Review of egusphere-2026-289 "Lake-Mountain synergy in convective clouds and precipitation over the Tibetan Plateau: a large eddy simulation study"

This manuscript presents an interesting large-eddy simulation study of controls on convection over an idealised high-altitude lake-mountain study area representative of the Tibetan Plateau. Sensitivity experiments varying the height of the mountain and removing the mountain or the lake are conducted to disentangle the different interacting processes which control where and how strong the convection is. The approach is a methodical one and there are some strong aspects to the analysis, but I do have some concerns about the model setup / results which need addressing, or at least justifying, in order for the reader to have confidence in the conclusions of the paper.

Major comments:

1) Initial / surface conditions: An initial temperature is given for the lake (284K) and a significantly warmer temperature for the land (300K). The initial near-surface air temperature (from the skew-T diagram in figure 3) is about 283K. This means there will initially be a significant positive surface heat flux from the land. How do the land (and lake) surface temperature and the surface fluxes evolve over time? Is there a diurnal cycle of radiation imposed? If so, what time of day / day of year / latitude is the model initialised with? Or are the surface temperatures fixed? It is import to be clear about this as the surface fluxes are ultimately driving the convection. If a diurnal cycle is not being imposed, how realistic is a 20 hour simulation with daytime surface conditions?
2) Lateral (y-direction) boundary: according to the text, these are period, in which case I would expect to see much more uniform results in the y direction since there is no variation in the topography or land surface in the y direction either. The results however (e.g. figure 5) show a very strong variation in the y direction with almost all the precipitation close to the centre line of the domain. This seems physically implausible. Assuming the model description is correct this would imply that the limited domain width is having a significant and non-physical impact on the convection. Did you do any sensitivity tests on this? Given these issues with the boundary conditions and lack of uniformity in the y direction, it casts uncertainties on the rest of the results in the paper and so this issue needs to be resolved.
3) Related to 2). Many of the results are averaged over the central 15km of the domain. Given the boundary conditions are periodic in the y direction there is no reason not to average over the whole width of the domain. However, given the

clear non-uniformity in the y direction noted in 2) the choice of what width to average over will affect the results. The choice of 15km seems arbitrary.

4) Choice of averaging time. Many figures show results averaged over hours 7-20 of the simulation. While I appreciate the need to average LES results to produce the mean flow, this is quite a long period to average over. The flow is definitely not statistically stationary over this period (as can be seen from the time series, e.g. figure 4. Why this choice of averaging window? And what are the implications of this on the results?
5) Averaging CAPE / CIN over pre / during and post convection. CAPE and CIN are primarily used to diagnose conditions conducive to convection and so I am not sure it makes sense to average these values over the whole 7-20 hours of the simulation which includes the convection (and post convection). To understand where and when convection occurs you need to study CAPE and CIN values before the convection initiates.
6) Why the choice of a sheared background wind profile? This does give low wind speeds at low levels, but becomes much stronger higher up. The results of the OL experiment suggest that this background wind dominates over any thermally induces lake-land breezes, while the OM experiment suggests that wave trapping / wave breaking is a key features of this setup which is again controlled by the background wind field alongside the stratification. In particular, a shear wind profile with wind speed increasing with height will promote wave trapping since the Scorer parameter decreases with height. This has a significant impact on the results over the mountain. Maybe this is realistic for the TP, but you should be clear about the rationale for the choice and the implications of that choice.
7) Section 2.4.1. I'm not sure this section is correct. If perturbations are from a horizontal average, then what do you do over the mountain where the horizontal intersects the terrain? Looking at later figures of e.g. θ', they can't be perturbations about a horizontal average as at a given level the values are all positive or negative (and by definition the horizontal average of a perturbation has to be zero). Is it perhaps perturbations from the background (upstream) profile or the initial profile? Please check and correct.
8) Explanation of cold air pooling, starting at line 475. Blocking can trap (potentially) cold air at low levels, but it cannot generate cooling. This must be through some diabatic process. It is not clear what the surface heat fluxes are (see comment 1 above), but it seems unlike that that is the cause of the cooling since it is not seen in the OL simulations. More likely is that the cooling is a result of evaporation / sublimation – possibly of precipitation since there is much less cooling in the OL simulation which contains less precipitations. Some further analysis is needed to properly determine the cause of this cooling.
9) You talk about how the moistening affect N_m, but not how the changes in potential temperature affect the stability. Maybe this is less important since the

changes (probably) happen after the convection and precipitation has occurred, but I can't be sure from the plots in the manuscript.

10) Figure 11 shows a vertical cross section of moist Froude number. The Froude number is useful defined as a bulk measure across some layer (i.e. over the height of the mountain), as in equation 8. How do you define a Froude number at a particular height? And why is that useful? If you want a local measure of the profile stability then something like a Richardson number would be more usual.

Minor comments

1) Line 62. "can profound influences" -> "can have profound influences"
2) Fig 1. The blue line floating about the ground to mark the lake is a bit confusing. I would suggest positioning this at the surface. Just ensure you make it thick enough that it stands out from the grey of the land surface.
3) Figure 2 caption. "The different sizes of the lake are marked." This seems a mistake. As far as I can see only one size of lake is used.
4) Figure 2. Why is the red dashed box bigger than the domain? Results are presumably only reported within the domain. Also mark on the distance upstream of the lake where the box starts (assuming that not all the domain is used).
5) Line 172. "Where" -> "where" (this is not the start of a sentence)
6) Line 201. Is this horizontal average in the x as well as the y direction? If so, how do you deal with terrain?
7) Line 201. I think you have θ' and θ the wrong way round here (<θ> is the average of θ and θ' is the perturbation about this average).
8) Line 210. "Where" -> "where" (this is not the start of a sentence)
9) Line 225. "Where" -> "where" (this is not the start of a sentence)
10) Line 225. Here I assume u is averaged over the layer 0-H_0 (and the same for N)?
11) Line 230. "Where" -> "where" (this is not the start of a sentence)
12) Line 320. "precipitation appears as a narrow in the leeward, terrain-locked band with limited downstream growth". This phrase is quite hard to understand. How about "precipitation appears as a narrow band locked to the terrain over the lee slope with limited downstream growth"
13) Figure 5. Missing label on y-axis. I assume this is distance in the y direction?
14) Figure 5 caption. "Time mean precipitation rate of 13h". What does this mean? Do you mean the time mean precipitation rate between 7 and 20 hours?
15) Figure 5 caption. The caption talks about difference plots (c), (e), (g) and (i) but these are not shown in the figure. Please update the caption to correctly describe the plots.
16) Line 335. "To diagnose the convective supply, instability" -> "To diagnose the convective supply and instability"

17) Line 357. “as mountain height increases, CAPE over the lake region increases”. I think this should be “CAPE over the lake decreases” from looking at figure 6? I don’t think the trends in CAPE and CIN are really clear. It depends a bit where over the lake you are looking. You might want to explain this logic more thoroughly.
18) Line 358. “exhibits the opposite tendency” is ambiguous as you are talking about two different tendencies in the previous line. I would be explicit and say “whereas precipitation over the lake increases.”
19) Line 395 “in the absence of lake” -> “in the absence of the lake”
20) Line 396 “deep convection occurs when moisture supports with suitable orographic lifting” does not make sense. Do you mean something like “deep convection occurs when moisture coincides with suitable orographic lifting”
21) Line 408. “Across the involving lake configurations” -> “Across the configurations with a lake present”
22) Figure 8. I assume the y axis here is height above ground level? Why not plot over the terrain as you do in other figures? At least you need to be explicit what you are plotting.
23) Line 444. “results in the precipitation formation is inhabited” -> “results in the inhibition of precipitation formation” or “results in the suppression of precipitation formation”?
24) Line 450 “using an open water configuration comparable to OM”. I think you mean OL not OM? There is no lake in OM.
25) Line 479. “hydrometeor of condensate growth and transport” does not make sense. Maybe just “hydrometeor growth and transport”?
26) Line 481. “enhanced hydrometeor” -> “enhanced hydrometeor mixing ratio”
27) Figure 10. Include a reference wind arrow on the plot to show wind speed?
28) Line 502. “N_m. and” -> “N_m, and”
29) Figure 11 caption. “most Froude number” -> “moist Froude number”
30) Figure 11 caption. “As in (a)” -> “as in (a)” - it is not a new sentence.
31) Line 536. “most trajectories” -> “Most trajectories” - start of a new sentence.
32) Line 538. “lower than in the involving lake experiments” -> “lower than in the experiments involving the lake”
33) Figure 12. Is the colour here water vapor mixing ratio? If so, why is it not conserved along a trajectory? Is this due to condensation and cloud formation?
34) Figure 12 caption. “in experiments with lake presence” is not true – you also show results for OM with no lake. Just remove this phrase?
35) Line 559-561. This sentence is repeated. Just delete the second occurrence.