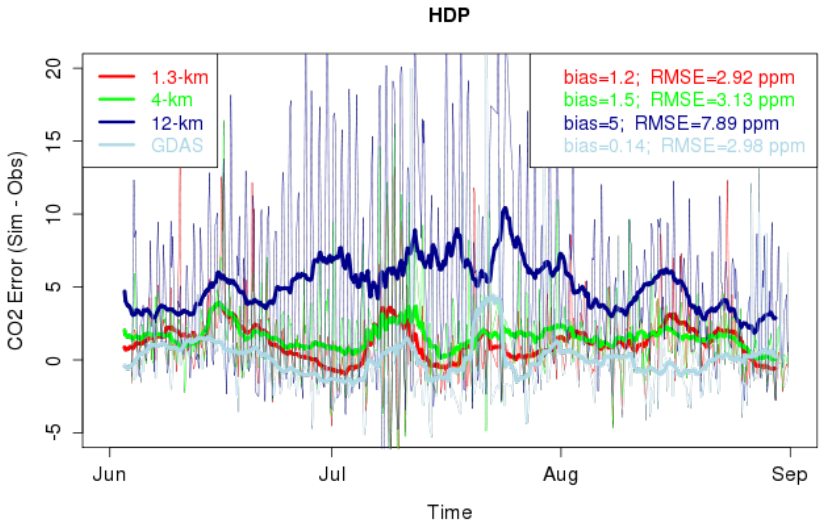
We thank Reviewer #3 for the constructive criticism of the Discussion paper. The reviewer's comments are shown below in *italics*, while our point-by-point responses are indicated as un-italicized.

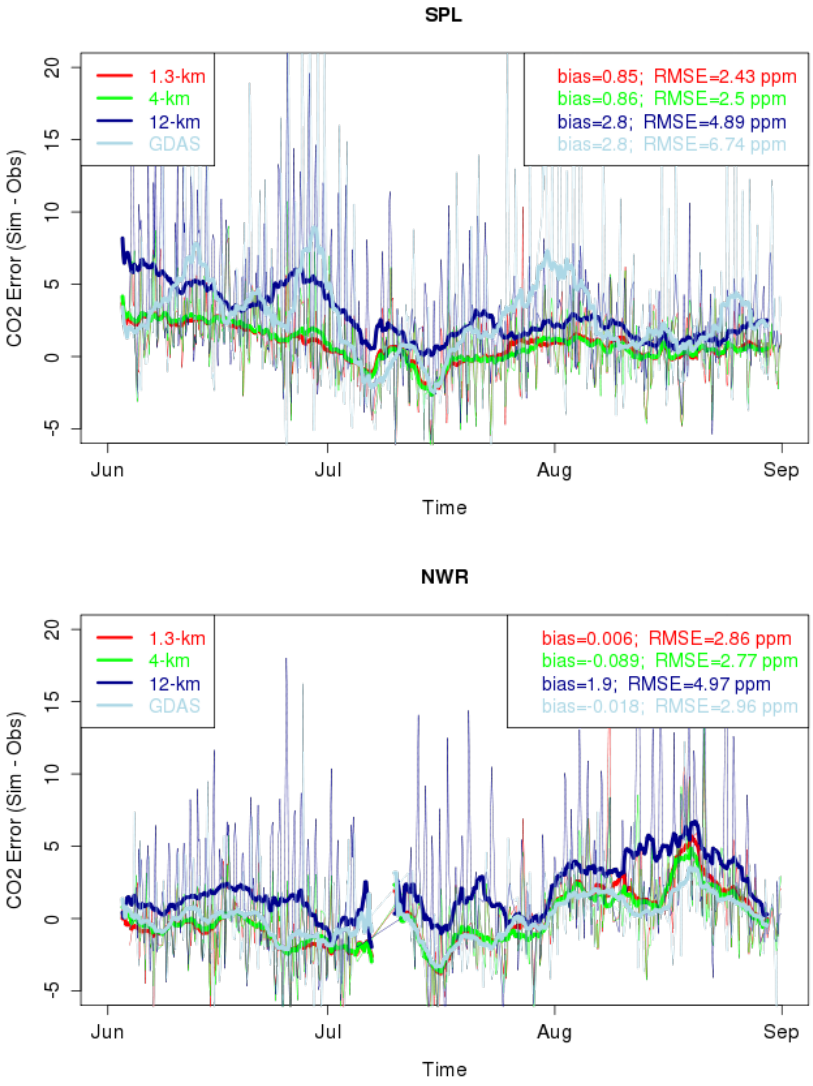
Reviewer #3

The major concern is that how different the CO_2 simulations and observations are compared from day to day, particularly when finer scale models are used as suggested? Averaged results might miss some crucial information hidden in the discrepancies between model simulations and site observations in present study.

We agree with the Reviewer that beyond the diurnal timescale, there is day-to-day variability in the model behavior that lead to variations in CO_2 model errors. We have now included in the revised paper the time series of CO_2 model errors at SPL, NWR and HDP (see below) with correlations of the CO_2 errors with various meteorological variables (geopotential height and its E⇔W gradient, U- and V-winds, and the windspeed). The time series plots and a Table of the correlations of the CO_2 errors with these meteorological variables will be added to the Supplement.

Errors at multi-day timescales are the most strongly correlated with different meteorological variables, depending on which is being examined: V-wind, U-wind, and geopotential height gradient for HDP, SPL, and NWR, respectively. The fact that errors are correlated with different meteorological variables depending on the site location points to a complexity that can only be unraveled with a substantial expansion of the paper. This could potentially be a subject for a future paper. This complexity is in contrast to the average diurnal biases that can in large part be linked to the underlying resolution of modeled terrain, which the current paper focuses on.





The related studies focusing on mountaintop such as this one are important and rarely explored. I would recommend this manuscript for publication after above concern is addressed.

Specific comments:

Line 146: How is the vegetation covered at these mountain stations? Are these monitoring sites far above the tree line? Local influences on CO_2 due to the surrounding plant cover at these sites may need to be considered.

Both HDP and NWR are above the tree line; SPL has a few sparse trees around the site. The RACCOON mountaintop observations have been filtered to remove local influences and to extract values that are more regionally representative, following the work in Brooks et al. (2012). These filtered observations were the ones used in the paper. We have added this reference and modified the text to clarify this point:

"We applied filtering to the mountaintop CO_2 observations to remove local influences and to extract values that are more regionally representative (Brooks et al., 2012). Observations were filtered out in which the within-hour standard deviation is greater than 1.0 ppm or when the differences between the top two inlets are greater than 0.5 ppm, which indicate periods when significant influences that are highly localized to the site are affecting the observations."

Brooks, B.-G. J., Desai, A. R., Stephens, B. B., Bowling, D. R., Burns, S. P., Watt, A. S., Heck, S. L. and Sweeney, C.: Assessing filtering of mountaintop CO_2 mole fractions for application to inverse models of biosphere-atmosphere carbon exchange, Atmos. Chem. Phys., 12, 2099–2115, 2012.

Lines 296-297: How much percent is contributed to the wildfires during the study period?
The exact percentage depends on the quantify under consideration: gross versus net fluxes, and the percentage would also depend upon the time of the day. Regardless, the percent is very small and is visually apparent from Fig. S4. We added an additional reference to Fig. S4 to clarify this point:
"Contributions from anthropogenic and wildfire emissions, on average, to the mean CO_2 diurnal cycle observed at all the mountain sites were secondary in comparison to the biosphere (Fig. S4). In particular, the wildfire contributions were episodic and averaged out to negligible contributions over Jun~Aug 2012 (Fig. S4)."

Lines 301-302 and Fig. 3: Fig. 3 illustrates the 3-month averaged diurnal cycles of the results from individual models and observations. Do they show similar diurnal cycles every day during these months? Consider addressing the variabilities of the diurnal cycles (e.g. error bars) in the supplement.
To illustrate the variability in the diurnal cycles we have added error bars to the average diurnal cycles shown in Fig. 3.

Fig. 4: Has the GDAS_1-deg_ASL in Fig. 4 been adjusted with the biospheric fluxes? If not, I would recommend drawing it as gray line and dot as presented in Fig. 3.
Fig. 4 is showing the average diurnal cycle of the footprint totals, which result solely from the simulated atmospheric transport. Thus biospheric fluxes are not incorporated into Fig. 4 and therefore the dashed + dot scheme paralleling Fig. 3 is not necessary here.

Fig. S5: Two CT Level 1 (dark blue) and two CT Level 2 (blue)?
We are not sure about the exact meaning of the Reviewer's comment here. The CT levels are color-coded as a gradation from dark blue (Level 1) to dark green (Level 8); Level 2 is indeed colored as blue.

Fig. S5 and Table 1: The differences between the site and model altitude (Table 1) seem to be generally associated with the CO_2 biases. For instance, larger differences such as WRF-12km, GDAS, and Carbon Tracker showed larger discrepancies in diurnal cycles of CO_2 at HDP. What

if the model altitude fixed as same as the mountain site? Could it be better correlated to the observational CO_2 data?
We are in full agreement with the Reviewer that CO_2 biases are associated with differences in site versus model altitudes, stemming from increasing discrepancies with terrain as the spatial resolution is degraded. This point is discussed extensively in Sect. 3.2.2. Adjusting the vertical level within the model is an approach that we explored Sect. 4.1 ("Approach 1: Adjust vertical level of simulations from which to compare against observed values")

Lines 336-380: Are these trajectories in a good agreement for each day during the study period both in nighttime and afternoon hours?
We have generated the time series of CO_2 error at different days during the study and examined the correlation between the errors with other meteorological variables to address this question. See details at the top of this response for more details.