single event.

Estimation of the transport rate of blowing snow Q and probability of replication

$Q=0.03V_1^3$ [g/(ms)] ・・・(1)

AMeDAS: Automated Meteorological Data Acquisition System

The total value from the beginning to the end of a blizzard.

Total transport rate of a single blizzard: Qsum [kg/m]

The probability of replication was calculated using Iwai's method on the assumption that the annual maximum values for Qsum follow the logarithmic normal distribution.

3. Results

Case of Naganuma

- Total transport rate of blowing snow Qsum

Naganuma AMeDAS (wind velocity, air temperature) and Eniwa-Shimamatsu AMeDAS (snow depth) data from the 23 winters from November 1981 to April 2004 were used.

The results were compared with the transport rate of blowing snow on February 23 and 24, 2008.

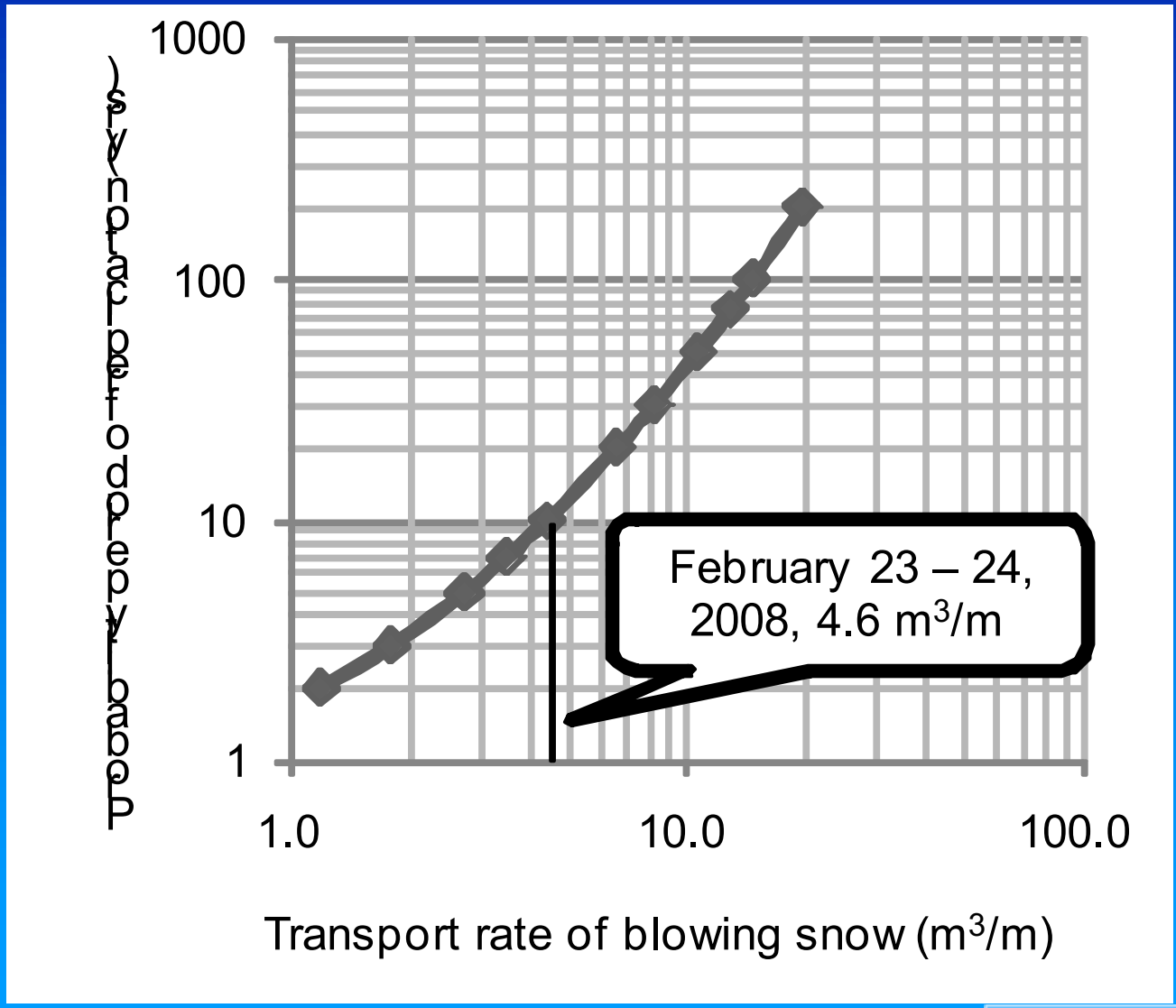
Period	Qsum [m^3/m]*
Feb. 12 – 18, 1991	8.6
March 8 – 9, 2003	5.0
Feb. 23 – 24, 2008	4.6

*Qsum was converted to a volume value on the assumption that the snowcover density was 350 kg/m^3.

Case of Naganuma

Probability period for replication of the blizzard in February 2008:

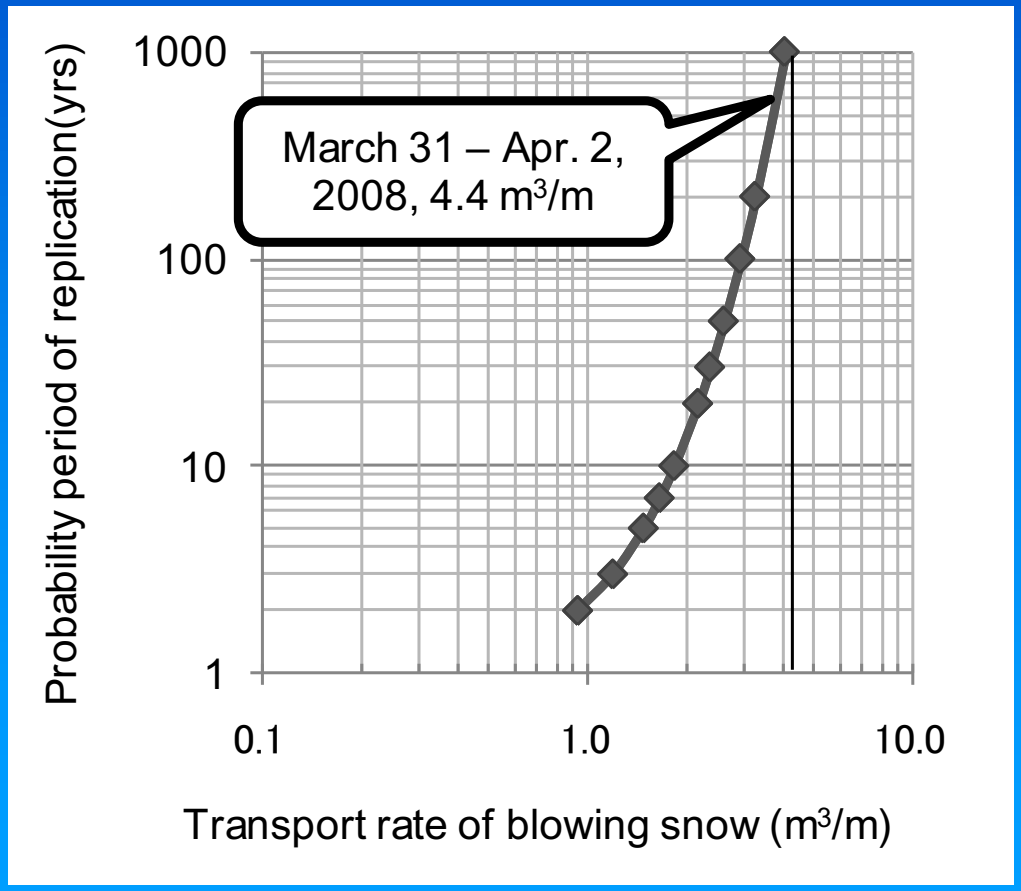
Approx. 10 years



Case of the Kushiro/Nemuro district

Attoko AMeDAS (wind velocity, air temperature and snow depth) Data from the 18 winters from November 1986 and April 2004 were used.

The probability period for replication of Qsum between March 31 and April 2, 2008 was more than 1,000 years.



4. Improvements of the method for estimating the maximum transport rate of blowing snow

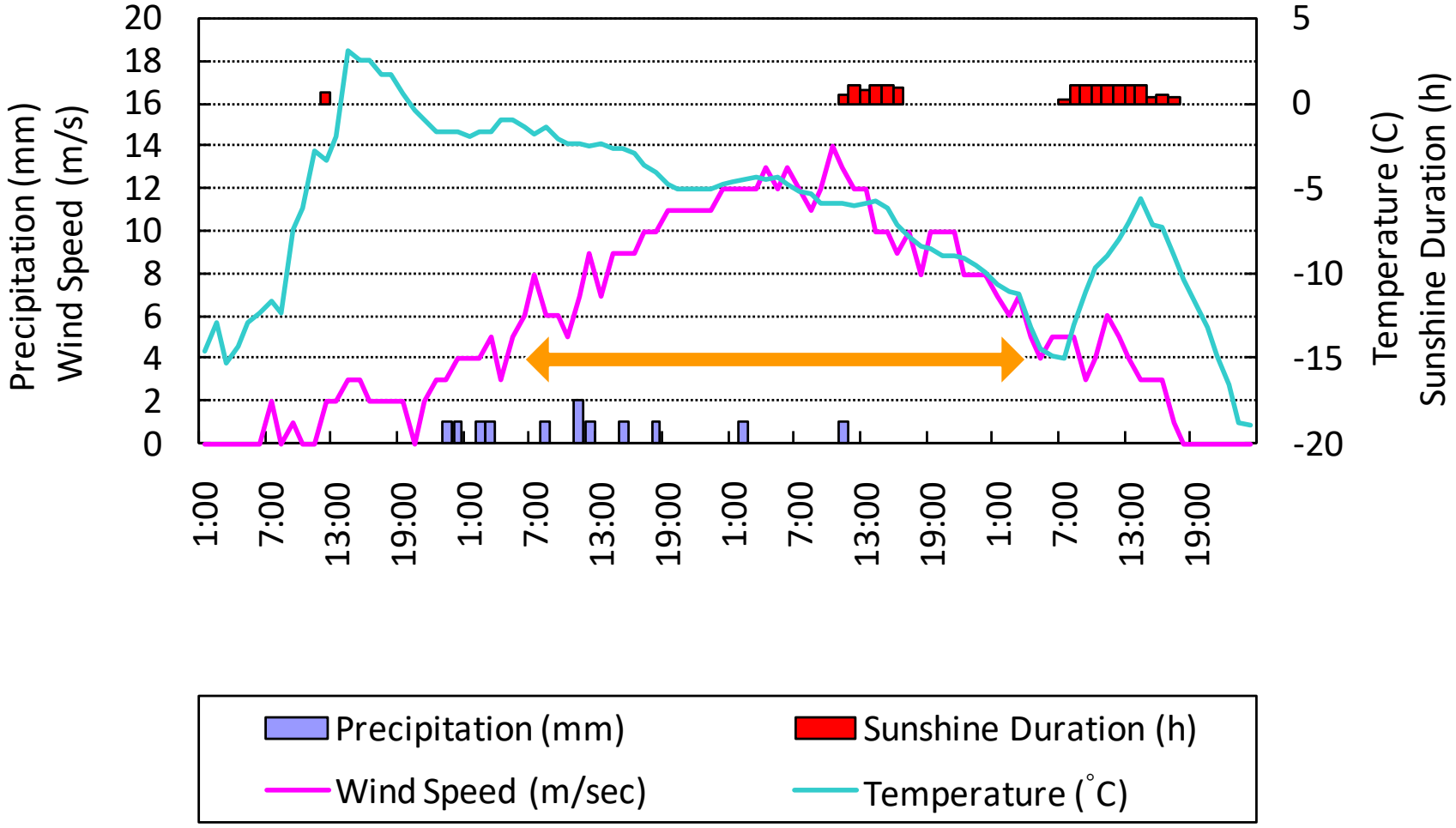
Problem

•The 10-year probability of replication seemed too large for Naganuma, which experienced a severe blizzard in February 2008.

•Weather conditions in February 1991, March 2003 and February 2008 were reviewed.

Weather conditions during blizzards

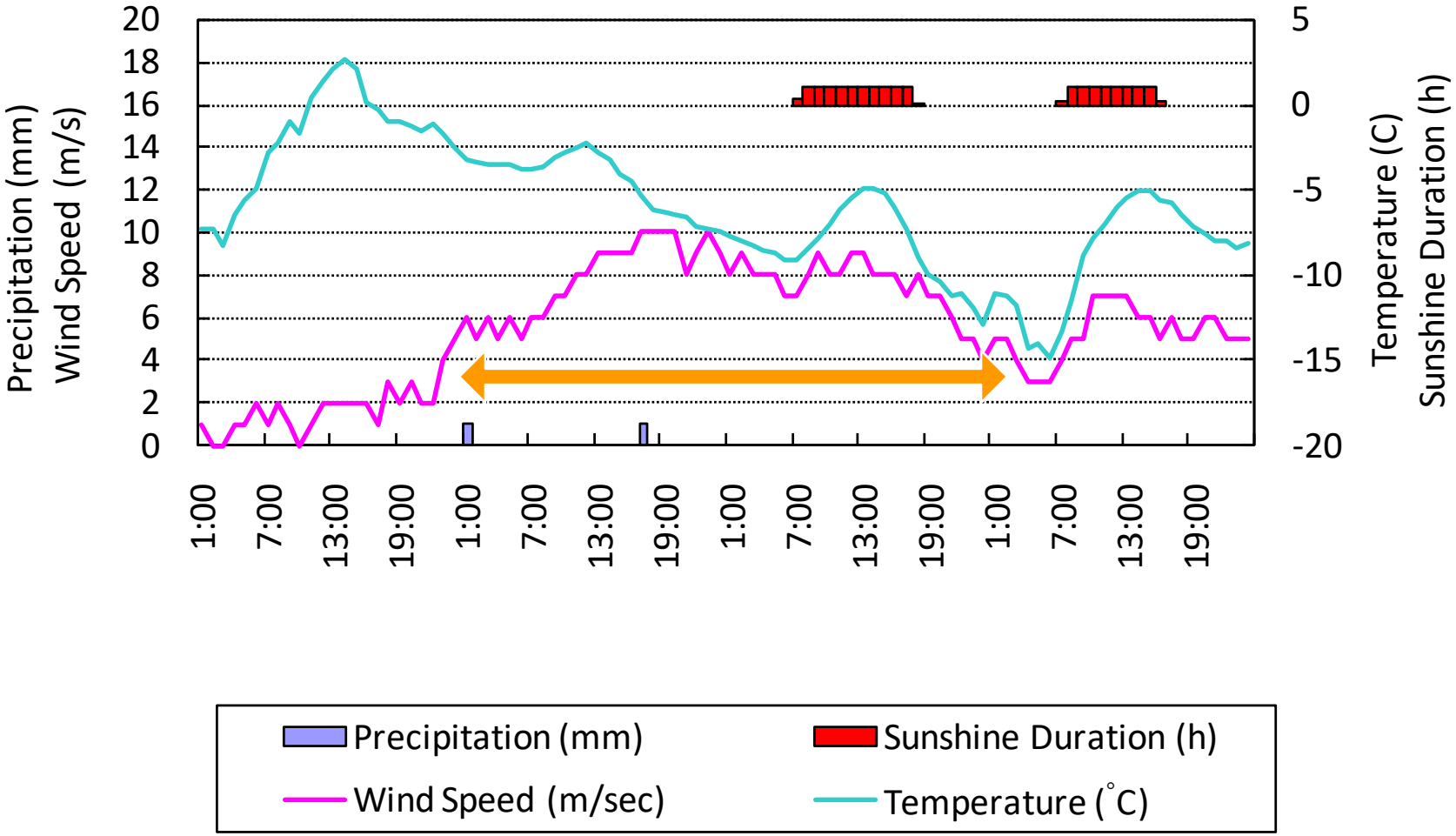
February 15 – 18, 1991



Weather conditions during blizzards

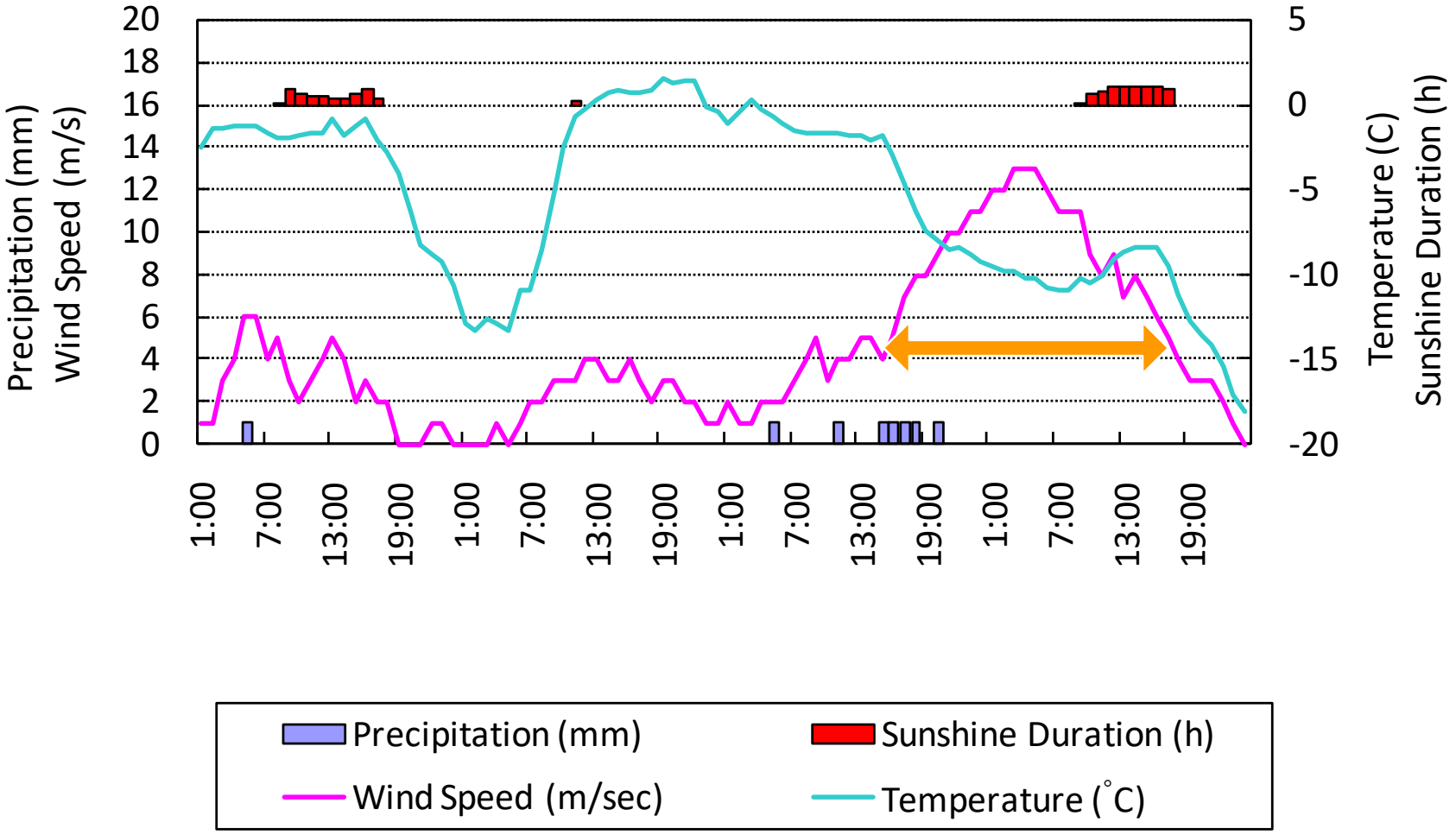
March 7 – 10, 2003

There was an almost total lack of precipitation.



Weather conditions during blizzards

February 21 – 24, 2008



Improvement of the method for estimating the total transport rate of blowing snow Qsum

- Blizzards are unlikely to occur when there is no fresh snow on the surface. There may be some overestimation regarding the transport rate of blowing snow when there is no snowfall.

- The total snowfall over a distance of 300 m on the windward side from 24 hours before the onset to the end of the blizzard was considered the maximum amount for Qsum.
- This value was defined as the maximum possible transport rate of blowing snow Qmax.

The total transport rate of blowing snow Qsum was calculated again on the assumption that:

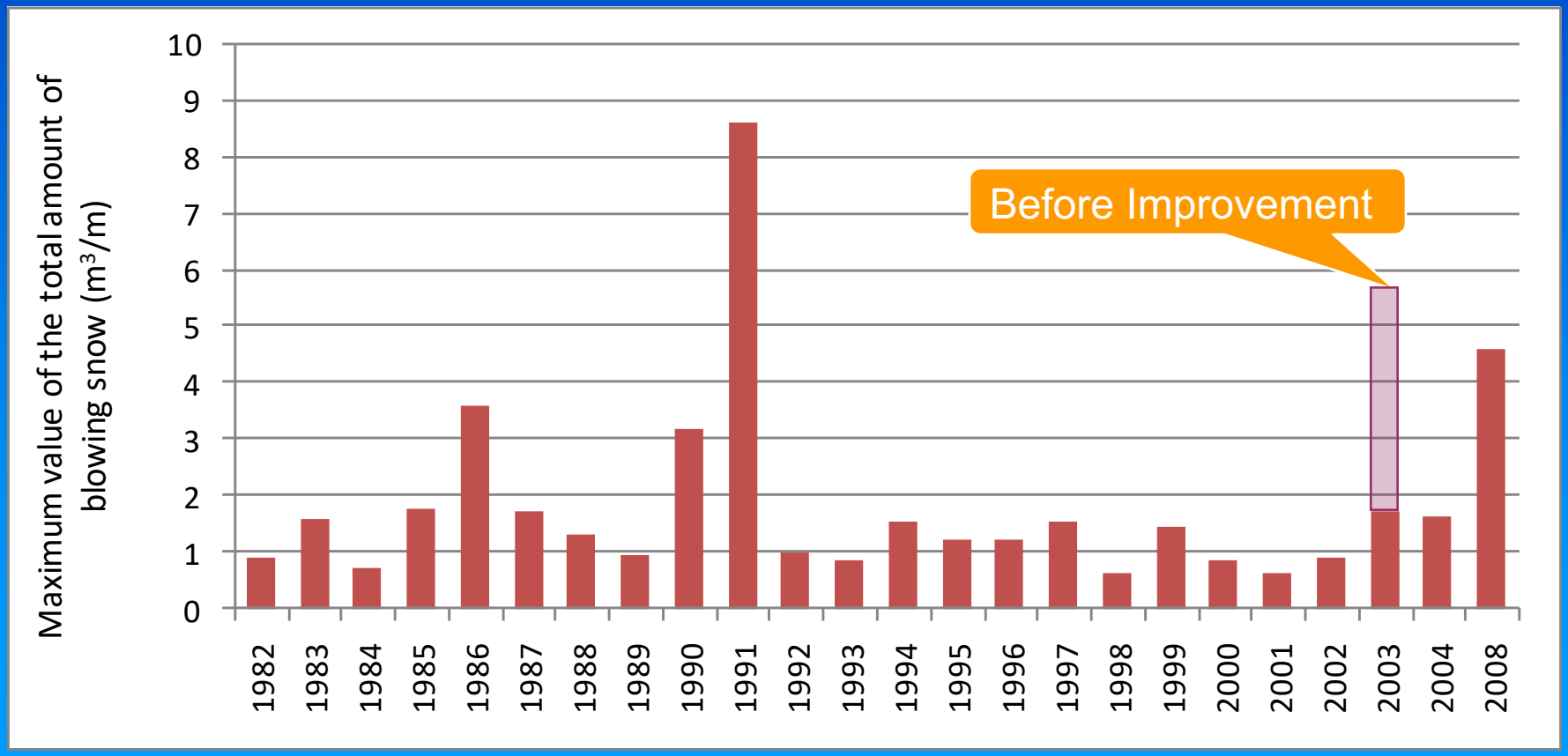
Qmax ＝300 x total snowfall

Qsum≦Qmax

Annual maximum values for the total amount of blowing snow Qsum

Qsum in March 2003 became smaller.

Qsum in February 1991 ＞ Qsum in February 2008



4. Conclusion

Conclusion

- The probability period was approximately **10 years** for Qsum **in Naganuma** on February 23 and 24, 2008, and **more than 1,000 years** for that **in Attoko** on March 31 and April 2, 2008.
- The calculation method for the total transfer rate of blowing snow was corrected. The results indicated that the probability period of replication for the **blizzard in Naganuma in February 2008 was approximately 30 years.**
- Qsum was still lower in February 2008 than that in February 1991 in Naganuma.

We intend to conduct a more detailed examination of this calculation method for the transfer rate of blowing snow in the future.


Thank you for your attention!