Response to Editor Mario Ebel

Please ensure that the colour schemes used in your maps and charts allow readers with colour vision deficiencies to correctly interpret your findings. Please check your figures using the Coblis – Color Blindness Simulator (https://www.color-blindness.com/coblis-color-blindness-simulator/) and revise the colour schemes accordingly. --> Figs. 5, 6, 7

Reply: Thank you for your instruction. We changed the color schemes for figs 5, 6, 7.

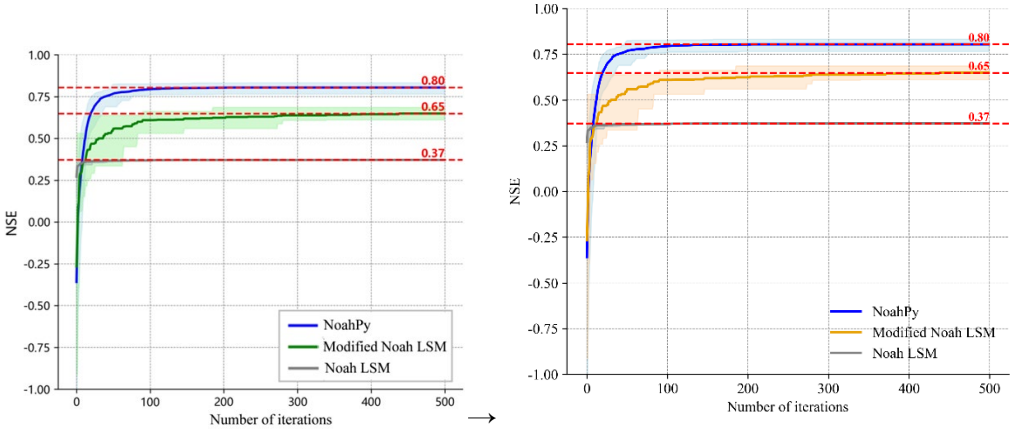

Fig 5

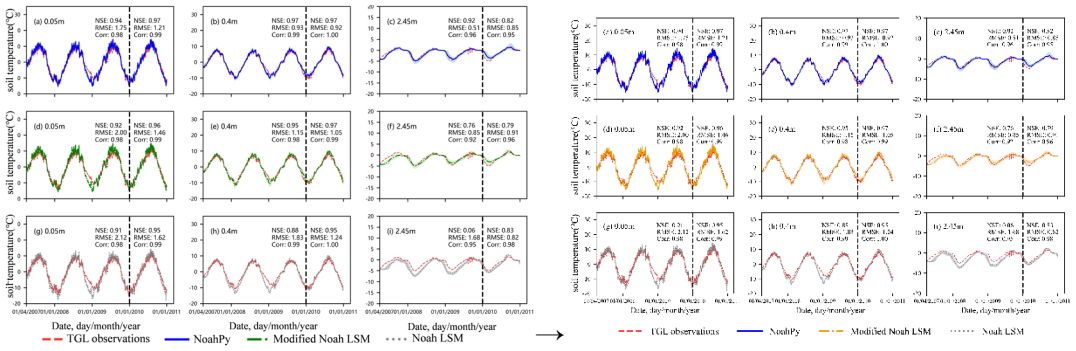

Fig 6

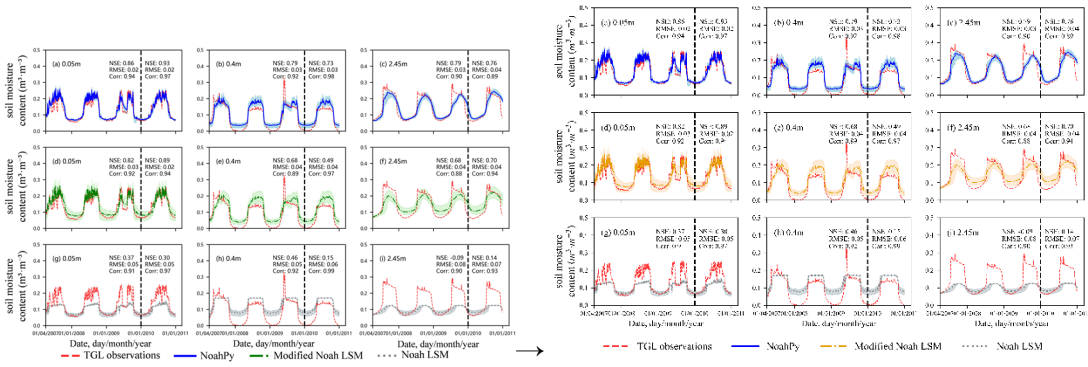

Fig 7

Response to Anonymous referee #3

I agree with Reviewer 2's concern regarding the use of the term "fully differentiable Noah LSM". Only the soil temperature and moisture solvers are differentiated through this study. Based on my understanding, it is not very appropriate to call the model "fully differentiable" (or by nature, the Noah model is not a fully differentiable LSM). The current terminology would lead to some confusion. I would suggest changing the term in the title and throughout the text to be something like "A python-based Noah LSM with differentiable soil thermo-hydrologic solvers".

Reply: Thank you very much for your suggestion. We have modified the relevant text to reflect your concerns. Please see the change tracked doc for all modifications we have made. Note, the line numbering refers to that in the change tracked doc.

In Abstract (Ln 16-18):
To overcome this limitation, we present NoahPy, a ~~fully~~ differentiable LSM developed by reconstructing the Noah LSM's governing partial differential equations into a process-encapsulated Recurrent Neural Network (RNN), with the heat–moisture solver forming the computational core.

Section 1 (Ln 70-72):
To address this gap, we introduce NoahPy: a ~~fully~~ differentiable LSM built upon a version of the Noah LSM already modified and validated for simulating permafrost thermos-hydrology on the Qinghai-Tibet Plateau (QTP).

Section 2.2 (Ln 110-111)
The implementation of NoahPy involves recasting the numerical solution of the modified Noah LSM's governing equations into a ~~fully~~ differentiable computational structure.
Ln 150-152
While some of these processes are mathematically not strictly differentiable, re-implementing them within PyTorch ensures that a valid gradient can be computed for every operation via the automatic differentiation engine. This makes the ~~entire~~ model ~~fully~~ differentiable in the context of gradient-based optimization.

Section 4 (Ln 370-371)
This study successfully demonstrated the development and application of NoahPy, a ~~fully~~ differentiable land surface model for permafrost.

Section 5 (Ln 417-420)
In this study, we developed NoahPy, a ~~fully~~ differentiable land surface model specifically improved for permafrost thermo-hydrology. We successfully recast the widely-used, Fortran-based Noah LSM into a "glass-box" Python framework that is both physically interpretable and implements differentiable operations ~~fully compatible with~~ for gradient-based optimization.