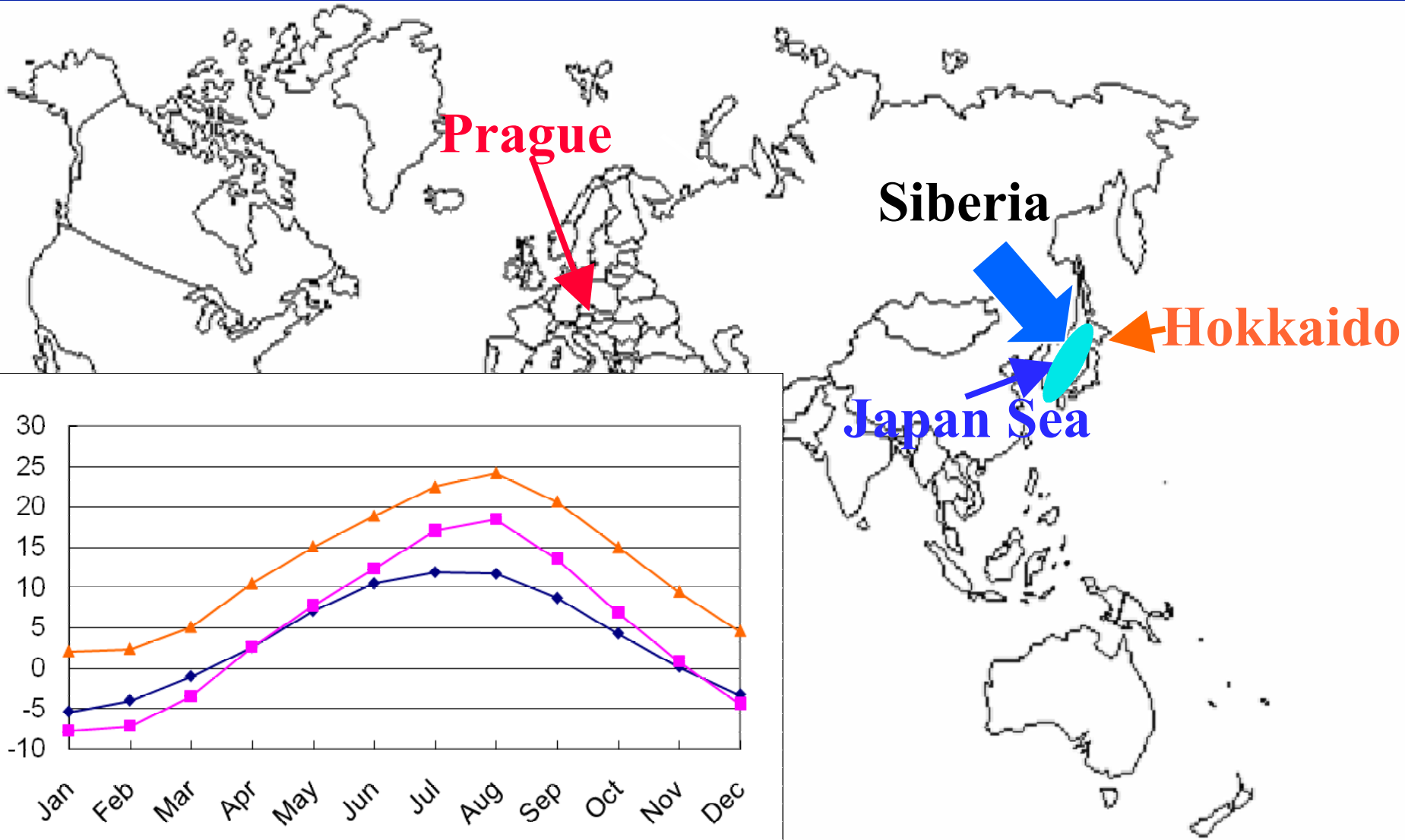


Problems in Visibility Measurement of Road in Blowing Snow

Sirwec 2008, Prague, 14 - 16 May



Overview of the winter in Hokkaido



1. Introduction

BACK GROUND

- Visibility in snowstorms can vary greatly by height or location.
- Visibility meters are usually installed at the height of 2 to 3 m on meteorological towers built at the roadside.
- It must be important to know the difference between measured visibility and actual visibility on the road.

OBJECTS

- To clarify visibility variations across the road
- To point out the problems which related to visibility measurement.



2. Overview the Study

Method to obtain the visibility data

The relationship between visibility (Vis) and snow mass flux (Mf)

$$Vis = 10^{-0.77 \log(Mf) + 2.85} \quad (1)$$

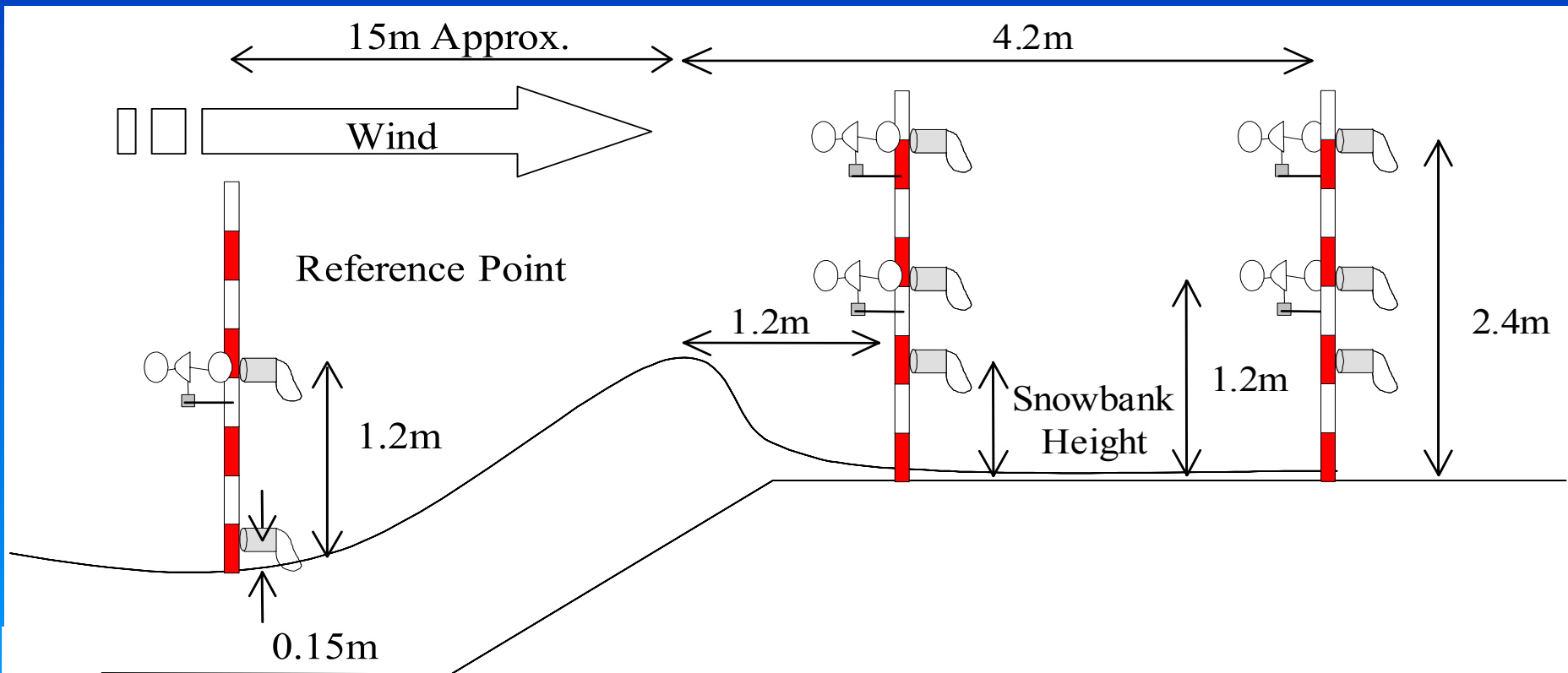
Mf : the mass of snow particles passing through a unit cross section in a unit time ($\text{gm}^{-2}\text{s}^{-1}$)

- The measured mass fluxes were converted into visibility expressions using Eq.(1) in this study.



Observation for Snow Mass Flux

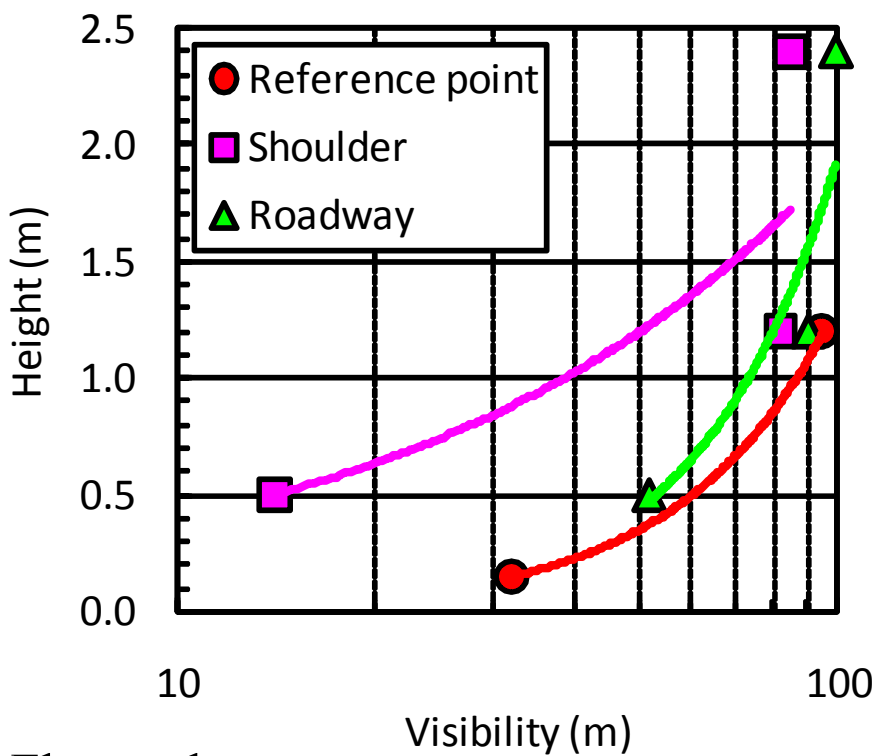
- Measured on the flat road and on the embankment road
- Measured at heights of 1.2 m and 0.15 m at the reference point which is approximately 15m windward from roadside
- Measured at heights of snow bank, 1.2 and 2.4 m above the shoulder and roadway



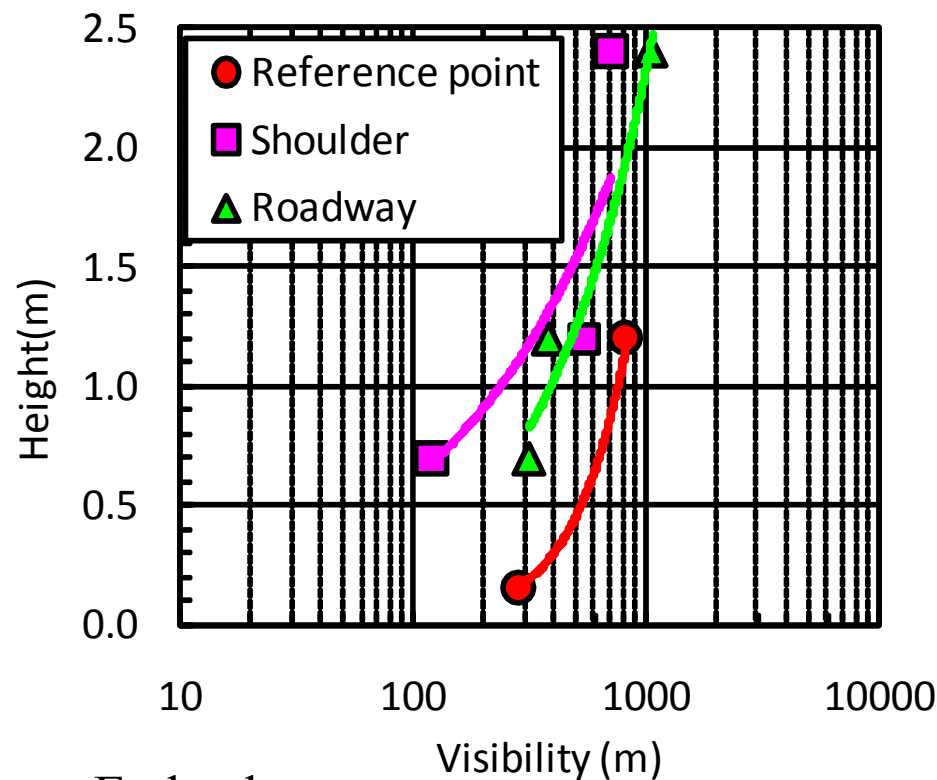
3. Result of the Study

Examples of Measurement of Visibility

- The visibility is different remarkably by height.
- The visibility on the roadway is different from that at the reference point



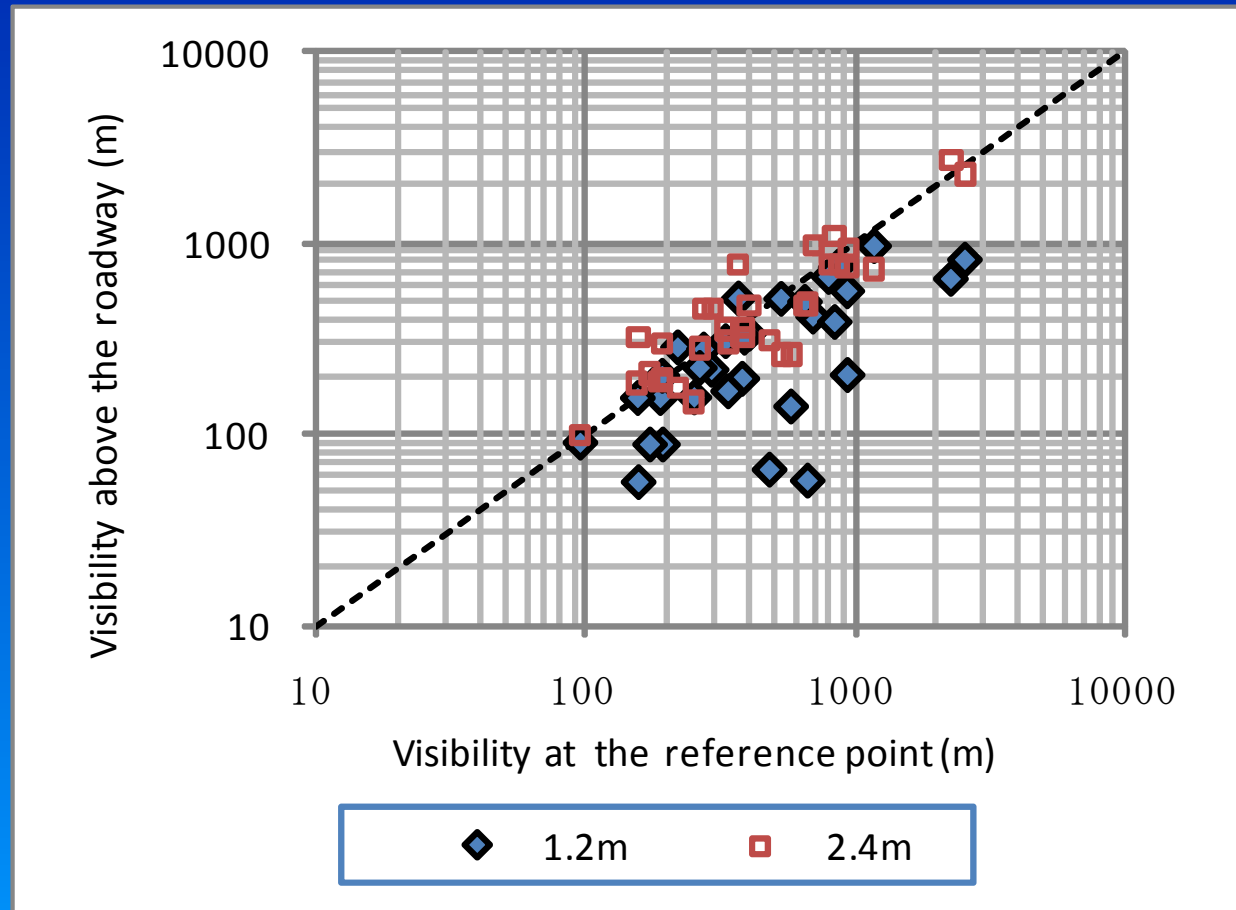
Flat road



Embankment

Visibility at the Reference Point (1.2-m level) and above the Roadway

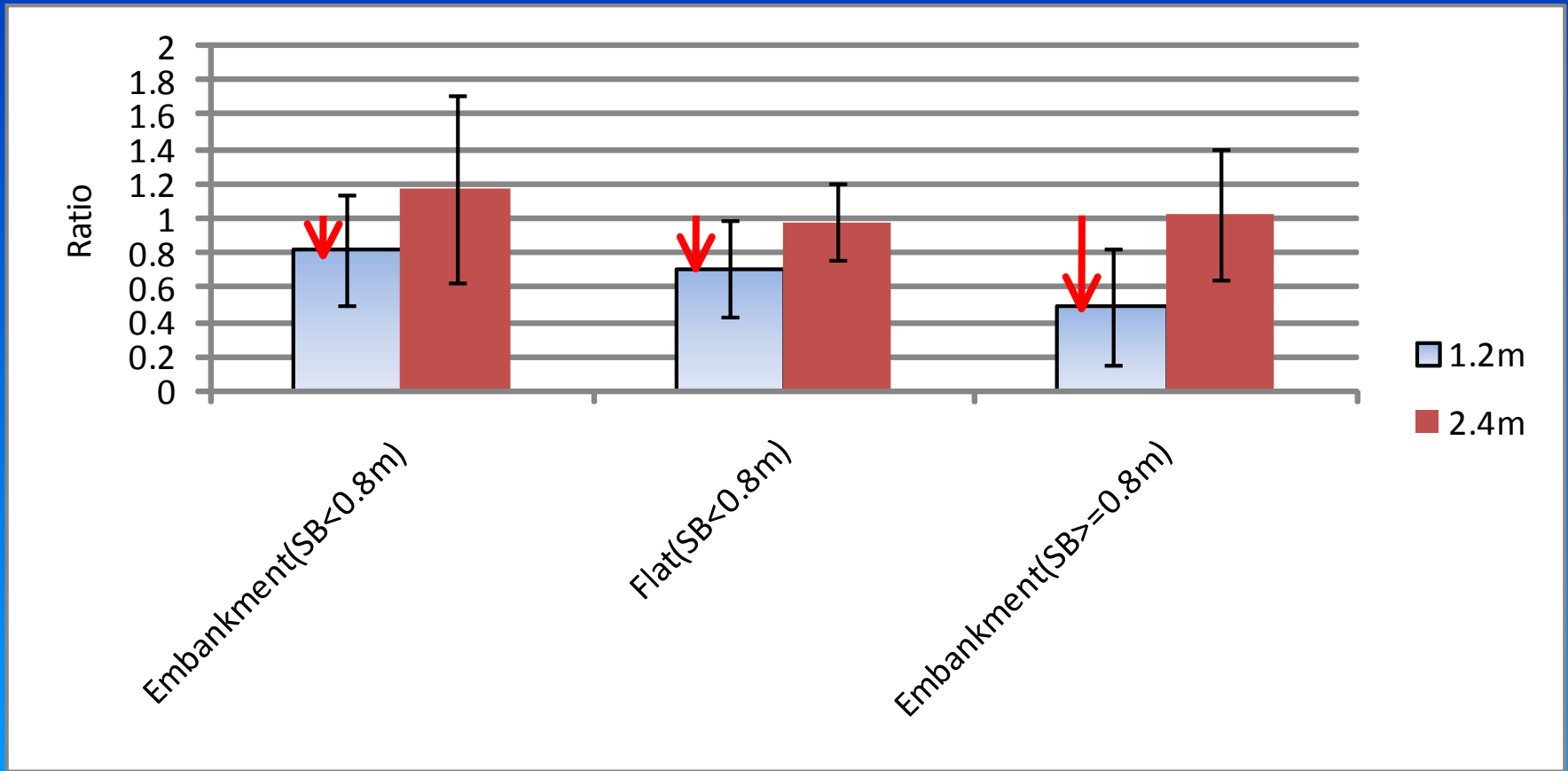
1. The visibility at the 2.4-m level was similar to that at the reference point.
2. The visibility at the 1.2-m level was lower than that at the reference point.



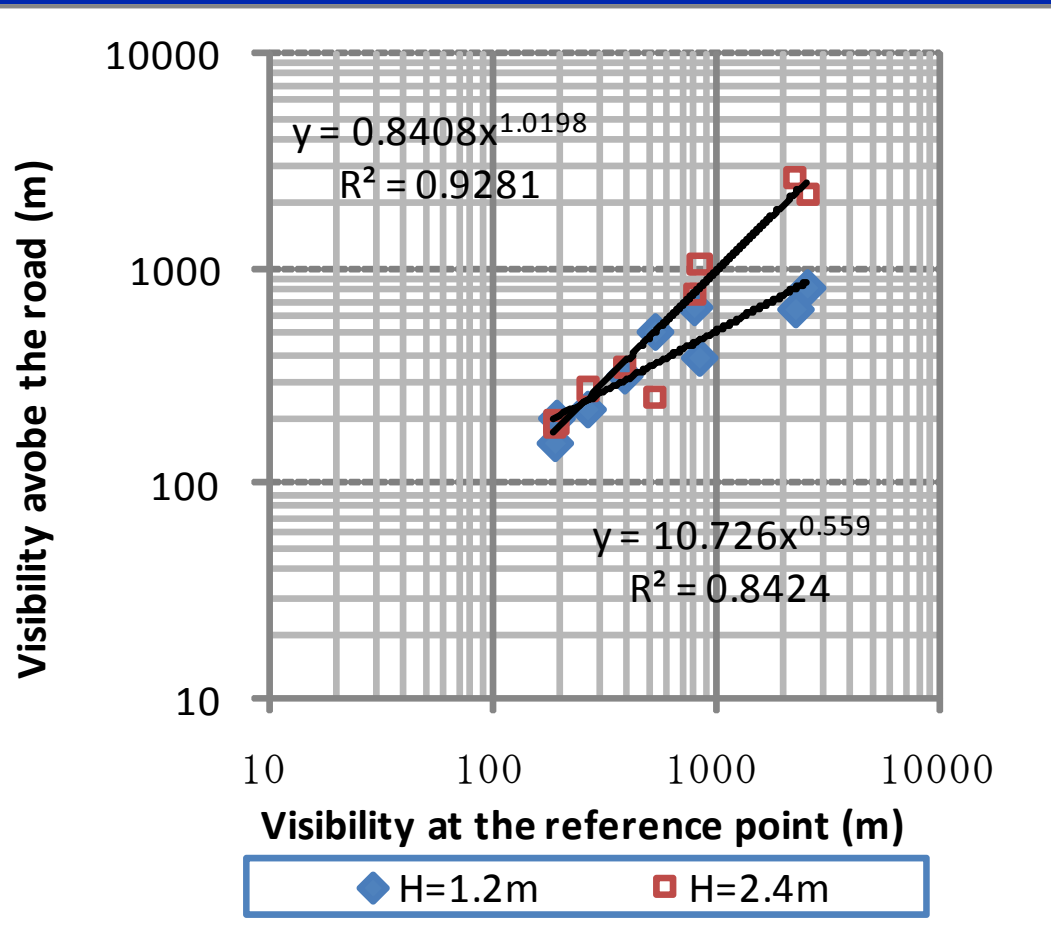
4. Analysis of Observation Results

Ratio = $\frac{\text{The visibility above the roadway}}{\text{The visibility at the 1.2m-level of reference point}}$

- 1.2 m-level visibility on roadway was 20 to 50% lower than Ref. point
- There was a case where visibility at 1.2 m above the roadway was 60 m while that at the reference point was 660 m.

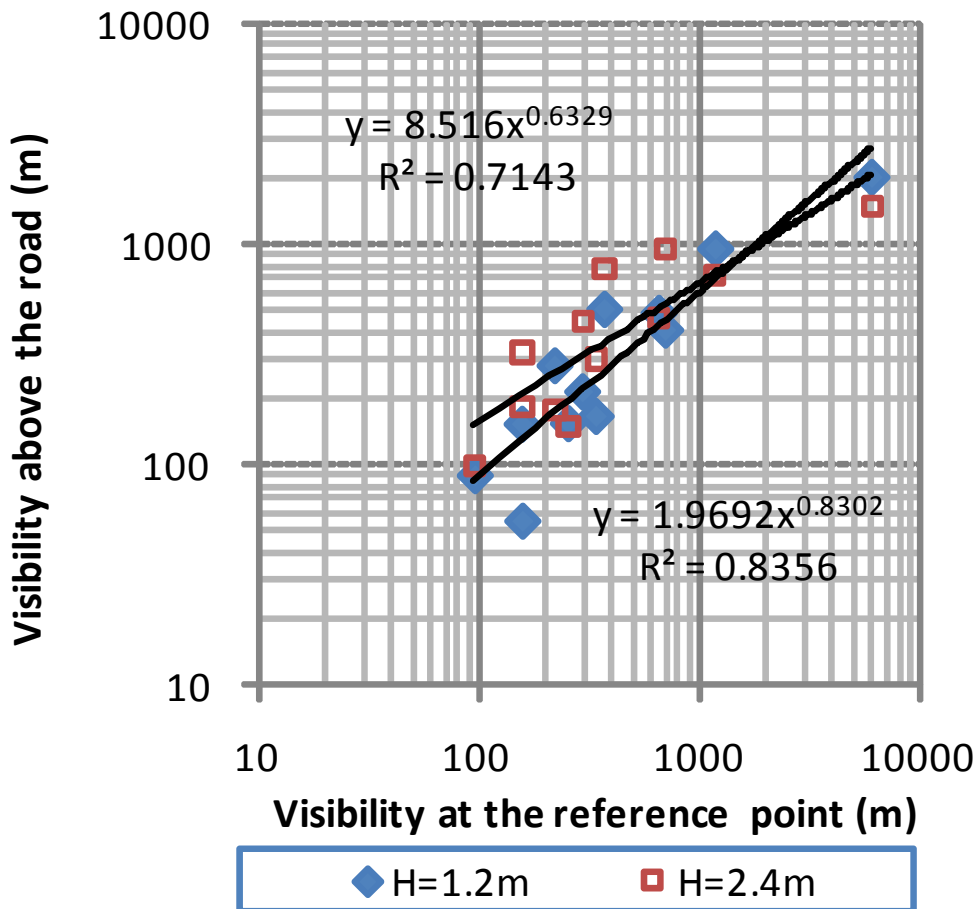


Visibility at the Reference Point and on the Roadway (Flat: SB<0.8m)



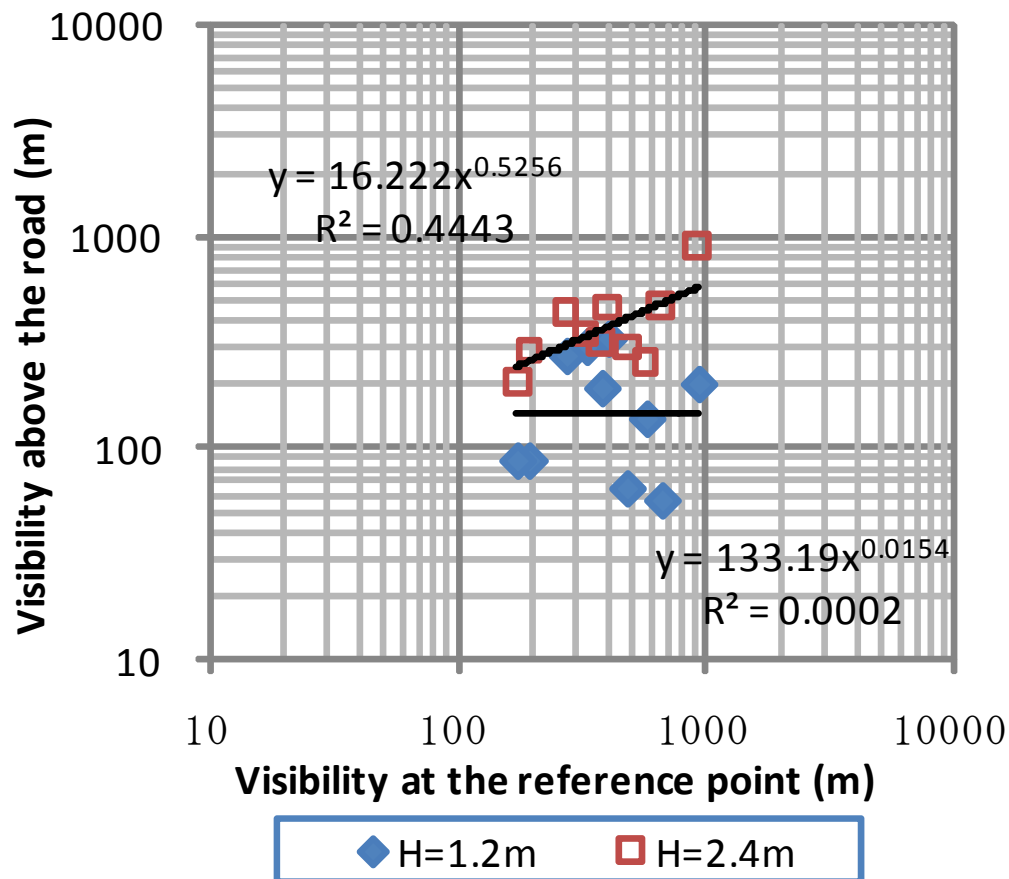
1. The correlation is strong.
2. The visibility at the 2.4-m level is similar to that at the reference point.
3. The visibility at the 1.2-m level is similar to that at the reference point when the visibility below 500 m.

Visibility at the Reference Point and above the Roadway (Embankment: $SB < 0.8\text{m}$)



1. The correlation is slightly weaker than for the flat road.
 2. The 1.2-m level of visibility above road is slightly lower than the that of reference point.
- Studies of a high-embankment section will be necessary, since these correlations may vary by embankment height.
 - Additional observation will be needed when the visibility is below 100 m.

Visibility at the Reference Point and on the Roadway (Embankment: $SB \geq 0.8\text{m}$)



1. The correlation between visibility at the reference point and that above the roadway became weaker
2. We should know that there is much difference in visibility between roadway and roadside when snow banks are 0.8m or higher.

5. Other Problems Concerning Visibility Measurement

1. **The concentration of blowing snow varies greatly by height:** The values vary depending on the height of visibility meter.
 2. **Temporal variations:** Which value should be adopted as the representative value, mean visibility or lowest visibility ?
 3. **The discrepancy between visible distance for drivers and meteorological visibility:** This is caused by differing condition of general illumination and the existence of road lighting or light-emitting delineators and other roadside facilities.
- **To introduce an indicator of road visibility from the viewpoint of drivers:** In aviation, the Runway Visual Range (RVR) used in addition to visibility. The RVR indicates the maximum visible distance of the runway or the specified lights or markers from the eye level of an pilot.

6. Conclusion

Snow mass flux observation was conducted to clarify problems concerning visibility measurement during snowstorms.

1. For both flat and embankment road, there was strong **correlation between the visibility on roadway and the that of reference point(1.2m-level)**, when the height of roadside snow bank was below 0.8m.
2. The **2.4m-level of visibility** on road section was **almost equal** to that of the reference point.
3. The **1.2m-level** of that was rather **lower** than that of the reference point.
4. When the height of roadside **snow bank** was **0.8m or over**, there were **difference of up to ten times** between visibility at the reference point and that on the roadway.
5. It was also considered **necessary to introduce an indicator for visibility estimation in road traffic** to represent visibility from the driver's point of view.

Thank you!

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