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# *Interactive comment on* "High-resolution modelling of interactions between soil moisture and convection development in mountain enclosed Tibetan basin" *by* T. Gerken et al.

**Anonymous Referee #2**

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This paper investigates the effects of changing soil moisture on convection around a mountain-enclosed lake in the Tibetan Plateau. The authors run a 2D model coupled to a land surface model with a range of initial soil moisture values, to determine the effects on surface fluxes and convection. The authors show that for low soil moisture values the system is moisture-limited, while at high soil moisture values it is radiation-limited (due to high cloud cover decreasing insolation), leading to the most intense convection occurring with intermediate soil moisture values. Overall the paper is interesting and novel, particularly by describing soil moisture impacts in a region of complex topography, and so a worthwhile addition to the literature. The structure is good, al-

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though some aspects of the presentation could be improved. I recommend the paper for publication once the following comments are addressed (probably between major and minor).

Major comments:

A key aspect that is not discussed in much detail is the role of flux heterogeneity on the development of convection. Much of the paper takes a 1D approach, looking at mean turbulent fluxes and the evolution of convection throughout the domain, but the highly heterogeneous terrain will surely induce mesoscale circulations which will have a significant impact on convective initiation. For example, the authors argue that the reduction in convection for the highest soil moisture values are due solely to a reduction in radiation due to increased cloud cover. From the results it is clear that this is indeed a factor. However, the reduction in sensible heat fluxes over land due to the high soil moisture will also reduce the land-lake temperature gradient, potentially reducing the magnitude of any mesoscale flows, and therefore convergence over land, which will also reduce the intensity of convection. I think the impact of surface heterogeniety in your results needs to be discussed throughout the paper (e.g. in P4649, L1-9). For example, the authors could show 2D plots of surface fluxes/temperatures, and some quantification of convergence in the different simulations.

My other main issue (although with an easy solution) is the description of the model domain, as it is not shown in Figure 1 and there are no lat/lon coordinates of the end points. Locations such as the Nyenchen Thangla mountain chain may not be known by many readers (including myself), and although a reference to another paper is provided, this information should be included here.

Specific Figure comments:

Figure 1: This figure is key to orient the reader during the subsequent analysis, but is not very useful at the moment. I think the results in the paper can be applied beyond the Tibetan Plateau, so many readers may not be familiar with the region. At the moment it



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mainly shows land use type, but this is not referenced during the analysis at all (except land vs lake, of course). I would make the following suggestions:

- The figure should show topography, as this is probably the most important forcing of convection. Either add this as a line contour, or replace the land use colour contours with topography.

- Add a line showing the model domain. Also show what part of the model domain is the 'edge' (where fluxes are reduced to zero – I assume this part is excluded from the subsequent analysis?) as well as which parts count as 'basin' and 'plain' (e.g. in figure 7).

- Change the colour of the cross showing the location of the Nam Co station, as it is very hard to see.

- In the caption: "the markers indicate 10km a.g.l..." I'm not sure what markers are being referred to here.

- It would be helpful to label locations referenced in the text (e.g. the Nyenchen Thangla mountain chain).

- either as an extra panel here, or in Figure 3, it would be useful to have a plot of topography along the model domain.

Figure 2: I suggest that the y-axis is changed to height agl, to be consistent with all the other figures.

Figure 3: The axis and legend labels are too small. The colour contour range seems to wide, as I can only see light red/blue, so maybe this could be reduced? Maybe some of the variability is hidden by the line contours. It would be clearer if the line contours were thinner (I can't see the w values inside). It is hard to distinguish the black and blue lines (either make the blue lighter, or remove the black lines and add a panel showing topography).



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Figure 5: Like in Figure 3, the blue and black are hard to distinguish, especially with so many lines. A lighter blue would be helpful.

Figure 9: All labels need to be bigger.

Figure 10: It is quite hard to read this plot as it is quite small, especially the dashed line (maybe make this another colour?)

Minor comments:

P4636, L20: There is quite a large body of literature showing the effect of surface heterogeneity at those scales on winds and convection in aircraft observations (Taylor et al 2007, Garcia-Carreras et al 2010), satellite (Taylor et al 2012) and models (Cheng et al, 2004 amongst others). In particular, Taylor et al (2012) shows that, in flat terrain, a negative soil moisture – rainfall feedback appears to be the norm (consistent with the convection-permitting simulations described in the following paragraph).

Taylor, C. M., D. J. Parker, and P. P. Harris (2007), An observational case study of mesoscale atmospheric circulations induced by soil moisture, Geophys. Res. Lett., 34, L15801, doi:10.1029/2007GL030572.

Garcia-Carreras, L., D. J. Parker, C. M. Taylor, C. E. Reeves, and J. G. Murphy (2010), Impact of mesoscale vegetation heterogeneities on the dynamical and thermodynamic properties of the planetary boundary layer, J. Geophys. Res., 115, D03102, doi:10.1029/2009JD012811.

Taylor, C. M., de Jeu, R. A., Guichard, F., Harris, P. P., & Dorigo, W. A. (2012). Afternoon rain more likely over drier soils. Nature, 489, 423-426.

Cheng, W. Y. Y. & Cotton, W. R. (2004), Sensitivity of a cloud-resolving simulation of the genesis of a mesoscale convective system to horizontal heterogeneities in soil moisture initialization. J. Hydrometeorol. 5, 934–958

P4643, L24: Here the authors are not using a single model grid point, but the model



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domain-mean, which will additionally introduce systematic differences due to heterogeneity in the domain(which the authors allude to earlier in the paper). How does Figure 5 change if the closest model grid point to the station is used, instead of the whole domain? Is 0.75 x FC still the 'best'? There is no need to necessarily show the figure, but a comment in the text would be useful.

P4644, L10-11: This directly contradicts the 2D vs 3D comparison, which shows stronger convective development in the 3D simulation.

Typographical errors:

P4633, L11: I would change 'convection development' with either 'convective development' or 'development of convection' (here and elsewhere in the paper).

P4633, L14: "and sensible heat fluxes, WHICH has a strong..."

P4634, L21: Remove 'semi-arid' (mountains are important triggers of convection everywhere).

P4637, L21: "it is situated AT 300 m distance FROM a small lake... to the northwest BY a 500 m"

P4637, L24: "AT 00:00, 06:00 ..."

P4640, L21: How come the simulation begins at 0400 LT while the initial profile is for 0600LT?

P4641, L9: Use LT instead of UTC.

P4641, L17: What do T1 and T2 refer to?

P4645, L14: "to soil moistures IN the moister 1.5 x FC case"

P4646, L7-9: Unclear, suggest rewriting this sentence.

P4647, L8: "which is associated WITH INCREASED cloud cover". The following two sentences are unclear.



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P4651, L22: Add a one sentence summary of the modelling approach (i.e. the fact that the model was run with a range of soil moistures).

P4651, L4-6: move “only with very dry land surfaces” to the end of the sentence.

Figure 7 (caption): “sensible and latent energy over THE lake, over THE plain ... in THE total domain”.

Figure 8 (caption): replace ’cloud particle concentrations’ with ’liquid water’ (or whatever specific diagnostic is actually plotted).

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 4631, 2015.