In this document, the reviewer comments are in black, the authors responses are in red.

The authors thank the reviewer for their detailed review and useful suggestions to improve the quality of our work.

General Comments:

This paper presents a unique set of observations of turbulence dissipation rates, both on the mesoscale across the Columbia River Gorge, and on a scale about the size of a model grid cell. The variability between sites is shown to exist in time and in space. Overall, this is an important study, to understand the differences that can be expected on different spatial scales. The paper is very well written, with figures and supplemental material to support the discussion.

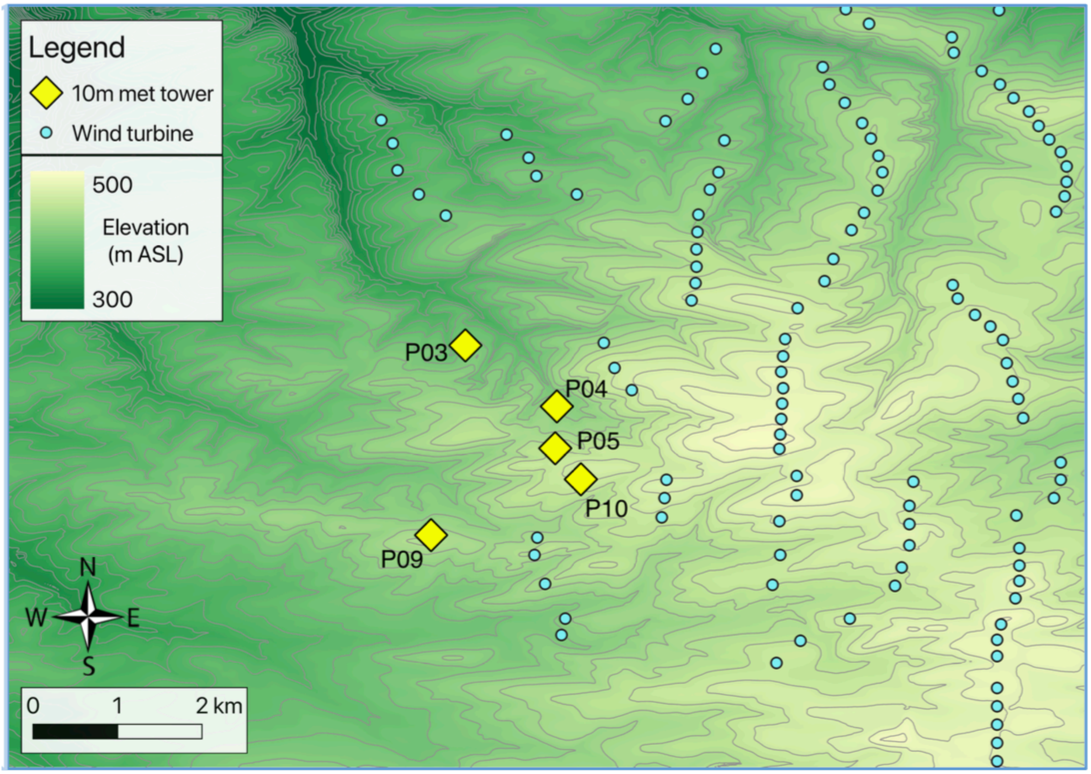
Thank you for finding our results interesting!

Specific Comments:

There is a lot of mention of topography being the reason for differences and variability between sites, but what is it about the sites' topography? Is it, for example, complexity of topography in a ~1km radius? Or maybe the slopes of the sites? In order to attribute the variability to topography, we need to know more about that topography. Furthermore, with no explanation of how the topography impacts dissipation, it is hard to negate the possibility that different instruments produce different magnitudes of dissipation and its diurnal cycle.

Thank you for pointing out that we should have described the topography of the Physics Site in more detail as follows:

- We have added the following sentences to the description of the division of the five meteorological towers in two sub-groups in Section 3.1: "An analysis of the topography of the region reveals two distinct sets of terrain characteristics. The terrain to the west of the sub-group of towers on the western side of the Physics Site (towers P03 and P09) has slopes that reach 60%, and the average slopes larger than 6%. On the contrary, the remaining towers east of this cluster, which we will refer to as "eastern" (towers P04, P05, and P10), are surrounded by a terrain with more gentle slopes, which are on average less than 6% and never exceed 25%."
- We have also made this point more explicit later in the Section: "The presence of steep topography increases the variability of turbulence dissipation rate even at small spatial scales".
- We have also modified a sentence in the Conclusions as follows: "Systematic differences emerged in ε measured on the western and eastern sides of the Physics Site, the former being located downwind of terrain with larger slopes compared to the latter, thus suggesting the possible impact of terrain slope in triggering the variability of ε."
- Finally, we have added 10-m elevation contour lines to the detailed map of the Physics Site in Figure 1:



We have also improved the description of the topography of Gordon Ridge, to give a more detailed explanation for the larger dissipation values recorded at the site, and we have added a detailed map of the area in the Supplement (see specific comment below).

In the conclusion, discuss what the microscale variability means for mesoscale modeling. How do models need to account for this subgridscale variability?
We agree that this is an essential question, but the answer requires extensive research, and a detailed response is beyond the scope of the work presented in this manuscript. To motivate additional research on the topic, we have rephrased some sentences of our conclusions as follows: "Assessing the spatial and temporal variability of ε within a typical grid cell of a mesoscale model will provide further insights into the validity of sub-grid scale ε parameterization schemes during various atmospheric stability conditions. As this variability appears to be dependent on several different atmospheric and topographic factors, complex techniques are likely needed to provide accurate spatial representations of ε over a mesoscale grid. Sophisticated tools such as physics-driven machine learning techniques (Sharma et al. 2011, Xingjian et al. 2015, Alemany et al. 2018, Gentine et al. 2018) are paving the path to capture the microscale variability of ε in mesoscale models accurately."

P3 1st full paragraph: Mention that Troutdale is on W side of Cascades, with the other sites in the Columbia Basin to the east of the Range
We have added the specification "… Troutdale (the only site on the western side of the Cascades)" in the paragraph.

P3L14: What height are the towers?

The tower heights range from 10 to 80m. However, since in this study we are only using the 10-m sonic anemometers (as specified a few lines later), we think it is better to omit this detail to not confuse the reader, and to just reference the overall WFIP2 observational paper (Wilczak et al. 2019) for those interested in details about the overall experiment.

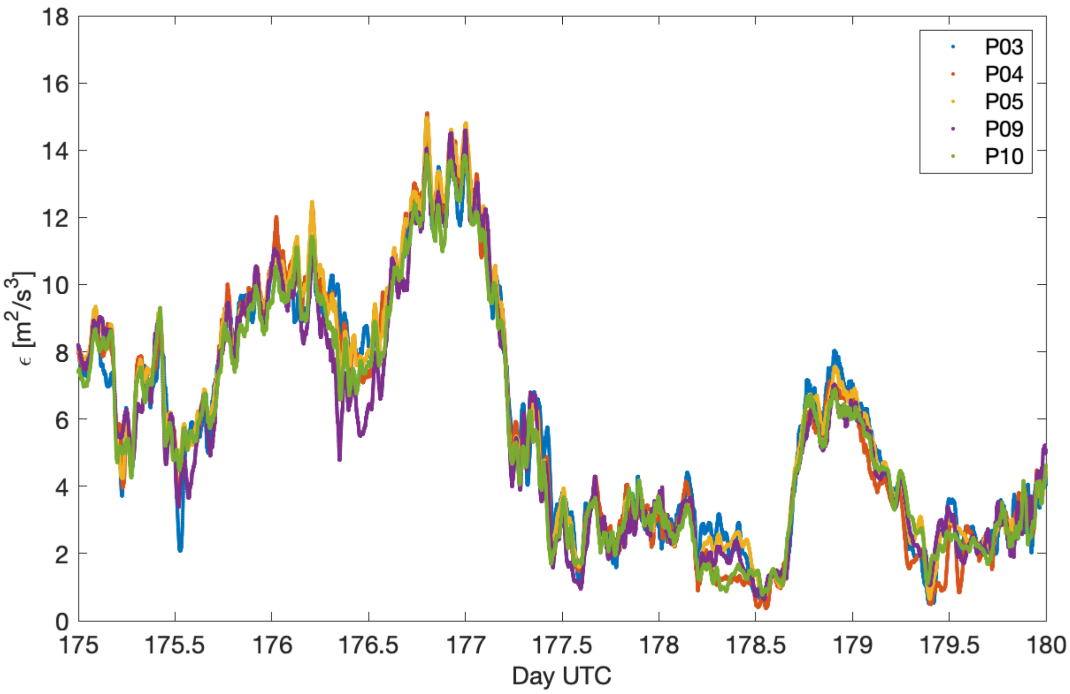
P3 2nd full paragraph: The sentence about the wind farms/turbine in the larger region is out of place in the paragraph about the sonics at the physics site. Move this sentence to the paragraph before, or break into pieces in previous paragraph and this one.
We have moved to the previous paragraph the following sentence: "Extensive arrays of wind turbines are located on the northern side of the Columbia River and on the south-western part of the studied region.". We have added to this paragraph this sentence: "Several wind turbines are located east of the Physics Site."

P4: Mention that Wasco, Gordon's Ridge and Vansycle Ridge are on the east side of the Cascades, in the Basin. How far apart from each other are the sites?
We have added specifications such as "in an area within the Columbia Basin" and "on the eastern side of the Cascades" for these locations. Moreover, the maps in Figure 1 show these locations and a scale bar, so that the interested reader can determine the distance between the different sites.

P5L11: why does a fast scan rate need to be removed?
To calculate accurate turbulence statistics from the azimuth structure-function method, the effective sensing volume transverse to the lidar beam needs to be much smaller than the range-gate size (Frehlich et al., 2006). During WFIP2, the fast scan rates violated this assumption and hence these scans were ignored in our analysis to provide accurate estimates. In the manuscript, we have added a reference to Frehlich et al., 2006 in the sentence for the reader who might be interested in more details about the method.

Figure 2: identify the maximum of the local regression, which is used for N
We have added a vertical line to the figure to identify the maximum of the local regression. We have also changed the caption of the figure accordingly.

Figure 3: Can you show an addition day on either end, to show the more-typical diurnal cycles?
We find that each particular day has some sort of unique behavior (see plot below), dependent on the complexity of the various quantities that impact turbulence dissipation rate. Even adding additional days would not really define a typical diurnal cycle, which is instead shown in Figures 10 and 11 for all the lidar locations.



P12: How does the topography impact the east vs west side of the Physics Site? What is the variability in terrain (there's 50m between the highest and lowest points, but is there a ridge, is it a uniform slope, which direction is higher/lower, etc)?
See our answer to the first comment of this review.

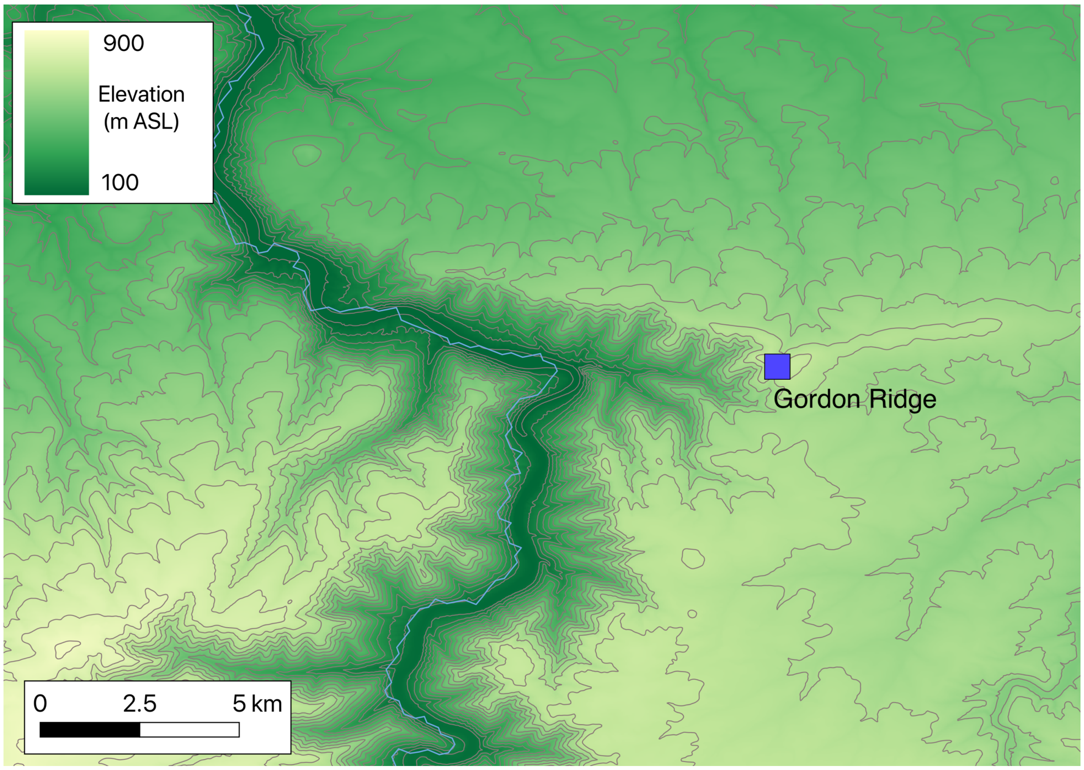
P12: Is this analysis done only when winds are from the southwest? If not, it would be interesting to see if the easterly winds contribute to the ratios greater than 1 in Fig 5.
The analysis considers all wind directions. We have tested whether (rare, see wind roses in the Supplement) easterly winds are responsible for the ratios greater than 1, but we could not find any significant dependence of the ratio on the wind direction.

P16L6: mention in the text the height shown in the figure
We have added the information about the height in the text.

P18L2: There are wind turbines east of Wasco; do these directions show elevated dissipation rates under easterly winds? It's hard to see in the supplement figure.
Unfortunately, as shown in the Supplement, easterly winds at Wasco were very rare, and usually with small wind speeds (which usually do not generate wind turbine wakes). As a consequence, we do not have a sufficient amount of data to infer conclusions about turbulence dissipation in wakes at Wasco. We refer to a paper with in situ measurements of dissipation in wakes (Lundquist and Bariteau 2015).

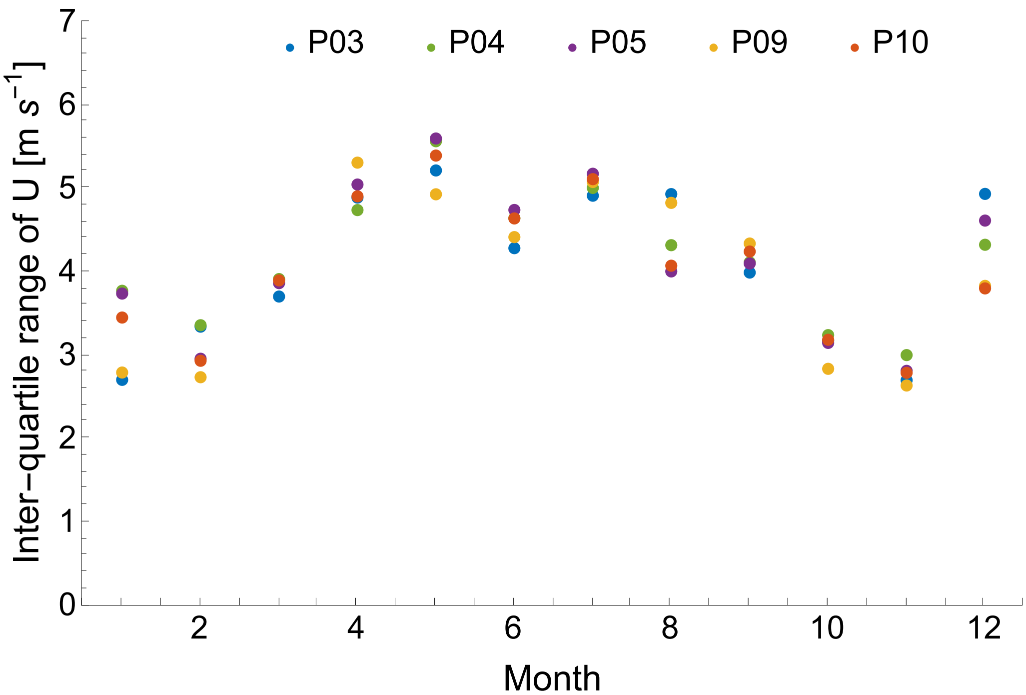
P18L14: what is it about Gordon's ridge that makes its topography special, compared to the other sites?

Thank you for pointing out that we did not describe this site in enough detail. We have now included a detailed map (see below) of the topography of the area in the Supplement. We have also added the following sentence to the paragraph: "When the wind flows from the west, the location of the WINDCUBE v2 lidar is at the easternmost edge of an area (~ 6 km wide) with a particularly complex topography, where the Deschutes River (tributary of the Columbia River) shapes a steep valley, with terrain slopes that locally exceed 70% (see map in the Supplement)."



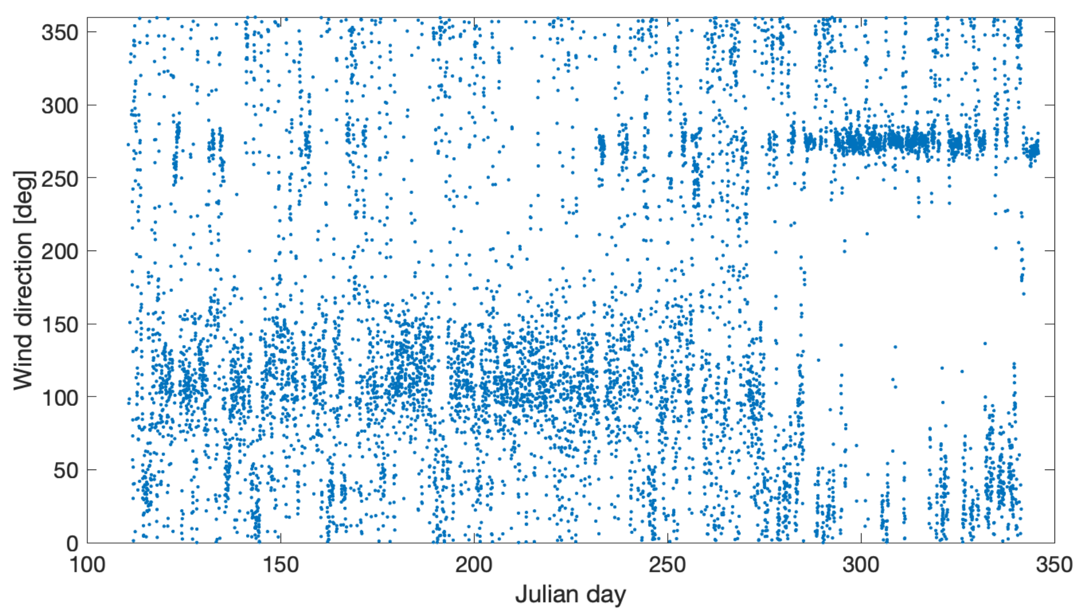
Supplement Fig 3: add interquartile range, like Fig 7

We have added the following plot to the Supplement.



Supplement 4: Why is Troutdale SO small in summer?

A clear shift in the prevailing wind direction between summer and fall occurs at Troutdale (see plot below, which shows wind directions at 100m AGL). At this location, as shown in the wind rose in the Supplement, easterly winds are associated with smaller wind speeds, while westerly winds usually cause larger wind speeds.



Technical Corrections:

P2L28: observational assessments Corrected.

P3L19: Physics Corrected.

P5L3: should one of the 260m top heights be different? Why specify Vansycle Ridge to 260m AGL? Corrected.
P6L16: “to the their” Corrected.
P12L9: an ideal candidate Corrected.