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To:
Mr. Partick Bird
United States Environmental
Protection Agency
5 Post Office Square, Mailcode 05-2
Boston, MA 02109

Date:
November 23, 2022

Subject: Beacon Wind – Request for use of COARE Bulk Flux Algorithm to Generate Hourly Meteorological Data for use with AERMOD

Dear Mr. Patrick Bird,

Beacon Wind LLC (Beacon Wind) would like to request approval from the United States Environmental Protection Agency (EPA), Region 1, to use the Coupled Ocean-Atmosphere Response Experiment (COARE) Bulk Flux Algorithm to Generate Hourly Meteorological Data for use with AERMOD for an application for their Beacon Wind Project located in federal waters off the southern coast of Massachusetts in the Outer Continental Shelf (OCS) Lease Area OCS-A 0520 (Lease Area). The justification and supporting information for this alternative model request is provided below.

Introduction

Beacon Wind is proposing an offshore wind renewable energy generation project located in federal waters off the southern coast of Massachusetts in the OCS Lease Area noted above and shown in **Figure 1**. The Beacon Wind Lease Area is 128,811 acres (521 square kilometers [km^2]) and is located approximately 20 statute miles (mi) (17 nautical miles [nm], 32 kilometers [km]) south of Nantucket, Massachusetts and 60 mi (52 nm, 97 km) east of Montauk, New York.

Beacon Wind proposes to develop the entire Lease Area in two wind farms, known as Beacon Wind 1 (BW1) and Beacon Wind 2 (BW2) (collectively referred to hereafter as the “Project”). The individual wind farms within the Lease Area will be electrically isolated and independent from the other via transmission systems that will connect two separate offshore substations to two onshore Points of Interconnection (POIs). Each wind farm will gather the power from the associated turbines to a central offshore substation facility and deliver the generated power via a submarine export cable to an onshore substation facility for final delivery into the local utility distribution system at the selected POI. The purpose of the Project is to generate renewable electricity from the offshore wind farms located in the Lease Area. The Project addresses the need identified by northeast states to achieve offshore wind power goals: New York (9,000 megawatts [MW]), Connecticut (2,000 MW), Rhode Island (up to 1,000 MW), and Massachusetts (5,600 MW).

BW1 will be developed first and constitutes the northern portion of the Lease Area. It covers approximately 56,535 ac (22,879 ha). The BW1 wind farm has a 25-year offtake agreement with the New York State Energy Research and Development Authority (NYSERDA) to deliver the power to its identified POI in Queens, New York, interconnecting with the New York Independent System Operator (NY ISO).

BW2 spans the southern portion of the Lease Area and will be developed after BW1 has started construction. It covers approximately 51,611 ac (20,886 ha). Beacon Wind is considering an Overlap Area of 20,665 ac (8,363 ha) that may be included in either wind farm. BW2 is being developed to addresses the need for renewable energy identified by states across the region, including New York, Massachusetts, Rhode Island, and Connecticut. The interconnectedness of the New England transmission system, managed by the New England ISO (ISO-NE), allows a single point of interconnection in the region to deliver offshore wind energy to all of the New England states (Connecticut, Rhode Island, Massachusetts, Vermont, New Hampshire, and Maine). The need for full-build out of the Lease Area is demonstrated by the magnitude of regional targets for offshore wind and the limited amount of developable area, given current and reasonably foreseeable Bureau of Ocean Energy Management (BOEM) leasing activity.

BW2 plans to deliver power to POIs in either Waterford, Connecticut (associated with ISO-NE) or Queens, New York (associated with NY ISO). Two locations are under consideration in Queens, New York for the single proposed BW1 landfall and onshore substation facility. Of the two sites under consideration, Queens, New York the onshore substation facility site that is not used for BW1 will remain under consideration, in addition to the Waterford, Connecticut site, for the single proposed BW2 onshore substation facility. The POI for BW2 will be determined at the time of the OCS preconstruction permit application submittal.

The generation of offshore wind energy itself does not emit air contaminants. However, there will be air emissions associated with vessel engines and other equipment involved in the construction and operation and maintenance (O&M) of the Project. The Beacon Wind Project will be subject to Prevention of Significant Deterioration (PSD) permitting and is required to submit an OCS Air Permit application that includes a dispersion modeling demonstration that air emissions from the Project will not cause or contribute to an exceedance of the National Ambient Air Quality Standards (NAAQS) or PSD increments. The NAAQS have been established for six pollutants designated by the EPA as “criteria pollutants”. The criteria pollutants are carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), particulate matter (PM), and sulfur dioxide (SO_2). PM is characterized according to size; PM having an effective aerodynamic diameter of 10 microns or less is referred to as PM_{10}, or “respirable particulate.” PM having an effective aerodynamic diameter of 2.5 microns or less is referred to as $PM_{2.5}$, or “fine particulate”; $PM_{2.5}$ is a subset of PM_{10}.

EPA’s Guideline on Air Quality Models[1] (“Guideline”) lists the Offshore and Coastal Dispersion (OCD) model as the preferred model for over-water dispersion. As is discussed in this request, OCD contains limitations in model formulation, technical disadvantages, and implementation related issues for the proposed Project that justify the use of an alternative model. Beacon Wind proposes to use the COARE bulk flux algorithm as implemented within the AERCOARE program, which is intended for use within AERMOD, for this model application.

The COARE bulk flux algorithm consists of equations that utilize air-sea temperature difference, overwater humidity and wind speed to parameterize the boundary layer parameters such as sensible heat, latent heat, and momentum fluxes. Even though the COARE algorithm was originally developed based on measurements in the tropics, it has since been improved, expanding its applicability outside of tropical environments.[2] The meteorological preprocessor, AERCORE, which implements Version 3.0 of the COARE algorithms, is used to generate model-ready meteorological data for use with AERMOD, which is the current EPA preferred model for short-range (within 50 kilometers) dispersion modeling.

EPA’s Support Center for Regulatory Atmospheric Modeling (SCRAM) lists AERCOARE[3] as an alternative model and states that the output from AERCOARE can be used by AERMOD in a marine environment. The SCRAM website indicates that an AERMOD-COARE approach was approved by EPA Region 10, with concurrence from the EPA Model Clearinghouse, as an alternative model to OCD for application in an Arctic ice-free environment. In that application, the COARE algorithm was applied to overwater measurements and the results assembled in a spreadsheet. AERCOARE replaces the need for post-processing with a spreadsheet, provides support for missing data, adds options for the treatment of overwater mixing heights, and can consider many different input data formats.

[1] https://www.epa.gov/sites/default/files/2020-09/documents/appw_17.pdf
[2] Fairall et al. 2003. Bulk Parameterization of Air—Sea Fluxes: Updates and Verification for the COARE Algorithm. Journal of Climate. February 2003.
[3] https://www.epa.gov/scram/air-quality-dispersion-modeling-related-model-support-programs

On April 1, 2011, EPA Region 10 granted approval for the use of output from the COARE algorithm coupled with AERMOD to estimate ambient air pollutant concentrations in an ice-free marine environment.[4,5] Since the EPA Region 10 approval in May 2011, there have been five (5) additional EPA Model Clearing house approvals to use AERMOD-AERCOARE. Those approvals include:

1. November 2019, EPA Region 6, Sea Port Oil Terminal (SPOT), Gulf of Mexico
2. January 2022, EPA Region 1, Vineyard Wind, OCS off the coast of Martha's Vineyard, Massachusetts
3. July 2022, EPA Region 1, Park City Wind, OCS off the coast of Martha's Vineyard, Massachusetts
4. July 2022, EPA Region 2, Empire Wind, OCS off the coast of New York, Long Island
5. July 2022, EPA Region 2, Atlantic Shores, OCS off the coast of New Jersey

As documented in the all the recent approvals (including the most representative for Park City Wind off the coast of New England[6]), the AERCOARE-AERMOD model was approved for use in an arctic marine ice-free environment because it satisfied the five (5) criteria contained in Section 3.2.2.e of EPA's Guideline. In each concurrence memorandum, the EPA Model Clearinghouse stated that its concurrence with the approvals did not constitute a generic approval of AERCOARE-AERMOD for other applications. This alternative model approval request for use of AERCOARE-AERMOD follows the format of previous requests.

Based on the proposed Project location, recent approvals of AERCOARE-AERMOD in the same geographic region, and the following technical advantages, options, and features available in the model, AERCOARE-AERMOD is being proposed as the preferred model for this application.

1. The Plume Rise Model Enhancements (PRIME) downwash algorithm can be used to assess impacts in the cavity and wake regions of structures. While the OCD model does incorporate platform downwash, Beacon Wind has proposed use of PRIME considering the platform as a solid structure which will result in conservative, overprediction of concentrations.

2. The use of EPA Tier 2 and 3 NO_X modeling options are not available in OCD but could be utilized with an AERCOARE-AERMOD approach. Specifically, the Ambient Ratio Method (ARM2), Plume Volume Molar Ratio Method (PVMRM) and Ozone Limiting Method (OLM) could be used by the Project to estimate the conversion of NO_X to NO_2.

3. Output can be generated in the statistical form that is needed to assess compliance with the newer percentile-based NAAQS, such as 1-hour NO_2, SO_2 and $PM_{2.5}$.

4. AERMOD-AERCOARE has the capability of handling a wider array of source configurations and does not limit the number of modeled sources as compared to OCD, such as the potential use of multiple line sources and more than 5 areas sources within the same model run.

5. The AERMOD-AERCOARE model can model volume sources, whereas OCD cannot.

6. Calm wind conditions can be processed by the AERMOD-AERCOARE model, whereas OCD cannot.

7. The dispersion algorithms used in the AERMOD portion of AERCOARE-AERMOD are considered state-of-art by EPA. OCD dispersion algorithms have not been updated to account for current advancements in boundary layer physics.

8. AERCOARE-AERMOD does not have a limit on the number of receptors that can be considered in an analysis, whereas OCD does limit the total number of receptors.

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[4] COARE Bulk Flux Algorithm to Generate Hourly Meteorological Data for Use with the AERMOD Dispersion Program; Section 3.2.2.e Alternative Refined Model Demonstration, Herman Wong, USEPA to Tyler Fox, USEPA, April 1, 2011.
[5] Model Clearinghouse Review of AERMOD-COARE as an Alternative Model for Application in an Arctic Marine Ice-Free Environment, George Bridgers, USEPA to Herman Wong, USEPA, May 6, 2011.
[6] https://cfpub.epa.gov/oarweb/MCHISRS/index.cfm?fuseaction=main.resultdetails&recnum=22-I-01

9. AERCOARE has the capability to utilize data from the Weather Research and Forecasting (WRF) model and output from the Mesoscale Model Interface (MMIF) program.

Alternative Model Justification

Section 3.2.2 of EPA's Guideline provides an approach for approval of an alternative model to determine whether it is more appropriate for a given application. Section 3.2.2 states that the request for an alternative approach must meet one of the following three (3) conditions:

(1) If a demonstration can be made that the model produces concentration estimates equivalent to the estimates obtained using a preferred model;

(2) If a statistical performance evaluation has been conducted using measured air quality data and the results of that evaluation indicate the alternative model performs better for the given application than a comparable model; or

(3) If the preferred model is less appropriate for the specific application, or there is no preferred model.

Beacon Wind's request falls under Condition 3 because OCD, the preferred model, is less appropriate due to practical and theorical model formulation issues needed for the proposed Project application. However, Condition 1 also applies because according to overwater field studies[7], the performance of AERCOARE-AERMOD has been found to be comparable to OCD making it a suitable alternative model for regulatory applications.

AERCOARE-AERMOD includes model formulations that reflects more advanced atmospheric dispersion science compared to the OCD model. However, OCD currently has some capabilities that AERCOARE-AERMOD modeling approach does not including:

(1) OCD can simulate platform downwash - Beacon Wind will utilize the PRIME downwash algorithm in AERMOD to account for downwash from the offshore substation platforms (OSPs) as a solid structure. However, the wind turbine generators will be associated with a very limited platform that is designed to be more aerodynamic thus limiting downwash.

(2) OCD can simulate shoreline fumigation - given the distance from the Lease Area to the coastline, shoreline fumigation will not be a concern for this Project.

To justify the application of an alternative model under Condition 3 in Appendix W, Section 3.2.2.e, the alternative model must meet the following conditions:

(1) The model has received a scientific peer review;

(2) The model can be demonstrated to be applicable to the problem on a theoretical basis;

(3) The data bases which are necessary to perform the analysis are available and adequate;

(4) Appropriate performance evaluations of the model have shown that the model is not biased toward underestimates; and

(5) A protocol on methods and procedures to be followed has been established.

Beacon Wind provides the following justification for each of the five (5) elements contained in Section 3.2.2.e.

[7] AERCOARE: An Overwater Meteorological Preprocessor for AERMOD, Wong, Herman, et. al, Journal of the Air & Waste Management Association, 2016, Vol 66, No 11, 1121-1140.

1. The model has received a scientific peer review.

The EPA Region 10 approval from April 2011 indicates that the COARE model formulation implemented into AERCOARE has been published in multiple peer-reviewed journals.[8]

EPA has also supported a peer-reviewed study that evaluates AERCOARE-AERMOD performance when using inputs from a prognostic meteorological model. The study examined the use of meteorological inputs from WRF-MMIF, which performed similarly to AERCOARE-AERMOD modeling using measured data from buoys, in most scenarios. The poorest performing cases in this study were attributed to bias and error in the prognostic dataset due to low-resolution ocean-surface temperature data.[9]

2. The model can be demonstrated to be applicable to the problem on a theoretical basis.

The EPA Region 10 April 2011 approval, along with the five (5) recent approvals noted above, contain similar documentation which justifies that the COARE algorithm is applicable on a theoretical basis.

The documentation included in past approvals is contained below:

"Version 3.0 of the COARE algorithm with journal references and a User's Manual can be accessed at: ftp://ftp.etl.noaa.gov/users/cfairall/wcrp_wgsf/computer_programs/cor3_0/ and http://www.coaps.fsu.edu/COARE/flux_algor/

These references provided copies of the code, descriptions of the scientific basis for the code, and detailed descriptions on how to use the COARE program. However, Shell acknowledges that COARE was not specifically designed to provide an input file for AERMOD, and there are certain steps that must be taken to produce the input files for AERMOD.

Communication with Ken Richmond of ENVIRON and marine boundary layer experts Dr. Andrey Grachev and Dr. Chris Fairall from the National Oceanic and Atmospheric Administration (NOAA) provided the following insight:

From Dr. Chris Fairall:

The original COARE version (2.5) (and the 2003 version (3.0)) was set up so that it could handle water and air temperatures from the tropics to the Arctic. Parameters such as the kinematic viscosity of air have T dependencies. I have listed below a few references to Arctic applications I dug up.
Minimum meteorological variables needed to run the COARE algorithm are the wind speed, the sea surface temperature, the air temperature, and some form of humidity measurement (e.g., relative humidity, absolute humidity, dew point, and wet bulb temperature). Barometric pressure, precipitation, and a typical mixed layer height are also input variables that can be provided or assigned by COARE default parameters. If options are selected for warm-layer heating and/or cool-skin effects, then solar radiation and downward longwave radiation are needed. Shell is not planning to invoke these options but has tested and provided a framework for the provision of these variables using measured solar radiation, cloud cover and ceiling height. COARE also contains several options for the surface roughness length based on wave period and wave height. Shell plans to use the default option that does not need these variables."

The current AERCOARE User Manual also states:

"AERCOARE uses Version 3.0 of the COARE algorithm that has been updated several times since the initial international TOGA-COARE field program in the western Pacific Ocean from November 1992 to February 1993. The basic algorithm uses air-sea temperature difference, overwater humidity, and wind

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[8] http://www.coaps.fsu.edu/COARE/; GitHub - NOAA-PSL/COARE-algorithm: Repository of the COARE bulk air-sea flux algorithm in python, matlab, and fortran.

[9] (U.S. EPA (2015)): 9 U.S. EPA (2015): Combined WRF/MMIF/AERCOARE/AERMOD Overwater Modeling Approach for Offshore Emission Sources, Vol. 2. EPA 910-R-15-001b, October 2015.

speed measurements to estimate the sensible heat, latent heat, and momentum fluxes. The original algorithm was based on measurements in the tropics with winds generally less than 10 m/s but has since been modified and extensively evaluated against measurements in high latitudes with winds up to 20 m/s. Based on these studies, AERCOARE is expected to be appropriate for marine conditions found at all latitudes including the Arctic."

Review of Fairall et al 2003 shows that Version 3 of the COARE algorithm was developed in part based on data obtained during the Fronts and Atlantic Storms Experiment (FASTEX) dataset; the FASTEX dataset was obtained in part off the coast of New Brunswick, Canada, approximately 350 miles from the Beacon Wind Lease Area.

The limitations of the algorithms that OCD uses have been documented by the EPA in the AERCOARE User's Manual V1.0:

"The current EPA guideline model for offshore sources is the OCD model. OCD has not been updated for many years and several of the dispersion model components and procedures are not consistent with AERMOD. The AERMOD modeling system is the U.S. EPA-recommended approach for assessing the near-source (< 50 km) impacts of new or modified sources as part of the New Source Review (NSR) and Prevention of Significant Deterioration (PSD) programs. The modeling system includes an AERMET meteorological processor that processes overland meteorological data for input to AERMOD.

Important routines in OCD that are independent of the onshore/offshore setting are inconsistent with current regulatory practices as embodied within AERMOD, namely:

- *OCD does not contain routines for processing either missing data or hours of calm meteorology. Such processing must be performed with a custom post-processing program.*
- *OCD does not contain the latest regulatory PRIME downwash algorithm (Schulman, L. L. et al, 2000). Many offshore sources are located on ships where downwash effects are important.*
- *The PVMRM and OLM methods are not included in OCD. These techniques are crucial for assessing the new 1-hour NO2 ambient standard.*
- *The new 24-hour PM2.5, 1-hour NO2, and 1-hour SO2 ambient standards are based on the 98th, 98th, and 99th percentile concentrations, respectively. These probabilistic standards and the EPA methods recommended for estimating design concentrations must be obtained by post-processing the hourly OCD output files. Such calculations are included in recent versions of AERMOD.*
- *OCD does not contain a volume source routine and the area source routine only considers circular areas without allowance for any initial vertical dispersion.*
- *Although OCD contains routines to simulate the boundary layer over the ocean, the surface energy flux algorithms are outdated and have been replaced within the scientific community by the COARE air-sea flux algorithms."*

Based on this justification, AERMOD-AERCOARE is applicable to the Beacon Wind application on a theoretical basis.

3. The data bases which are necessary to perform the analysis are available and adequate.

The database to perform that evaluation of AERCOARE as an alternative model are available and accurate:

"The four model evaluation data sets used in the current study were provided by EPA R10 from the archives supporting development of the MMS (BOEM) version of CALPUFF and OCD Version 4 (DiCristofaro and Hanna, 1989). These studies occur under a wide range of overwater atmospheric stabilities that might be expected in coastal waters regardless of the latitude. The tracer measurements in Pismo Beach and Cameron occur in level terrain near the shoreline downwind of offshore tracer releases. These two studies provide tests of overwater dispersion without the complications due to air modification over the land or complex terrain. The Ventura study is similar; however, the receptors are

located 500 meters (m) to one kilometer (km) inland from the shoreline, so some air modification may have affected dispersion in this study. The Carpinteria complex terrain tracer study involved shoreline measurements observed on a bluff near plume level. The Carpinteria data set had much lighter winds and the transport distances were less than the other three studies."

The EPA Region 10 approval in May 2011 indicated the following with respect to the limited tracer study data in its application to an arctic marine environment:

"R10 is aware that there are not tracer gas experiments for every geographic region, climatic region, or synoptic region for use in a performance evaluation. That includes the Arctic region. Nonetheless, R10 determined the three tracer gas experiments are acceptable because of the similarity of the tracer gas experiment and marine Arctic sea-surface temperatures and as discussed below."

The following is a passage from Shell's 11 March 2011 response to the R10 Technical Staff AERMOD-COARE Information and Data Request dated 07 March 2011 (Shell 2011b).

"The selection of experiments to use in the model evaluation was extensively discussed with EPA throughout the fall of 2010. Originally, Shell has selected only the Pismo Beach, CA and Cameron, LA experiments for the evaluation using based on the shoreline, near sea-level location of the receptors. At the specific request of EPA, the Carpinteria, CA experiment was added. Shell suggested at the time that the Carpinteria experiment was not appropriate since the setting involved receptors on a bluff located on the coastline, a setting not seen in the Arctic. The Carpentaria experiment was also more a test of the complex terrain algorithms, not over water dispersion. However, Shell included the Carpinteria experiments at EPA's request. No mention or request was made by EPA at that time to include either the Ventura, CA experiments or the Oresund experiments. The reason for not including the Ventura, CA experiments was that receptors in that case were well inland and no longer reflected the marine environment. The COARE-AERMOD approach is not equipped to simulate changes in the meteorology along the path of the plume. The Oresund experiments were never used in any previous OCD evaluation. They were only used in earlier CALPUFF evaluations. Shell felt that the differences in the use of CALPUFF, principally a long-range transport model, and AERMOD, used for within 50 kilometers, made this comparison less relevant. In addition, the other experiments had already been prepared for OCD and that made it straightforward to adapt them to evaluation with the COARE-AERMOD approach. With the Oresund experiments, the input data were in CALPUFF format and transforming these data to a format for the COARE-AERMOD approach would involve a number of assumptions and judgments that could ultimately impact the results. Shell's concern was that the results of the evaluation could depend on these assumptions and judgments rather than the true model performance."

Further, EPA Region 1 requested that additional data be provided for the August 9, 2021, alternative model request for Park City Wind. The additional data requested was to support that the argument that the development of the COARE algorithms occurred using data sets with similar observations patterns (i.e., wind speed and air/sea temperature difference) representative of the project area off the New England coast. Based on the additional data provided by Park City Wind, which is included Attachment 2 of EPA Region 1's technical review of the Vineyard Wind alternative model approval request[10], EPA Region 1 concluded the following in their technical review:

"Region 1 concludes the meteorological datasets used to develop AERCOARE and the four tracer studies used in the evaluation are sufficiently available and adequate for determining the effectiveness of the modeling approach."

Given the proximity of Beacon Wind and Park City Wind, both located off the New England coast, the additional documentation provided by Park City Wind does not need to be re-examined for Beacon Wind.

4. Appropriate performance evaluations of the model have shown that the model is not biased toward underestimates.

[10] https://gaftp.epa.gov/Air/aqmg/SCRAM/mchisrs/22-I-01-Region1_MCHrequest-ParkCityWind-TSD.pdf

Model evaluation results for AERCOARE were presented in detail in two (2) documents: (1) April 1, 2011, memorandum from EPA Region 10 and (2) EPA/ENVIRON October 2012 Model Evaluation Study[11]. The results of both model performance evaluations indicated the model is not biased toward underestimates as discussed below.

As documented in the October 2012 Model Evaluation Study, AERCOARE Version 1.0 (12275) was applied to prepare the overwater meteorological data for the Cameron, Louisiana, and the Pismo Beach, California offshore datasets. AERCOARE simulations were conducted using five (5) different methods for the preparation of the meteorological data, including the estimation of mixing heights, the use of horizontal wind direction (sigma theta data), and limitations on other variables provided to AERMOD to calculate concentrations from the field studies.

For both evaluation studies, AERMOD was run using AERCOARE along with default options for rural flat terrain for both simulations. Quantile-quantile (Q-Q) plots were prepared based on a comparison of independently ranked modeled versus observed concentrations. A Q-Q plot is a useful tool for determining if a model has an underprediction bias especially at the upper end of the observed concentration profile. **Figure 2** and **Figure 3** provide Q-Q plots for the Cameron, Louisiana, and Pismo Beach, California datasets, respectively. The figures show that the AERCOARE-AERMOD modeled concentrations are biased toward over-prediction for the highest concentrations, with less than a factor of two underprediction bias at the lower concentrations. Importantly, AERCOARE-AERMOD does not appear to be biased toward underestimates for the highest modeled concentrations, regardless of the five (5) different meteorological preparation options examined in this study.

In EPA Region 1's review of Park City Wind, examination of whether the use of prognostic meteorological data generated by WRF could result in systematic underprediction of concentrations lead to the following conclusions:

> *"Additionally, Region 1 reviewed U.S. EPA (2015) to see if the WRF-MMIF inputs for AERCOARE resulted in underprediction. U.S. EPA (2015) used the four overwater dispersion study datasets listed above to compare AERCOARE/AERMOD predicted concentrations against the measured concentrations from the campaigns. This study also compared results across a set of combinations of WRF-MMIF inputs and settings. The results of this study show AERCOARE/AERMOD driven by WRF-MMIF inputs resulted in the high-end of the distribution of concentrations exceeding the measured concentrations in the Pismo and Ventura studies. Concentrations agreed well for the Carpinteria study at the high-end of the distribution in most cases. In the Cameron study, and under some of the scenarios in the Carpinteria study, the modeling resulted in underpredictions at the high-end of the distribution in some scenarios. Namely, when mixing heights were diagnosed by MMIF, instead of using the mixing heights directly from WRF, AERCOARE/AERMOD concentrations were underpredicted in some cases. The model runs using WRF-simulated mixing heights performed better, when compared to measured concentrations. Overall, however, the U.S. EPA (2015) study noted concentration bias could be attributed mainly due to error in sea-surface temperatures output from the WRF model.*
>
> *A key element to both the original Region 10 approval study and the U.S. EPA (2015) study was an evaluation of the sensitivity of the modeling results to a minimum mixing height. The Region 10 approval found AERCOARE/AERMOD results were highly overpredicted when using AERMOD's default minimum mixing height of 1 meter. Region 10's sensitivity study, summarized in ENVIRON (2012) found a minimum mixing height of 25 meters for overwater applications was more physically realistic and resulted in better model performance. The Region 10 approval allowed for the use of a minimum mixing height of 25 meters for the application of AERCOARE/AERMOD and a minimum limit on the absolute value of Monin-Obukhov Length of 5 meters. These limits are recommended in the EPA's AERCOARE User's Guide[12].*

[11] (U.S. EPA (2012)): Evaluation of the Combined AERCOARE/AERMOD Modeling Approach for Offshore Sources; EPA 910-R-12-007, October 2012.
[12] https://gaftp.epa.gov/Air/aqmg/SCRAM/models/related/aercoare/AERCOAREv1_0_Users_Manual.pdf

> *Based on the findings from the studies reviewed in the prior EPA approvals and the additional WRF-MMIF-based study, Region 1 concludes it is evident the AERCOARE/AERMOD approach does not result in systematic underprediction of concentrations. Instead, the evidence more likely leads to the conclusion the approach is conservative."*

Beacon Wind proposes to use 12-km WRF data and MMIF for 2018-2020. The proposed MMIF settings will include the recommendations of 25 meters for the minimum mixing height and a minimum Monin-Obukhov length of 5 meters.

5. A protocol on methods and procedures to be followed has been established.

Beacon Wind will submit a modeling protocol which will include a detailed description of modeling methodologies and procedures consistent with the Guideline on Air Quality Models (Appendix W of 40 CFR 51). If this alternative model request is approved by EPA, the protocol will reflect the use of AERCOARE-AERMOD.

Conclusions

The justification contained herein supports the use of AERCOARE-AERMOD as an alternative model, in lieu of OCD, for the Beacon Wind Project. Based on this justification and recent precedents for approving AERCOARE-AERMOD in the Atlantic OCS (including Park City Wind, also off the coast of New England), Beacon Wind proposes the use of AERCOARE-AERMOD as an alternative model for this application.

If you have any questions or require any additional information, please contact me at (770) 851-5594 or kim.zuk@aecom.com.

Yours sincerely,

Kimberly Zuk
Senior Air Quality Scientist
AECOM

Figure 1: Beacon Wind Project

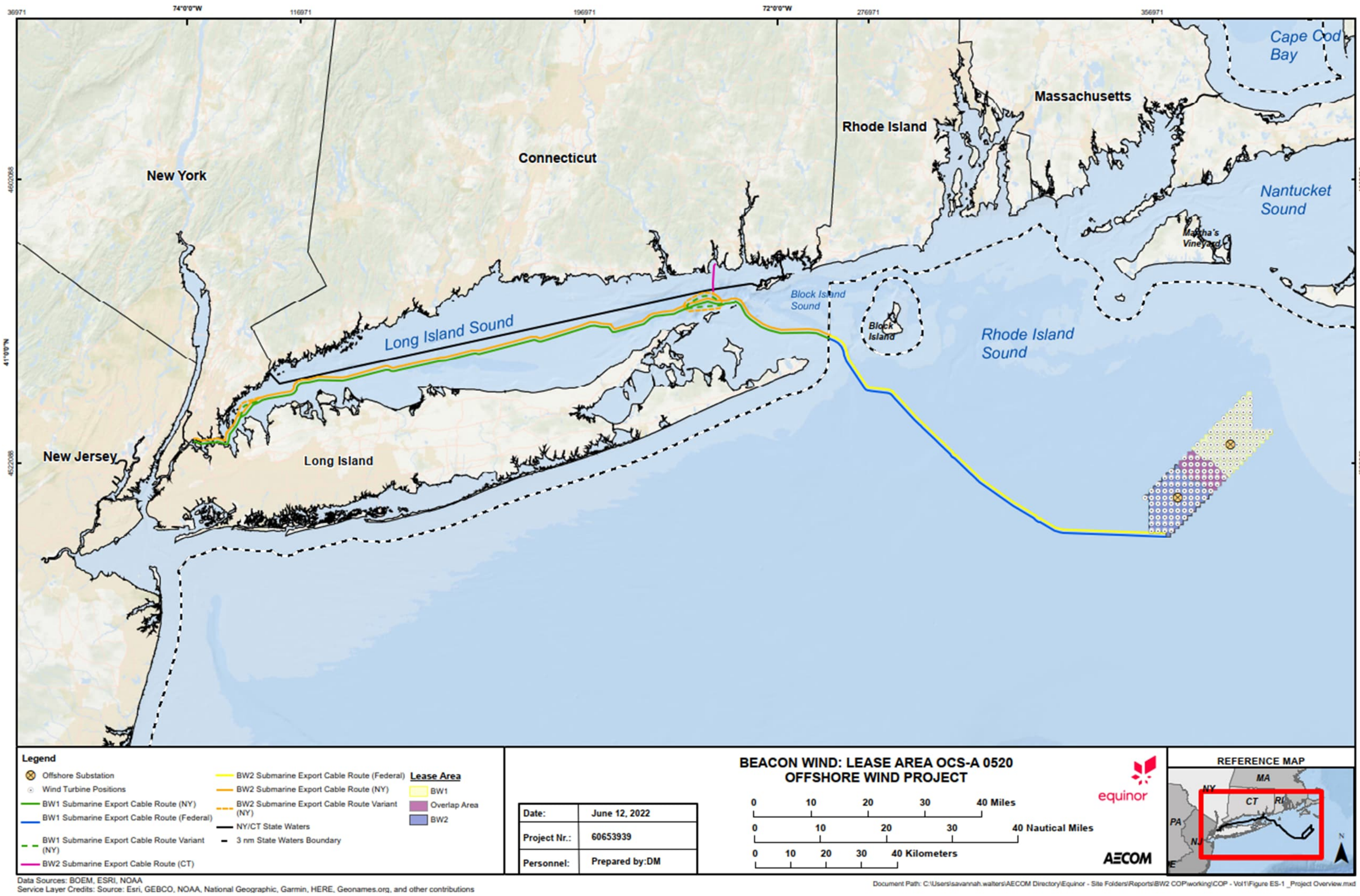
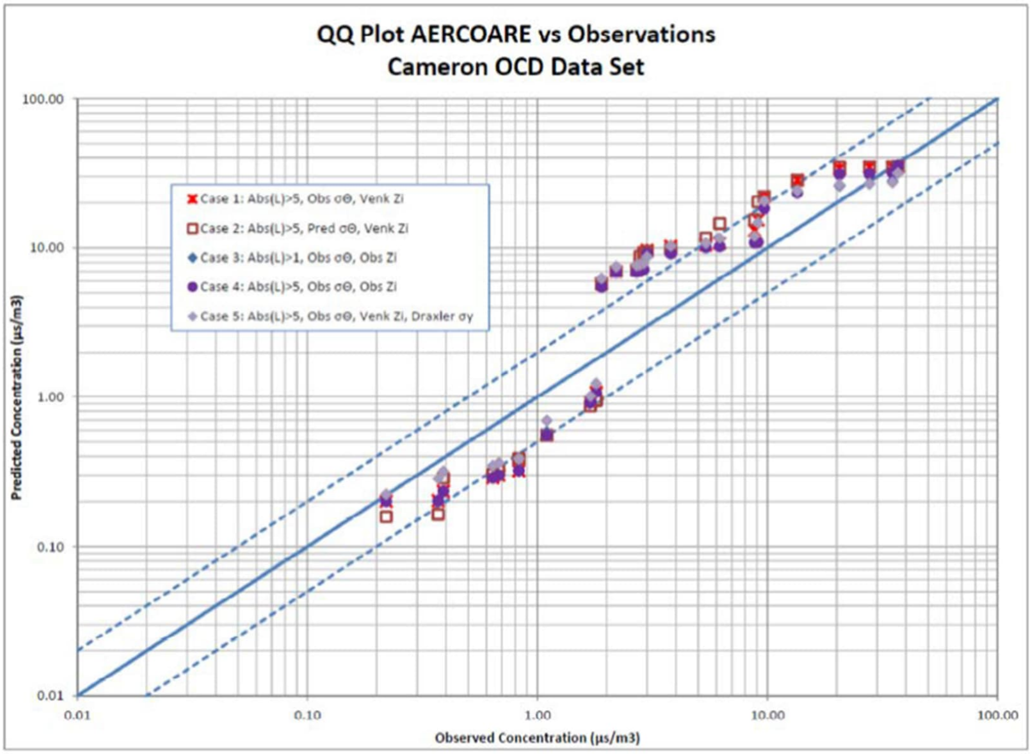
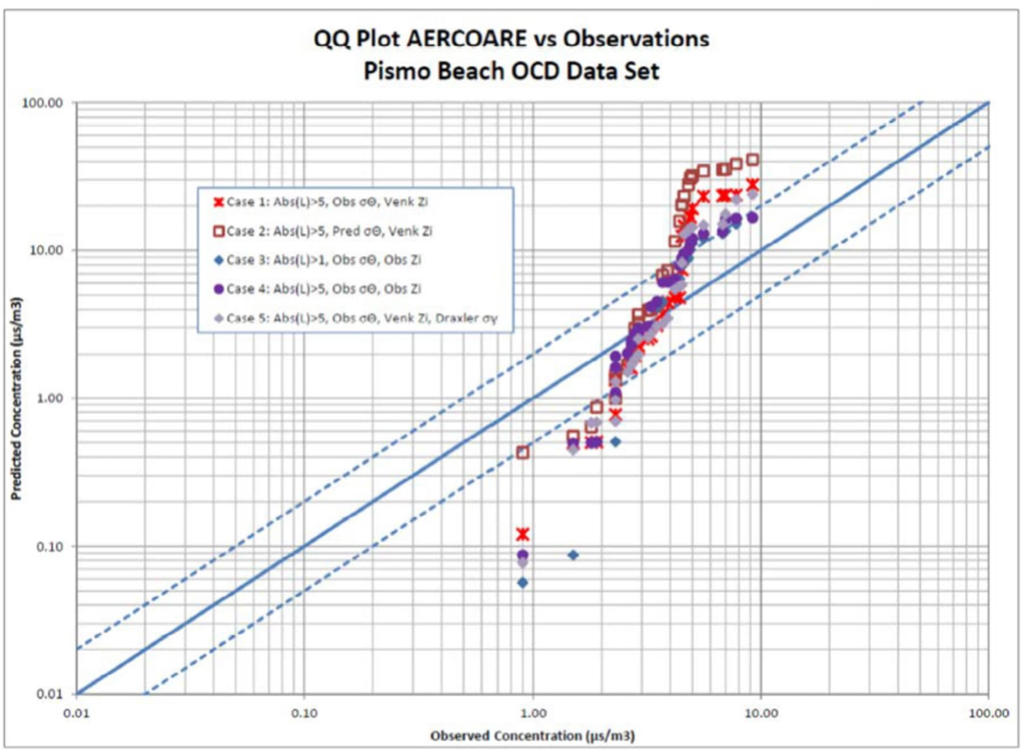


Figure 2: QQ Plot of AERCOARE versus Cameron, Louisiana, Tracer Study Results



Source: Evaluation of the Combined AERCOARE/AERMOD Modeling Approach for Offshore Sources; EPA 910-R-12-007, October 2012.

Figure 3: QQ Plot of AERCOARE versus Pismo Beach, California, Tracer Study Results



Source: Evaluation of the Combined AERCOARE/AERMOD Modeling Approach for Offshore Sources; EPA 910-R-12-007, October 2012.