The paper described a method to identify three types of sea breezes – pure, backdoor, and corkscrew – from WRF model simulations conducted over the US Northeast. The simulations cover only one year (September 2019 – August 2020) and used two-way nested domains of 6 and 2 km resolution. Statistics of the results are presented, as well as a sensitivity analysis to the values of the thresholds adopted to identify the sea breezes and a comparison of the typical wind power production to be expected for each sea breeze type.

The paper is well written and the figures are clear, but there are so many issues with the paper that, in my opinion, it should be rejected for publication in this journal, although it might be suitable somewhere else.

Response: Thank you for your comment. We sincerely appreciate the time you spent reviewing this work. In this revision, we have revised the paper substantially based on yours and other reviewer's comment. The key changes are

- The title of the paper has changed to *Detecting and Characterizing **Simulated** Sea Breezes Over the U.S. Northeast Coast with Implication for Offshore Wind Energy*.
- An additional analysis has been conducted to examine the variability of individual sea breeze cases.

I'll focus on major issues first.

The first major issue is that it is not clear why this paper is relevant for wind energy. The authors focus on sea breezes along the US East Coast and only at the end of the Discussion section present two figures somewhat relevant to offshore wind to presumably show that the power output depends on the sea breeze type. How innovative or useful is this type of information? Why was the turbine placed in the center of domain 2? How would a developer or wind farm operator benefit from this information? I suggest that the authors choose a different journal, one perhaps focused on climatological or meteorological aspects.

Response: Thank you for your comment. This paper is not a validation study, it is to introduce a method to detect sea breeze events over the U.S Northeast Coast from WRF simulation. In this revision, we have changed the title to be better reflect our purpose. To our best knowledge, this is the second paper to develop numerical method for sea breeze detection from WRF simulation and it is the first to apply over the U.S. Northeast Coast where there is huge offshore wind potential (https://www.northeastoceandata.org/data-explorer/?energy-infrastructure|planning-areas). As sea breezes are a significant coastal phenomenon, detecting sea breezes from numerical model will be relevant to the wind energy community and offshore wind forecasting.

The second issue is that the simulations cover only one year, therefore they are not long enough to produce meaningful statistics, climatologically speaking. The paper does not explain why the period was chosen. I would understand if the authors had collected observations over that period and wanted to validate the model results, but they did not, which is in fact my third issue. There is no model validation and we are left with no convincing evidence that the two-step method indeed finds sea breeze events correctly.

Response: Thank you for your comment. As we mentioned in the Major comment 1, model validation is not the focus of this study; rather it is to develop a method to detect sea breeze. Therefore, we believe a year-long simulation is enough to demonstrate our method so that others can use the method and apply in their long-term simulation. This work started off in 2019 and that is why we run the simulation from 2019 to 2020. The validity of our method is shown in the composite figures which demonstrated the key structures and features associated with each type of sea breeze.

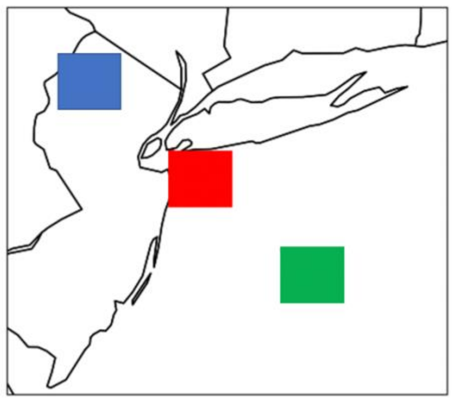
The fourth issue is methodological. The paper uses averages and means abundantly. I am particularly troubled by the use of average wind directions. Since the wind is a vector, the sum of vectors is not an average. What's the average of a northerly (0°) and southerly (180°) wind? A wind from the east (90°)? It does not make any physical sense. As such, Figures 4, 6-8, and 11 are not acceptable because they show "average" wind vectors.

Response: Thank you for your comment. I understand your concern which would be an issue if we did the averaging over just a few points. However, what we did is a regional average which will not be affected by a few outliers. For a spatial extent of a quadrant size domain defined in our study, very rarely, will you see wind direction changes drastically from 0° to 180 ° from one quadrant to the other. If that happens, that usually mean the region is influenced by cyclonic conditions and those cases are filtered out in the first place (Lines 129-130: *Days with cyclonic conditions over the targeted region are rejected, as sea breeze identification would be difficult due to rapid changes in wind direction in these cases*). In addition, I have checked all the selected days as well as all the unselected days to make sure our method works.

In addition, even taking the averages over each sea breeze type at each hour is at least questionable. The authors make the implicit assumption that each sea breeze type evolves exactly the same at each hour and therefore taking the average at hour, say, 11 LT is meaningful. But this is not true, differences occur at 11 LT due to the season, due to the position of the sea breeze front, due to the background wind flow, to list a few. Aside from vectors, this is especially troublesome with convergence and divergence fields used to identify the average position of the sea breeze front, because averaging a positive and a zero or negative value at a grid cell, for example, could dilute the signal of the sea breeze location. The authors need to find alternative methods to characterize the statistics of the sea breezes, for example using median values or some pattern recognition techniques.

We understand that each sea breeze case is different from one another. By taking the average of a specific sea breeze type events, the mean development of the sea breeze is revealed (Figures 6-9). The effectiveness of our method is demonstrated as key sea breezes features (e.g., calm zone, coastal jet) appear in the composite figures.

We acknowledge your concern about the differences between individual cases. In this revision, we have conducted additional analysis to examine the variability of simulated sea breeze events. Our results suggest that the temporal development of the calm zone for the pure sea breeze and the positioning of the coastal jet for the corkscrew sea breeze is rather consistent across their identified cases respectively.



To do that, we have defined three regions to quantify the variability of the identified sea breeze cases (as shown in the figure). They are located on land (blue), over the coast (red) and over the ocean (green). The size of region is about 3 % of the entire regional domain. For each sea breeze type, we calculate the standard deviation of WS10 and WD10 from the identified sea breeze events over all three regions from 08 LT to 20 LT, and the results are shown in the tables below.

Table1 : Variability of simulated pure sea breeze cases over land, coast region and ocean

Standard Deviation of WS10(m/s) for the Identified Pure Sea Breeze Cases													
	08 LT	09 LT	10 LT	11 LT	12 LT	13 LT	14 LT	15 LT	16 LT	17 LT	18 LT	19 LT	20 LT
Inland	1.4	1.3	1.2	1.1	1.2	1.3	1.4	1.3	1.1	0.9	1.0	0.8	0.8
Coast	2.3	2.0	1.8	1.6	1.5	1.4	1.3	1.4	1.4	1.4	1.3	1.2	1.4
Ocean	3.0	2.8	2.5	2.1	1.8	1.7	1.7	1.6	1.5	1.6	1.7	1.8	1.8
Standard Deviation of WD10 (degree) for the Identified Pure Sea Breeze Cases													
	08 LT	09 LT	10 LT	11 LT	12 LT	13 LT	14 LT	15 LT	16 LT	17 LT	18 LT	19 LT	20 LT
Inland	119	111	94	77	62	58	58	62	63	63	56	51	55
Coast	102	119	114	105	92	78	65	60	55	54	53	62	51
Ocean	118	129	112	108	107	116	115	110	106	97	85	78	76

For the pure sea breeze cases (Table1), the variability of WS10 is largest during the morning hours and decreases after that. Overall, the variable of WS10 is greater over the ocean than that on land. As for WD10, the variability is large during the morning hours. Note that, based on our methodology and the shape of the coastline, the pure sea breeze is identified from potential days of three different wind regimes (Northwesterly, Northly and Westly). Therefore, it is not a surprise that variability of WD10 is large during the morning hour. However, variability of WD10 drastically decreases after the morning hour due to the influence of sea breeze development. Note that the standard deviation of WD10 over the ocean is relatively large until late afternoon. This is mainly due to the development of the calm zone (Figure 6 of the manuscript). After the calm zone moved away from the coast, standard deviation of WD10 reduces significantly (16 LT to 20 LT).

Table2 : Variability of simulated corkscrew sea breeze cases over land, coast region and ocean

Standard Deviation of WS10(m/s) for the Identified Pure Sea Breeze Cases													
	08 LT	09 LT	10 LT	11 LT	12 LT	13 LT	14 LT	15 LT	16 LT	17 LT	18 LT	19 LT	20 LT
Inland	1.1	1.0	1.1	1.1	1.1	1.0	0.9	0.8	0.6	0.8	1.0	0.6	0.7
Coast	1.8	1.7	1.6	1.7	1.9	1.7	1.8	1.7	1.8	1.8	1.7	1.6	1.8
Ocean	2.4	2.3	2.1	1.9	1.8	1.9	2.1	2.2	2.3	2.5	2.4	2.4	2.2
Standard Deviation of WD10 (degree) for the Identified Pure Sea Breeze Cases													
	08 LT	09 LT	10 LT	11 LT	12 LT	13 LT	14 LT	15 LT	16 LT	17 LT	18 LT	19 LT	20 LT
Inland	68	67	58	48	42	43	44	43	43	44	40	46	40
Coast	79	80	69	55	45	36	32	35	28	28	28	35	31
Ocean	67	78	85	75	75	78	66	62	60	57	48	36	31

Table 2 shows the results from the corkscrew sea breezes. In general, the characteristics are similar to that from the pure sea breeze cases. One important aspect is that the small variabilities of WD10 over the coast region during the late afternoon hours. This suggests that the position of the simulated jet core (Figure 7 of the manuscript) over this region is rather stable, which would have significant offshore wind energy implication in terms of wind turbine positioning.

Table3 : Variability of simulated backdoor sea breeze cases over land, coast region and ocean

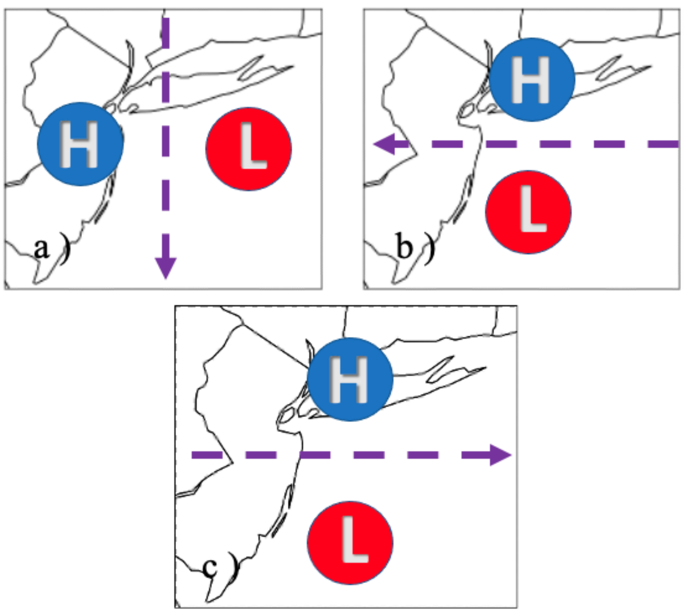
Standard Deviation of WS10(m/s) for the Identified Pure Sea Breeze Cases													
	08 LT	09 LT	10 LT	11 LT	12 LT	13 LT	14 LT	15 LT	16 LT	17 LT	18 LT	19 LT	20 LT
Inland	0.9	1.1	1.6	1.7	1.6	1.7	1.7	1.7	1.8	1.4	0.8	0.4	0.3
Coast	2.4	2.3	2.2	2.4	2.5	2.4	2.3	2.3	2.3	2.3	2.2	2.3	2.4
Ocean	3.5	3.7	3.6	3.5	3.4	3.0	2.9	3.0	3.0	3.0	2.9	2.8	2.7
Standard Deviation of WD10 (degree) for the Identified Pure Sea Breeze Cases													
	08 LT	09 LT	10 LT	11 LT	12 LT	13 LT	14 LT	15 LT	16 LT	17 LT	18 LT	19 LT	20 LT
Inland	16	17	20	29	34	37	35	31	31	27	27	29	31
Coast	13	14	17	18	16	16	17	16	18	22	22	28	26
Ocean	107	94	42	37	58	65	78	62	36	24	17	22	29

Table 3 shows the results from the backdoor sea breezes. Because of low occurrence rate, It has the smallest variability, which also indicates that the development of the individual backdoor sea breeze does not differ much from the mean condition (Figure 8 of the manuscript).

Corresponding texts and tables have been added to the manuscript. Note that we have changed the alignment of three regions in other attempts, such as horizontal and vertical. However, that does not change the table results significantly.

The last major issue is probably just a matter of explaining things better. There must be a sub-region or location of focus of the study, otherwise how can there be one sea breeze type for the entire domain 2? If the sea breeze is affecting New Jersey, it must be east-to-west, but in the northern shores of Long Island is it north-to-south? If it's a pure sea breeze in New York City, could it be corkscrew somewhere else? I suspect that the issue is partly due to Figure 3, which I find very obscure. Where is the land? Is the prevailing wind the geostrophic wind? Where is north and south? Which way is the sea breeze flow?

Response: Thank you for your comment. You are right. We are not detecting sez breeze over the entire domain but only a subregion which is square-shaped area covering the New York metropolitan region (Figure 2b of the manuscript). In this revision, we have reworked Figure 3 to avoid further confusion (see figure below). It shows three idealized scenarios where the arrow indicates geostrophic wind.



Minor issues

1. Why were the 4 quadrants introduced? I don't understand their purpose as they are not used. The text near line 130 talks about "mean … for each individual quadrant", is this an area average over all grid points in the quadrant? Then a

"dominant wind regime" for that day is obtained. What does dominant mean? How many hours out of 24? What if different quadrants had different sea breeze types?

Response: Thank you for your comment. The 4 quadrants are introduced to help detect sea breeze events in our simulation. They are heavily used in our detection method to determine the wind regime and categorize sea breeze type. The dominant wind regime for the region (all 4 quadrants) is determined when at least 2 of 4 quadrants share the same wind regime (NW, W, N, BD and CS). This is step 1 of our detection method and it only examines SLP and wind field at 08 LT for each particular day. The identified days have the potential for sea breeze development and are subjected to step 2 of our detection method. Please see section 2.2 of the manuscript for more details.

2. Table 2: It suggests that 246 days had sea breezes in a year, which seems too many. Again, maybe the sea breeze types are not mutually exclusive, but then I do not understand how the averages are even calculated.

   Response: Thank you for your comment. The 246 days identified in Table 2 suggest days with the potential for sea breeze development. This is the results from the Step 1 of our detection method based on wind regime characteristic. These days are later subjected to Step 2 of the detection method and a total of 61 simulated sea breeze events have been identified.

3. 185: here it seems that only 61 days were identified, but Table 2 is not consistent.

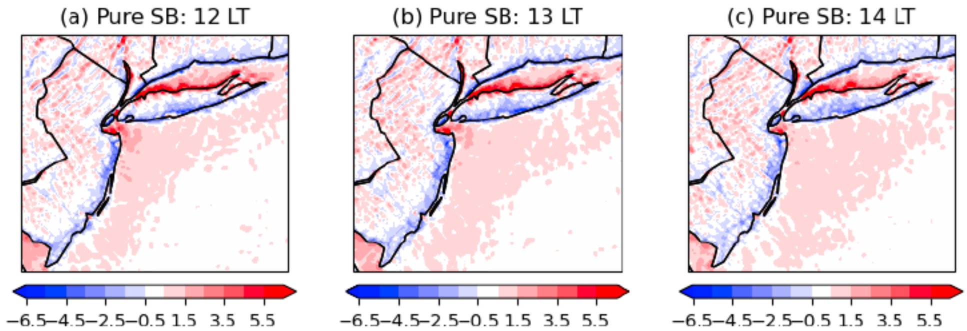
   Response: Thank you for your comment. Please refers to Minor comment 2 for more details.

4. 205: again, I am confused about the averaging, are you averaging over all 3 types of pure sea breeze here? If so, it seems even more questionable to average over such a broad range of wind directions.

   Response: Thank you for your comment. Figure 6 shows the average of all the 28 identified pure sea breeze events. In addition, there is no 3 types of pure sea breeze in our study, but only 3 types of sea breeze (pure, corkscrew and backdoor).

5. Figure 6: even given the fourth major issue above, it seems to me that the only location with a sea breeze here is Long Island.

   Response: Thank you for your comment. From 12 to 15 LT, there is also sea breeze occurring over the coast of New Jersey, as evidenced from the surface divergent map.



6. Figure 8: The corkscrew sea breeze seems to be in New Jersey only.

   Response: Thank you for your comments but I think you are referencing to Figure 7. Based on the plot, it does seem like New Jersey is mostly impacted by corkscrew sea breeze. Corresponding sentences has been added to the revised manuscript.

7. Figure 9: because these figures are averages, the dynamic evolution is basically lost. There is no meaningful difference between the fields at 12, 13, and 14 for the pure sea breeze case, for example. Averaging out conv/div, the signal is diluted and the front is less distinguishable.

   Response: Thank you for your comment. The rational of using averaging are provided in the response to the Major comments. Based on Figure 9, the position of the sea breeze front is different for each sea breeze types. In this revision, we change the Figure to show the difference at 09, 13 and 17 LT so that the evolution of the sea breeze front for each sea breeze type can be seen clearly. Corresponding sentences has been changed in the revised manuscript.

8. Line 260: I disagree that "Overall, the results indicate …" There is no evidence that the method works!

   Response: Thank you for your comment. As we mentioned in our response to your Major comment, this is not a validation study. We think our method works as it has successfully identified different sea breeze events as well as the associated sea breeze characteristics from the model simulation.

9. Line 292: which 10-MW turbine?

   Response: Thank you for your comment. We use the power coefficient from IEA 10MW RWT.

10. Line 293: why was this location chosen? Is it where a lease area is proposed? Please explain.

Response: Thank you for your comment. This area is subject for major offshore wind farm construction, and we have mentioned that in the introduction section of the revised manuscript. Please refers to our response to Major comment 1 for more details.

11. Line 319: Your methodology of averaging out everything washes out the details of the timing and evolution of the sea breezes, that is why your results are not consistent with past studies.

    Response: Thank you for your comment. The rational of using averaging are provided in the response to the Major comments. This is a modeling study and the first modeling study showing the spatiotemporal evolution of different types of sea breezes whereas the past studies are mostly observational and are for point measurements. Therefore, certain discrepancies between these two types of studies are expected.