

Case Study of Blowing Snow Potential Diagnosis with Dynamical Downscaling

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Reference: Tanji, S., and M. Inatsu 2019: Case study of blowing snow potential diagnosis with dynamical downscaling. *SOLA*, 15, 32–36, doi:10.2151/sola.2019-007.

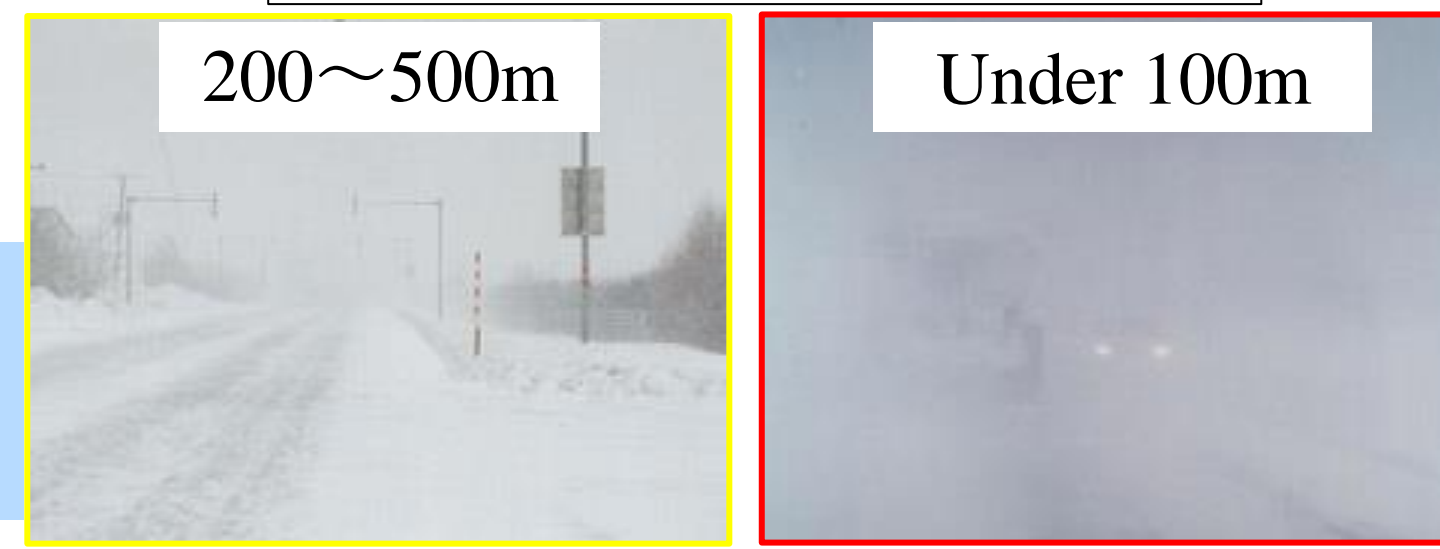


Introduction

Blowing snow is a phenomenon that strong wind resuspends surface snow particles or blows snowfall particles. Blowing snow in road often causes poor visibility and these situations have risks for traffic accidents. Some blowing-snow prediction systems operated in Japan use weather forecast data with 5-km grid mesh. However, blowing snow is caused by background wind, mostly turbulent surface flow under the boundary layer. We found a large scale gap between the resolution of weather forecast data in conventional blowing snow prediction system and the scale of blowing snow development.

This study aims to diagnose blowing-snow potential with 1-km resolution dynamically downscaled (DDS) data and find an add value of DDS data.

Driver's view in poor visibility



http://northern-road.jp/navi/info/guide1_2.html

Case

31 Jan 2019 - 1 Feb 2019

- Strong wind caused blowing snow around Sapporo in the morning on 1 Feb.
- Expressway between Sapporo and Ebetsu had been closed from 2330 UTC on 31 Jan to 0410 UTC on 1 Feb.
- Traffic accidents had happened for low visibility in Ishikari city.

Data & Methods

DDS

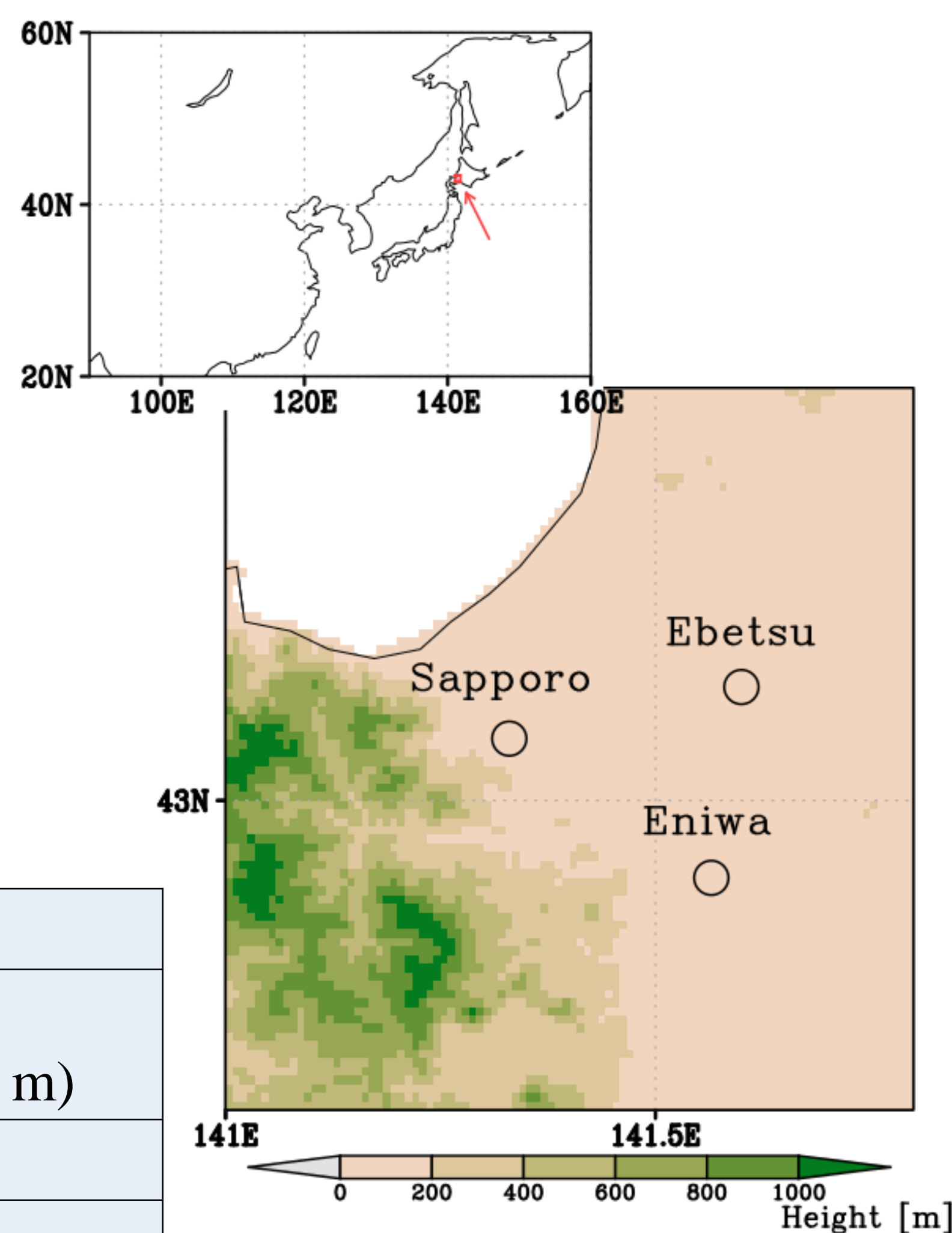
◆Original data

MesoScale Model (MSM) analysis provided by the Japan Meteorological Agency

Time interval	3 hourly
Resolution	5 km

◆Model configuration

Horizontal grid mesh	90 × 90
Vertical layers	32 layers (model top: 19,981 m)
Integration time	72 hours
Resolution	1 km
Domain	141.0 °E - 141.8 °E by 42.7 °N - 43.4 °N



Snow concentration n (g/m^3)

$$n(z) = \frac{P}{w_f} + \left(n_1 - \frac{P}{w_f} \right) \left(\frac{z}{z_1} \right)^{-\frac{w_b}{kU_*}} \quad (1)$$

$$U_* = \frac{kU(10)}{\ln \frac{10}{z_0}} \quad (2)$$

Red character: use meteorological data

◆Thresholds of environment

$$\begin{aligned} U_{10} &\geq 5 \text{ m/s} \\ T &\leq 0^\circ \text{C} \end{aligned} \quad (3)$$

If weather conditions violate these thresholds, we neglect the second term of the right hand of (1).

Visibility (m)

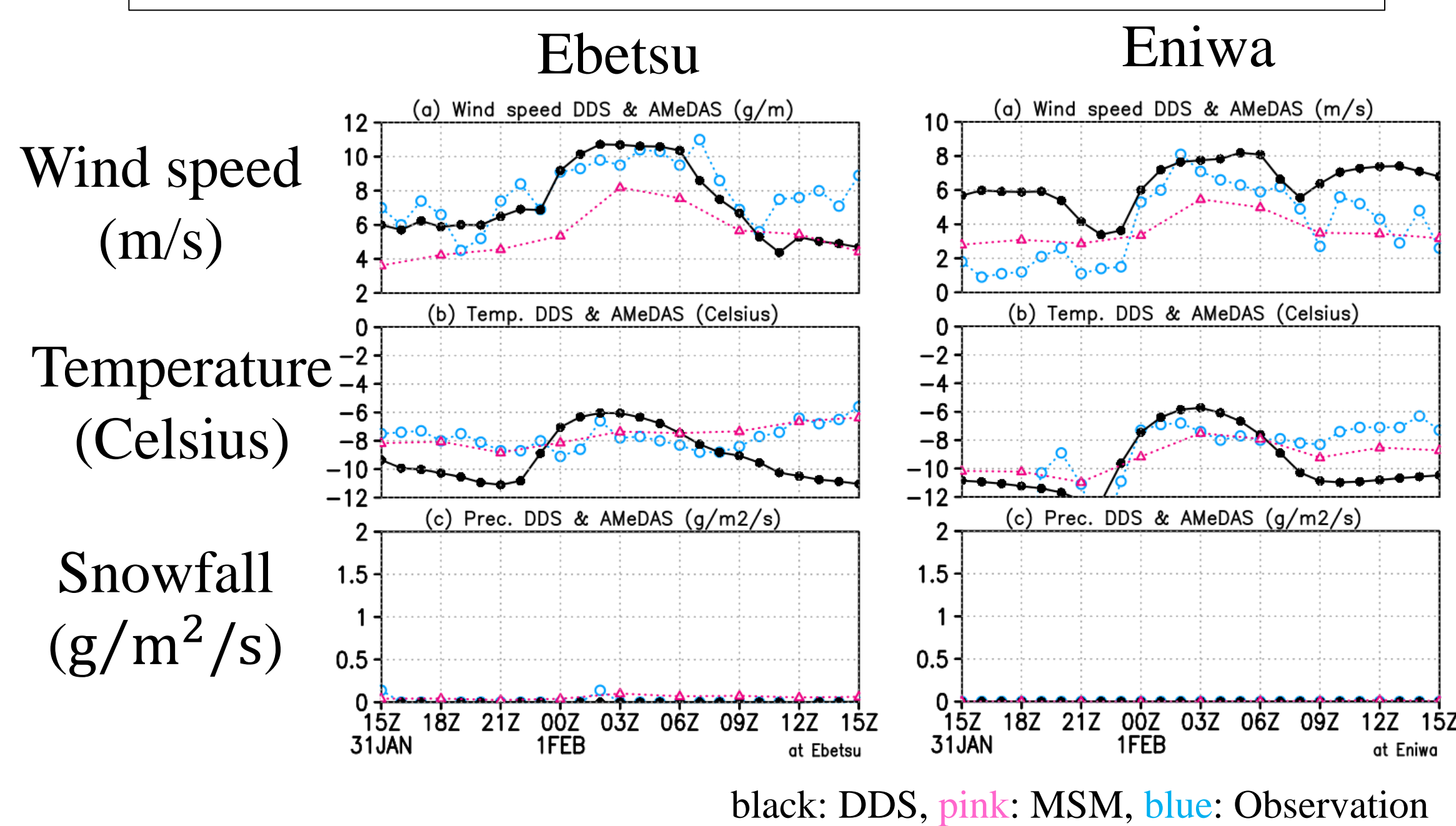
$$\log(vis) = -0.773 \cdot \log(n(z) \cdot U(z)) + 2.845 \quad (4)$$

We estimate snow concentration and visibility at **1.2 m** from the surface, a height of driver's eyes.

Matsuzawa and Takeuchi (2002)

Results

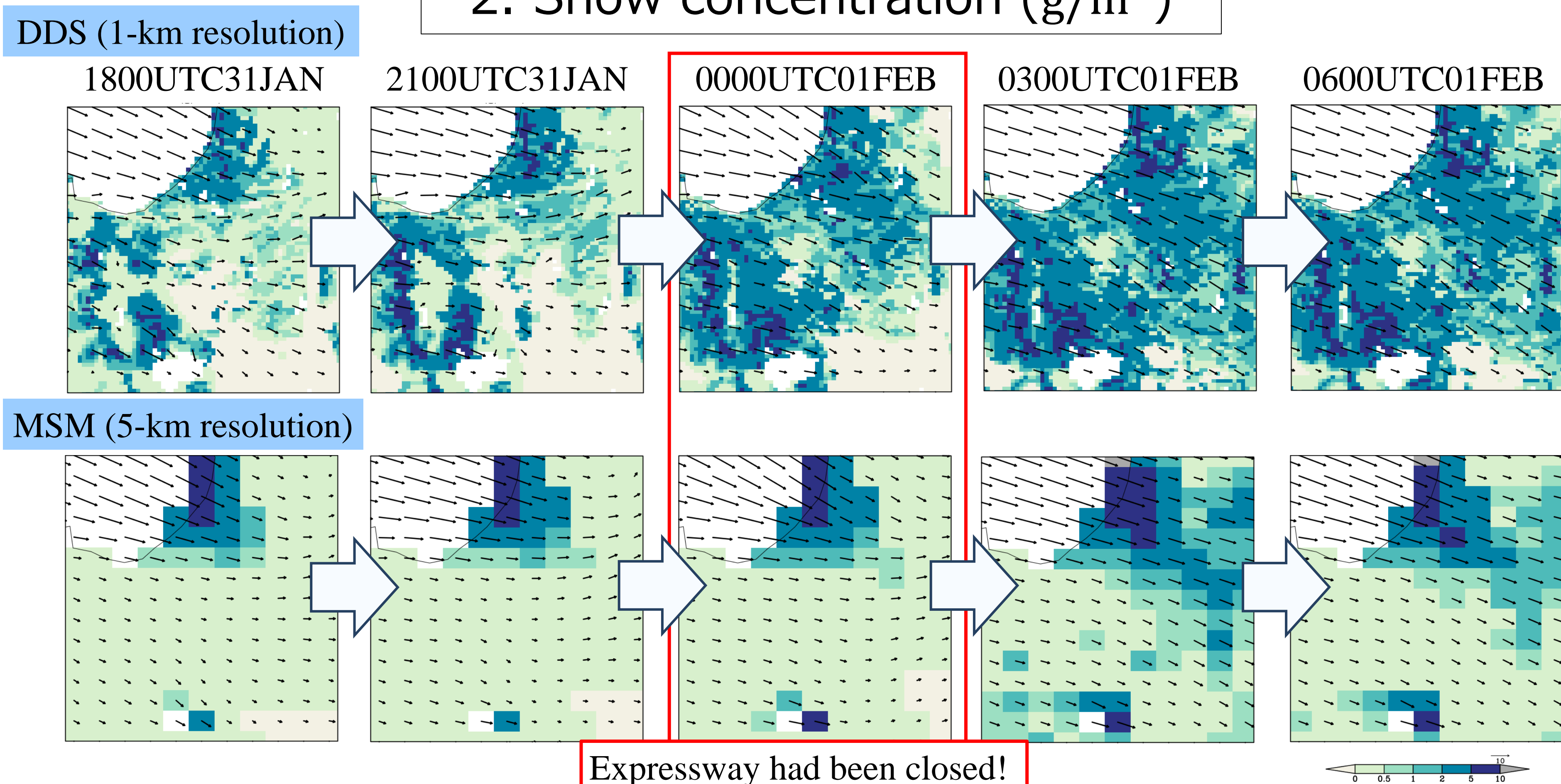
1. Comparison with observation



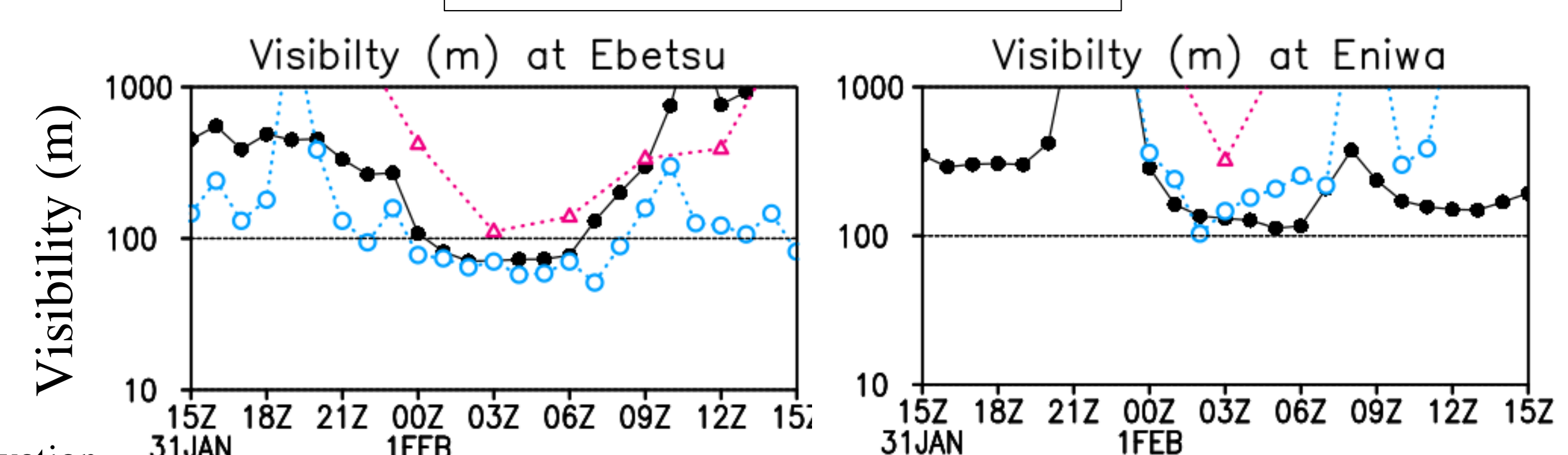
black: DDS, pink: MSM, blue: Observation

- The DDS reproduced an increase of the wind speed after 0000 UTC on 1 Feb, whereas the MSM analysis provided a rather constant wind.
- Based on DDS data, the snow concentration increased on almost all grids in the three hours just before expressway closing.
- Visibility based on DDS data and based on observation data became low rapidly, about 100-500 m visibility, at 0000UTC. This time was just after closing expressways around Ebetsu.

2. Snow concentration (g/m^3)



3. Visibility (m)



black: DDS, pink: MSM, blue: Observation

Summary

- ◆ We have estimated snow concentration and visibility based on the dynamically downscaled data with 1-km resolution.
- ◆ The temporal variation of blowing snow **could be diagnosed based on the DDS data.**
- ◆ In contrast, the blowing snow potential **with the meso-scale model analysis did not reproduce the blowing snow development.**