Review of "US East Coast synthetic aperture radar wind tlas for offshore wind energy" by Ahsbahs et al, submitted to Wind Energy Science Discussions

The paper provides the first atlas of the offshore wind resource along the US East Coast derived from high spatial resolution (2 km) SAR products from four satellites at 10 m above sea level. A detailed comparison against two independent data source is also provided, buoys and WIND Toolkit, as well as a discussion of biases, seasonality, and gradients. This is one of the best papers I have ever reviewed and it should definitely be published soon. I only have a few minor comments and suggestions.

Answer: Thank you very much for a fast and very positive review. We highly appreciate your constructive comments and have followed them all as specified in the following.

1. It was not until page 5 (line 15) that the 10-m height was mentioned. It is important to let the reader know that the atlas is valid at 10 m asl earlier than that. I recommend that you add this information in the abstract ("We present the first synthetic aperture radar (SAR)-based, offshore, 10-m wind atlas …") and even in the Introduction around p. 2 lines 20-30.

Answer: Agreed. We have added this information to the abstract and the introduction.

2. Similarly, you need to mention the height of the buoy measurements in section 2.3 (it is mentioned later (p. 6 line24) but it should be here) and the height of the WIND Toolkit output in section 2.4 (10 m – is this a real model level or an interpolated value? If interpolated as I think, how?)

Answer: Buoy measurements are at heights between 2 and 7 m above the sea level. We have added sentences at your suggested locations. The 10m wind variables from WRF are used directly.

3. In the abstract, the WRF model is mentioned, but also the WIND Toolkit project should be mentioned, otherwise the reader thinks that the authors ran the WRF model themselves. Instead, they used WIND, which is a well-documented, publicly available dataset.

Answer: We have added this in the abstract and modified the sentence to: "The SAR wind atlas is used as a reference to study wind resources derived from the Wind Integration National Dataset Toolkit (WTK), which is based on seven years of modelling output from the Weather Research and Forecasting (WRF) model." Throughout the rest of the manuscript, we have used 'WTK' consistently about this data set.

4. P. 2 , l. 19: a noun is missing "SAR-derived [what?] show…"

Answer: It is SAR derived wind speeds. We have corrected the sentence to:

"It has been shown that SAR-derived winds can accurately depict wind speed gradients measured by ground based lidars near the coastline (Ahsbahs et al., 2017) and that SAR wind fields show similar mean wind speed variations as those experienced by wind turbines (Ahsbahs et al., 2018)."

5. P. 4, l. 5: what is a "scene"? A snapshot? A picture?

Answer: In principle, the same scene can be observed from different angles; each leading to their own image. As we are only looking at co-polarized images here, these terms are almost interchangeable. We

have changed all occurrences of “scene” to “SAR image” as this is more understandable for the wind energy community.

6. P. 5, l. 13: what exactly is the “normalized radar cross section of the ocean surface”? I am unclear on what exactly it is that the SAR measures on the ocean surface. Is it a reflectivity of some sort? Is it related to white caps of the waves? Please add a brief description here. Also, briefly describe how the GMF works.

Answer: The normalized radar cross section is the quantity for the radar backscatter per unit area. GMFs are empirical functions relating the radar backscatter to the wind speed. We have tried to clarify this to the reader:

“SAR wind retrievals from the database of the Technical University of Denmark are used for this study and their processing is described in the following. SAR images are measures of the radar backscatter from the Earth’s surface. The intensity of this backscatter is commonly referred to as the normalized radar cross section (NRCS). Level-1 SAR data are downloaded from the data providers and calibration is applied to obtain the NRCS. The processing is done using the SAR Ocean Products System (SAROPS) software package (Monaldo et al., 2014). Radar backscatter and thus the NRCS of the ocean surface is determined by Bragg scattering (Valenzuela, 1978). This scattering mechanism is most sensitive to wave lengths on the order of 10 cm. At this scale, waves can be assumed to be in local equilibrium with the wind speed and therefore, the NRCS and the wind speed are correlated. An empirical Geophysical Model Function (GMF) can link the NRCS and additional radar parameters to the wind speed at 10 m height above the sea surface.”

7. P. 5, l. 20. Either a period “.” is missing (before “Climate Forecast…”) or the phrase is incomplete. It’s good that it was not the WIND’s wind direction that was used here.

Answer: We have rephrased to:

“Two sources of wind directions are used for the SAR wind retrieval: until 2010, wind directions come from the National Center for Atmospheric Research Climate Forecast System Reanalysis (CFSR) reanalysis data and from 2011 onwards, wind directions from the Global Forecast System (GFS) are used.”

8. P. 6, l. 25: briefly describe how the extrapolation from 5 m to 10 m is calculated in the COARE 3.0 algorithm for the buoy data.

Answer: We have added the following sentences and a reference to briefly describe this algorithm:

“In this algorithm, atmospheric stratification is described using the difference between the air and sea temperature together with empirically found constants. The wind speed is then extrapolated considering atmospheric stability and roughness as described by Charnock’s relation (Charnock, 1955).”

9. Figs. 2 and 3: what are the black lines with vertical error bars? Medians? Please add info in the captions.

Answer: The black lines indicate the mean SAR wind speed per wind speed bin (binned by buoy winds) and one standard deviation. We have added a description to the text:

“SAR wind speeds are split into 1 m/s bins according to the buoy wind speed. The SAR mean wind speed and standard deviation around this mean are calculated and plotted as well.”

And in the caption of the two figures:

“The black curves indicate the mean within each 1 m/s bin and the vertical lines around the mean value indicate one standard deviation within this bin.”.

10. Fig. 4: please use the same color bar for Fig. 4a and 4b. They are similar but not identical in the current figure.

We changed this. A GIS team NREL is remaking the plots with nicer plotting libraries.

11. Fig. 7: the month of “Feb” should be capital.

Answer: We have made the change.

12. P. 27, l. 4: missing noun after “from”, maybe “SAR”?

Answer: We have rephrased to “Mean wind speed maps from SAR and WTK have been compared in this study.”

13. Future work, item ii). I do not agree with this recommendation, remove it or explain it better. Why would randomly sampling model output, which actually includes seasonal and diurnal variability correctly, be a better way to present a wind atlas? This procedure would mimic the SAR behavior, but it would not necessarily provide a better estimate of the actual wind resource. I think the authors are saying that this random sampling method would be a better to validate SAR, not a better way to represent the wind resource. If so, please clarify/rephrase

Answer: We agree so we have revised the section on future work completely and removed this point. The focus is now on future perspectives for SAR-based wind atlases alone:

“With an increasing archive of Sentinel-1 data, future wind atlases will be based on samples, which are more distributed over the time of day. The rapid growth of our SAR data archives over time will in itself improve the accuracy of wind resource statistics. Further, a weighting of the SAR scenes by month could partly overcome seasonal biases and give better estimations of the Weibull parameters while retaining the observational character of a SAR-based wind atlas.”