

# Review of “Measurement Report: Strong Valley Wind Events during the International Collaborative Experiment – PyeongChang 2018 Olympic and Paralympic Winter Games Project”

Authors: P. Joe, G. Lee and K. Kim

The manuscript focuses on the analysis of strong gusty winds during the Olympic and Paralympic Winter Games of 2018. Strong gusty winds and their spatial divergence along the field of play can lead to unsafe and/or unfair conditions for athletes for example of the down-hill and half-pipe events. Accordingly, nowcasting is essential for the organizers of the events which need to decide if test runs or even the main event can take place or need to be rescheduled. Unfortunately, the scale or grid of forecasts is an order of magnitude bigger than the scale or size of the field of play making the decision for the organizers challenging.

Upper air analysis showed that the wind field was mainly synoptically forced by north-westerly winds. Near the surface, due to vortex shedding on the mountain ridges, these winds can lead to gusts and divergence of the wind field within the field of play. Further, local valley-wind systems can establish on the field of play which are not necessarily forecasted by common weather prediction models making the prediction of safe and fair events even harder.

The manuscript focuses on two venues and three events of which two were during the winter games which are case studies of 2-3 days for investigating the wind field rather than just gusty winds. Therefore up-to-date analysis techniques are used like wavelets, Hovmueller plots, and eigenvector frequency spectrum for determining the periodicity of gusts.

While this seems a valid approach to further investigate and evaluate the measurement network, the manuscript would benefit from the following:

- have a clear goal and narrative: I could not find a formulation of a clear goal or main objective like improving nowcasting. Also the mentioned objectives are quite broad and were not used to organize the manuscript. Accordingly, also the structure seems rather like a list of analysis tools than a cohesive study leading to improvement of our understanding. The analysis tools are chosen appropriately in my opinion, however, their results are not well organized nor well presented and most of the physical interpretation of the results is missing in my opinion. I highly recommend revising the manuscript such that a main goal is formulated and reached through a cohesive narrative.
- Figures: I can find mistakes, poor choice of organizing subplots, missing units, wrong colors, not good choice of color scales etc. in almost every figure (more details see below). Besides the figures themselves, the manuscript has too many figures. A selection would make sense in my eyes to have a more straight forward study instead of presenting all results. But if the manuscript remains a measurement report, maybe the amount of figures is appropriate.
- Analysis tools: Details are given below, but some techniques are not applied correctly (as far as I could see) their interpretation is incomplete or even incorrect in my eyes. As the main structure of this manuscript is missing, I stopped reading carefully after section 3.4. Also the Appendix seems very long and could be improved in a way that the frequency analysis using eigenvalues is better understood and also shows why this analysis tool is better or gives more insights than wavelets. So far I see not a discussion on this and I think one of the techniques is sufficient.
- Discussion: I could not find a real discussion in which publications are used to set the results of the manuscript into the context of our knowledge. If the manuscript remains a measurement report I would combine Discussion and Summary.
- Summary: I could not find what the novelties of the manuscript are, what the main outcome is or what the general implication for atmospheric science is. But this should be fine for a measurement report.

Due to my above mentioned points, I recommend major revisions.

### Language:

Language use is correctly, but the manuscript needs more structure and a cohesive narrative to make it more reader friendly. Also for a measurement report some structure (like the formulated objectives) would be beneficial. Further, the manuscript would benefit from shorter and more precise sentences.

Title, L1, L14, L39, L41, L89, L97, L100, L126, Fig.7, L270, L355: You are using the phrase “strong gusty wind events”, “gusty winds”, “strong gusty winds” or similar versions of this phrase. Since this is the main topic of your manuscript I would highly recommend to keep wording the same: “strong gusty winds”. Since the manuscript focuses on the wind conditions for different events, why not choosing a catchy title like “Measurement Report: Challenging winds during the International...”

### Abstract

L5: “turbulence were” or “turbulence is” – Is turbulence itself influencing the athletes or the strong winds themselves?? Also do you actually have turbulence data? 1-min averages do not observe turbulence.

L6: “Three types of wind data” – I would argue that you use different wind statistics of one signal (10-min averages, and 1-min maximums of the 1-min signal)

L6-7: ...were reported every minute... → automatic weather stations with a 1-min resolution, right? What turbulence information did you get from the measurements?

L10-11: I am confused... do you mean: “Wavelet analysis was used for investigating turbulence while the method of eigenvalue analysis was utilized for frequency estimation of motions.” (you specify in the next sentence how this indicated the frequency caused by vortex shedding)

### Introduction

Overall the introduction is good and provides an introduction into the study. I only have a few comments or questions or recommendations:

Since the phrase gust is used multiple times, I would recommend to start with the definition of gusts and then lead to why or how they most likely affected winter athletes and then how it affected the PyeonChang Winter Olympic Games.

First paragraph (L14-17: competition was altered to provide safe conditions) is in contradiction to the second paragraph (L17-25: no safe conditions during women’s slope style event). So was it just an attempt to provide safe conditions or did they not know better or was the competition altered after some events?

L19-21: what are the different ways? What is “small-scale nature of winds”? Why is the 1-2 minutes apart important? How does this lead to unfair competition?

L21: What are head-wind gusts?

L22: What is WSS? What does it stand for? I see that it is a reference, but I could not access the link (03.Nov, Austria) I also see WSS used later on for measurements. Please clarify.

L25-26: To avoid confusion, I would end the sentence after “...is conducted”. Further, the phrase “race course” is used in L41 and L93 and should be adjusted

L27: “...extremely small by normal...” change to “...is a fraction of the scales used for normal operational forecasts.” (assuming it is a fraction of the usual scales)

L27-30: You give an example of different “field of play” → it would be very beneficial to also have the scales for operational forecasts to give the examples more meaning...

L70: What is upper air observations? Radio sondes? Lidar measurements? I would at least mention what kind of measurement this is.

L75-78: Objectives are formulated: I did not find them again in the manuscript. Why is the manuscript not structured so it is easy to find the objectives (i)-(iv).

L79-81: Why is this not a summary of all sections? Instead the (i)-(iv) naming is used again which is very confusing

### Project Background/Setup

Would it be possible to add a (small) map of Japan and location of the events and then the other included pictures of Figure 1?

Further comments to Figure 1 can be found below under the section “Figures”.

L90: Could you add a marker for Peak B in the small plots?

L92: Abbreviations are introduced but I do not see where they are used afterwards. Delete if not used.

L94: Is it important to mention the avalanche chute? Seems quite irrelevant and is not mentioned again in the text

L100-104: This is results/interpretation/discussion which does not belong to this section!

L105: Since the events got labels and dates in a table, why not using this label “Event 1”? Same for the other events.

L112: add the section number/reference to the corresponding section

L112-113: I do not understand why this added information is interesting or relevant.

L114: “..are described elsewhere (Lee et al. 2021).” change to “...are described in Lee et al. (2021).”

L116: I would like to know what kind of upper air soundings or at least which temporal/spatial resolution the measurements had.

L117-118: so 1-min data and then 10-min averages were computed. Are the running averages overlapping? So I have 10-min averages every minute?

L118: Abbreviation “WSS”: Since this is the max within one minute, I think a naming like  $WS1_{max}$  would also make sense

L119: “...terrain, It should...” → “...terrain, it should...”

L119-120: The sentence is confusing, please revise.

### Wind Time Series

L124-125: delete the sentence about other, but not used parameter or move to Section 2

L125: “...later two winds...” → use the introduced abbreviations WS1 and WSS. Further, of course WS1 and WSS have a higher fluctuation than WS10, because it is the mean of the signal acting like a filter. I do not see this as a major result or even mention worthy. But what I would suggest to introduce Figure 14 instead of Figure 2 here which actually gives statistics about the wind speed distribution of the events as well as overall during the winter of this year.

L127-129: A mean of a signal has less fluctuations than the signal itself. This paragraph and the corresponding Fig. 3 are redundant and do not provide any useful information.

### Upper Air Analysis

L138: please provide dates when the period between Olympic and Paralympics was

L145-153: You use Reynolds numbers as indicator for mechanical turbulence as also other studies do. This statement is followed by “The interpretation of high Reynolds number is imprecise” making the before statement obsolete. Even the sentences afterwards don’t make it clear what your real interpretation or conclusion is about Reynolds numbers. Please clarify if Reynolds number do indicate vortex shedding or wake turbulence or not.

### Hovmueller Analysis

L157: From where are the potential temperature and wind speed measurements? I thought temperature measurements are not shown?

L158: “co-slope”: I never heard that phrase and actually find it confusing in combination with cross-slope. I would suggest “along-slope” and “cross-slope”.

L158-159: How were these components retrieved? How are you sure it is up-hill or down-hill? Did you also have information of the vertical wind speed? Was the rotation into the along-slope and cross-slope components 2-dimensional or 3-dimensional? Were the wind speed measurements perpendicular to the slope or aligned with gravitation? Please provide more information on this part

as you can only provide “real” down- and up-slope wind if the station was mounted as such. Otherwise the vertical wind component needs to be taken into account (3-dimensional rotation).

L159-160: essential to mention that altitude is decreasing from left to right! (maybe add a statement that it simulates the down-hill path an athlete would take)

L170-171: “Not unexpectedly,...” → sentence redundant, delete

L171-172: I do not fully agree with the decision to proceed with 10-min averages. Especially since the events are just minutes apart and that you want to show the real gustiness of winds which can change rapidly, why choosing the 10-min averages??

L176-177: I see a diurnal pattern of rising and sinking temperature during all events, however, event2 and 3 differ from event 1 that they have cold-air pools, but also not every night. Please revise statement.

L178-180: Are nighttime conditions relevant?

L182: Any idea why?

L183-185: I would argue that the mentioned “local effect” is simply the different slope orientation of BOKX and BOKSS and not necessarily small-scale local motions like cold-air drainage or similar. The strength of along- and cross-slope flows of BOKX and BOKSS differ in strength, because the slopes have different orientation, but are part of the same valley. So when rotating the wind speed components into along- and cross-slope components into this framework the strength differs even if wind speed and direction is similar at both stations. I would look into spatial differences instead of comparing the cross-slope and along-slope winds to investigate local effects.

L186-187: I would interpret that cold-air drainage and pooling at the lower elevation lead to the low wind speeds.

L191: This is redundant and already mentioned, further, this is not part of the investigation, right?

L192-193: I do not agree, for example BOKSS cross-wind on event 1 are stronger than on event 2. Besides, are the observations for the along-slope winds relevant? If yes, for what?

### Wavelet Analysis

Looking at the wavelet spectra I have some comments:

- the cone of influence is missing. Please add those to all your graphics
- WS10 can not be used for this analysis since it is a statistical metric from WS1. So analysing WS1 already contains every information which can be gained from this technique.
- Similar: the interpretation of the wavelet of WSS is complex and I actually do not know how to do it, since it is a maximum within a 1-min window, but the location of the maximum within the window is unknown. So analyzing the periodicity of a maximum, but its actual “time location” is unknown seems wrong to me.
- Accordingly, the only signal which can be investigated is most the 1-min averages.
- Looking at the spectrum: I am quite sure you did not rectify your wavelet power spectrum as presented by Liu et al. (2007). This is essential for this analysis! Please revise your analysis accordingly.
- I think when applying this correction, the results might be better comparable with the eigenvalue analysis.

I did not further read the text, because I guess it will be revised after the analysis is revised.

Liu, Y., San Liang, X., & Weisberg, R. H. (2007). Rectification of the Bias in the Wavelet Power Spectrum, *Journal of Atmospheric and Oceanic Technology*, 24(12), 2093-2102. Retrieved Dec 2, 2021, from [https://journals.ametsoc.org/view/journals/atot/24/12/2007jtecho511\\_1.xml](https://journals.ametsoc.org/view/journals/atot/24/12/2007jtecho511_1.xml)

### Frequency Analysis

Overall: I did not understand this analysis even when looking at the Appendix. Please make the analysis more clear, maybe even with simple example to understand how your detection of periodicity/frequency works. Further, there should be a way of averaging spectra and showing this

for each event instead of so many subfigures. Also the spectra look mirrored, so why showing both sides? What are negative frequencies?

Further comments:

L233-234: I do not understand the sentence about stationarity. You have to make sure there is no nonstationarity in your data or if so remove it by common techniques. So please provide information how this was assured.

L242: Any idea why multiple maxima/minima? Maybe also here some rectification/normalization is needed for analyzing the spectra?

L262: Why 2-hour segment?

L268: What do you mean with “finer granularity”?

L268: How can you have longer periods which are not even sampled twice within a 2-hour segment? I am confused.

### Discussion

I am a big fan of combining results and discussion, so a narrative can be kept instead of separating results and discussion. The one paragraph simply a or multiple results. Next paragraph interpretation. Next paragraph discussion how this fits into the outcome of other studies. But this is up to each author how to approach this. Nevertheless I struggle with this section, because it is a summary not a discussion:

L270-280: that's part of the introduction/motivation for this study

L281-284: this paragraph wraps up the results of a previous section

L285-290: Where is this threshold from? Why should it be used? References?

L291-302: This is a description of the field sites and should be in Section 2

L304-312: The first three sentences are simply wrong (see comments before). The rest needs to be revised, because I am quite sure that Evs and Wavelet analysis should not differ this much! And if so, please discuss accordingly. Why is it here mentioned that gusts can not be resolved? I got the impression that the paper actually wanted to investigate those! Please comment on this.

L313-317: What would be the appropriate observations and what is needed to interpret them? Using wavelets or EVs to detect common frequencies of the last few hours?

L318-319: Where is this shown or investigated? Is that important for athletes?

L324: If the common periodicity of occurrence of gusts is 20min, how does a mean of 20min help detecting them? Averaging over this period might make them undetectable!

L327-328: This description of the hills need to be mention in section 2

L331: I would not bring a new figure with new results in the discussion! Seems like a complete new topic! Further, the correlation coefficients seem a little low to show a significant correlation between the parameter.

L332: “supingport” → “supporting”

L333-338: I would suggest to show Figure 14 way earlier (section 3.1), because it gives a good overview of the wind distributions during the different events! Further, the description of “bi-modal” is misleading, because the events show a different distribution, but I do not see any bi-modal distribution of one event!

### Summary

Why are the suddenly citations in the summary? Anything up for discussion or being part of the introduction (like other studies already showed that...) should be mentioned earlier! Besides, the second last paragraph (L381-389) was confusing. Please clarify.

### Figures (recommendations and comments)

- Figure 1: units are missing on color scale; I would use blue instead of gray for water; have a color scale without white; color brightness should increase or decrease with elevation; please add a bigger map of Japan; insert “Peak B” and “Peak J” in the subplots; what is SRTM03? Maybe add the synoptic flow as an arrow for each event.

- Figure 2: very sure the colors are wrong; maybe add rectangles for the events instead of arrows; or simply use Fig. 14 instead of this one; how is WSS wind direction defined?
- Figure 3: I would not include in the revised version; also colors are wrong
- Figure 4: quite sure the units of the color scale is wrong; also add units; use a gradient color scale with brightness of color increasing or decreasing; do not use white as a color!! What is the red line? → add some comments in the caption
- Figure 5: please reorganize date and time: 21 Feb 12:00 – 22 Feb 12:00; the 4th-8th plots are not discussed/presented: either delete or discuss in a more detailed fashion; add units to the color bar; the altitude decreasing from left to right is not intuitive → comment in the caption or add words like peak and valley to the plot
- Figure 6: “BOKX Event 1 Feb 11 00 – Feb 13 00” → “BOKX Event 1: 11 Feb 00:00 – 13 Feb 00:00” (otherwise very confusing!!!); super small figures; maybe choose a few and add the rest to the appendix; color scales need units!; what are the lines in subplot (h)?
- Figure 7: only use WS1; when the spectrum is rectified: use a linear scale, not an exponential!; Do not use white as a color! Add the cone of influence!
- Figure 8: see Fig. 7
- Figure 9: pretty sure WS1 is shown not WS10 (as written on the axis); Subplot (e) is not explained in the caption
- Figure 10 & 11: There should be a better way of presenting this... maybe averaged spectra or similar? Or something like Fig. 12?
- Figure 12: do not use white as a color!; why is there a “gap” in subplot (c)?
- Figure 13: would not include, do not see the gain in the figure
- Figure 15: maybe show as an opener showing what went wrong

I hope the detailed feedback does not discourage you! There is already a lot of great work done, it just needs some more work! If you can show what physical insight you gained and what you learned from this study, and what needs to be done for nowcasting of future events (maybe even on other sites), maybe this manuscript can even be turned into a publication instead of a measurement report (but that is up to the editor, not to me). Looking forward to the revised version!