Reviewer #1: The paper by Seo and Dirmeyer, titled "Implementation of Multi-layer Snow Scheme in Seasonal Forecast System and Its Impact on Model Climatological Bias," investigates the effects of implementing a multi-layer snow scheme on the climatological biases of a seasonal forecast system. Traditional single-layer snow schemes in land surface models often inadequately capture the insulating effects of snowpack, leading to warm and cold biases during winter and snow melting seasons. The study compares the performance of the Global Seasonal Forecast System (GloSea) versions 5 (single-layer) and 6 (multi-layer) over a 24-year period. Findings reveal that the multi-layer snow scheme in GloSea6 shifts the snow melting season by two weeks, improving surface temperature, permafrost extent, and overall model climatology. This enhancement mitigates near-surface warming bias and improves precipitation simulation over snow-covered regions.

➔ *We thank the reviewer for the comments. We hope we have adequately clarified our descriptions and addressed the points raised.*

However, it overlooks critical differences in vegetation treatment between the Noah and Noah-MP models. Suzuki and Zupanski (2018, doi: https://doi.org/10.1007/s11707-018-0691-2) provide a thorough examination of the uncertainties in solid precipitation and snow depth prediction, which is highly relevant to this study. The differences between the land surface models are notable: the Noah model uses a one-canopy layer with a simple canopy resistance and a linearized energy balance equation representing the combined ground-vegetation surface, considering seasonal LAI and green vegetation fraction. In contrast, the Noah-MP model includes snow interception features such as loading-unloading, melt-refreeze capabilities, and sublimation of canopy-intercepted snow, along with a detailed representation of radiation transmission and attenuation through the canopy, within- and below-canopy turbulence, and different options for representing the biophysical controls on transpiration. Therefore, the changes affect not only snow-covered areas but also the global vegetation albedo and surface temperature. In their results, they report that the snow depth changes, but the snow water equivalent does not. The reason for the longer period of snow cover is believed to be due to the more accurate representation of radiation and turbulent fluxes beneath the vegetation canopy. Therefore, the multi-layer snow model is not the critical factor in this case.

➔ *We agree that vegetation treatment is also a critical factor influencing snow physics in seasonal forecast systems. Compared with the Noah LSM, the improvement of snow simulation in the Noah-MP is due not only to the implementation of multi-layer snow scheme, but also to a semi-tile subgrid scheme to separate vegetation and bare soil. However, this study has used JULES LSM, which is a community model developed by UK Met Office, rather than Noah and Noah-MP LSMs. We have tried to correct any of confusion that may arise regarding the use of land surface model.*

In both GloSea5 and GloSea6 models, there are no changes to vegetation treatment. The surface of each land grid box subdivided into five types of vegetation (broadleaf trees, needle-leaved trees, temperate C3 grass, tropical C4 grass and shrubs) and four non-vegetated surface types (urban areas, inland water, bare soil and land ice). Regarding Leaf Area Index (LAI), the ancillary parameters are derived from satellite data processed to be consistent with these land cover and plant functional type classifications.

To enhance the completeness of your study, it is crucial to discuss the impact of vegetation treatment in addition to the multi-layer snow scheme. By addressing these points, the manuscript will provide a more holistic view of the improvements in seasonal forecast systems and their broader climate implications.

- ➔ *In this study, there is no modification of vegetation in GloSea5 and GloSea6 runs, but the model configuration for the vegetation is now briefly described in the manuscript. Thus, the information of prescribing vegetation according to plant function types has been added in Lines 123-127*

  "Other land surface physics are consistent in GloSea5 and GloSea6. For land surface types, five vegetation (broadleaf trees, needleleaf trees, C3 grasses, C4 grasses and shrubs) and four non-vegetated surfaces (urban, open water, bare soil and permanent land ice) are classified and the monthly climatology of leaf area index, derived from MODIS satellite product (Yang et al., 2006), is prescribed corresponding to the plant functional types. Snow is present on every land tile, including inland water when its temperature is below freezing."

  ** Yang, W., Tan, B., Huang, D., Rautiainen, M., Shabanov, N. V., Wang, Y., Privette, J. L., Huemmrich, K. F., Fensholt, R., and Sandholt, I.: MODIS leaf area index products: From validation to algorithm improvement, IEEE Transactions on Geoscience and Remote Sensing, 44, 1885-1898, 2006.*

Specific Comments

Introduction and Background: Please include a discussion on the handling of vegetation in land surface models, specifically contrasting the Noah and Noah-MP models.

Methodology: Please provide detailed descriptions of the Noah and Noah-MP models, focusing on their treatment of vegetation and snow processes. In addition, please discuss how these differences might affect your results and the broader implications for climate modeling.

Results and Discussion: Please analyze the impact of vegetation treatment on your findings, especially in terms of global vegetation albedo and surface temperature.

Conclusion: Please emphasize the importance of considering both snow and vegetation processes in land surface models.

- ➔ *Both forecast models (GloSea5 and GloSea6) have used the JULES LSM, but several updates in the model physics are implemented. Neither Noah nor Noah-MP are part of the model configurations used here. Therefore, we try to reflect only the reviewer's suggestion for describing the vegetation treatment in the JULES LSM.*