acp-2021-100
Responses (highlighted with blue) to Referee #2
31 May 2021

General comment:
The manuscript described two different wind intensification cases in a mountain area from one event, using the reanalysis data, Doppler lidar data, and wind profiler data. The authors performed many analyses using the limited datasets, and the manuscript included many figures. However, the manuscript lacked important descriptions about the novelty of this study, validations of the data used, and the generality of the observed case(s), as commented below.

We appreciate Referee#2's helpful and constructive comments, which help us to improve the manuscript substantially. We have more emphasized the importance and uniqueness of our selected event; the capability and reliability of adopted datasets were also addressed in our revised manuscript. Additionally, the climatological information has been added to understand more about the generality for the event. A set of responses to your comments is provided below and specific locations of revised manuscript were also noted as following responses and revised/added lines in the manuscript.

Major comments:

- If I understand the study correctly, the manuscript described two different wind intensification cases from one event. The first part of the manuscript described characteristics of a wind intensification observed at the lee side of the mountain range, and the latter part described another intensification in a valley. The title of this manuscript included "downslope," therefore, I did not know why the latter part was needed. I could not understand the relationship between the two intensification cases. The introduction also lacked information about the relationship.

  Thank you for pointing out the problems. In this extreme strong wind event, there were two different wind patterns (one is more like "gust" in the leeward side of the mountain, another one is "sustained" strong wind over the mountainous area), and they all have huge impacts on human activities (ex: Olympic games and wildfires) in Korea. Furthermore, these two different wind patterns were both presented near Taebeak Mountain Range (TMR) at the same time when a low-pressure system (LPS) was approaching. The results implied that the interactions between large-scale weather systems and complex terrain should play an important role in dominating the wind patterns in this area. We have analyzed the detailed evolution of the winds and their

mechanisms have been verified. Although the pressure gradient force (PGF) is main factor to accelerate the winds, different mechanisms were found in these two locations due to different topographic features. A description has been improved (especially in abstract, Lines 45-47) and to emphasize the discrepancies of wind patterns in this mountain range, additionally, the title has been modified for clarity.

- It seems that a large part of the analysis of this study relies on the reanalysis data (LDAPS), which are not pure observational data. Were the observations assimilated enough to resolve the local wind intensifications (time? spatial resolution?)? The authors should provide more details about the dataset and evaluate the dataset in terms of how the data can resolve the local wind intensifications.

  It is a valid point. In this study, we use the reanalysis dataset of the LDAPS but does not used its forecast outputs. Basically, the LDAPS reanalysis dataset was assimilated by various platforms with high resolution of wind observations (like weather radar, AWS, sounding, wind profiler and satellite). The errors between conventional observations and LDAPS have been minimized conscientiously by the KMA and the quality of wind information is able to resolve small-scale weather phenomena over complex terrain in Korea. We modified the title to "**An analysis of an extreme wind event in a clear air condition associated with a low-pressure system during ICE-POP 2018**". The detailed descriptions about the LDAPS dataset have been improved in Section 2.3 (Line 220).

- This manuscript presented a case study of one case only and lacked descriptions/analysis about the generality of the event. How frequent did the wind intensifications happen? Is the mesoscale pressure pattern common? Did the mesoscale pressure pattern always produce the wind intensifications? Are the analyzed phenomena unique in this area?

  This a particularly good suggestion. The uniqueness of our selected event has been addressed based on the historic observational record of KMA. In fact, this event is one of two extreme strong wind events in past decade. The two extreme strong wind events were both affected by the passing LPS (low-pressure system), the result implied that the mesoscale pressure pattern is usually an important factor to dominate the wind intensifications in Korea. The detailed descriptions about the climatological information have been revised in Lines 352-367.

- It was unclear what is the new finding(s) of this study. What are different compared with the previous studies?

This study is first attempt to document the evolution of extreme strong winds in the TMR associated with the moving LPS by observationally cased datasets. Furthermore, the mechanisms of the strong winds over complex terrain have also been verified. Although there were a few numerical studies to investigate the wind patterns and they provided some explanations in the same areas, it still lacks observationally based evidence to convince their findings. This study provided new insights that the PGF play an important role to accelerate the wind speed, however, there were two different mechanisms dominating the PGF associated with the interactions between the LPS and terrain (i.e., channeling effect and adiabatic heating coupled with LPS). We have emphasized these points in the paragraphs of this revision (Lines 102-106, Lines 139-142).

- It was tough to follow the manuscript, because I felt a difficulty to identify a downstream/upstream site through the manuscript. I was confused about which site corresponded to a downstream/upstream in each sentence. I think that major reasons of my confusion are:
- Observation sites had similar names (e.g., DGW, GWW, GWU).

Since these were officially given names from the KMA, we still prefer to use those names in this study. However, we summarized that information for each station in a table (Line 211) to make it clearer (based on the suggestion from Referee#1).

- Fonts of the site names in each figure are too small.

The fonts of the site names have been enlarged in all figures throughout the manuscript.

- In the first part of the study, DGW was referred as an upstream site, while it was referred as a downstream site in the later part. I would suggest reorganizing the paragraph or rewording sentences to make the reader easy to identify the downstream/upstream sites.

The paragraphs and sections have been reorganized and the words (upstream) have been replaced when we mentioned the difference between the YPO and DGW (Section 4.2.2, Line 635).

- It was unclear that how the pressure gradient force was produced by adiabatic warming at the lee side of the mountain. Was there precipitation in the mountain area? It was also unclear that how/why the pressure gradient force was intensified in the DGW site.

  To clarify the causes of PGF in the leeward side of the mountain. We were following a constructive suggestion from Referee#1; relatively lower pressure may have contributed from large-scale weather systems. Therefore, we did a new analysis to evaluate the contributions from the LPS. The results from this new analysis suggested that relatively lower pressure was deduced by the combined effect in speed-up stage. In particularly, the PGF was produced by adiabatic warming coupled with the passing LPS at the leeward side of the mountain, the details about the intensified PGF have been revised in last paragraph in Section 4.1.2 (Lines 579-597) and Figure 10. There are no precipitation along the northeastern coast of South Korea according to the AWS observations. Thus, we can eliminate the effects from the precipitation in this event.

- Language:
- There were so many "can" and "could" used in the manuscript, especially in Section 2. This obfuscates the sentences. I was confused by this, and it was unclear that the things were actually done or not.

  We have checked these problems and corrected them carefully throughout the manuscript.

- Sentences with past forms and those with present forms were mixed inconsistently in the same paragraphs, even in the same sentences.

  The manuscript edited by a professional editorial company to avoid this kind of sentences and to improve readability.

- There were many sentences that used parentheses to state inverse things (e.g., lines 405, 420, and many others). I needed to read the sentences back and forth. This technique should not be used so frequently in a manuscript.

  We have fixed all of these sentences throughout the manuscript.

- "East Sea": Because I did not know "East Sea," I googled it and found that there is "Sea of Japan naming dispute." I recommend using "Sea of Japan," which has been

most commonly, historically used in the world, or putting down with "East Sea," like "Sea of Japan (a.k.a. East Sea in Korea)." Alternatively, do not use both names in the manuscript to avoid the unnecessary argue.

We modified to " East Sea in Korea" (Line 328)

Minor comments:

Line 49: GDW was first used here.
Rewords to "a mountainous station" in abstract for clarity (Lines 53-54).

Figure 2: Use consistent formats for x- and y-axis labels.
The format of labels in Figure 2 have been modified (Line 319).

Line 323: What is 184 for?
This redundant word has been removed.

Figure 4: What does the wind burb direction represent? Horizontal wind direction, direction along the cross section, or others?
The tail of wind barbs indicates the wind direction. This description about the wind barbs has been added in the figure caption (Line 404-405).

10 and 11: Are the labels of terms consistent? I was confused.
They are different. Since the wind speed have significantly different between lower and higher layers, it is difficult to identify the wind speed patterns by the same color. Thus, we preferred to use different color labels in these two figures to emphasize their characteristics.

Line 470 "sub-cloud warming": Did clouds form? Where? Maybe this manuscript needs more descriptions about the weather condition including clouds (and precipitation). Introduction highlighted and stated that wind intensification influences precipitation, while this case did not produce precipitation. This could be a reason that the value of this study was ambiguous.
There were no precipitation in this event, to avoid the confusing and follow the suggestions from the reviewer. We have removed redundant descriptions about the precipitation in introduction and emphasize clear air conditions in this event (Lines 335-338). We have also evaluated the contributions from large-scale weather system. The

results indicates that the PGF was produced by adiabatic warming coupled with the passing LPS. The details have been revised in Section 4.1.2 (Lines 579-597).

Lines 366-367: I did not understand how/why the propagation of the upper wind toward the low level was related to the wind intensification.
This sentence was moved to Lines 504-505 to appropriately explain the wind intensifications from the LDAPS dataset.

Figure 11: I did not see any wind intensification near the surface at the DGW site. This is inconsistent with Fig. 13. Why?
There were no significant wind intensifications at the DGW site since it has manifested persistent strong wind when the LPS was approaching. This sustained strong wind produced the PGF associated with channeling effects, and the channeling effect accelerated the wind speed only around the DGW site. This is the reason why DGW always measures stronger wind than the YPO site (this result is consistent with Figure 13).

Line 564: What does "an almost out of phase" mean?
It means that there is a negative relation (opposite phase) between the wind speed and pressure. The wind speed usually increased when the pressure was dropped. The description has been improved in Line 640.

Lines 572-576: I could not understand this sentence. This is too long. Please also check the grammar.
This sentence has been removed due to the new analysis was performed.

Lines 626-630: The sentences did not make sense to me. The second sentence did not follow the third sentence. Maybe need more descriptions.
These sentences have been revised for clarity in Lines 695-704.

Line 651: I could not find the high wind speed area.
The color labels have been changed in Figure 15 (Line 729) to clarify the strong wind speed near the DGW site (narrow segment along the valley).