UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 2
290 BROADWAY
NEW YORK, NY 10007-1866

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 power project

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

ANNAMARIA COLECCHIA Digitally signed by ANNAMARIA COLECCHIA Date: 2022.07.20 10:23:47 -04'00'

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

Richard Ruvo Digitally signed by RICHARD RUVO Date: 2022.07.20 12:56:26 -04'00'

TO: George Bridgers, Director of Model Clearinghouse
Air Quality Modeling Group, 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) air permitting effort. The AERCOARE meteorological data preprocessor program will be used in conjunction with AERMOD (AERCOARE/AERMOD) to conduct an air quality modeling analysis as part of the OCS air permit application for the proposed Atlantic Shores Offshore Wind, LLC's Atlantic Shores projects to be located off the coast of New Jersey. Atlantic Shores Offshore Wind, LLC ("Atlantic Shores") has sought approval to allow the use of the AERCOARE/AERMOD model for their air quality modeling analysis, under 40 CFR Part 51, Appendix W §3.2.2(b), Condition (3), for the project's OCS air permit application. Under Condition (3), an alternative model may be used if the Regional Office finds the conditions specified in Appendix W §3.2.2(e) are satisfied.

Atlantic Shores submitted their alternative model request on May 31, 2022. The request provided evidence and justifications supporting approvability of the modeling approach under Appendix W §3.2.2(b), Condition (3). EPA's prior approvals of the AERCOARE/AERMOD, using measured meteorological measurements from buoys or prognostic meteorological data, are well documented in the Model Clearinghouse's public database.

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 the Atlantic Shores OCS air permit application. We have found the proposed application of the model is satisfactory under the requirements of §3.2.2(e).

A technical analysis summarizing our review and the May 31, 2022 alternative model request submitted by Atlantic Shores are included below for your consideration. Please feel free to contact Annamaria

Colecchia at (212) 637-4016 if you have any questions regarding the request.

Technical Review of the Atlantic Shores Offshore Wind, LLC Request to Use the AERCOARE Meteorological Data Preprocessor Program in conjunction with AERMOD in support of its Outer Continental Shelf (OCS) Permit Application for the Atlantic Shores projects

1. Background and Project Overview

Atlantic Shores Offshore Wind, LLC ("Atlantic Shores") is proposing to construct two offshore wind energy generation projects on the Outer Continental Shelf (OCS), 8.7 miles off the coast of New Jersey in Bureau of Ocean Energy Management (BOEM) Lease Area OCS-A 0499. Atlantic Shores will develop the lease area as two projects – Project 1 and Project 2 – collectively referred to hereafter as the Projects. Both projects are covered under the OCS permit application and this request. Project 1 is located in the western 54,175 acres of the lease area and Project 2 is located in the eastern 31,147 acres, with a 16,102 acre Overlap Area that could be used by either project. The Projects will consist of up to 200 wind turbine generators (WTGs) and 10 small offshore substations. The proposed OCS windfarm requires an OCS air permit under 40 CFR Part 55 and section 328 of the Clean Air Act (CAA). The requirements of EPA's Prevention of Significant Deterioration (PSD) at 40 CFR Part 52.21, including air quality modeling requirements, apply to the Projects.

The Projects will trigger PSD review for nitrogen dioxide (NO_2), carbon monoxide (CO), particulate matter (PM) with diameter 10 microns or less (PM_{10}); and PM with diameter 2.5 microns or less ($PM_{2.5}$), and greenhouse gases (GHGs). The Projects will trigger Nonattainment New Source Review (NNSR) for the ozone precursors, oxides of nitrogen (NOx) and volatile organic compounds (VOCs).

Atlantic Shores has requested to use an alternative model, as provided in §3.2 of the Guideline on Air Quality Models (40 CFR Part 51, Appendix W, hereafter referred to as the *Guideline*), to conduct its PSD air quality modeling analysis. Specifically, Atlantic Shores has requested to use the Coupled Ocean-Atmosphere Response Experiment (COARE) bulk flux algorithm, as implemented in the AERCOARE meteorological data preprocessor program, to prepare meteorological data for use in the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) dispersion program to assess ambient impacts in a marine environment. Atlantic Shores submitted their request to initiate the alternative model approval process on May 31, 2022 (Attachment 1).

In its May 31, 2022 request, Atlantic Shores indicated its preference to utilize the AERCOARE/AERMOD alternative modeling approach over the EPA's guideline model, the Offshore and Coastal Dispersion (OCD) model. Atlantic Shores' May 31, 2022 request presented ten technical reasons, options, and/or features available in the alternative model to support its request. Atlantic Shores' presented the criteria listed below:

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, Atlantic Shores has proposed use of PRIME considering the platform as a solid structure which will result in conservative, overprediction of concentrations.

2. The Plume Volume Molar Ratio Method (PVMRM) and Ozone Limiting Method (OLM) may be used by the Project to estimate the conversion of oxides of nitrogen (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 $PM_{2.5}$.

4. The AERMOD-AERCOARE model can model multiple line sources, and more than 5 areas 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 AERCOARE-AERMOD are considered state-of-art by USEPA. OCD dispersion algorithms have not been updated to account for current advancements in the understanding of the boundary layer.

8. AERCOARE-AERMOD does not artificially limit the number of receptors that can be considered in an analysis.

9. Several of the programs (MAKEUTM, MAKEGEO) used to generate inputs into the OCD model require changes to the program Fortran code to generate the correct inputs for OCD.

10. AERCOARE will directly accept Weather Research and Forecasting (WRF) data model predicted hourly meteorological output from the Mesoscale Model Interface (MMIF) program.

EPA Region 2 has reviewed the applicant's alternative model request and determined that the use of the proposed alternative model is acceptable.

2. Modeling Approach

Atlantic Shores has not yet submitted its OCS air permit application for the Projects, which will include an air quality impact analysis report, as required under 40 CFR Part 52.21 and 40 CFR Part 55. On May 31, 2022, Atlantic Shores provided EPA with a proposed modeling protocol (Protocol) for the Projects in which AERCOARE/AERMOD was proposed as an alternative modeling platform for near-field impact assessment. The Projects will use prognostic meteorological data provided by EPA from the WRF model and extracted by EPA using MMIF for overwater and on-land locations. A prognostic model evaluation will be provided to demonstrate that the WRF data adequately replicates observed conditions in the 2018-2020 time period at the selected sites. Secondary formation of $PM_{2.5}$ will be determined using EPA's Modeled Emission Rate for Precursors (MERP) methodology for nearby representative hypothetical sources. In the May 31, 2022 protocol, Atlantic Shores proposed to use the EPA guideline model, OCD for assessing the effects of shoreline fumigation at the nearby Brigantine National Wildlife Refuge Class I area. However, on July 13, 2022, in response to Region 2 comments indicating that shoreline fumigation should not be limited to Class I area receptors, Atlantic Shores retracted the proposed use of OCD. They revised their proposal to address the shoreline fumigation using debug files in AERCOARE/AERMOD and to present a quantitative analysis in the OCS application as discussed further below. Certain details of the protocol are still being prepared by the applicant for example the WRF-MMIF evaluation, and other details of the protocol are under review. However, those details will be reviewed in parallel with this alternative model request.

3. Alternative Model Proposal Review

a. Regulatory Analysis and Background

40 CFR Part 52.21(l) states that all applications of air quality modeling shall be based on the applicable models specified in the *Guideline*. However, Part 52.21(l) also provides that on a case-by-case basis a modification or substitution of an air quality model may be used following written approval. In addition, the use of a modified or substituted model is subject to notice and opportunity for public comment. The alternative model approval process and conditions are outlined in Section 3.2 of the *Guideline*. Section 3.2.2(a) specifies that the determination of acceptability of an alternative model is a Regional Office responsibility in consultation with EPA's Model Clearinghouse (MCH). An alternative model may be used subject to Regional Office approval if found to satisfy the requirements listed in Section 3.2.2. Section 3.2.2(b) states the alternative model shall be evaluated from both a theoretical and performance perspective before regulatory use and outlines the three separate conditions where an alternative model may be approved. Condition 3 under Section 3.2.2(b), where there is no preferred model for the specific project, applies to this case where Atlantic Shores has requested the use of the AERCOARE/AERMOD.

The *Guideline* specifies the preferred model for overwater sources is the OCD model. OCD is a straight-line Gaussian model developed to determine the impacts of offshore emissions from point, area, or line sources on the air quality of coastal regions. Some of the key features of OCD potentially applicable to offshore sources are the inclusion of platform building downwash and continuous shoreline fumigation. However, as discussed in Section 1 of this document, OCD does have limitations, as described by Atlantic Shores in its request to use an alternative model for its air quality modeling analyses. The following limitations are of particular importance to the Projects:

(1) OCD does not provide for the multi-tiered screening approach for NO_2 modeling (specifically the Tier 2 ARM2 or Tier 3 PVMRM/OLM refined screening approaches);
(2) OCD does not contain options to generate outputs in the statistical forms consistent with current NAAQS;
(3) OCD does not account for calm wind conditions when calculating predicted pollutant concentrations;
(4) OCD cannot be used to model volume sources, and has a limited ability to model line sources; and
(5) OCD does not account for current advancements in dispersion theory.

In addition, the key features of OCD not provided in AERCOARE/AERMOD are either not applicable to the Projects, or AERCOARE/AERMOD provides a more appropriate and conservative approach. In order to consider the impact of shoreline fumigation, Atlantic Shores will provide an assessment of plume spread rate using AERMOD debug options. The proposed assessment will evaluate impacts on a single, nearest, most elevated point source during a selection of a few highly stable hours to demonstrate the range of distance in which shoreline fumigation would be of concern. These results will be provided at a later date.

Regarding downwash features, while OCD accounts for platform downwash, Atlantic Shores' proposed use of AERCOARE/AERMOD as an alternative model will utilize the PRIME downwash algorithm, which will provide conservative results by treating the proposed platform structure as a solid structure without airflow under the platform.

For these reasons, Atlantic Shores has requested the use of an alternative model (AERCOARE/AERMOD) via Condition 3 under Section 3.2.2(b) and provided justification for the alternative model consistent with the requirements listed in Section 3.2.2(e).

Section 3.2.2(e) sets forth the five elements that must be satisfied for alternative model approval under Condition 3 of Section 3.2.2(b):

I. The model or technique has received a scientific peer review.
II. The model or technique can be demonstrated to be applicable to the problem on a theoretical basis.
III. The databases which are necessary to perform the analysis are available and adequate.
IV. Appropriate performance evaluations of the model or technique have shown that the model or technique is not inappropriately biased for regulatory application.
V. A protocol on methods and procedures to be followed has been established.

The EPA has approved use of AERCOARE/AERMOD as an alternative model in the past under §3.2.2(b). The first approval was in 2011, where EPA Region 10 approved the use of the AERCOARE/AERMOD system for a project in the Arctic Ocean off the north coast of Alaska.[1] EPA Region 6 approved the use of AERCOARE/AERMOD for a project off the coast of Texas in the Gulf of Mexico in 2019.[2] EPA Region 1 approved the use of AERCOARE/AERMOD in two instances for windfarm projects - Park City Wind on January 28, 2022[3] and New England Wind Phase 2 on July 5, 2022[4].

The following section of this technical review document provides an examination of Atlantic Shores' justification for the approval of AERCOARE/AERMOD for its overwater source with respect to the requirements of Section 3.2.2(e).

b. Evaluation of Approach under Section 3.2.2(e)

[1]The Model Clearinghouse Information Storage and Retrieval System (MCHISRS) Record for the April 2011 Region 10 approval of AERCOARE/AERMOD is available at: https://cfpub.epa.gov/oarweb/MCHISRS/index.cfm?fuseaction=main.resultdetails&recnum=11-X-01

[2]The Model Clearinghouse Information Storage and Retrieval System (MCHISRS) Record for the November 2019 Region 6 approval of AERCOARE/AERMOD is available at: https://cfpub.epa.gov/oarweb/MCHISRS/index.cfm?fuseaction=main.resultdetails&recnum=19-VI-01

[3] The Model Clearinghouse Information Storage and Retrieval System (MCHISRS) Record for the January 2022 Region 1 approval of AERCOARE/AERMOD is available at: https://cfpub.epa.gov/oarweb/MCHISRS/index.cfm?fuseaction=main.resultdetails&recnum=22-I-01

[4] The Model Clearinghouse Information Storage and Retrieval System (MCHISRS) Record for the July 2022 Region 1 approval of AERCOARE/AERMOD is available at: https://cfpub.epa.gov/oarweb/MCHISRS/index.cfm?fuseaction=main.resultdetails&recnum=22-I-02

In its alternative model request, Atlantic Shores referenced the April 2011 EPA Region 10 approval and EPA MCH concurrence with the use of AERCOARE/AERMOD for an Arctic marine ice-free environment on the basis that the alternative model satisfied the five criteria contained in Section 3.2.2(e) of the Guideline. The April 2011 EPA MCH concurrence memorandum stated the Region 10 approval did not constitute a general approval of AERCOARE/AERMOD for other applications. However, the memorandum did state that the April 2011 Region 10 approval concurrence request did provide "a good basis for consideration of AERCOARE/AERMOD for other applications, subject to Regional Office approval based on an assessment of the appropriateness of the performance evaluations (3.2.2(e), element 4) and the availability of the necessary data bases (3.2.2(e), element 3) on a case-by-case basis." In addition, the request references the EPA Region 1 and Region 6 AERCOARE/AERMOD approvals, that do not constitute a generic approval of this alternative model system but do provide a good basis for such considerations provided technical justifications are provided. Therefore, the justification for the use of AERCOARE/AERMOD for the Atlantic Shores modeling analysis addressed each of the five elements in Section 3.2.2(e), with emphasis on elements 3 and 4, as discussed below.

I. *The model or technique has received a scientific peer review.*

   As detailed in the April 2011 Region 10 approval, the science behind the COARE algorithm, which has been incorporated into AERCOARE, has been published in scientific peer review journals. Information pertaining to the scientific peer review can be found at: http://www.coaps.fsu.edu/COARE/.

   Furthermore, the EPA supported a study to evaluate AERCOARE/AERMOD performance when specifically using inputs from a prognostic meteorological model, as is proposed for Atlantic Shores' application. The peer-reviewed EPA report demonstrated the approach, using meteorological inputs from WRF-MMIF, 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 (U.S. EPA (2015))[5].

II. *The model or technique can be demonstrated to be applicable to the problem on a theoretical basis.*

   The EPA has previously found the AERCOARE/AERMOD approach to be applicable, on a theoretical basis, for the simulation of pollutant dispersion in the marine atmospheric boundary layer. In the April 2011 Region 10 alternative model approval, EPA deemed AERCOARE/AERMOD to be appropriate for use in the Arctic marine ice-free environment. In the 2019 Region 6 approval of AERCOARE/AERMOD, EPA determined the model was also appropriate on a theoretical basis for use in the subtropical marine environment off the coast of Louisiana. In the 2022 AERCOARE/AERMOD approvals, EPA Region 1 deemed it was appropriate on a theoretical basis for use in the marine environment off the coast of Massachusetts. In addition, the user manual for AERCOARE[6] developed by Region 10 indicates that AERCOARE is expected to be appropriate for marine conditions at all latitudes.

[5] 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.
[6] *U.S. EPA (2012): User's Manual AERCOARE Version 1.0, EPA 910-R-12-008, October 2012.*

III. The databases which are necessary to perform the analysis are available and adequate.

This element of §3.2.2 of the Guideline refers to the databases collected to develop and verify the proposed modeling methodology. The marine meteorological databases used to develop the COARE algorithm are available publicly in the scientific literature, as listed in Fairall et al.[7] Datasets from dispersion experiment campaigns have been used to verify the accuracy of the AERCOARE/AERMOD modeling approach. There are a limited number of historical overwater dispersion datasets available in the record that involve study of air pollutant dispersion in the marine atmospheric boundary layer. Historically, four robust tracer studies from the 1980s have been used in the performance evaluations of OCD, CALPUFF, and AERCOARE/AERMOD that are discussed in the request by Atlantic Shores and in the Region 10, Region 6, and Region 1 approvals of AERCOARE/AERMOD.

Similar to the Region 1 approvals, Atlantic Shores has provided additional information related to the meteorological parameters measured at the Delaware Bay buoy (#44009), located near the Projects. These sufficiently demonstrate that that the referenced tracer studies were representative of the marine environment off the coast of New Jersey.

IV. Appropriate performance evaluations of the model or technique have shown that the model or technique is not inappropriately biased for regulatory application.

In their request, Atlantic Shores noted EPA's prior Region 10 approval of AERMOD/AERCOARE relied on the results of demonstrations showing no bias toward underestimates, using the campaign datasets listed above. EPA Region 6's approval of AERMOD/AERCOARE also relied on the results found in the original Region 10 approval. EPA Region 1's approval considered quantile-quantile (Q-Q) plots for the Cameron and Pismo Beach studies, comparing the combinations of AERCOARE/AERMOD simulations to measurements from each study. The Q-Q plots demonstrate the model tends to overestimate concentrations at the upper-end of the distribution for both studies.

In their review of the Park City Wind request, Region 1 also reviewed the 2015 EPA study to see if the WRF-MMIF inputs for AERCOARE resulted in underprediction. A key element to both the original Region 10 approval study and the U.S. EPA (2015) WRF-MMIF 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 AERCOARE User's Manual[8].

Based on the above information, Region 2 concludes it is evident the AERCOARE/AERMOD approach does not result in systematic underprediction of concentrations. Instead, the evidence

[7] Fairall, C.W.; Bradley, E.F.; Hare, J.E.; Grachev, A.A.; Edson, J.B. (2003): Bulk Parameterization of Air-Sea Fluxes: Updates and Verification for the COARE Algorithm. Journal of Climate, Vol. 16, pp. 571-591. https://doi.org/10.1175/1520-0442(2003)016%3C0571:BPOASF%3E2.0.CO;2.

[8] https://gaftp.epa.gov/Air/aqmg/SCRAM/models/related/aercoare/AERCOAREv1_0_Users_Manual.pdf

more likely leads to the conclusion the approach is conservative.

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

Atlantic Shores submitted a modeling protocol to EPA on May 31, 2022. The modeling protocol outlined the modeling techniques employed in the air modeling analyses conducted in support of the Projects. This modeling protocol supplemented the applicant's demonstration of AERCOARE/AERMOD as an alternative model contained in their May 31, 2022 request to initiate the alternative model approval process.

Atlantic Shores intends to use EPA's national 2018-2020 12-km WRF prognostic model dataset to provide meteorological inputs to the AERCOARE/AERMOD system. Atlantic Shores will provide a prognostic model evaluation as part of their permit application, as required under §8.4.5.2. of the *Guideline*.

Atlantic Shores has asked EPA Region 2 to run MMIF to provide the meteorological input files for AERCOARE from the EPA's 2018-2020 national WRF dataset. EPA's guidance for use of MMIF for AERMOD applications[9] will be referred to in setting up and running MMIF. Atlantic Shores has specified use of coordinates: 74.126° W, 39.248° N as the data extraction point for the prognostic dataset. MMIF will be ran by EPA using the following settings:

- Use of WRF output settings for mixing height ("AER_MIXHT = WRF", as opposed to a MMIF diagnosis of mixing height).
- Use of surface characteristics provided by WRF (as opposed to use of AERSURFACE)
- Use of a minimum mixing height of 25 meters, as used in EPA Region 1 and 10 approvals.
- Use of a minimum absolute value of Monin-Obukhov Length of 5 meters, as used in EPA Region 1 and 10 approvals.
- Minimum wind speed of 0 m/s ("AER_MIN_SPEED = 0")

Atlantic Shores intends to run AERCOARE using default settings recommended in AERCOARE User's Manual, except as specified below:

- Minimum wind speed used by AERMOD is 0.283 m/s. Wind speeds below this value will be considered calms; WSCALM = 0.283 m/s.
- Mixing heights provided by WRF-MMIF will be used, instead of calculated by AERCOARE. The minimum mixing height of 25 meters, assigned under the MMIF processing step, will be maintained.
- Warm layer and cool-skin effects will not be considered.
- Friction velocity will be determined from wind speed only; wave-height will not be considered.

4. Conclusions and Conditions for Use

[9] U.S. EPA (2018): Guidance on the Use of the Mesoscale Model Interface Program (MMIF) for AERMOD Applications. EPA-454/B-18-005, U.S. EPA Office of Air Quality Planning and Standards. Available at: https://gaftp.epa.gov/Air/aqmg/SCRAM/models/related/mmif/MMIF_Guidance.pdf

EPA Region 2 has reviewed the alternative model request submittal provided by Atlantic Shores and has determined that the proposed AERCOARE/AERMOD modeling approach is acceptable as an alternative model for the air quality modeling analysis submitted in support of its OCS air permit application. Based on our review, we find that the proposed approach addresses the five elements contained in Section 3.2.2(e) of the Guideline. As such, pursuant to Sections 3.0(b) and 3.2.2(a), Region 2 currently intends to approve the use of AERCOARE/AERMOD as an acceptable alternative model for the Atlantic Shores projects. We seek the concurrence from the Model Clearinghouse.

As with the prior alternative model approvals of AERMOD-COARE, approval to use this alternative model is made on a case-by-case basis. Should an air permit applicant or state desire to use AERCOARE/AERMOD in an overwater modeling analysis for a different facility and/or location, a request for alternative approval must be made to the appropriate EPA Regional Office containing the appropriate technical justifications/demonstrations consistent with the *Guideline*.

Attachment 1 – Atlantic Shores' Alternative Model Request dated May 31, 2022

PRINCIPALS

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May 31st, 2022

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Subject: Request for Approval for Use of COARE Bulk Flux Algorithm to Generate Hourly Meteorological Data for use with AERMOD

Dear Ms. Colecchia

This letter requests approval of an alternative model for the Atlantic Shores offshore wind projects.

Atlantic Shores Offshore Wind, LLC ("Atlantic Shores") proposes to construct, operate, and decommission two offshore wind energy generation projects ("the Projects") in Lease Area OCS-A 0499. Atlantic Shores accordingly seeks a permit for emissions associated with sources subject to the Outer Continental Shelf (OCS) Air Regulations at 40 CFR Part 55. The OCS air permit process will include the use of air quality dispersion modeling to document compliance with certain requirements to protect ambient air quality.

The Projects are in federal waters on the Outer Continental Shelf (OCS), just over 8.7 miles from the New Jersey shoreline (see Figure 1). Project 1 is located in the western 54,175 acres of the Lease Area (also referred to as the Wind Turbine Area [WTA]) and Project 2 is located in the eastern 31,147 acres of the WTA, with a 16,102 acre Overlap Area that could be used by either Project 1 or Project 2. The Overlap Area is included in the event engineering or technical challenges arise at certain locations in the WTA.

The Offshore and Coastal Dispersion (OCD) model is currently listed as the preferred model for over-water dispersion in EPA's Guideline on Air Quality Models (see Section 4.2.2.3 of Appendix W). Atlantic Shores will continue to use OCD for modeling the impacts of over-water emissions sources on on-shore locations where shoreline fumigation may be important (i.e., emissions from the WTA impacting receptors at the Brigantine Wildlife Refuge). However, for impacts over-water, the Proponent is requesting the Coupled Ocean-Atmosphere Response Experiment (COARE) bulk flux algorithm as implemented within the AERCOARE.

The COARE bulk flux algorithm is a series of equations which use the air-sea temperature difference, overwater humidity, and wind speed measurements to estimate the sensible heat, latent heat, and momentum fluxes. The COARE algorithm was developed based on measurements in the tropics, but has been extensively refined, evaluated, and globalized to improve its applicability in environments outside of the tropics (Fairall et al, 2003). The version 3 of the COARE algorithm has been implemented within the meteorological data processor program AERCOARE, to prepare meteorological data for use in the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD). AERCOARE, in conjunction with AERMOD is an alternative model for assessing compliance with air quality standards when emission sources and dispersion occur over water.

AERCOARE-AERMOD is preferred by Atlantic Shores over OCD because of the following technical advantages, options, and features available in the 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, Atlantic Shores has proposed use of PRIME considering the platform as a solid structure which will result in conservative, overprediction of concentrations.

2. The Plume Volume Molar Ratio Method (PVMRM) and Ozone Limiting Method (OLM) may be used by the Project to estimate the conversion of oxides of nitrogen (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 PM2.5.

4. The AERMOD-AERCOARE model can model multiple line sources, and more than 5 areas 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 AERCOARE-AERMOD are considered state-of-art by USEPA. OCD dispersion algorithms have not been updated to account for current advancements in the understanding of the boundary layer.

8. AERCOARE-AERMOD does not artificially limit the number of receptors that can be considered in an analysis.

9. Several of the programs (MAKEUTM, MAKEGEO) used to generate inputs into the OCD model require changes to the program Fortran code to generate the correct inputs for OCD.

10. AERCOARE will directly accept Weather Research and Forecasting (WRF) data model predicted hourly meteorological output from the Mesoscale Model Interface (MMIF) program.

Pursuant to Section 3.0 and 3.2.2.a of 40 CFR 51, Appendix W (Guideline on Air Quality Models[1]), approval of an alternative refined model is the responsibility of the Regional Administrator. 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.

Atlantic Shores will be seeking approval to use AERCOARE-AERMOD using 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. In addition, model performance of the AERCOARE-AERMOD modeling approach has been found to be comparable to OCD using the tracer studies from overwater field

[1] https://www.epa.gov/sites/production/files/2020-09/documents/appw_17.pdf

studies[2]. In this study, the authors conclude that AERCOARE-AERMOD could be applied as an alternative to OCD for many regulatory applications.

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

The Atlantic Shores offshore substations resemble platforms, so consideration of platform downwash effects is relevant. However, Atlantic Shores will treat any platforms as solid structures without airflow under the platform. This procedure will result in an overestimate of downwash effects and lead to conservative, overprediction of concentrations.

Similarly, consideration of shoreline fumigation may be relevant, given the proximity of Atlantic Shores to the Brigantine Wilderness Refuge. Therefore, Atlantic Shores will continue to use the OCD model to assess this impact. For the NAAQS and PSD Class II Increment analyses, Atlantic Shores will demonstrate as part of the permit record that peak concentrations are located at overwater receptors.

Under Condition 3, there are five elements that must be addressed (see Section 3.2.2.e):

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.

On April 1st, 2011, the USEPA Region 10 granted approval for the use of output from the COARE algorithm coupled with AERMOD to estimate ambient air pollutant concentrations

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[2] 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.

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 USEPA'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 1st, 2019, the proposed Sea Port Oil Terminal (SPOT) requested the use of AERCOARE-AERMOD for a proposed offshore oil export facility. The SPOT request documented several limitations of OCD, as well as the key dispersion features of OCD that are not available within AERCOARE-AERMOD (i.e., platform downwash and shoreline fumigation). The SPOT request documented that the applicant would model the platform sources as solid structures and that the project's operation was sufficiently offshore that shoreline fumigation would not be a concern.

On August 9th, 2021, the Park City Wind offshore wind project requested the use of AERCOARE-AERMOD for a proposed offshore wind project using WRF-MMIF prognostic data versus the observational data as the meteorological data being used in the modeling demonstration. The Park City Wind request documented several limitations of OCD, as well as the key dispersion features of OCD that are not available within AERCOARE-AERMOD (i.e., platform downwash and shoreline fumigation). The Park City Wind request documented that the applicant would model the platform sources as solid structures and that the project's operation was sufficiently offshore that shoreline fumigation would not be a concern.

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

On January 28th, 2022, USEPA approved the use of AERCOARE-AERMOD for Park City Wind.[5] Two key differences of the Park City Wind project when compared to the SPOT alternative model approval that are relevant to Atlantic Shores, is the underlying

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

meteorological data being used and the geographic location of application. These were specifically documented in the Model Clearinghouse review:

"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

[6] 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.

consistent with Appendix W, Section 8.4.5 (Prognostic Meteorological Data, Discussion and Recommendations)."

As documented in the USEPA Region 10 memorandum, the USEPA Region 6 SPOT approval, and the USEPA Region 1 Park City Wind approval, the AERCOARE-AERMOD 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 USEPA's Model Clearinghouse stated that its concurrence with the approvals did not constitute a generic approval of AERCOARE-AERMOD for other applications. However, USEPA's Model Clearinghouse stated:

"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 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."

Atlantic Shore South's request to use AERCOARE-AERMOD is therefore modeled after the SPOT and Park City Wind requests. Therefore, Atlantic Shores 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 the Region 10, 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 AERCOARE/AERMOD performance when using inputs from a prognostic meteorological model. The report documented that using meteorological inputs from WRF-MMIF, 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.[7]

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

Both the Region 10, April 2011 approval and the 2019 SPOT approvals 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.'"

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[7] (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.

"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 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 paper 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.

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 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."

For these reasons Atlantic Shores 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 AERCOARE model evaluation document 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 Region 10 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.""

Park City Wind supplemented its requested by providing documentation that the distribution of meteorological conditions (specifically wind speed and air/sea temperature difference) used to develop COARE and occurred during the AERCOARE/AERMOD verification studies cover a range of conditions of importance off the New England Coast.

As the Projects are located off the mid-Atlantic Coast, Atlantic Shores is providing the same documentation to support that the distribution of meteorological conditions used to develop COARE cover the range of conditions of importance off the mid-Atlantic Coast.

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.

The April 1, 2011, memorandum from USEPA Region 10, in conjunction with the USEPA/ENVIRON October 2012 Model Evaluation Study, 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, 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 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.

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[8] See Fairall et al, 2003. "Most of our measurements for U > 12 m/s were acquired in the Fronts and Atlantic Storms Experiment (FASTEX) (North Atlantic) and Moorings (North Pacific) field studies."

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 Pismo Beach, California is shown as Figure 5. As shown, the model concentrations generally are within the factor of 2 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 over-prediction for the highest concentrations, with less than a factor of 2 under-prediction at the lower concentrations. Importantly, AERCOARE-AERMOD 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 USEPA Region 1 for Park City Wind specifically examined whether the use of prognostic meteorological data generated by WRF could result in systematic underprediction of concentrations, in the technical support document they 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 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.[9]

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."

The modeling protocol submitted by Atlantic Shores documents the proposed settings used in MMIF of 25 meters for the minimum mixing height and a Monin-Obukhov length of 5 meters.

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

Atlantic Shores has developed and submitted a modeling protocol document for USEPA Region 2 review and approval. The modeling protocol outlines the modeling techniques

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

that will be employed by the Atlantic Shores Projects, and it conforms with the modeling procedures outlined in the Guideline on Air Quality Models (Appendix W of 40 CFR 51), associated USEPA modeling policy and guidance, as well as New Jersey Department of Environmental Protection (NJDEP) Air Quality Modeling Guidelines.

Summary

Based on the information and rationale provided in this document, along with supporting references, data and past precedents, Atlantic Shores believes that the proposed AERCOARE-AERMOD 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 NO2 conversion using PVMRM or OLM, AERMOD's ability to generate the concentrations in the statistical form of the new NAAQS, and the distance of the proposed source location from the shoreline.

If you have any questions or require additional information, please contact me at 978-461-6265 or jsabato@epsilonassociates.com.

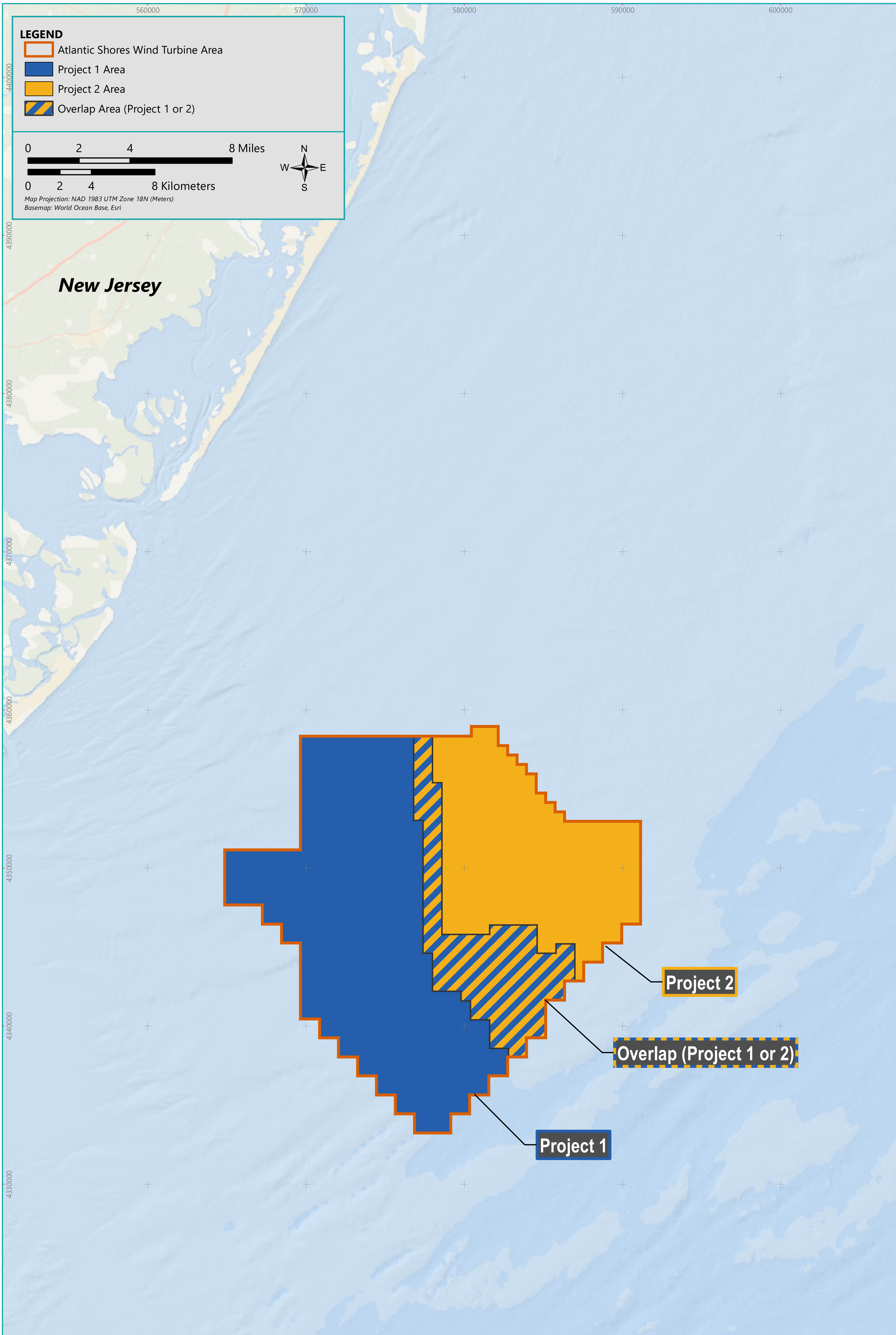
Sincerely,

EPSILON ASSOCIATES, Inc.

Joseph E. Sabato

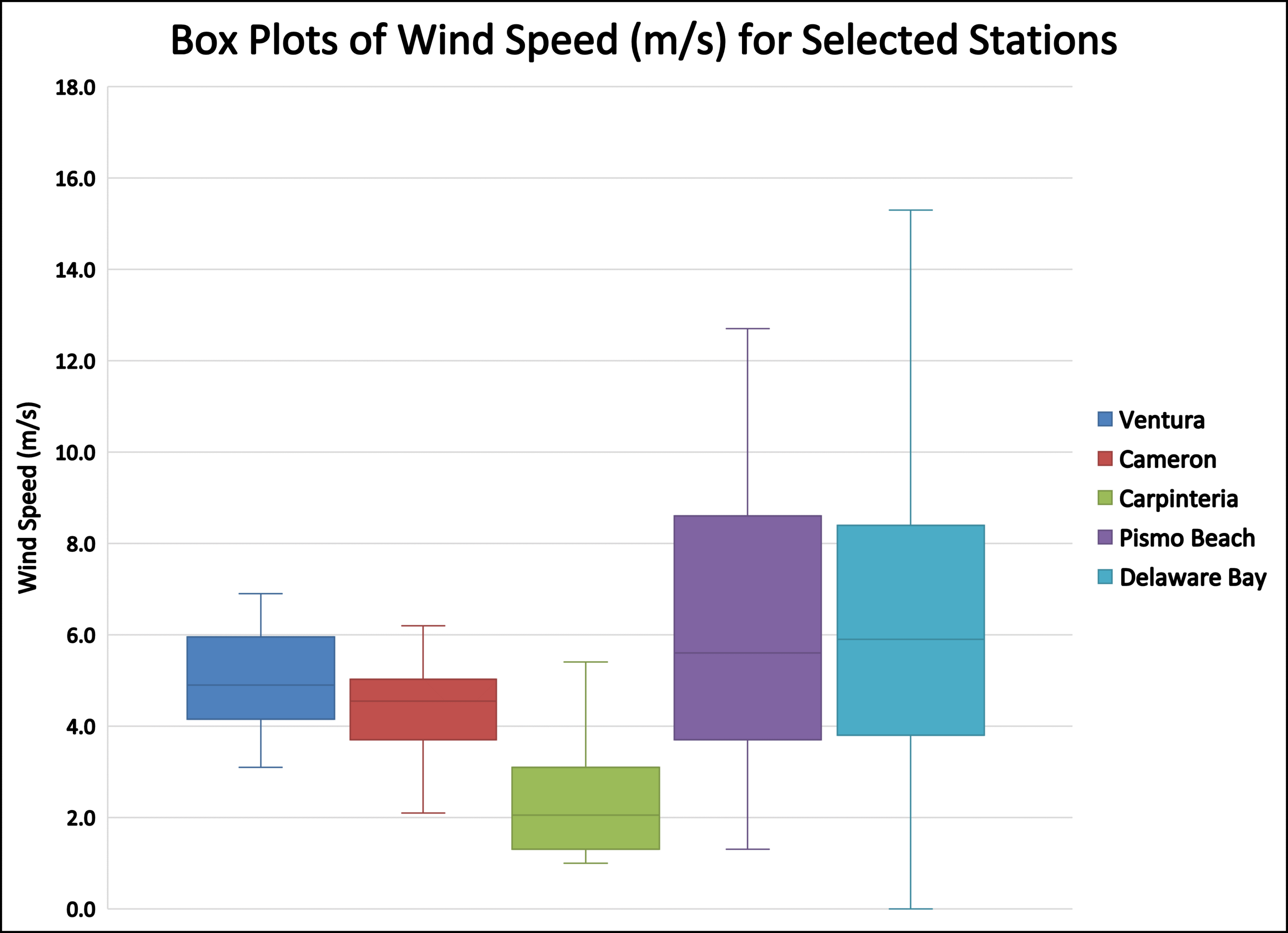
Joseph Sabato, CCM
Senior Consultant

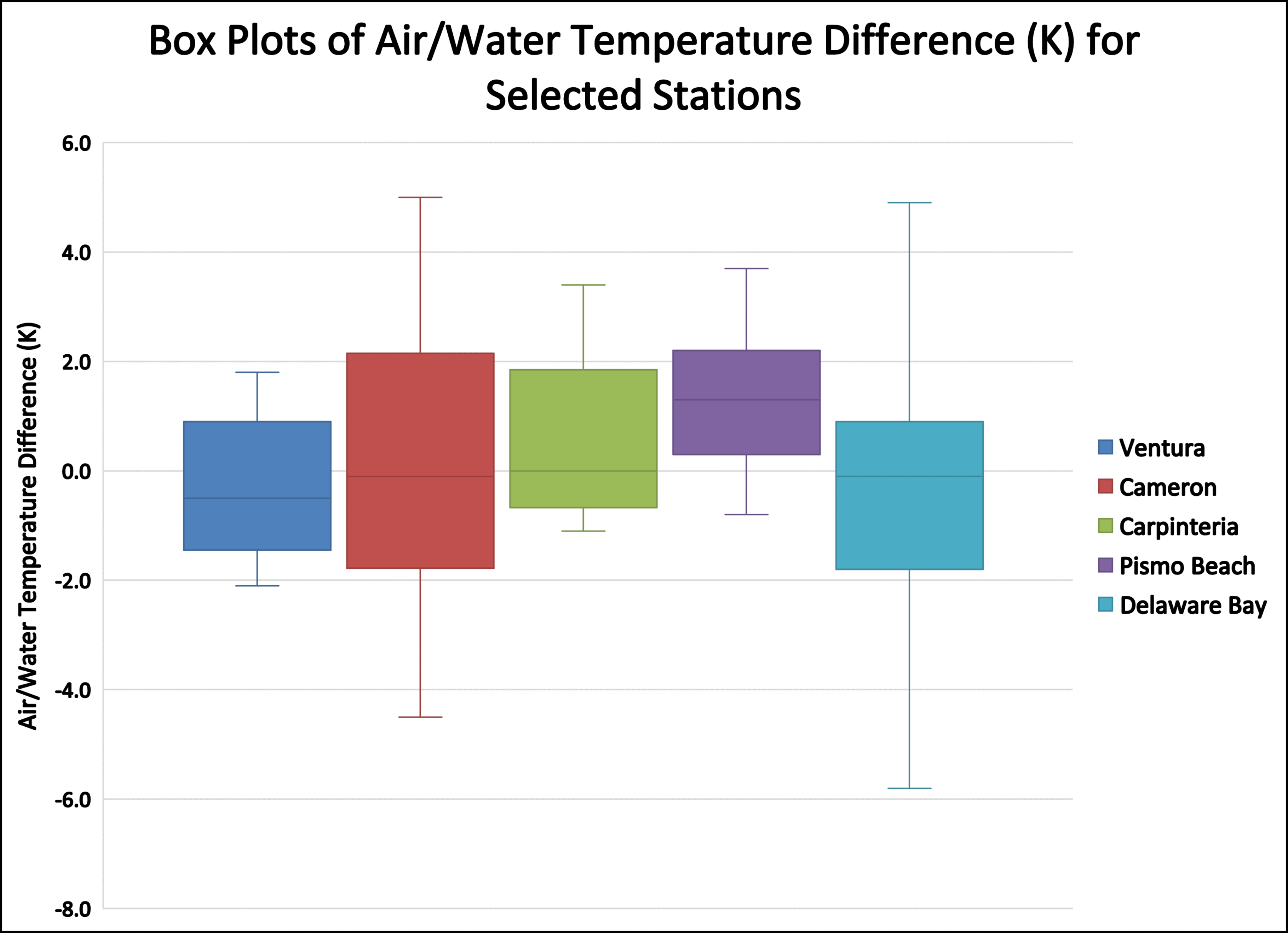
Figure 1 Atlantic Shores Location
Figure 2: Box and Whisker Plots of Wind Speed (m/s)
Figure 3: Box and Whisker Plots of Air -Sea Temperature Difference (K)
Figure 4: Q/Q Plot for Cameron, LA
Figure 5: Q/Q Plot for Pismo Beach, CA



ATLANTIC SHORES
offshore wind

Figure 1
Overview of the Projects


Box Plots of Wind Speed (m/s) for Selected Stations
Wind Speed (m/s)
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Ventura
Cameron
Carpinteria
Pismo Beach
Delaware Bay



Box Plots of Air/Water Temperature Difference (K) for Selected Stations
Air/Water Temperature Difference (K)
6.0
4.0
2.0
0.0
-2.0
-4.0
-6.0
-8.0
Ventura
Cameron
Carpinteria
Pismo Beach
Delaware Bay

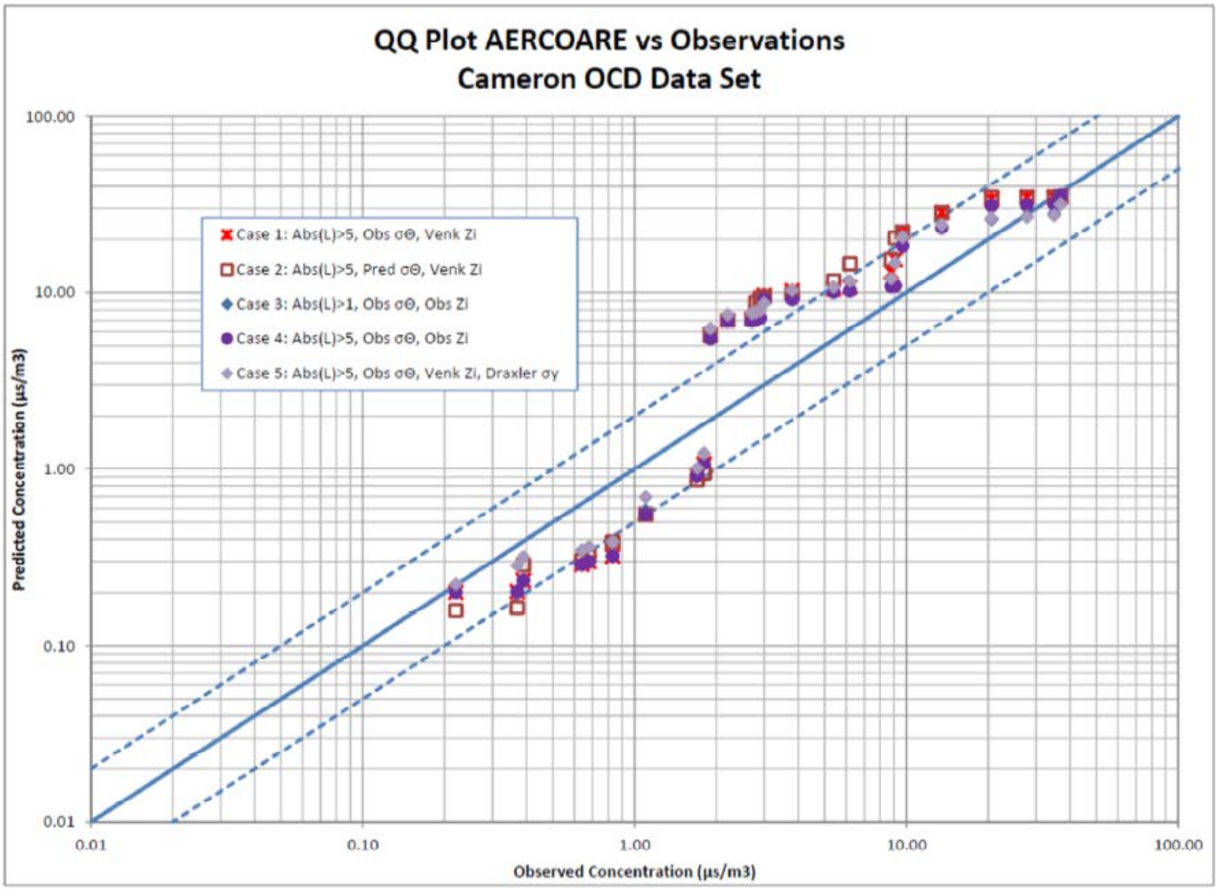


Figure 4: QQ Plot of AERCOARE versus Cameron, Louisiana, Tracer Study Results

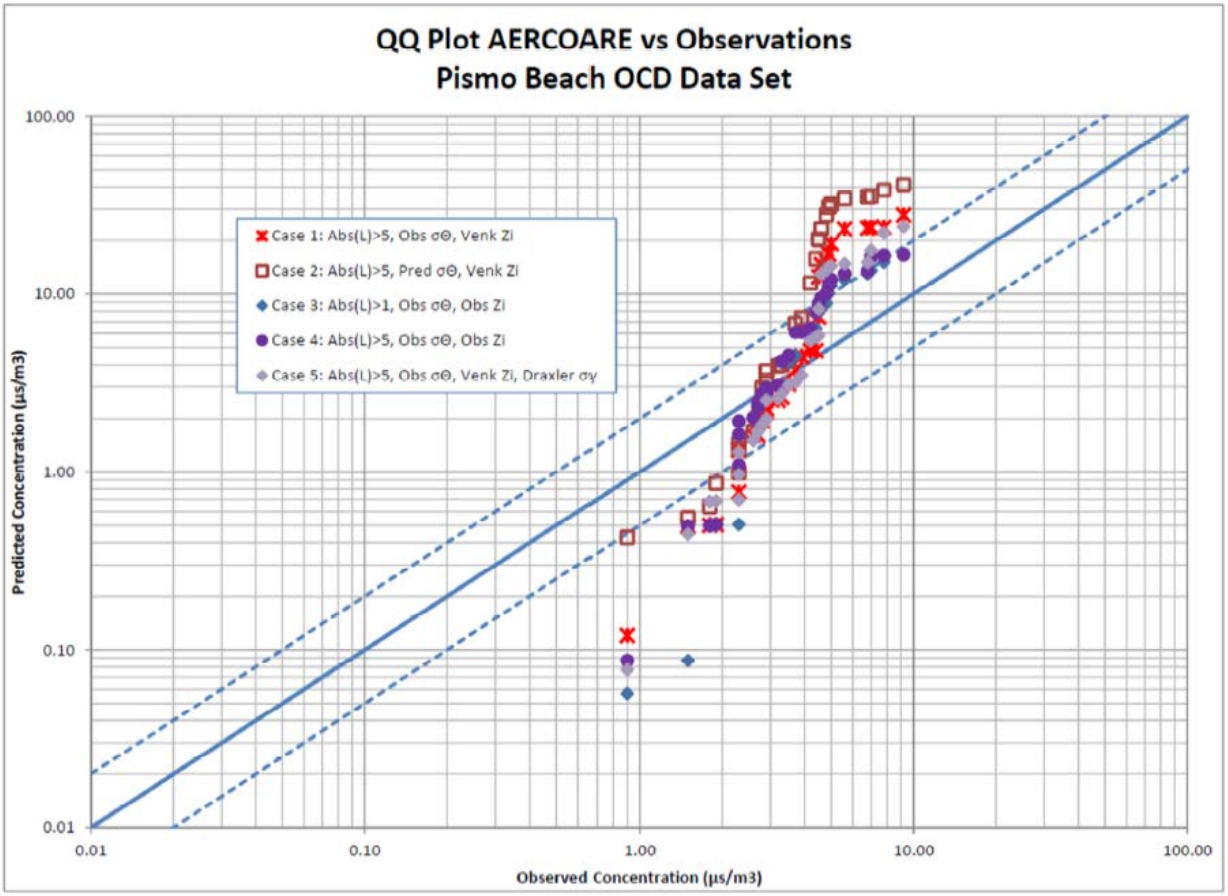


Figure 5: QQ Plot of AERCOARE versus Pismo Beach, California, Tracer Study Results