We thank the editor and referees for the encouraging comments and suggestions to improve the manuscript.

We undertook minor revisions to incorporate the comments raised by referee 2. We have given point-by-point responses to the referees' comments and made necessary changes to the manuscript in response to suggestions. We believe that the revised manuscript fully satisfies the referees' concerns.

Referee comments are shown in bold. Author responses are shown in plain text.

Referee 1

The authors have clearly addressed all of my concerns. I especially appreciate the changes that were made to the figures to make them more readable, and the clarification of the methods. Lateral water transfers (both surface and subsurface) are clearly very important in this complex terrain system on representation of ET. Great work!

We thank Dr. Aaron Alexander for their thorough review and encouraging comments on the manuscript.

Referee 2

We thank Dr. Zhao Yang for their thorough review and suggestions to improve the manuscript.

Specific Comments:

1. The authors should more clearly articulate the significance of lateral flow beyond the references already cited. While the current discussion is helpful, it would benefit from elaboration on how lateral flow becomes increasingly important at hyper-resolution scales. A critical assumption in many land surface models (LSMs) is that surface and subsurface runoff are removed from the system at the end of each time step. When lateral flow is explicitly represented, however, this water remains within the domain and continues to interact with the hydrological cycle. This distinction is crucial and should be emphasized in the introduction, as it fundamentally affects water and energy flux partitioning in LSMs (Yang et al., 2021).

We thank the referee for the suggestion. We have included this point in the introduction of the revised manuscript.

Page 3, Lines 93-95:

"In standard LSM simulations, surface and subsurface runoff are removed from the system at the end of each model time step. In LSM simulations with lateral flow representation, runoff remains in the system and continues to affect other water cycle components such as ET and soil moisture."

2. Paragraph starting 53, This paragraph makes a valuable attempt to summarize different representations of lateral flow, but the discussion is somewhat limited. Key contributions are missing, for instance, the work by Peter Hazenberg (Hazenberg et al., 2015a, 2015b), the Advanced Terrestrial Simulator (ATS), HydroGeoSphere, among others. The authors are encouraged to expand this section and provide a more comprehensive overview of existing modeling frameworks.

We thank the referee for the suggestion.

Herzenberg et al. (2015a) and Hazenberg et al. (2015b) details a hillslope-based formulation with specified connectivity for land surface modelling, and we have now cited this work appropriately in the paragraph (page 2, lines 58-59).

Further, the referee refers to integrated surface subsurface hydrological models that incorporate lateral flow. There formulations have not been used in LSMs likely because of the challenges in coupling them. We believe that an introduction focussed on LSMs works better for this paper. We have now made it clear our summary in the paragraph starting on line 53 pertains only to lateral flow in LSMs.

Page 3, lines 70-74:

"It is worth noting that this summary pertains to modelling systems that includes lateral flow processes in LSMs used for Earth system modelling. Other models of lateral flow have been developed in the domain of integrated surface subsurface hydrological modelling to understand watershed system function (Bhanja et al., 2023; Brunner and Simmons, 2012). But these formulations have not been used in LSMs, likely due to the challenges in coupling them with LSMs."

3. I believe the manuscript inaccurately states that subsurface flow is simulated on the LSM grid in WRF-Hydro. As far as I know, both surface and subsurface routing are handled on the routing grid. Please double-check this and revise accordingly.

We thank the referee for noting this error. The referee is correct that both surface and subsurface routing are handled on the routing grid, and we have revised this.

Pages 4-5, lines 116-117:

"WRF-Hydro has the capability to simulate overland, shallow subsurface, and channel flows on the fine resolution routing grid."

4. Line 289-295, The description of the "water balance" is somewhat misleading. What the authors present appears to be a partial water budget rather than a rigorous water balance analysis. A complete water balance requires quantification of all relevant terms (e.g., precipitation, ET, surface runoff, subsurface runoff, streamflow) and verification that the total inputs and outputs are conserved. Given that baseflow is disabled in the simulation, it is essential to demonstrate whether the budget closes with the available terms. The claim that ET and runoff exceed precipitation and that the difference can be attributed to soil moisture is problematic unless explicitly supported by budget closure analysis. Please provide evidence to substantiate this interpretation or revise the claim.

We thank the referee for raising this intricate point. The water cycle terms we present are based on estimates that close the water balance. However, the referee is correct that the manuscript did not contain enough information to substantiate this. In the revised manuscript, we include more detail about the calculation of the water cycle terms and add Appendix Table A2 to support Table 3 in the manuscript by demonstrating water balance closure as detailed below.

In the Methods (page 9, lines 220-231):

"2.4. Water balance in the simulations
The simulated water cycle components are used to understand the influence of lateral flow on surface water partitioning. In control simulations using Noah-MP LSM without lateral flow, incoming precipitation is partitioned into ET, surface runoff (variable name: *sfcrnoff*), underground runoff (variable name: *udgrnoff*), and changes in soil moisture in the four layers (0-10 cm, 10-40 cm, 40 – 100 cm, 100 – 200 cm) of the soil column. The volumetric soil moisture in each layer converted to water depths are used to estimate the total soil moisture change for water balance calculations. The total runoff

is estimated in two ways (a) as the sum of the surface and underground runoff components, and (b) as the residual of precipitation after ET and soil moisture changes. We use these components to demonstrate the closure of the water balance in the control simulations. In simulations including lateral flow, the total runoff consists of overland flow, channel flow and underground runoff components simulated on the fine resolution routing grid. The runoff terms on the routing grid are not written to output files to reduce computational expense. Hence, we estimate the total runoff in the lateral flow runs as the residual of precipitation after ET and soil moisture changes, closing the water balance in a manner consistent with the control simulations."

Table A2. Domain average water cycle terms accumulated over a 2-year period from 2015-12 to 2017-11 in the simulations. Negative soil moisture changes indicate a loss of moisture from the 2-m soil column over the 2-year period.

Variable	Simulation								
	CTL1	LAT1-100	LAT1-250	CTL4	LAT4-100	LAT4-250	CTL10	LAT1-100	LAT1-250
Precipitation, *P* (mm)	1504.4	1504.4	1504.4	1504.7	1504.7	1504.7	1503.1	1503.1	1503.1
ET (mm)	1264.3	1307.7	1289.1	1262.9	1317.2	1308.1	1260.8	1309.6	1304.8
Soil moisture change, *SM* (mm)	-17.9	-12.2	-13.5	-17.9	-14.2	-14.6	-17.9	-15.0	-15.7
Surface runoff, *sfcrnoff* (mm)	46.2			46.5			47.5		
Underground runoff, *udgrnoff* (mm)	211.8			213.2			212.7		
(a) Total runoff (*sfcrnoff* + *udgrnoff*), Ro (mm)	258.0			259.7			260.2		
(b) Total runoff (*P* – *ET* – *SM*), *Ro* (mm)	258.0	208.9	228.8	259.7	201.7	211.2	260.2	208.5	214.0
Water balance closure error, *P* – *ET* – *SM* – *sfcrnoff* – *udgrnoff* (mm)	0.0			0.0			0.0		
Runoff ratio (*Ro/P*)	0.17	0.14	0.15	0.17	0.13	0.14	0.17	0.14	0.14

In the Results (page 15, lines 307-311):

"Appendix Table A2 lists the domain average precipitation, ET, runoff components, and the change in soil moisture from the nine simulations. In the control runs, total runoff estimated as (a) the sum of the surface runoff and underground runoff components matches (b) the residual of precipitation after ET and total soil moisture change, demonstrating the closure of the water balance. In simulations including lateral flow, total runoff is estimated as the residual of precipitation after ET and total soil moisture change."

We then go on to discuss the changes in partitioning due to including of lateral flow (which was part of the original manuscript).

Hazenberg, P., Y. Fang, P. Broxton, D. Gochis, G.-Y. Niu, J.D. Pelletier, P.A. Troch and X. Zeng, 2015a: A hybrid-3D hillslope hydrological model for use in Earth system models, Water Resour. Res., 51, doi: 10.1002/2014WR016842.

Hazenberg, P., P. Broxton, D. Gochis, G.-Y. Niu, J.D. Pelletier, P.A. Troch, and X. Zeng, 2015b: Testing the hybrid-3D hillslope hydrological model in a controlled environment, Water Resour. Res., 52, 1089–1107, doi: 10.1002/2015WR018106.

Yang, Z., Huang, M., Berg, L. K., Qian, Y., Gustafson, W. I., Fang, Y., Liu, Y., Fast, J. D., Sakaguchi, K., and Tai, S.-L.: Impact of Lateral Flow on Surface Water and Energy Budgets Over the Southern Great Plains—A Modeling Study, Journal of Geophysical Research: Atmospheres, 126, e2020JD033659, https://doi.org/10.1029/2020JD033659, 2021.