Responses to the interactive comment on “The effect of low density over the “roof of the world” Tibetan Plateau on the triggering of convection” by Referee#2

(Authors)

Thank you very much for the comments on the manuscript. Here is our response.

General comments

1. Although the observation and reanalysis data used are briefly described in Section2, there appears to be no section describing the LES model in the main paper. Without knowing which model is used, its domain size and resolution and major paramterisations etc., it is impossible to understand the likely impact of model errors in the results presented here. While it’s fine to move further detail to an appendix, the basic information should be presented in the main text prior to the presentation of any results.

   We have added the basic descriptive information (domain size, resolution and major parameterization scheme) about the LES model in the main paper.

2. In various places, the variation of behaviour with air density is considered, but it is often not made clear to what extent this means the fixed variation of density due to the orography, or the synoptic variations which may occur at any given location.

   Thanks. We agree that synoptic variations are usually accompanied by a change of pressure and temperature, and thus density will change at any given location. However, because the density difference between TP and low elevation regions is mainly due to the height above sea level rather than synoptic variations, we do not discuss this issue in the manuscript. For example, the surface pressures in the four LES experiments (CON, $1.2\rho_{CON}$, $1.4\rho_{CON}$, $1.7\rho_{CON}$) are about 580 hPa, 695 hPa, 810 hPa and 985 hPa, respectively. Their corresponding elevations are about 4.5 km, 3.0 km, 2.0 km and 0.2 km, respectively. At any given location, the variations

of surface pressure caused by synoptic variations are usually confined to $\pm$20 hPa. However, in subsequent studies we may consider adding analysis and discussion of the effects of synoptic pressure and temperature variations on LES results.

3. There is considerable discussion of relationships between density ρ and CBL height h. However, it is not obvious that comparing a geometric height/thickness measure across large variations in density is appropriate. Consideration should be given to how the relationships would look with a mass-based measure of thickness (corresponding to a pressure-based rather than height-based vertical coordinate). The same applies to the question of variations in vertical velocity with density – these relationships may look very different between geometric vertical velocity and pressure velocity).

   Thanks for your suggestion. An excellent question. We replotted Figure 2(a) and Figure 3 with the vertical coordinate changed to a pressure-based coordinate, in Figures N2(a) and N3. h_p is the mixed-layer thickness expressed in units of hPa in Figure N2(a). There are no significant differences in h_p for the four LES experiments (CON, $1.2\rho_{CON}$, $1.4\rho_{CON}$, $1.7\rho_{CON}$) before 12:30 LST. The growth rate dh_p/dt slows down for lower density experiments after 12:30 LST. For large ρ, h_p is significantly larger than for small ρ. The main reason for this is that the rapid growth rate of h for small ρ makes up for the effect of ρ in the morning. Compared to the high ρ case, the thicker h results in an obvious decrease of w_e and dh/dt for small ρ in the afternoon. The relationships between geometric vertical velocity w and pressure velocity ω can be written as: $\omega = -\rho g w$. Compared to the low ρ case, the large ρ makes up for the effect of the weaker local w (Figure N3 (d) X $\approx$ 3.0 km), thus there are no significant differences in pressure velocity ω, and in the penetration depth d_{th} expressed in units of hPa as shown in Figure N3 (c) and (d).

Specific comments

p.4, line 119 Kelvin are not degrees, i.e. the unit is K, not ℃.

Thanks, it has been revised.

p.3, lines 75–76 Are “very small” horizontal scales of “tens of metres” adequately resolved by the LES configuration used in the study?

p.454, lines 454–455 A resolution on the order of 6km is not an LES model, but in the realm of the highest-resolution global NWP models, or "cloud-system resolving models". Or should this read “A domain size of 6.4km x 6.4km x 6.0km. . . ”? This would make the horizontal and vertical resolution 250m and 40m respectively, which seems more reasonable, but still unable to resolve well the "tens of metres" scale referred to on lines 75–76.

Thanks for your suggestion. The descriptions of domain size and resolution were inaccurate. The LES are performed on a numerical domain of 128 x 128 x 150 grid points. The horizontal and vertical resolutions are 50 m and 40 m, respectively.

Figures 2, 4 The panels should be formatted so that legends do not obscure the actual data points.

Thanks, it has been revised.

Figure 3 The (a), (b), (c), (d) labels in white can barely be read against the patterns in the actual plots. These labels should probably be moved outside the plot area.

Thanks, it has been revised.

p.17, lines 520–527 The original datasets used are stated to be available "upon request", rather than being deposited in a readily-accessible archive. I would draw attention to this, but leave it to the editor’s discretion whether this is sufficient to meet the journal’s data policy without further justification.

Thanks for your suggestion. Due to the huge volume of data, here we did not upload the reanalysis data, which is available at https://apps.ecmwf.int/datasets/data/interim-full-mnth/levtype=sfc/ and https://apps.ecmwf.int/datasets/data/interim-full-daily/levtype=sfc/. We are certainly

willing to upload all other data used in this manuscript (include the surface and radiosonde observation and LES results).

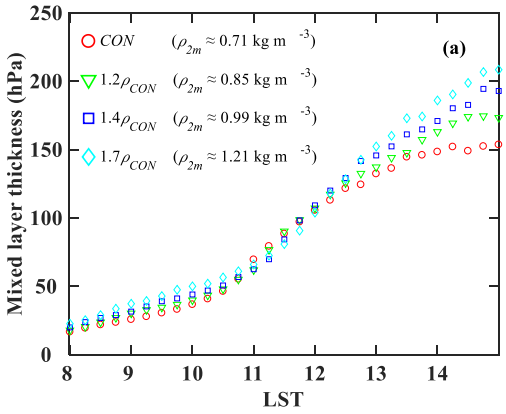

Fig. N2 The time variations of (a) mixed layer thickness h_p expressed in units of hPa for the four LES experiments (CON, 1.2ρ_{CON}, 1.4ρ_{CON} , 1.7ρ_{CON})

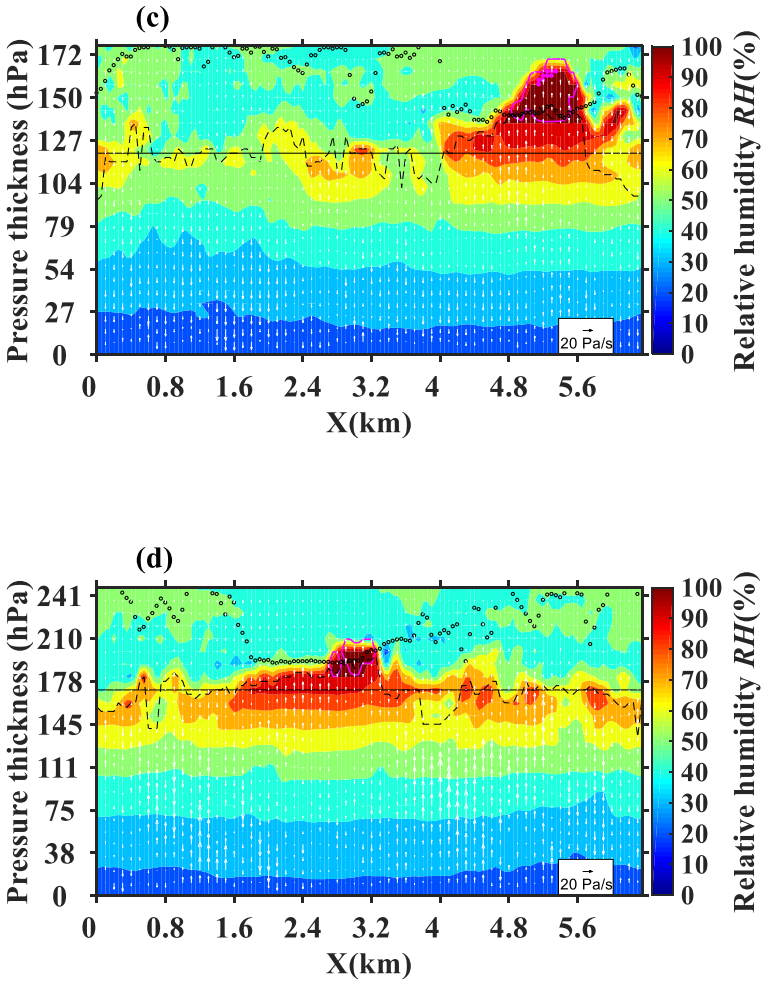

Fig. N3 Same as Figure 3 (c) and (d), but with a pressure-based vertical coordinate. The X-axis wind speeds are not plotted in the Figure.