Comments on "Stably Stratified Canopy Flow in Complex Terrain" (ACPD 14-28483 by X. Xu, C. Yi and E. Kutter)

December 8, 2014

General Comments:

The manuscript reported numerical studies of stably stratified canopy flow with complex terrain using Reynolds averaged Navier-Stokes (RANS) equations and RNG k-ϵ turbulent model. Thermal stratification in canopy flow is a long-standing problem for numerical modeling using available computational fluid dynamics (CFD) techniques. The major challenge is the intermittent turbulence associated with canopy flow under thermal stratification conditions. Advanced tools such as large eddy simulations (LES) cannot accurately capture the intermittent turbulence feature. On the other hand, direct numerical simulation (DNS) needs prohibitive computational resource makes it un-realistic to handle this problem. So the studies conducted in this work represent the latest effort in this area, in particular, the quantification and budget analysis of turbulent kinetic energy (TKE) under stably stratified canopy flow in complex terrain. Overall, the paper is a very good study and this reviewer recommends for publication with ACP after minor revision.

Special Comments:

Page 28488 L22-25: the authors mentioned the computational domain size and grid used. On Page 28489 L4 provided the surface roughness height to be 0.01m. Did the authors conduct mesh independence studies to make sure the mesh sizes chosen in the simulation were fine enough so that the numerical results obtained were not sensitive to the mesh size? Please clarify this issue. Also please clarify what mesh size used close to the ground of the terrain and mesh size used in the area far away from the ground.

Page 28486 L1-5: This manuscript mentioned super-stable layers near leaves. The authors provided reference of Yi et al. (2005). Are there any research reports to show the turbulent flow field in this region? It is a tough task and might be out of the scope of this paper, just curiosity. A friendly reminder here is that the paper should emphasize that the flow is fully turbulent, even in the region of the super-stable layer. Even though RANS can still handle super-stable layer, the reason is that no matter RANS or large-eddy simulation (LES), turbulent intermittence is a significant challenge for accurate numerical simulations which might finally rely on experimental measurement.

Page 28496 L10-15 about discrete Richardson number for stability of canopy flow, is there any way to output your RANS results of turbulent intensity, which might be directly used to check the consistence with the predicted Richardson numbers shown in Fig. 4? Answer to this question is optional (the paper extensively discussed the Ri and temperatures (Fig 3 and Fig 4)).

Page 28497 L25-30 about wind flow structures, there are two major factors to form the scenario, "converges towards the hill," the terrain and the cooling rate. Which factor is the dominant term? If cooling rate removed, will still generate this phenomenon? Please explain.

Page 28501 L12-24 about turbulent kinetic energy budget analysis in Figures 9-10, is there any way to validate the each term, e.g. any available experimental data about these? Which of these terms can be determined through experimental measurement? In such a way, it might be helpful to validate CFD results in the future (based RANS methodology).

<u>Other comments:</u>

Overall this study brings lots of transition phenomena due to thermal stratification and the complex terrain interaction each other. For instance, the wind shear changes from the case $\frac{H}{L} = 0.6$ to $\frac{H}{L} = 1.0$ are very interesting (Fig. 6 and Fig. 7 of the paper), look forward to seeing experimental measurement for this variation. It is a very good work.