Reviewer 2:

We sincerely thank the reviewer for taking the time to thorough review our manuscript and for providing the helpful and constructive comments and suggestions for improvement. We hope that we have addressed the Referee's comments -our responses are in black color font.

The manuscript's goal to better understand the importance and effects of grid resolution on climate simulation in complex terrain is important. Especially, there is still a lack of studies with regional climate models in the convection permitting scale range. The manuscript is well designed and written in general too. I have two major issues (or better to say: wishes) and a few minor comments as given below. Therefore, I suggest a major revision.

1. *The manuscript discusses simulations with 25, 5, and 1 km. One result is that the 25-km simulation misses the observed diurnal cycle and the authors explain this by a lack of ability of the simulation to resolve the complex orography. Another explanation might be that convection parameterisations have an issue in simulating a proper diurnal cycle. It would add value to the manuscript if the authors can do simulations with 5 or 1 km set-ups, but the orography smoothed to the 25-km simulation orography. This would strongly support the authors conclusion.*

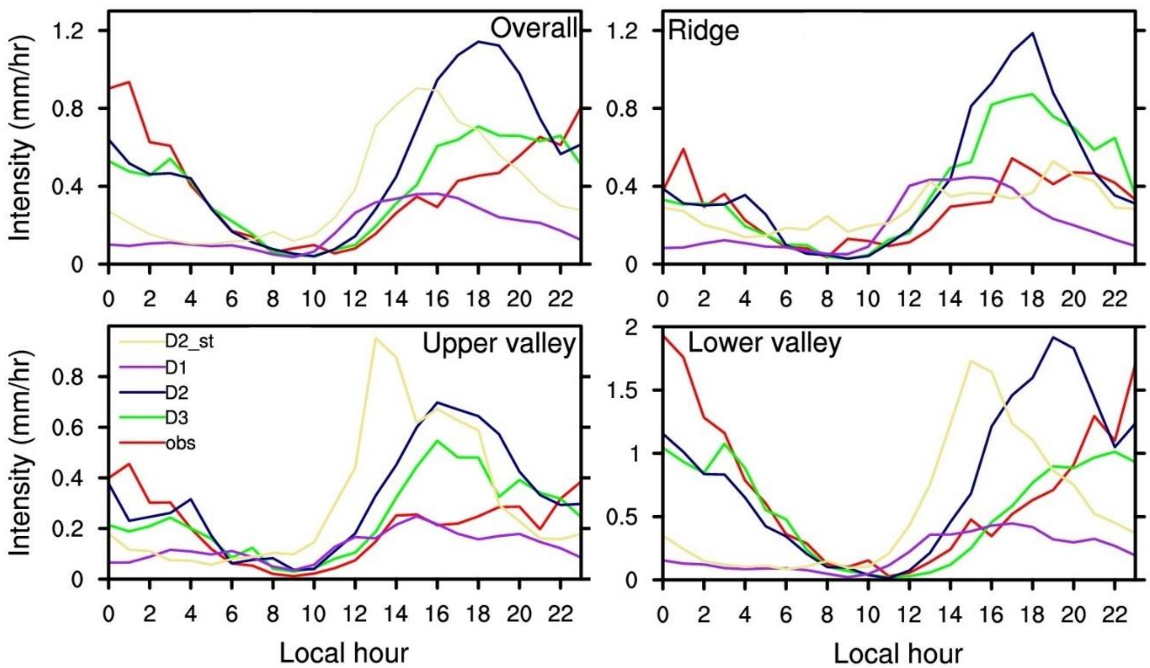
Response: We agree with the reviewer that convection parameterization in general has a common early convection triggering issue. To address the issue raised, we performed monsoon season simulation for 5km with 10 arc minute (~20 km) topography (abbreviated D2_st) keeping spin up and all other options exactly same. The updated Figure 5 with addition of new D2_st line and new Supplement Figure 2 are added (enclosed herewith) in the revised manuscript. We have also enclosed two more figures from our original manuscript related to these features to make the comparison easier to follow here.

- Based on this additional simulation, we have **also highlighted the impact of convection** permitting option (convection parameterization related deficiencies in sub-grid scale precipitation) wherever its role was not properly mentioned (or shadowed), however dominancy of topography to resolve the timings and shape of diurnal cycle, and spatial distribution of precipitation during monsoon in study area is quite clear and it does not alter our main conclusion on dominancy of topography to resolve these features (Figures below).

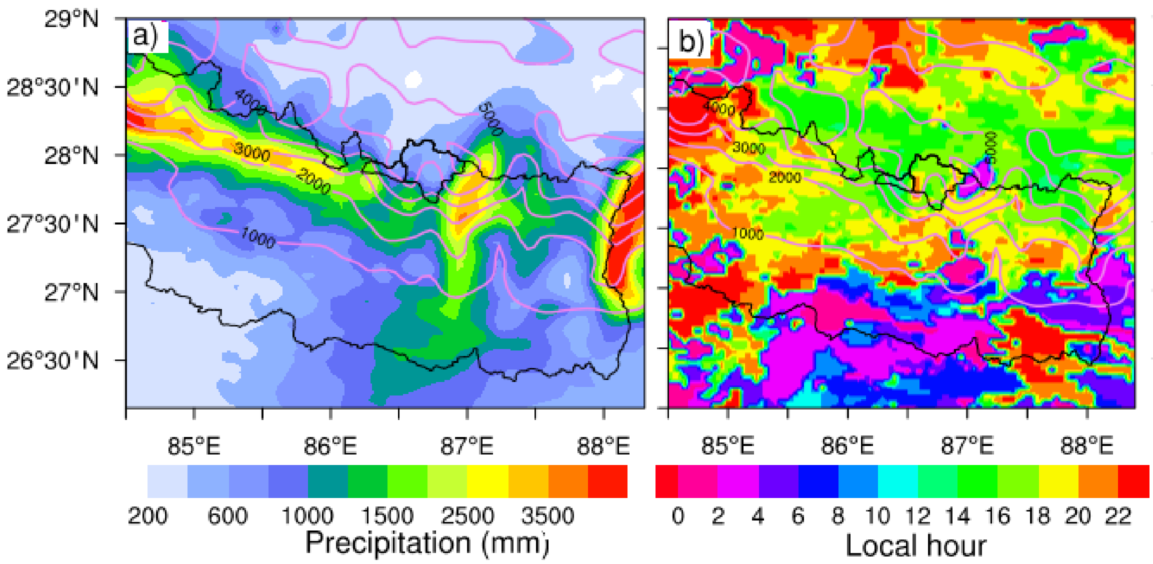
  We have mainly addressed and highlight following issues in the revised manuscript

  A. The potential deficiencies of convection parameterization in coarser resolution besides the topography for its deficiency on representing spatial distribution of precipitation in monsoon season is mentioned.
  B. It is quite clear from new Supplement Figure 2 that D2 with coarse topography (D2_st) completely misses the **double precipitation maximum zones with the drier valleys in between during monsoon** as evident in Figure 10 (original supplement Figure 2; D2 Monsoon) and widely demonstrated by previous studies (Karki et al., 2017, Bookhagen and Burbank, 2006, Shrestha et al., 2012, Maussian et al., 2014, Gerlitz et al., 2015). However, it follows its own topography showing mountain, valley contrast for precipitation distribution to the scale topography is resolved there. It thus also indicates how strongly the topography affects the precipitation distribution in complex Himalayan terrain.

C. Though, D2_st even with its coarse topography (~20 km) resolves the large scale southern foothills mid night to early morning monsoonal precipitation peak features to some extent (but random compared to D2) with the impact of explicitly resolved convection (and as a result of relatively less heterogeneous terrain in south), **the mountain valley contrast in our study area is very unrealistic** compared to D2 (Supplementary Figure 2 and Figure 17 comparison, and updated Figure 5) due to its coarse topography.
   Further, the pattern seems unrealistic and shows evenly distributed peak hours from north to south in western side (Supplement Figure 2 and Figure 17).
   Hence, it supports our conclusion of dominancy of topography on resolving diurnal cycle (mountain valley circulation) in the study area.
   We have presented and discussed briefly the results from the additional simulation in our revised manuscript now.



Updated Figure 5: Diurnal precipitation during monsoon seasons in different WRF resolutions and observation, categorized into overall (all average), ridge, upper valley and lower valley.



New planned Supplement Figure 2: Spatial distribution of a) monsoonal precipitation (mm) and b) peak precipitation hour during monsoon in D2_st domain (shaded). Elevation contour from D2_st topography is also plotted and labelled at every 1000 m.

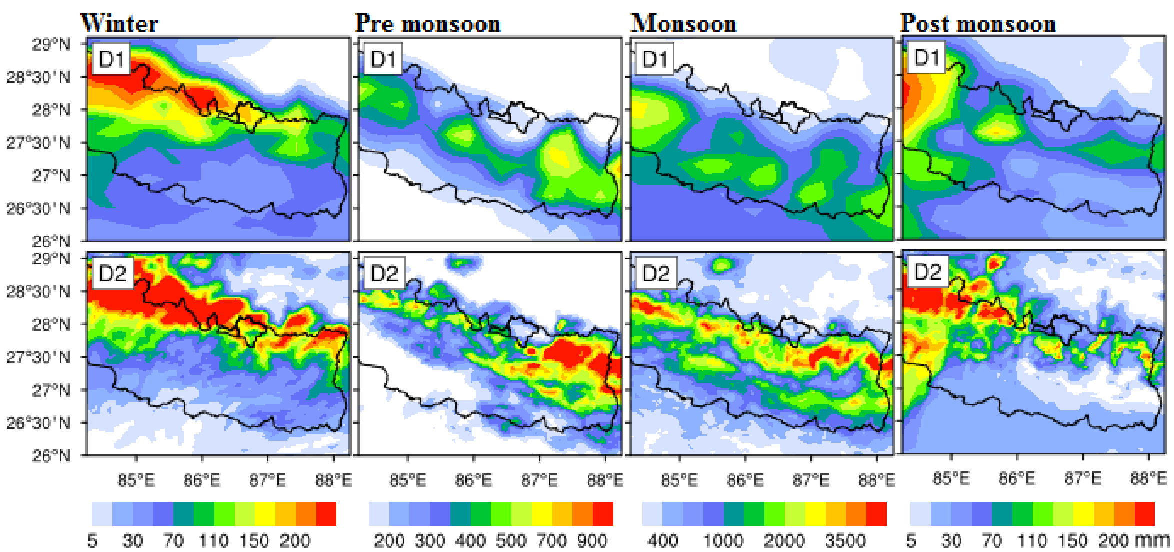


Figure 10 in revised manuscript (Supplement Figure 2 in original manuscript) : Seasonal distribution of precipitation in larger area in D2 and D1 domain resolutions.

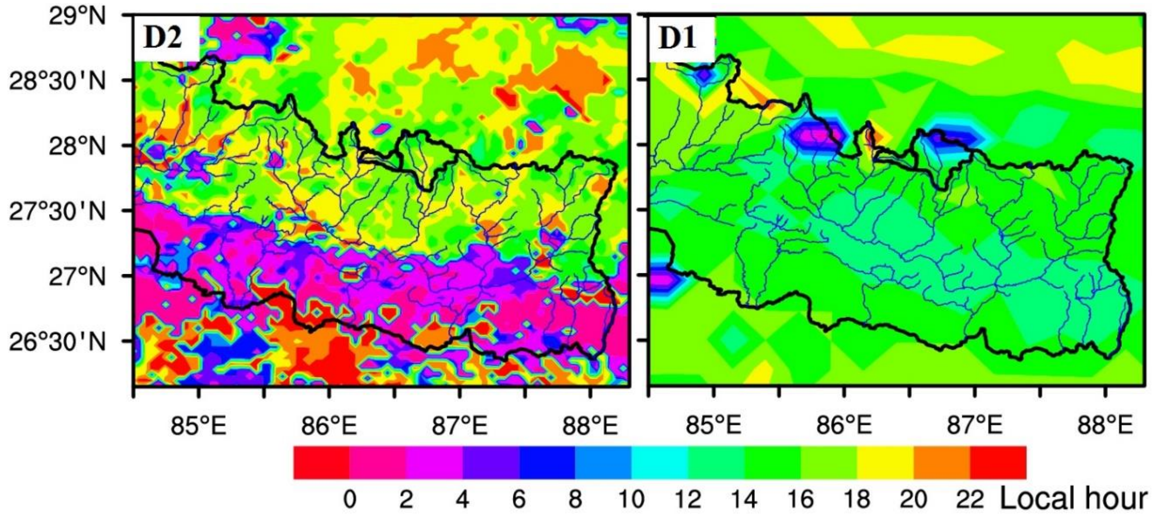


Figure 17 in revised manuscript (original Figure 16): Spatial pattern of peak precipitation hour (local) during monsoon season in large area of D2 and D1.

2. *There is no shallow convection parameterisation applied in the 5-km set-up? Please, clarify. I assume simulations with or without shallow convection differ substantially in the case of the 5-km set-up.*

Response: We agree with the reviewer that the result can differ as these are the gray zones. However, the multi-year simulation by one of our co-authors (Shabeh ul Hasson) for the whole Himalayan region using KF convection parameterization (resolves shallow convection as well) at 6 km resolution identified the spuriously very high precipitation in random areas (not shown) for some years. In addition, Collier and Immerzeel (2015) also found the further worsening of precipitation output in their short period simulation in Himalaya with inclusion of KF scheme at 5 km.

For these reasons, we had performed 5 km simulation by explicitly resolving convection (not included shallow as well) as simulated earlier for similar grid resolution (Collier and Immerzeel, 2015, Norris et al., 2016). The result from our 5 km simulation has captured the essential features that 1 km shows. It is further consistent to Norris et al., 2016 simulation with explicitly resolved 6.7 km simulation indentifying overall overestimation of the similar magnitude.

Thank you very much if you are directing to use the independent shallow convection parameterization scheme available in WRF are not tested for the region and might perform better. We will definitely consider the limited (2 schemes) independent shallow convection available in WRF and do sensitivity experiments if we consider similar scale in our future simulations.

Given the computational resources limitations to repeat whole simulations, and the time to rewrite and revise the whole manuscript it takes, we keep it as limitation for the current study.

To clarify if shallow convection parameterization is used or not, and to support why we turned off convection parameterization, we have added the following lines in revised manuscript (line 12 page 5).

Although D2 is gray zones for explicitly resolving the convection, Collier and Immerzeel (2015) found the further worsening of precipitation output in their short period simulation in Himalaya with inclusion of KF scheme (resolves shallow convection as well) compared to explicitly resolved convection at that scale. In addition, the multi-year simulation at 6 km with KF parameterization by one of our co-authors (Shabeh ul Hasson) found the spuriously high precipitation in some areas (not shown) for some years. For these reasons, cumulus parameterization is completely turned off in both D2 and D3 in order to explicitly resolve the convective precipitation processes.

Minor comments:

1. *The first part of the title is too general and in the second part the reference of the comparison is missing (perhaps better to replace comparison with evaluation). I suggest the title to be revised.*

Response: We agree and would like to revise the title as below;

- Quantifying the added value of high resolution climate models: A systematic comparison of WRF simulations for complex Himalayan terrain (original)
- Quantifying the added value of convection-permitting climate simulations in complex terrain: A systematic evaluation of WRF over the Himalaya (revised).

2. *Please, give a reference to the TREELINE project already in the introduction.*

Response: corrected.

3. *Sec. 2: decrease of the precipitation in the valleys with and because of north-south orientation?*

Response: It may not be due to north-south orientation only because similar decrease is observed in east-west orientated Rolwaling valley. However, the main reason for this is the leeward effect of multiple mountains blocking the main monsoonal flow.

4. *Eq. 1 & 2: Index m missing at the Os in the numerators?*

Response: We used alternative approach taking difference from mean rather than individual observed values for precipitation since the common approach is not meaningful (denominator 0) in the case with 0 precipitation values (Myansbrugge, 2010). Theoretically, the approach is same.

5. *You refer to Fig. S1 two times. If it is an important Fig. think about putting it in the main text.*

Response: Now, realizing the importance of these figure and their mention in several places, we have moved both Figures from supplement to main text in revised manuscript.

6. *Page 9, line 25: These are the mean observed temperatures probably?*

Response: corrected.

7. *At the end of Sec. 4.1 there is some speculation which should be avoided.*

Response: corrected

8. *Page 12, line 23: Earlier in the manuscript it was mentioned that bias correction was applied for temperature. Why does the coarse simulation show smoothness after bias correction using the fine-scale orography?*

Response: The writing (line 37 page 6) was making confusions to readers. We applied altitude correction only to the data which were extracted for station location but not for all the simulated grid points. We rewrote the sentence now as:

> Thus, simulated temperatures extracted for station locations (not entire grids used for spatial mapping) only are adjusted using a constant lapse rate of 6 ^{o}Ckm-1, which has been observed over the whole Koshi basin (Salerno et al., 2015).

9. *Fig. 2 can be omitted. I think the text can be shortened quite a bit if carefully reconsidered. There are some minor language issues like missing "a"s, "s"s and "the"s*

Response: We moved this figure to supplement and deleted most of the contents related to this in main text. The unnecessary texts are further omitted and the grammatical errors tried to reduce.

References:

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