REGION 2
NEW YORK, N.Y. 10007

August 20, 2024

MEMORANDUM

SUBJECT: Concurrence Request for Approval of Alternative Model AERCOARE in Conjunction with AERMOD, in Support of Outer Continental Shelf PSD air permitting of the Atlantic Shores Offshore Wind Project 3

FROM: Brian Marmo, Regional Air Quality Modeler
Permitting Section, Air Programs Branch, Air and Radiation Division
EPA Region 2, New York, New York

BRIAN MARMO Digitally signed by BRIAN MARMO Date: 2024.08.20 12:08:36 -04'00'

THRU: Richard Ruvo, Director
Air and Radiation Division
EPA Region 2, New York, New York

Richard Ruvo Digitally signed by RICHARD RUVO Date: 2024.08.20 17:24:55 -04'00'

TO: George Bridgers, Model Clearinghouse Director
Air Quality Modeling Group, Air Quality Assessment Division
Office of Air Quality Planning and Standards

The U.S. Environmental Protection Agency (EPA) Region 2 seeks concurrence from the Model Clearinghouse regarding the prospective EPA Region 2 approval of an alternative model for an Outer Continental Shelf (OCS) Prevention of Significant Deterioration (PSD) permitting action. Specifically, EPA Region 2 seeks concurrence on the use of the AERCOARE meteorological data preprocessor program to be used in conjunction with AERMOD (AERCOARE/AERMOD) in conducting an air quality modeling analysis for the Atlantic Shores Offshore Wind Project 3, LLC's ("Atlantic Shores P3Co") proposed Atlantic Shores Offshore Wind Project 3 ("Project 3") PSD permit application. Project 3 is located approximately 8.4 miles off the coast of New Jersey.

EPA Region 2 approved the use of the AERCOARE/AERMOD alternative model for Atlantic Shores South on July 20, 2022[1]. The lease area for Project 3 borders the lease area for Atlantic Shores South. In addition, EPA Region 2 approved the use of the AERCOARE/AERMOD alternative model for Empire

[1]The Model Clearinghouse Information Storage and Retrieval System (MCHISRS) Record for the Region 2 approval of the Atlantic Shores South AERCOARE/AERMOD is available at:
https://cfpub.epa.gov/oarweb/MCHISRS/index.cfm?fuseaction=main.resultdetails&recnum=22-II-02

Wind on July 13, 2022[2], and for Ocean Wind on August 29, 2023[3]. Similarly, EPA Region 1 approved the use of the AERCOARE/AERMOD alternative model for New England Wind 1 (formerly Park City Wind) on January 28, 2022, New England Wind 2 on July 5, 2022, SouthCoast Wind (formerly Mayflower Wind) on December 13, 2022, Beacon Wind on December 15, 2022, and most recently, VNE 1 on May 17, 2024. EPA's Model Clearinghouse concurred with EPA Regions 1 and 2 on all of these alternative model approvals. With the exception of Empire Wind, which used buoy data, all of these approvals also provided for use of the AERMOD-AERCOARE modeling system applying WRF-MMIF meteorological data from the EPA 12-km CONUS WRF 2018-2020 datasets.

Atlantic Shores P3Co has sought approval to allow the use of the AERCOARE/AERMOD alternative model for the air quality modeling analysis of their OCS wind farm project. Atlantic Shores P3Co's alternative model request justifies this based on these recent alternative model approvals of AERCOARE/AERMOD in the same general geographic area and lists a number of technical advantages, options, and features available in AERCOARE/AERMOD, which EPA's preferred Ocean and Coastal Dispersion (OCD) model does not have the capability to do. The request details its appropriateness for approval under 40 CFR Part 51, Appendix W §3.2.2(b), Condition (3). Under Condition (3), an alternative model may be used if the Regional Office finds that all sub-elements of Condition (3), specified in Appendix W §3.2.2(e), are satisfied. Although a final modeling protocol has not yet been submitted, modeling elements that will be summarized in the final protocol have been discussed with Atlantic Shores P3Co. Modeling approaches proposed will not deviate significantly from the Atlantic Shores South project. All elements specific to the development and application of meteorological data using MMIF and AERCOARE have been agreed upon and will be summarized in the final modeling protocol.

EPA Region 2 has conducted a thorough review of the request and intends to approve the use of AERCOARE/AERMOD as an alternative model to conduct the air quality modeling analysis as part of Project 3. The EPA agrees with the conclusions of Atlantic Shores P3Co, notably that the project occurs in the same general geographic area as projects which have received recent approval of alternative modeling requests, including the Atlantic Shores South project, which borders Project 3, and is therefore, exposed to the same general climatic conditions. Total project emissions and the cumulative area of past approvals for the prior OCS wind projects in the region are similar. The EPA has also confirmed the key model settings, methodology, and conditions-of-use for Project 3 match those specified in the recent past regional approvals. Namely, Atlantic Shores P3Co will use the 2018-2020 EPA CONUS WRF-MMIF dataset, will use AERCOARE default settings, will impose a 25-meter minimum mixing height in MMIF, and will impose a minimum absolute value of 5 meters for the Monin-Obukhov length in MMIF. Furthermore, Atlantic Shores P3Co referenced the analysis submitted in March 2024 as part of the Atlantic Shores South modeling report, which documented that shoreline fumigation is

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[2]The Model Clearinghouse Information Storage and Retrieval System (MCHISRS) Record for the Region 2 approval of the Empire Wind AERCOARE/AERMOD is available at: https://cfpub.epa.gov/oarweb/MCHISRS/index.cfm?fuseaction=main.resultdetails&recnum=22-II-01

[3] The Model Clearinghouse Information Storage and Retrieval System (MCHISRS) Record for the Region 2 approval of the Ocean Wind AERCOARE/AERMOD is available at: https://cfpub.epa.gov/oarweb/MCHISRS/index.cfm?fuseaction=main.resultdetails&recnum=23-II-01

not a concern. Since the lease areas for the two projects border one another, we conclude that the March 2024 shoreline fumigation analysis is also appropriate for Project 3.

Based on our professional judgment, no additional model evaluation is necessary given the similarities in proximity, emissions units and scenarios being modeled, and general timeframe for development between Atlantic Shores P3Co and previously approved alternative model requests by EPA Region 2 with concurrence from the Model Clearinghouse. Additionally, Atlantic Shores P3Co's technical justification sufficiently addresses any concerns or considerations of modeling technique that is being proposed for use on this project. The EPA finds the technical analysis provided by Atlantic Shores P3Co, and its citations to past AERCOARE/AERMOD alternative model approvals, is fully applicable to Project 3. We request your concurrence on our finding to approve the alternative model AERCOARE in conjunction with AERMOD in support of OCS PSD air permitting of Project 3.

Please feel free to contact Brian Marmo at (212) 637-4352 if you have any questions regarding the request.

Attachment 1 – Atlantic Shores P3Co Alternative Model Request dated July 1, 2024

July 1, 2024

Mr. Brian Marmo and Ms. Neha Sareen
United States Environmental Protection Agency Main Regional Office
290 Broadway
New York, NY 10007-1866
via email at: Marmo.Brian@epa.gov; Sareen.Neha@epa.gov

Subject: Atlantic Shores Offshore Wind Project 3 Request for Approval to use COARE Bulk Flux Algorithm to Generate Hourly Meteorological Data for use with AERMOD

Dear Mr. Marmo and Ms. Sareen:

This alternative model request is being submitted on behalf of Atlantic Shores Offshore Wind Project 3, LLC ("Atlantic Shores P3Co" or the "Proponent") in advance of their Outer Continental Shelf (OCS) Air Permit Application for Atlantic Shores Offshore Wind Project 3 ("Project 3" or the "Project"). Project 3 is an offshore wind project in Lease Area OCS-A 0549 (the "Lease Area"). The Lease Area is located on the Outer Continental Shelf (OCS) approximately 8.4 miles from the New Jersey shoreline (see Figure 1). The Project consists of up to 157 wind turbine generators (WTGs) and up to 8 offshore substations (OSSs) within the Lease Area. The Project's OCS Air Permit Application will include a demonstration of potential air quality impacts from air emission sources associated with the Project.

The current preferred model specified in the Environmental Protection Agency's (EPA's) Guideline on Air Quality Models (Appendix W of 40 CFR Part 51)[1] for air quality assessments of over-water sources that may have impacts in coastal areas is the Offshore and Coastal Dispersion (OCD) model, per Section 4.2.2.3 of Appendix W. The OCD model was developed in the 1980s and does not incorporate the latest dispersion modeling science recently developed and available in the Coupled Ocean-Atmosphere Response Experiment (COARE) bulk flux algorithm, which has been incorporated in the AERCOARE meteorological data processor program. The AERCOARE processor can be used to prepare a meteorological database that is representative of dispersion conditions over water that can be used with the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) in place of its meteorological processor AERMET.

The Proponent is therefore requesting EPA's approval to use AERCOARE in conjunction with AERMOD to model offshore air emission sources associated with the Project. EPA has approved or indicated that they intend to approve this AERMOD-AERCOARE alternative modeling approach for several other

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[1] See: eCFR: Appendix W to Part 51, Title 40 -- Guideline on Air Quality Models.

offshore wind projects, including Atlantic Shores South, VNE 1, New England Wind 1 (NEW1) (formerly Park City Wind), New England Wind 2 (NEW2), SouthCoast Wind (formerly Mayflower Wind), Beacon Wind, Empire Wind, Coastal Virginia Offshore Wind—Commercial (CVOW-C), Ocean Wind, and US Wind's Maryland Offshore Wind Project. [2] Atlantic Shores Offshore Wind, LLC requested to utilize AERCOARE-AERMOD for Atlantic Shores Offshore Wind South in May of 2022 and was granted the approval in July of 2022. This alternative model approval request for Atlantic Shores Project 3 is based on the alternative model approval request for Atlantic Shores South.

AERMOD-AERCOARE is preferred by the Proponent over the OCD model because of the following technical advantages, options, and features available in the alternative model:

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, the Proponent has proposed the use of PRIME considering the platforms (i.e., the OSSs and jacked-up vessels) as solid structures, which will result in a conservative overprediction of concentrations.
2. The Plume Volume Molar Ratio Method (PVMRM) or Ozone Limiting Method (OLM) may be used for the Project to estimate the conversion of nitrogen oxides (NOx) to nitrogen dioxide (NO_2). If PVMRM or OLM are not used, the Ambient Ratio Method (ARM2) screening technique will be used within the model.
3. Output can be generated in the statistical form that is needed to assess compliance with the newer statistically based National Ambient Air Quality Standards (NAAQS), such as 1-hour NO_2 and particulate matter 2.5 microns or smaller ($PM_{2.5}$).
4. The AERMOD-AERCOARE model can model multiple line sources and more than five area sources within the same model run and does not limit the number of sources that can be modeled simultaneously.
5. The AERMOD-AERCOARE model can model volume sources.
6. Calm wind conditions can be processed by the AERMOD-AERCOARE model.
7. The dispersion algorithms used in the AERMOD portion of AERMOD-AERCOARE are considered state-of-the-art by EPA. OCD dispersion algorithms have not been updated to account for current advancements in the understanding of the boundary layer.
8. AERMOD-AERCOARE does not artificially limit the number of receptors that can be considered in an analysis.

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[2] See: https://cfpub.epa.gov/oarweb/MCHISRS/index.cfm?fuseaction=main.results (accessed April 2024).

9. Several of the programs (MAKEUTM, MAKEGEO) used to generate inputs for the OCD model require changes to the programs' Fortran code to generate the correct inputs for OCD.
10. AERCOARE can accept Weather Research and Forecasting (WRF) model predicted hourly meteorological output from the Mesoscale Model Interface (MMIF) program.

It should be noted that while the AERMOD-AERCOARE modeling approach contains algorithms for simulating the atmosphere that are technically superior to the OCD model, the OCD model currently has capabilities that the AERMOD-AERCOARE modeling approach does not. Namely, OCD has algorithms to estimate the effects of both platform downwash and shoreline fumigation.

The Project's OSSs and any jacked-up vessels resemble platforms, so consideration of platform downwash effects is relevant. However, the OSSs and jacked-up vessels will be modeled with the AERMOD model that includes the PRIME downwash algorithm and the platforms will be treated as solid structures without airflow under the platforms. This procedure will result in an overestimate of downwash effects and lead to a conservative overprediction of concentrations.

An analysis of shoreline fumigation documenting that shoreline fumigation is not a concern was presented as part of the Atlantic Shores South modeling report submitted to EPA in March 2024, and modeling files supporting this analysis were sent to EPA Region 2. The analysis used the same datasets to run both AERMOD-AERCOARE and OCD.

For the NAAQS and Class II Increments, an analysis was done using a single most elevated point source at the northwesternmost portion of the lease area which is closest to shore. A polar receptor grid was laid out in the direction of shore. The OCD modeling results indicated that the peak hourly concentration resides at overwater locations near the ASOW lease boundary where the receptor is not subject to shoreline fumigation, therefore shoreline fumigation will not be relevant to NAAQS and Class II Increments.

To document that AERMOD-AERCOARE is appropriately conservative when modeling impacts at the Brigantine Wilderness, the nearest Class I area to the Project, modeling was done using the same single most elevated point source as in the NAAQS and Class II analysis. Both AERMOD-AERCOARE and OCD were used to model peak one-hour, 24-hour, and annual concentrations at 46 receptors for locations at the Class I Area. AERMOD-AERCOARE resulted in higher concentrations compared to OCD despite the receptors at Brigantine being within the thermal internal boundary layer and potentially subject to shoreline fumigation.

Background

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.[3,4] The COARE algorithm output was assembled with other meteorological variables in a spreadsheet to form the AERMOD overwater meteorological input files. After EPA's 2011 approval of the use of the COARE algorithm in spreadsheet form, the COARE air-sea flux procedure was coded into the AERCOARE program.

On October 1, 2019, the proposed Sea Port Oil Terminal (SPOT) and more recently on August 9, 2021, the NEW1 offshore wind project requested the use of AERMOD-AERCOARE for the permitting of offshore facilities. Both projects' requests documented several limitations of OCD as well as the key dispersion features of OCD that are not available within AERMOD-AERCOARE (i.e., platform downwash and shoreline fumigation). The SPOT and NEW1 requests documented that the applicants would model the platform sources as solid structures and that the projects' operation was sufficiently offshore such that shoreline fumigation would not be a concern.

On August 9, 2021, the NEW1 offshore wind project requested the use of AERCOARE-AERMOD for a proposed offshore wind project using WRF-MMIF prognostic data rather than observational data as the meteorological data used in the modeling demonstration.

On November 24, 2021, NEW1 provided supplemental information to EPA Region 1 to document that the meteorological conditions (specifically wind speed and air/sea temperature difference) used to develop COARE and that occurred during the AERMOD-AERCOARE verification studies cover a range of conditions typically seen off the New England Coast.

On January 28, 2022, EPA approved the use of AERMOD-AERCOARE for NEW1.[5] Two key differences between the NEW1 and SPOT alternative model requests that are relevant to the Project are the underlying meteorological data and the geographic location of application. These differences were specifically documented in EPA's Model Clearinghouse review:

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[3] 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.

[4] 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.

[5] See: https://cfpub.epa.gov/oarweb/MCHISRS/index.cfm?fuseaction=main.resultdetails&recnum=22-I-01

"We will highlight on Pages 11 and 12 that Vineyard Wind LLC and EPA Region 1 provide additional information and analysis to demonstrate the tracer studies used to develop the COARE algorithm are sufficiently representative of the marine environment off the coast of Massachusetts. This is an important supplement beyond any previous information provided in the EPA Region 10 or EPA Region 6 alternative model requests/approvals given that this is the first regulatory application of AERCOARE (COARE algorithm) in this offshore region of the US.

A final distinction to point out with the alternative model request for the Park City Wind project is the underlying meteorological data being used in the modeling demonstration. For Park City Wind, Vineyard Wind LLC is proposing to use WRF-MMIF prognostic data versus buoy observational data as the meteorological input data to the AERCOARE preprocessor. Considering that the COARE algorithm was originally developed using offshore buoy data, the use of prognostic data could introduce unintended and inappropriate biases into its application in a regulatory compliance demonstration. To alleviate such concerns, EPA Region 1 provided additional justification in their technical review and citation of a relevant 2015 EPA peer-reviewed report.[6] This report demonstrated that using meteorological inputs from WRF-MMIF performed similarly to AERCOARE-AERMOD modeling using measured data from buoys, in most scenarios. It is the assessment of EPA Region 1 that the use of WRF-MMIF data with AERCOARE-AERMOD does not result in systematic underpredictions of concentrations and is more likely to yield a more conservative conclusion. The Model Clearinghouse agrees with this assessment, notes that it is supported by Agency peer-reviewed research, and finds that it is consistent with Appendix W, Section 8.4.5 (Prognostic Meteorological Data, Discussion and Recommendations)."

As documented in EPA Region 10's April 2011 approval, EPA Region 6's SPOT approval, and EPA Region 1's approval for NEW1, the AERMOD-AERCOARE model was approved for use in an arctic marine ice-free environment because it satisfied the five criteria contained in Section 3.2.2.e of Appendix W. In each concurrence memorandum, the Model Clearinghouse stated that its concurrence with the approvals did not constitute a generic approval of AERMOD-AERCOARE for other applications. However, the Model Clearinghouse stated in the Empire Wind alternative model approval[7] that:

"Given the possible importance of platform downwash and shoreline fumigation, the Model Clearinghouse recommends caution and careful review before additional alternative model considerations of the coupled AERCOARE-AERMOD approach in other projects. As similarly stated in the respective EPA Region 6 and EPA Region 10 concurrence responses, this case-specific Model

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

[7] See: https://cfpub.epa.gov/oarweb/MCHISRS/index.cfm?fuseaction=main.resultdetails&recnum=22-II-01

Clearinghouse concurrence does not constitute a generic approval of a coupled AERCOARE-AERMOD approach for other applications elsewhere. However, the scope of the technical assessment submitted with the EPA Region 1, EPA Region 6, and EPA Region 10 Model Clearinghouse alternative model requests continue to provide a good basis for such considerations."

The Proponent's request to use AERMOD-AERCOARE as an alternative to OCD is modeled after the SPOT and NEW1 alternative model requests.

Alternative Model Request Justification

Pursuant to Sections 3.0 and 3.2.2.a of 40 CFR Part 51, Appendix W, approval of an alternative refined model is the responsibility of the Regional Administrator (EPA Region 1). There are three separate conditions outlined in Section 3.2.2.b of Appendix W under which an alternate model may be approved by the Regional Administrator for regulatory use, as listed below:

"3.2.2.b: An alternative model shall be evaluated from both a theoretical and a performance perspective before it is selected for use. There are three separate conditions under which such a model may be approved for use:

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 in appendix A; or

3. If there is no preferred model."

The Proponent is seeking approval to use AERMOD-AERCOARE for the Project under Condition 3. Although OCD is listed as a preferred model in Appendix W, this request is made because the preferred model is less appropriate (i.e., outdated science) for its application to the Project, as described above. In addition, model performance of the AERMOD-AERCOARE modeling approach has been found to be comparable to OCD using the tracer studies from overwater field studies.[8] In this June 2016 AERCOARE model evaluation study, the authors conclude that AERMOD-AERCOARE could

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[8] Wong H, Elleman R, Wolvovsky E, Richmond K, Paumier J. 2016. AERCOARE: An overwater meteorological preprocessor for AERMOD. Journal of the Air & Waste Management Association, 66(11), 1121–1140. https://doi.org/10.1080/10962247.2016.1202156.

be applied as an alternative to OCD for many regulatory applications. EPA and the Model Clearinghouse have previously allowed and approved alternative model requests for conditions where there is a preferred model but it is determined to be less appropriate for the specific application.

Under Condition 3, an alternative model or technique may be approved for use provided that the following five elements are addressed (see Section 3.2.2.e Appendix W):

1. The model has received scientific peer review;
2. The model can be demonstrated to be applicable to the problem on a theoretical basis;
3. The databases that 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.

Therefore, the Proponent provides the following justification for each of the five elements contained in Section 3.2.2.e.

1. The model has received scientific peer review.

As described in EPA Region 10's April 2011 approval, the science behind the COARE algorithm, which has been implemented in AERCOARE, has been published in multiple peer-reviewed journals. Information pertaining to scientific peer review can be found at the following site: http://www.coaps.fsu.edu/COARE/.

In addition, EPA supported a peer-reviewed study that evaluates AERMOD-AERCOARE performance when using inputs from a prognostic meteorological model. The report documented that using meteorological inputs from WRF-MMIF performed similarly to AERMOD-AERCOARE 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. [7]

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

The EPA Region 10 April 2011 approval and the 2019 SPOT approval contain the same documentation that the COARE algorithm is applicable on a theoretical basis. That documentation is repeated verbatim 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's 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 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 the Fairall et al. (2003) paper shows that Version 3.0 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.

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 NO_2 ambient standard.*
- *The new 24-hour $PM_{2.5}$, 1-hour NO_2, and 1-hour SO_2 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."*

For these reasons the Proponent believes that AERMOD-AERCOARE is applicable to the problem on a theoretical basis.

3. The databases that are necessary to perform the analysis are available and adequate.

The June 2016 AERCOARE model evaluation study describes the tracer datasets available for analysis:

"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 April 2011 approval noted the following regarding the limited tracer 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.'"

NEW1 supplemented its alternative model request by providing documentation that the distribution of meteorological conditions (specifically wind speed and air/sea temperature difference) used to develop AERMOD-AERCOARE and that occurred during the AERMOD-AERCOARE verification studies cover a range of conditions typically observed off the New England Coast.

EPA Region 1 concluded the following in their technical review of the NEW1 alternative model request:

"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."

As the Project is located off the mid-Atlantic Coast, Atlantic Shores P3Co is providing the same documentation to support that the distribution of meteorological conditions used to develop AERCOARE cover the range of conditions of importance off the mid-Atlantic Coast. This documentation was also included in the Atlantic Shores South alternative model request.

There are four tracer datasets that were used to validate the AERCOARE model, three of them occur in California and one in Louisiana. The four validation datasets contain a total of 100 hours of meteorological data for comparison. These same validation studies are the ones that were used to validate the Off-Shore Coastal (OCD) Dispersion Model which is the EPA preferred overwater model.

Data from the Delaware Bay buoy (44009) was downloaded from January 4th, 1984 through December 31st, 2020, from the National Data Buoy Center as this was the period where data was available for both wind speed and the air/sea temperature difference. The Delaware Bay buoy is located approximately 91 kilometers from Atlantic Shores and represents the closest location where both wind speed and air/sea temperature difference data are available.

The data from the Delaware Bay buoy and the four tracer gas studies were examined to determine the distribution of each dataset for wind speed (meters/second, m/s) and air/sea temperature difference (Kelvin, K). Wind speed at the Delaware Bay buoy ranges from 0 to 25 m/s and from 1 to 12 m/s across the four validation datasets. Air/Sea Temperature Difference ranges from -19.9 to 12 K at the Delaware Bay buoy and from -5 to 5 K across the four validation datasets. The distribution of wind speed and air/sea temperature difference appears in Table 1 below for each of the datasets.

Table 1: Wind Speed and Air/Sea Temperature Difference Summary Statistics

Wind Speed (m/s) Summary Statistics for Selected Locations								
Location	**Variable**	**Observations**	**Minimum**	**25th Percentile**	**Median**	**Average**	**75th Percentile**	**Maximum**
Cameron, LA	Wind Speed (m/s)	26	2.1	3.7	4.6	4.5	5.0	6.2
Carpinteria, CA		36	1.0	1.3	2.1	2.3	3.1	5.4
Pismo Beach, CA		31	1.3	3.8	5.6	6.0	8.3	12.7
Ventura, CA		17	3.1	4.2	4.9	5.0	5.8	6.9
Delaware Bay		248,875	0	3.8	5.9	6.3	8.4	25
Air/Sea Temperature (K) Difference Summary Statistics for Selected Locations								
Cameron, LA	Temp. Difference (K)	26	-5	-2	1	0	2	5
Carpinteria, CA		26	-1	-1	0	1	2	3
Pismo Beach, CA		31	-1	0	1	1	2	4
Ventura, CA		17	-2	-1	0	0	0	2
Delaware Bay		274,915	-19.9	-1.8	-0.1	-0.8	0.9	12

The datasets were also examined visually using box and whisker plots. Box and whisker plots are one way of comparing datasets to ascertain the distribution. The box and whisker plots for wind speed for Delaware Bay and the four validation datasets were plotted, broadly they show that wind speeds at Delaware Bay are moderately higher than those observed during the validation studies. This is one reason the COARE algorithm utilized the Fronts and Atlantic Storm (FASTEX) dataset as it generally contained higher wind speeds than were observed at tropical latitudes.8 In other words, the COARE algorithm implemented into AERCOARE was specifically evaluated against a higher wind speed dataset to make it more globally applicable. The Box and Whisker Plots for Wind Speed are shown in Figure 2.

Similarly, box and whisker plots were used to examine the distribution of the air/sea temperature difference between Delaware Bay and the four validation studies. The median of the Delaware Bay dataset is similar to the median air/sea temperature difference in the four validation studies and the 25th and 75th percentiles are similar to what was measured during the validation studies and that the air/sea temperature difference seen in mid-Atlantic is similar to what was measured during the validation studies. The Box and Whisker Plots for Air/Sea Temperature Difference are shown in Figure 3.

Based on the information above: that the databases available occur under a wide range of overwater atmospheric stabilities that might be expected in coastal waters regardless of the latitude, the COARE algorithm implemented in AERCOARE was developed to be applicable for water temperatures from the tropics to the arctic, while the wind speeds seen off the coast of the mid-Atlantic do appear to be moderately higher than what was measured during the validation studies, the COARE algorithm has been validated against a dataset to specifically account for those conditions. It can be concluded that the necessary datasets to evaluate the AERCOARE are available and are adequate and that the meteorological inputs needed to populate AERCOARE are available and adequate.

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

EPA Region 10's April 2011 approval, in conjunction with the EPA/ENVIRON October 2012 Model Evaluation Study,[9] present the detailed results of the model evaluation studies. Each of these studies reach the conclusion that the model is not biased toward underestimates.

As documented in the October 2012 Model Evaluation Study, AERMOD-AERCOARE Version 1.0 (12275) was applied to prepare the overwater meteorological data for the Cameron, Louisiana and the Pismo Beach, California offshore datasets. AERMOD-AERCOARE simulations were conducted using five 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.

9 EPA. 2012. Evaluation of the Combined AERCOARE/AERMOD Modeling Approach for Offshore Sources.

AERMOD was run using default dispersion options for rural flat terrain for both simulations. Peak calculated concentrations were compared to peak observed concentrations (from tracer gas in-field concentration measurements), resulting in a total of 101 paired samples for statistical analysis. Quantile-quantile (Q-Q) plots were prepared, among other statistical analyses, to test the ability of the model predictions to represent the frequency distribution of the observations. Q-Q plots are ranked pairings of predicted and observed concentrations. The rank of the predicted concentration is plotted against the same ranking of the observed concentration. The Q-Q plots were evaluated to determine whether the models are biased toward underestimates at the important upper end of the frequency distribution.

The Q-Q plot for the Cameron, Louisiana dataset is presented as Figure 4 and the Q-Q plot for the Pismo Beach, California dataset is shown as Figure 5. As shown, the model concentrations generally are within the factor of two bounds of the plot. In addition, no apparent difference in the model performance under the five different AERCOARE meteorological data preparation cases were observed. The AERMOD predictions using AERCOARE-prepared meteorological data tend to be biased toward overprediction for the highest concentrations, with less than a factor of two underprediction at the lower concentrations. Importantly, AERMOD-AERCOARE does not appear to be biased toward underestimates for the higher end of the frequency distribution, regardless of the five different meteorological preparation options examined in this study.

The Technical Support Document prepared by EPA Region 1 for NEW1[10] specifically examined whether the use of prognostic meteorological data generated by WRF could result in systematic underprediction of concentrations. In the Technical Support Document, EPA noted the following:

> *"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*

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

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.[11]

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."

Consistent with the ASOW North alternative model request precedent and recent informal guidance from EPA staff, the Proponent proposes to use WRF-MMIF data for the Project. On May 17, 2024, the Proponent made a request to EPA Region 2 AERCOARE meteorological input files using the appropriate EPA WRF meteorology. On May 30, 2024, EPA Region 2 provided the Proponent with MMIF-processed WRF data for the Project's location for the years 2018-2020.

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

The Proponent will submit a modeling protocol for EPA Region 2 review and approval. The modeling protocol will outline the modeling techniques that will be employed for the Project, which will conform with the modeling procedures outlined in the Guideline on Air Quality Models (Appendix W of 40 CFR Part 51) as well as associated EPA modeling policy and guidance and New Jersey Department of Environmental Protection (NJDEP) Air Quality Modeling Guidelines.

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11 *https://gaftp.epa.gov/Air/aqmg/SCRAM/models/related/aercoare/AERCOAREv1_0_Users_Manual.pdf*

Summary

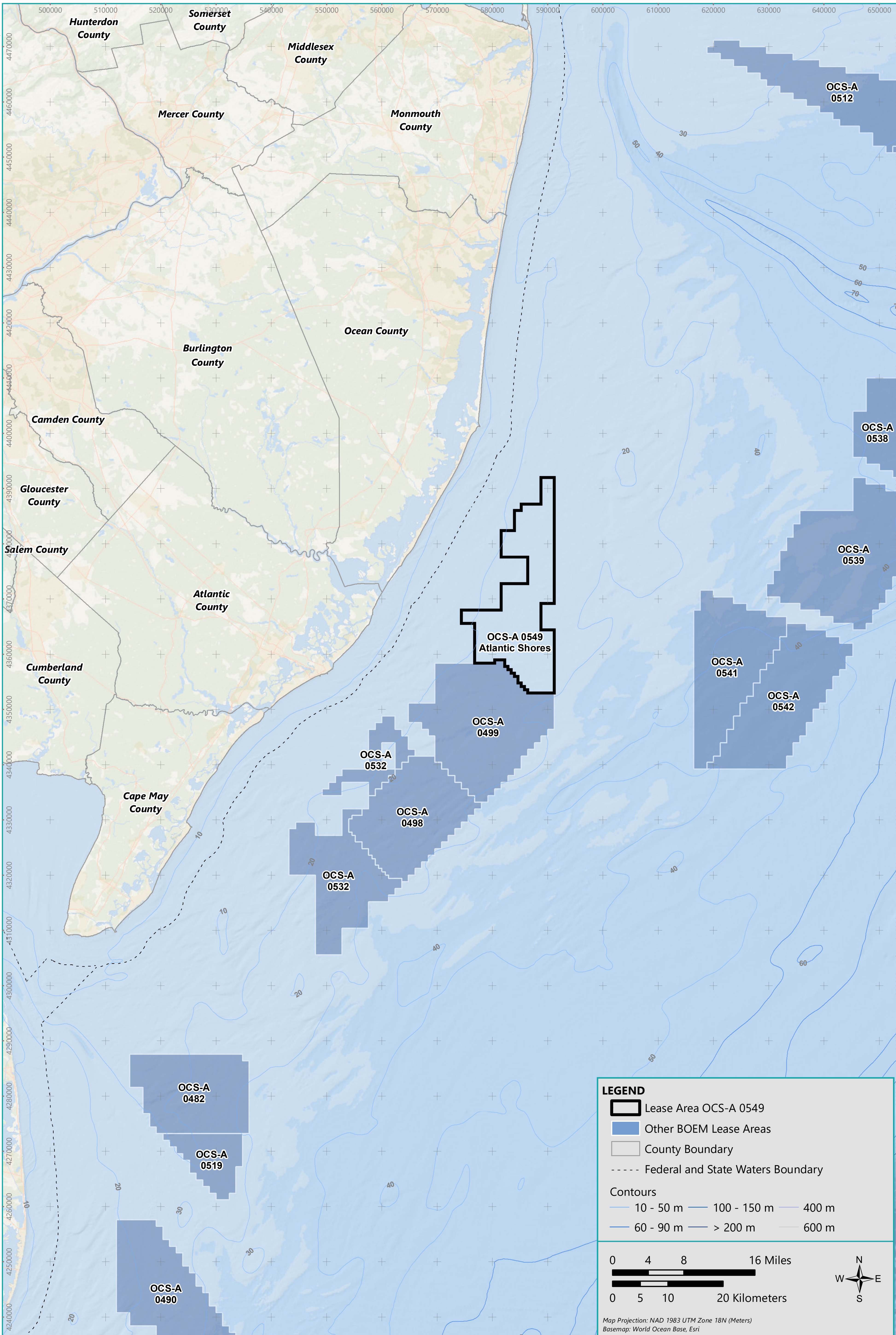
Based on the information and rationale provided in this document, along with supporting references, data, and past precedents, the Proponent believes that the proposed AERMOD-AERCOARE modeling approach is justified as a more suitable method for estimating dispersion in the OCS off the Atlantic Coast than OCD. The surface fluxes calculated by the COARE algorithm in conjunction with the overwater meteorological data are preferred to the conventional application of AERMET, which is only applicable over land surfaces. AERMOD is preferred over OCD because of the PRIME downwash algorithm, the ability to simulate volume sources, the ability to incorporate NOx to NO_2 conversion using PVMRM or OLM, the ability to generate the concentrations in the statistical form of the new NAAQS, and the distance of the proposed source location from the shoreline. Therefore, the Proponent respectfully requests consideration and approval of this alternative model request for modeling air emission sources associated with the Project.

If you have any questions or require additional information, please contact me at 978.461.6202 or ajablonowski@epsilonassociates.com.

Sincerely,

EPSILON ASSOCIATES, INC.

AJ Jablonowski
Principal



ATLANTIC SHORES offshore wind

Figure 1

Atlantic Shores Lease Area OCS-A 0549

Figure 2 Box and Whisker Plots of Wind Speed (m/s)

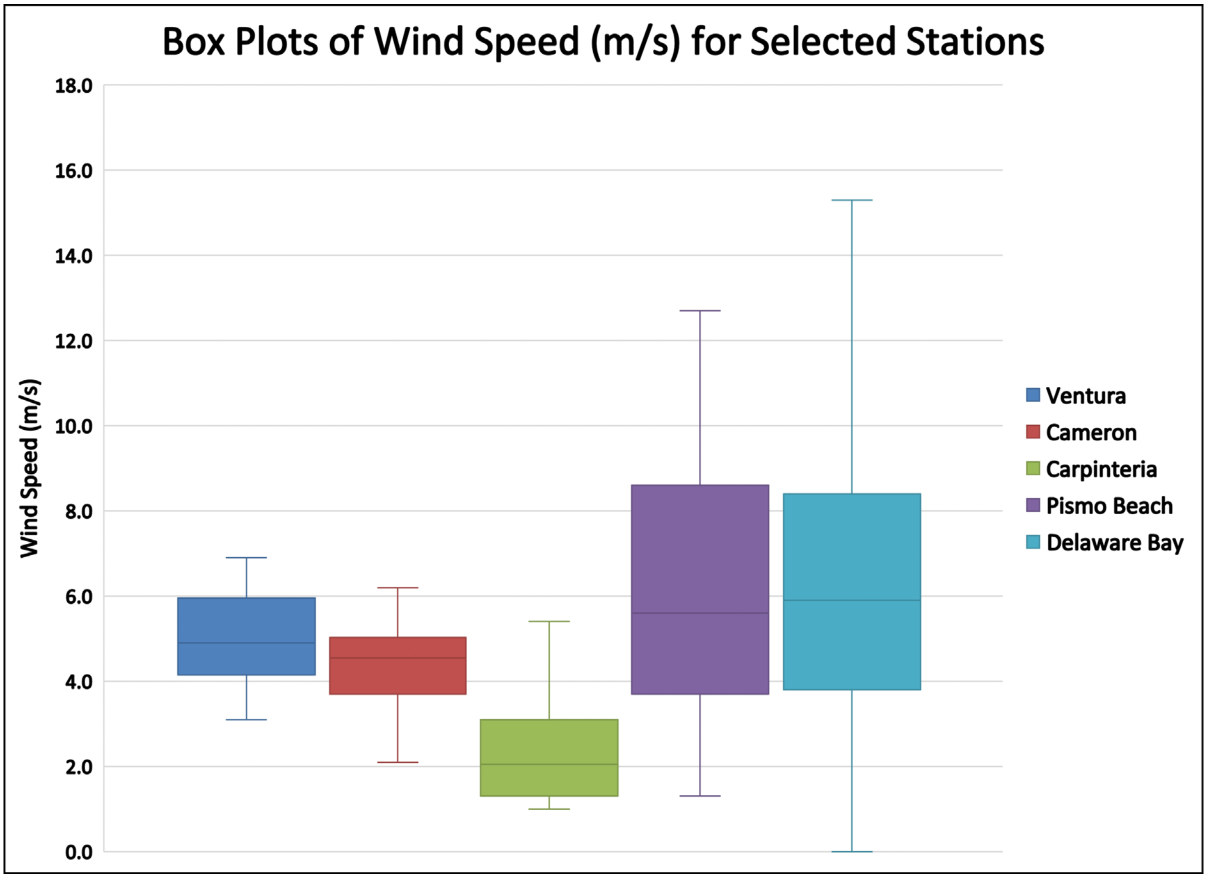


Figure 3 Box and Whisker Plots of Air -Sea Temperature Difference (K)

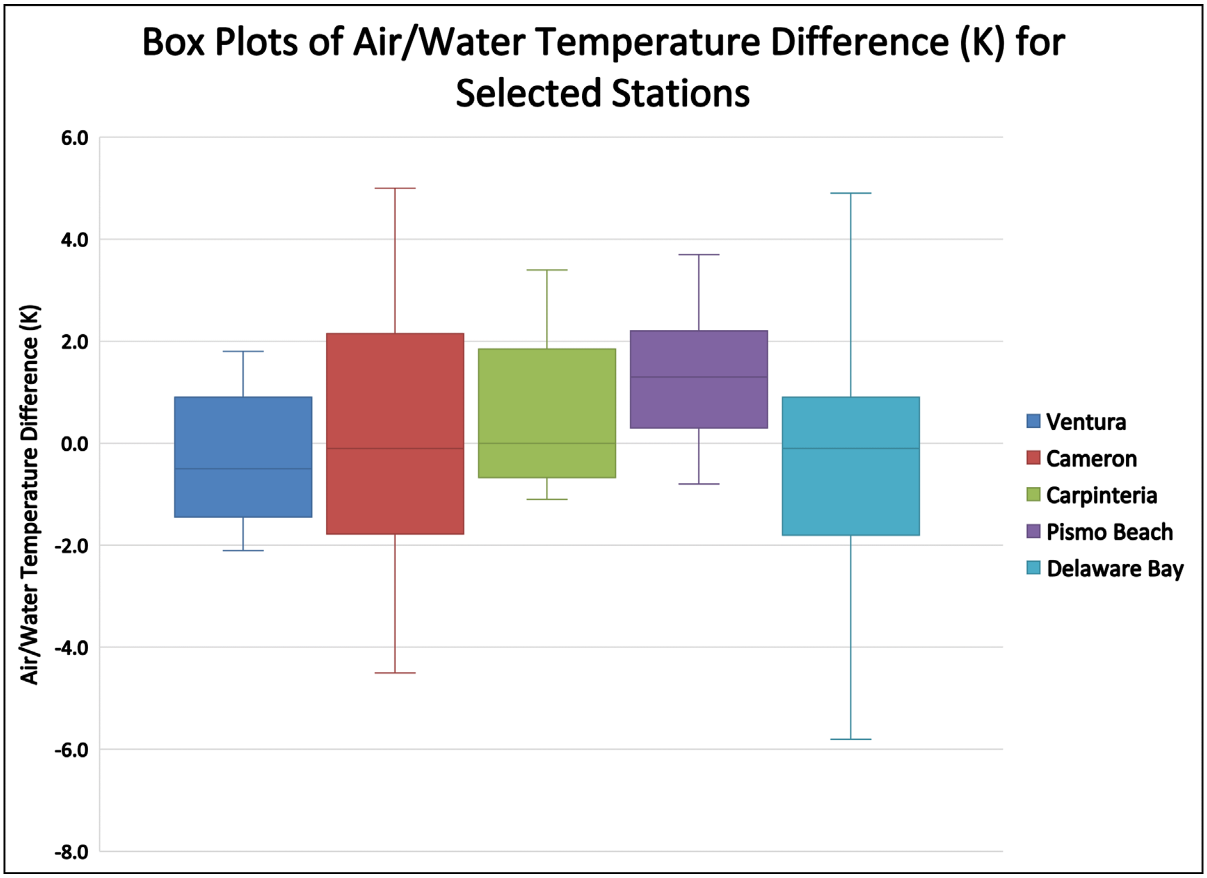


Figure 4 Q-Q Plot of AERCOARE versus Cameron, Louisiana, Tracer Study Results

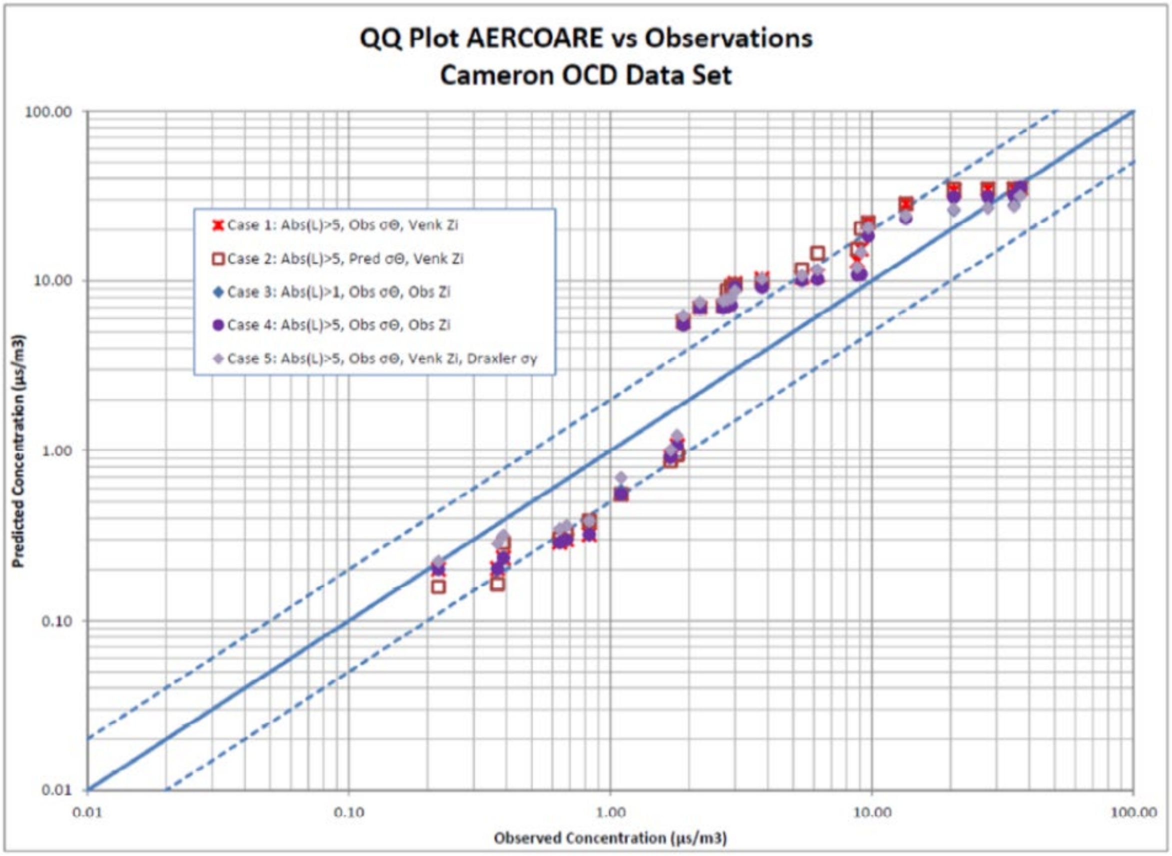


Figure 5 Q-Q Plot of AERCOARE versus Pismo Beach, California, Tracer Study Results