

吹雪時の視程障害度の評価に関する研究

Assessing Snowstorm-induced Poor Visibility

積雪寒冷地の冬期道路において、ドライバーは降雪、吹雪による視程障害によって厳しい環境での走行を強いられています。このため、道路防雪林や防雪柵、視線誘導施設の整備、視界情報の提供や交通規制などが行われており、その際に視界状況が調査・把握されています。しかし、現在道路で用いられている視程は気象学上定義されたものであり、道路交通に必ずしも適した視程の計測や評価が行われていないという問題があります。

寒地土木研究所では、道路交通により適した吹雪時における視程の計測手法や評価方法の提案に向けドライバーが吹雪時に感じている視程について研究を行っています。

Drivers on winter roads in cold, snowy regions have to drive under severe conditions of snowfall and snowstorm-induced poor visibility. To secure road safety, snowbreak woods, snowfences, delineation facilities and visibility information have been provided, and traffic restrictions have been implemented. For effective provision of these services, surveys on visibility have been conducted when traffic restrictions are imposed. The visibility standards used for road traffic safety are determined according to meteorological definitions of visibility and are not perfectly suitable for measuring and assessing visibility for road traffic. The Civil Engineering Institute for Cold Region has been conducting research on the snowstorm-induced visibility reductions subjectively experienced by drivers, in order to provide methods for measuring and assessing snowstorm-induced poor visibility for road traffic.



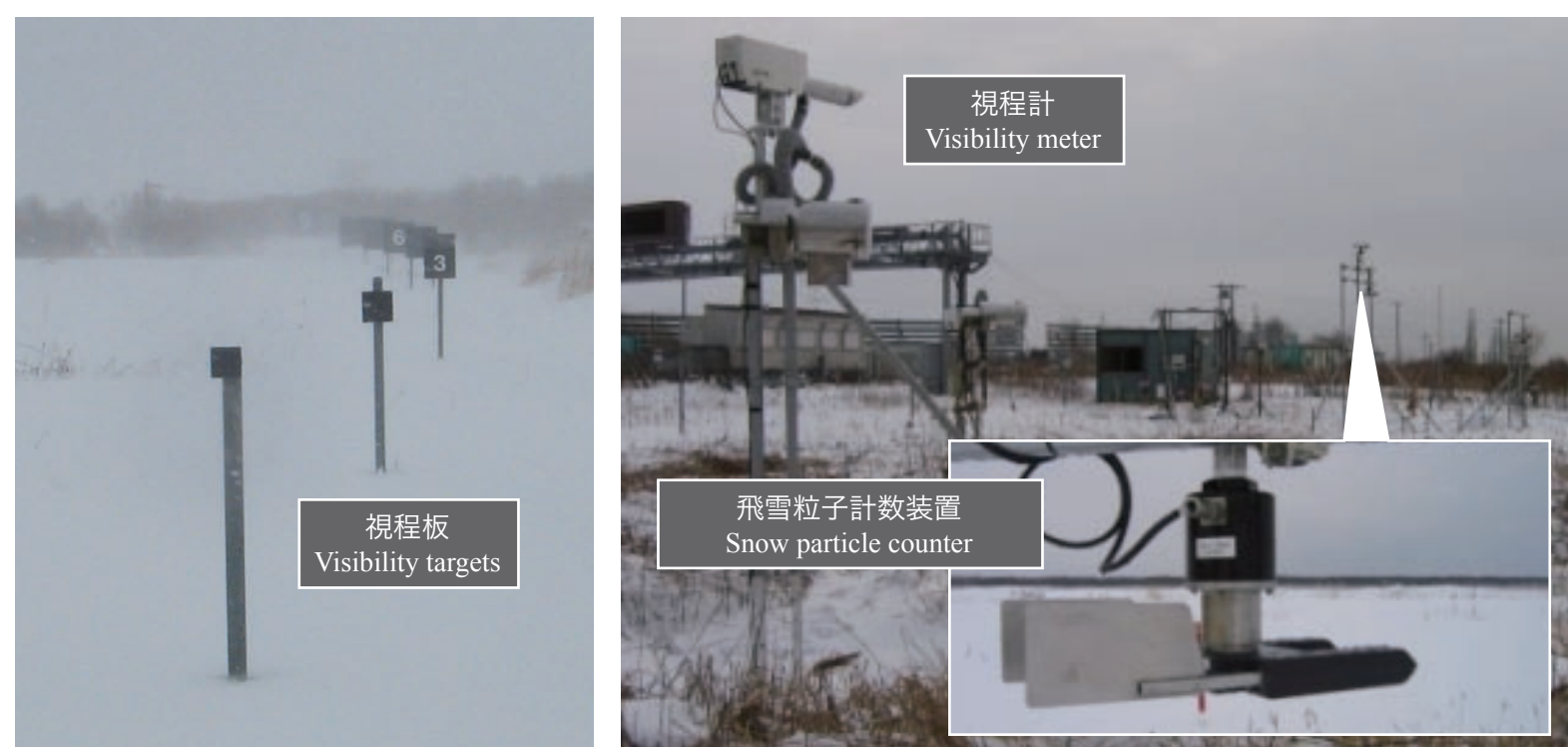
▲地吹雪による視程障害
Poor visibility caused by blowing snow without snowfall

吹雪視程障害時の視程と気象状況の関係

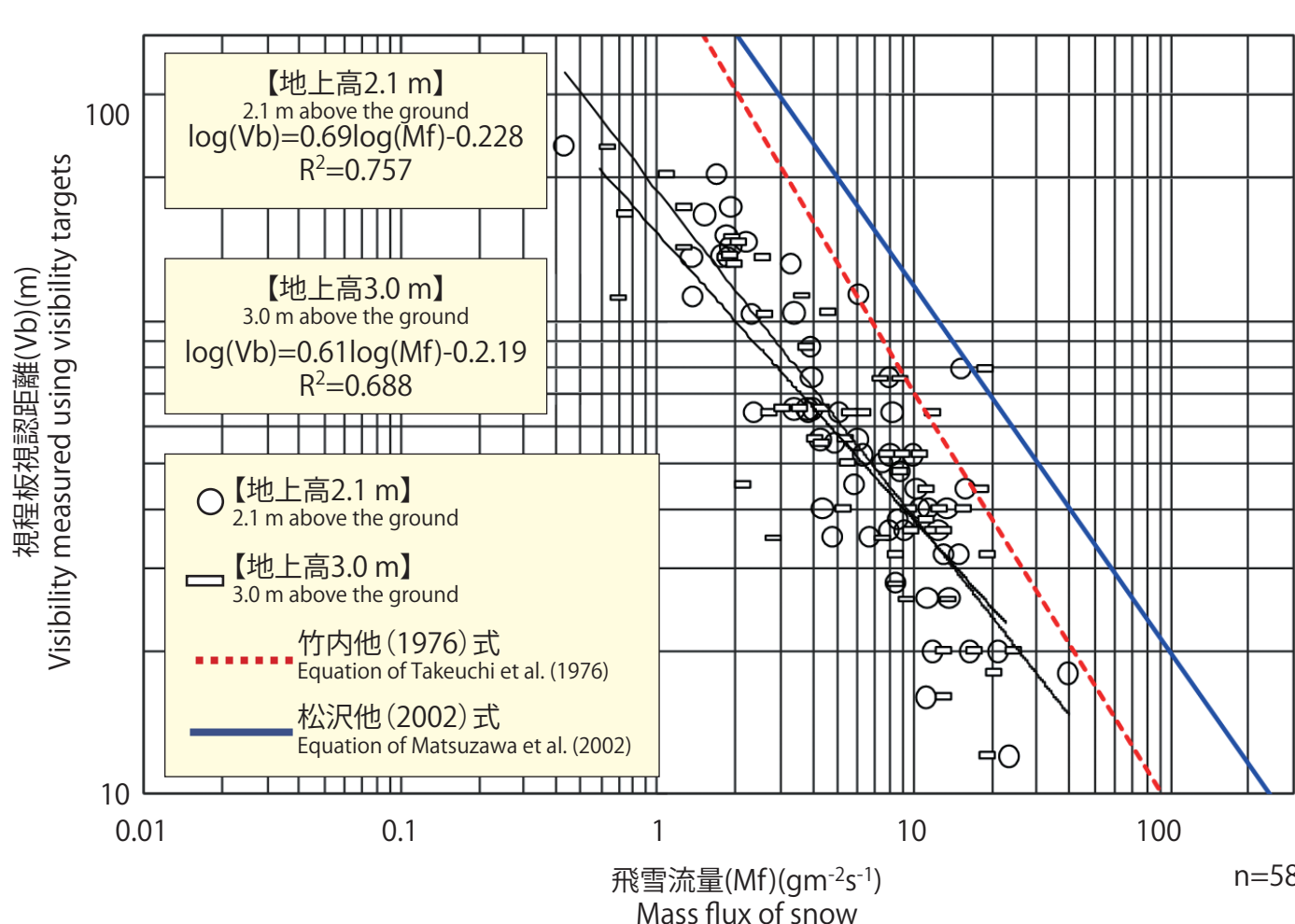
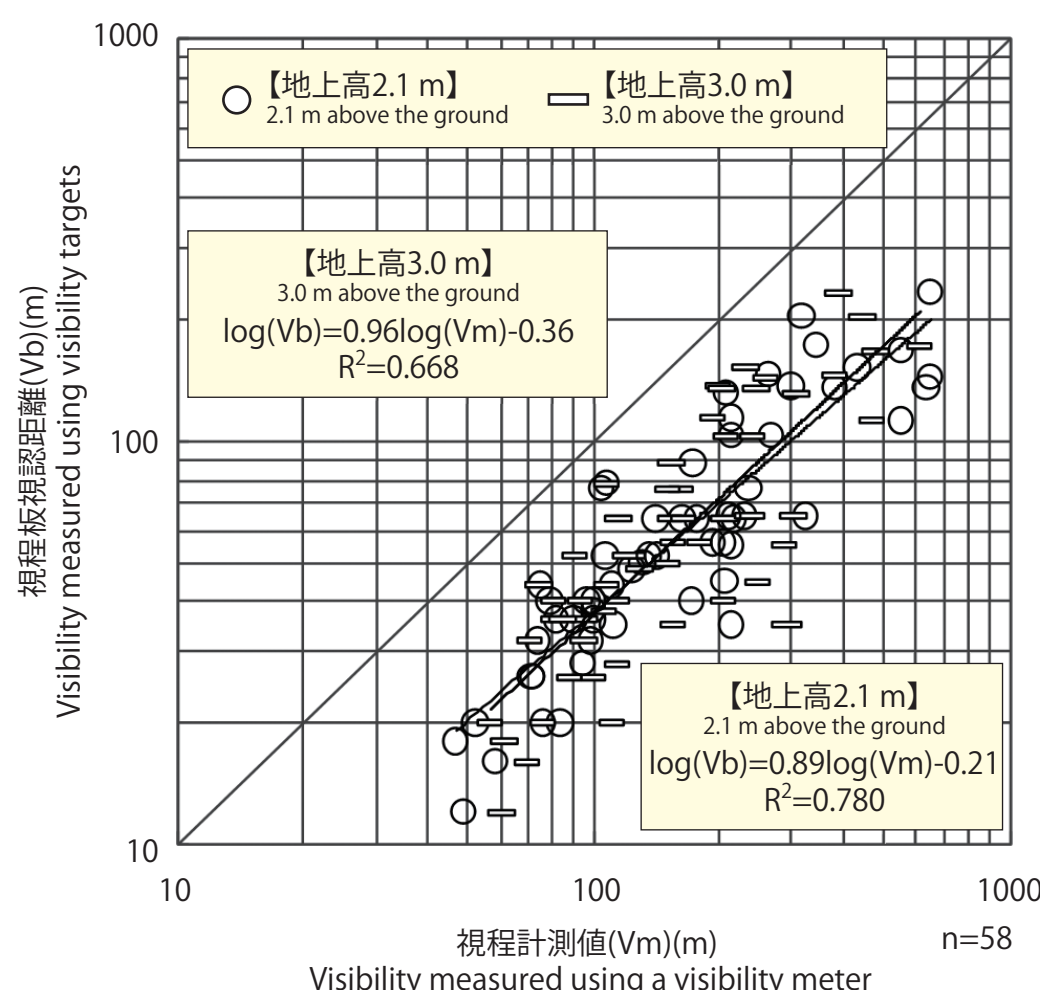
Relationship between visibility distance and weather conditions under snowstorm-induced poor visibility

視程は気象学上では、視角0.5〜5°の黒色の対象物を空を背景に目視で視認できる最大の距離とされます。道路上では視程を連続して機械的に把握するため、写真に示すような視程計を用いて視程の計測が行われています。写真に示す視程板を被験者に見せて得られる気象学上の視程（視程板視認距離）と視程計で計測された視程計測値を比較したところ、視程板視認距離は視程計測値より短い傾向が見られました。また、視程板視認距離と吹雪に関する気象データとの関係について調査を行ったところ、視程板視認距離は単位断面を通過する雪粒子の質量である飛雪流量($\text{g}/\text{m}^2/\text{s}$)などと相関が高いことが明らかになりました。

Visibility, in meteorological terms, is the maximum distance at which a human can discern a black object that occupies 0.5 - 5 degrees of visual angle against the sky. To mechanically and continuously measure visibility on the road, visibility measurement using a visibility meter shown in the photo below is used. When meteorological visibility obtained by showing the visibility targets to test subjects (visibility distance measured using visibility targets) was compared to that measured using a visibility meter, the former tended to be lower than the latter. Our survey on the relationship between the meteorological data on a snowstorm and visibility distance measured using visibility targets revealed that the visibility distance measured using visibility targets correlates highly with the mass flux of snow ($\text{g}/\text{m}^2/\text{s}$), which is the mass of snow particles that pass through a unit cross section.



▲視程板、視程計、飛雪粒子計数装置による視程把握
Measurement of visibility distance using visibility targets, and a visibility meter, and a snow particle counter



▲視程計測値、飛雪流量と視程板視認距離
Visibility measured using visibility targets vs. visibility distance using a visibility meter; and visibility distance using visibility targets vs. mass flux of snow

吹雪視程障害時にドライバーが感じる視程

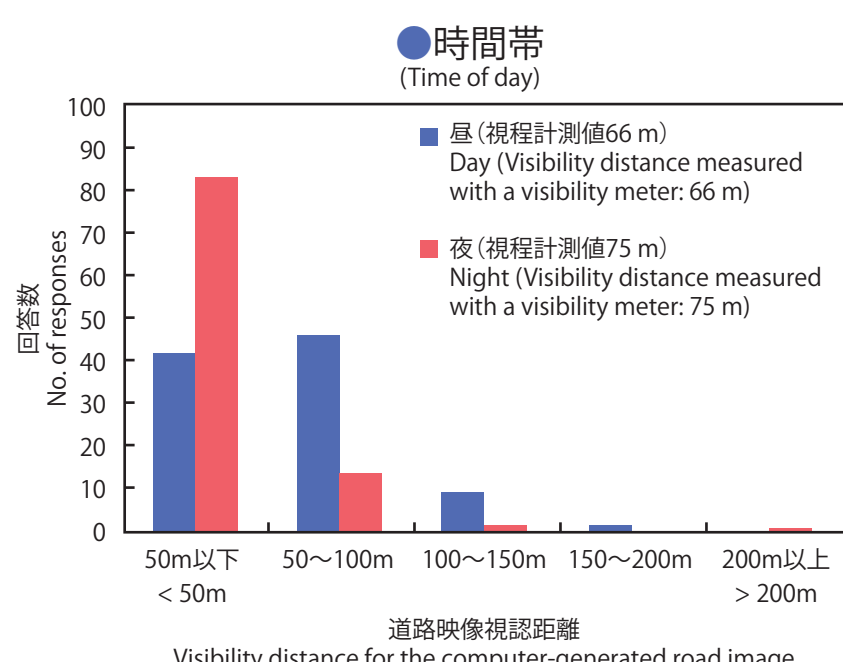
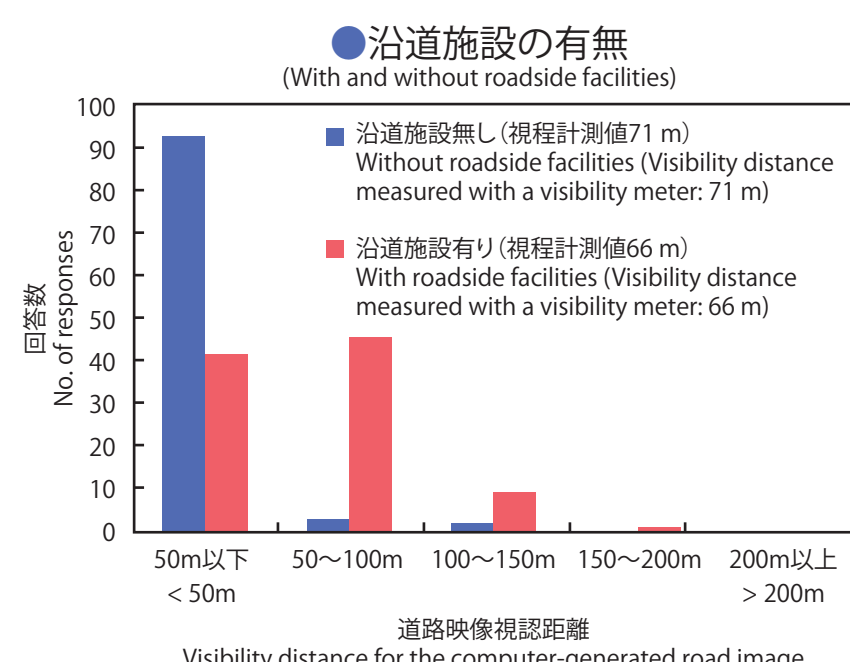
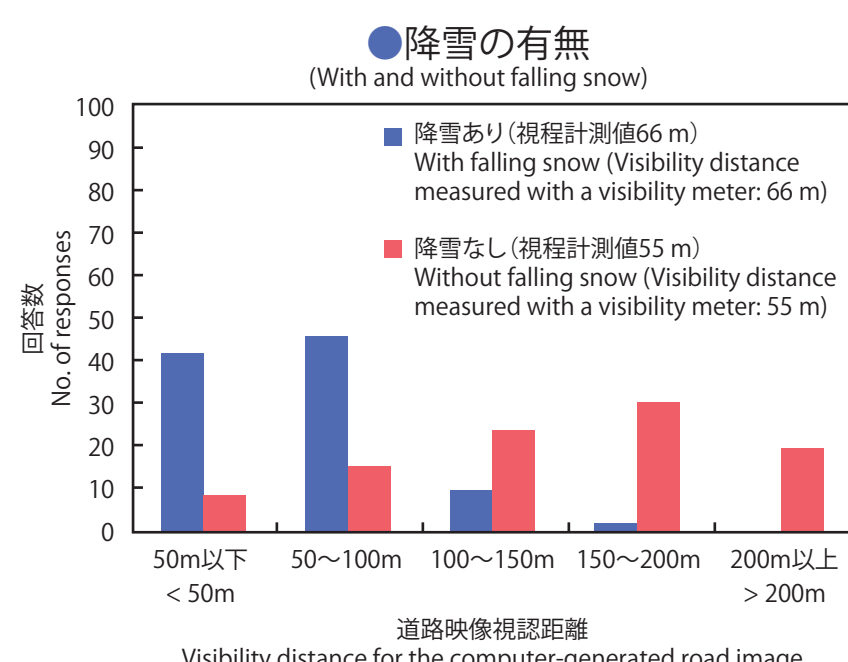
Subjective visibility distance for drivers under snowstorm-induced poor visibility

吹雪時にドライバーが感じる視程に影響を与える気象条件や沿道環境などの要因やその影響度について明らかとするため、走行中の道路映像を被験者に屋内で見せる調査を行っています。その結果、吹雪時の道路映像から被験者が感じる視認距離は降雪が無い場合に比べ降雪の有る場合の方が短く、沿道家屋や電柱などの沿道施設が無い方が有る場合より短く、昼間に比べ夜間の方が短いなどの傾向が見られました。一方、吹雪の向きの違いに関しては視認距離にあまり違いが見られませんでした。

To clarify the factors, including weather conditions and roadside environment, that act on the subjective visibility distance judged by drivers during a snowstorm, we have been conducting experiments in which test subjects view images of roads. The subjective visibility distance in the experiment tends to be less when snow is falling, when there are no roadside facilities such as utility poles or houses, or at night than when snow is not falling. Differences in the direction of blowing snow did not affect the subjective visibility very much.



▲吹雪視程障害時の走行中の道路映像
Road image taken from a moving vehicle under snowstorm-induced poor visibility



▲吹雪時の気象条件や走行環境が異なる道路映像に対する視認距離の回答数
Number of "visible" responses for each visibility distance by test subjects viewing road images with different weather conditions and driving environments