Reply to comments of Reviewer#2

Authors would like to thank the anonymous reviewer for thorough evaluation of our manuscript and constructive comments. Point-by-point responses to the reviewer's comments are given below in bold fonts and corresponding changes in the manuscript have been highlighted in red color.

General comment: This study uses WRF v3.8.1 to explore the effects of spatial resolution on local meteorology. It is very interesting that they found the finer spatial resolution can reduce the biases in simulated meteorology and improve representation of CH through domain feedback into regional-scale simulations. However, in this study, there are too many descriptions of the simulation, but no enough physical explanation to the simulation. It's difficult to make sense that why it occurred. In my view, this manuscript still needs major revision before it can be accepted.

Response: Thanks for the suggestion. Here, we mainly show that more realistic representation of the highly complex terrain, through finer resolution implemented with 3s terrain data leads to better local meteorology of the central Himalaya. Following reviewer's suggestion more discussions including physical explanations have been presented in the revised version of the manuscript, as described in response to specific comments.

Comment 1: Section 2.2: How do you process the different temporal resolution of datasets, using the mean value or instantaneous value?

Response 1: Collocated instantaneous values between model and observations have been compared. This is mentioned in the revised manuscript (Page: 9; Lines: 188-189).

Comment 2: Line 182-184: It is available of ERA interim at 0.125∘×0.125∘, but it's the interpolation results, which may not represent the true performance of ERA interim, especially over the complex terrain regions. It's better to add the comparison between WRF and ERA interim at 0.75∘×0.75, even there is much less grids of ERA in D03.

Response 2: As suggested, ERA interim at 0.75 x 0.75^0 has been used for comparison in the revised manuscript (Figure 2; Pages:10-12; Lines: 204; 245-246).

Comment 3: Please update the figure captions: i.e., units of all the variables in Figure 3; caption of Figure 6 is not clear (Fig 6a is the comparison between WRF simulation at D01 and the observation?); Figure 8 is only focused D01, etc. you should make them clear in figure caption.

Response 3: Thanks for pointing this out. We have revised the figure and provided clear caption with details of units. Radiosonde and model d01 is also marked clearly (please see Figures 3, 7a, and 9 in the revised version).

Comment 4: Line 259-262: Why did it happen? The different vertical distribution and the lower correlation at lower altitudes mostly come from the influence of land-air interaction. Please discussing the possible factors of your results.

Response 4: We agree that the interactions of the underlying surface with lower troposphere profoundly affects the dynamics and local circulations. In mountainous terrains, most important interactions include slope winds and the synoptic scale flow (Solanki et al., 2019). Orographic drag has been suggested to be additional source of the lower correlation (Zhou

et al., 2018, 2019). This is discussed in the revised version of the manuscript (Page: 16 Lines: 312-322; Page: 20-21 Lines: 382-406).

Comment 5: How do you process the different spatial representation of different simulation and observation? For D01, one grid can indicate the mean situation of 15*15km area; meanwhile, for D02, it only indicates that in 5*5km area, etc. please show details of your methods to compare the grid simulation and the in-situ observation.

Response 5: The nearest grid point to the observational site is used for comparison (Page: 9; Lines: 188-189) (e.g. Mues et al., 2018; Singh et al., 2016).

Comment 6: Line 286-287: It's very interesting that WRF shows a warm bias south side of Himalaya. Many previous studies pointed that there is obvious cold bias over Tibet (including Himalaya), i.e., Zhou et al. (2017) and Gao et al. (2015). Did you check your location of observation site and WRF grids? The warm bias in your WRF simulation is due to the lower terrain height of the grids than the Observed, please check if they are located over valley and the observed located over ridge

Response 6: Thanks for valuable suggestion. The observation site is a mountain ridge. We performed further analysis of model output by accounting for the altitude difference through linear interpolation of the meteorological parameters to the actual altitude of site in the revised version (Figure 6d-f, Table 1). Altitude adjusted data of model shows cold bias in

agreement with Gao et al., (2015). This is discussed in the revised version of the manuscript (Page: 20-21; Lines: 371-399).

Comment 7: Figure 5: as the WRF resolution increasing, the diurnal cycle simulation of T and RH are better, but it didn't work for wind speed. please check the location of the WRF grids and observed station, if both them located valley or ridge? Besides, Zhou et al. (2019) stressed the importance of turbulent orographic form drag (TOFD) on the diurnal cycle simulation of wind speed. It's better to give more explains of inconsistent diurnal cycle of wind between simulation and observations.

Response 7: The processes such as local circulation, slope wind interaction with the synoptic-scale flow are the key factors governing the diurnal winds over mountain ridge, as shown in Solanki et al., (2016, 2019). We agree with reviewer's view that turbulent orographic form drag (TOFD) could modify the diurnal evolution of wind over such terrains (Zhou et al (2019). These all aspects with relevant references have been included in the revised version of the manuscript (Page: 20-21; Lines:382-406).

Comment 8: RH is also dependent on Temperature. What's the performance of the WRF in simulation Specific Humidity (Q)? Please compare the Q between WRF simulation and observation.

Response 8: Comparison of specific humidity between model and observations has been investigated (new Figure S1 in the Supplement). The specific humidity (Q2) shows the

explicit dependent on the horizontal grid resolution the bias decreases with increasing the grid resolution. The Q2 shows better correlation (0.67 for d01, 0.72 for d02, and 0.77 for d03) than RH (0.43 for d01, 0.45 for d02 and 0.52 for d03). This is discussed in the revised version of the manuscript (Page: 18; Lines: 350-354).

Comment 9: Section 3.4: What are the effects of feedback on the wind direction? In WRF-WF experiments, there are obvious difference among the simulated wind direction at three resolutions. Is there any improvement in the WRF-F experiments?

Response 9: The slight improvement in the wind direction is observed in WRF-F, such improvements are explained in the corresponding section 3.4 (Page 24, Line 459-462), where the effect of the feedback is discussed and changes can be seen in the wind rose plot as shown in Figure S2 and S3. Nevertheless, smaller changes were seen in correlations for WS10 (by 0.05) and T2 (by -0.02) (Figure S2). Variations in wind speed and direction shows an improvement in dominant flow direction e.g. easterly, westerly and north-westerly (Figure S3).

Comment 10: Section 3.5: You should check the orographic variation in WRF model output, when you input different geographic data. multi-scale orographic variations are key factors of Wind and moisture simulation over complex terrain, i.e., south side of Himalaya (Wang et al., 2020).

Response 10: The orographic variations in WRF model output have been checked for different geographical input data (Figure 11, Figure S6). As suggested, the spatial

distribution of relative humidity is included in the revised version of the manuscript (new Figure S6; Page:27-28; Lines:525-529). The impact of the orographic variation with different resolution topographic data in RH (Figure S6) shows the differences are in range of -1 to 1% in d02 and -3% to 3% in d03. Such variations are due to inclusion of the SRTM3s high resolution topographic data allowing the model to capture more variation, such orographic features are seen to impact the distribution of moisture in line with suggested study (Wang et al., 2020).