Response to comments of Reviewer 2

The authors wish to thank the reviewer for addressing suggestive comments which will improve the quality of this article. In this response, the original comments are in italics.

General Comments:

This is a very interesting paper and definitely adds value to the science in the snow mass budget. I have following review suggestions for authors to consider.

(a) Authors estimated surface sublimation and blowing snow transport for the snow mass budget. Authors pointed out that air temperature, relative humidity, and wind speed are three important variables those affect most on the snow transport and surface sublimation. It would be nice to see which variables affect most on the surface sublimation and snow transport. Figure 1 indicates that snow rate is higher when temperature is lower and relative humidity is higher. But it is not consistent. Blowing snow transport may be higher at high wind speed, but Figure 1 shows that higher snow rate is observed for lower wind speed. This may be because of increasing surface sublimation. This raise a question that at lower wind speed air may not carry moisture for a long distance over land surface. So, have you considered changing the RH of air spatially in your model.

A: Snow rate in Fig.1d indicates precipitation rate, not the sublimation rate. "Snow rate" of the vertical axis labeled in Fig.1d was modified to "Snowfall rate" to avoid the confusion. Relative humidity is very important to surface sublimation, and wind speed is a relatively important factor to affect blowing snow transport. As can be seen from Figure 2, the simulated blowing snow sublimation corresponded to the high wind speed and low relative humidity well. The spatial variation of relative humidity was considered in our 3-d mesoscale model, as well as the advection effects of moisture. Yes, we agreed that there will be less moisture advection under the condition of lower wind speeds.

(b) You have considered 18km grid resolution. Highly terrain land and presence of vegetation may decrease the wind speed because of friction. How did you consider those in your model?

A: We agreed that the highly terrain land and vegetation may decrease the wind speed because of friction. There is no spatial topography variability within 18km grid resolution, and the vegetation effects are considered as increased roughness length. The spatial distribution of vegetations and roughness length was added as a new Figure 9, and the subsequent figure numbers have been changed correspondingly. The content between line 11 and line 20 on page 945 has been modified as following:

Vegetation data from the US Geological Survey (USGS 2002), which are used in our simulation, indicate largely evergreen needle-leaf trees and mixed wood forests over the Canadian boreal forests, and deciduous needle-leaf trees over Siberia (Fig. 9a-c). These tall trees result in larger roughness lengths over forested area above the trees than over the tundra and prairies (Fig. 9d). Within the forest canopy, winds are greatly reduced and do not reach the wind threshold for blowing snow for surface snow within the forest canopy. Indeed, if a fully operational land surface scheme such as CLASS (Verseghy, 2000) is used, the presence of vegetation would cause sub-canopy wind speeds to be extremely low resulting in almost no blowing snow transport or sublimation where there are forests (Pomeroy et al., 1999).

Minor suggestions:

1) Page 934 line 1: a reference is required for "parallel MC2 (version 4.9.8)", because it is not familiar to all readers.

A: two references are added.

Benoit, R., Desgagne, M., Pellerin, P., Pellerin, S., Chartier, Y., and Desiardins, S.: The Canadian MC2: A semi-Lagrangian, semi-implicit wideband atmospheric model suited for finescale process studies and simulation, Mon. Weather Rev., 125, 2382-2415, 1997.

Thomas, S. J., Girard, C., Benoit, R., Desgagné, M., and Pellerin, P.: A new adiabatic kernel for the MC2 model, Atmos. Ocean, 36, 241-270, 1998.

2) Page 936 line 28: better to mention the blowing snow criteria.

A: blowing snow criteria was mentioned earlier at line 1 on page 936.

3) Page 938 line 11-14: what do you mean by 54-hour integration? Explain more explicitly.

A: The following sentence was added to line 12 on Page 938 to explain the 54-hour integration.

Every two days, a 54-hr mesoscale numerical simulation was performed with initial and lateral boundary conditions interpolated from CMC analysis data.

4) Page 939 Equation 1: Give little explanation how did you take measurement of each terms in the right hand side.

A: The field experiment over St. Denis National Wildlife Area (SDNWA) measures snow depth and density at different days, giving the evolution of surface Snow Water Equivalent (SWE). Hourly measurements of precipitation was measured by Alter-shielded Geonor precipitation gauge, and corrected for wind-undercatch using the algorithm of MacDonald and Pomeroy (2008). In this paper, we validated the simulated SWE evolution against observed value instead of individual terms due to the lack of direct measurements for sublimation and blowing snow transport. The following text was added to line 27 on Page 938 to explain the snowfall rate measurement. The reference was added to the reference list as well.

Snowfall rate was measured by the Alter-shielded Geonor precipitation gauge, and corrected for wind-undercatch using the algorithm of MacDonald and Pomeroy (2008).