

#### Response to comments by Reviewer #4:

This paper optimizes the snow depth data simulated by the model by using the snow depth data observed at the station. The main questions are as follows:

1. The title of the article is not accurate, and the purpose of assimilation cannot be obtained. The meaning of "snow" is too broad, so it needs to be specific;

**Reply:** Thanks for your sincere and constructive suggestions. In this study, the Genetic Particle Filter was used as a data assimilation scheme to improve the simulation accuracy of snow depth by Noah-MP model, as the reviewer said, the meaning of "snow" is too broad in the title, and we will change a new title which can highlight the theme of this article.

2. Is the  $W_s$  in NOAH-MP optimized by snow depth observation?  $W_s$  is the snow water equivalent. Is there any difference between the two?

**Reply:** Thanks for your sincere and constructive suggestions. The snow water equivalent was calculated by snow depth and snow density in Noah-MP model, and the snow water equivalent was optimized by snow depth observation. In this study, most of the sites do not have snow water equivalent observation data, so the experimental results of snow water equivalent were not shown in the paper.

3. The observation operator and model operator mentioned in Flow Chart 1 are not seen in the text, and need to be clarified;

**Reply:** Thanks for your sincere and constructive suggestions. In this study, we just assimilated the station observation data into the Noah-MP model, and we haven't assimilated remote sensing observation data into the model, the observation operator is an identity matrix in this study. And the model operator is the Noah-MP model.

4. The optimized state variables are not seen in the paper. If only the simulation results of NOAH-MP are corrected, which can not be regarded as assimilation;

**Reply:** Thanks for your sincere and constructive suggestions. In this study, the Genetic Particle Filter (GPF) was used to improve the simulation accuracy of snow depth by Noah-MP model, and the performance of GPF was investigated across snow climates. We don't understand what you mean, can you be more specific?

5. The calculation formula of  $f_{snow}$ ,  $g$  needs to be given. Snow depth is also used in the calculation formula of  $f_{snow}$ ,  $g$ . If snow depth is assimilated, has this been considered? If regional assimilation is carried out, how is  $f_{snow}$ ,  $g$  calculated?

**Reply:** Thanks for your sincere and constructive suggestions. The main work of this study is to investigate the performance of Genetic Particle Filter across snow climates, and examine the feasibility of GPF used as a snow data assimilation scheme in point-scale. If snow depth is assimilated, the  $f_{snow}$  can also be updated. The regional assimilation is our next work, the snow albedo will be assimilated into land surface model to improve the  $f_{snow}$ . Here, we verified the feasibility of GPF used as snow data assimilation scheme and prepare for the regional assimilation experiment.

6. The introduction of assimilation process in this paper is not complete and detailed enough, and needs to be further improved.

**Reply:** Thanks for your sincere and constructive suggestions. We will thorough revise the manuscript according to the reviewer's suggestion.