External Peer Review comments regarding the C-PORT

Response to Peer Review Comments

U.S. Environmental Protection Agency
Office of Research and Development
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I. INTRODUCTION

EPA's Office of Research and Development, National Exposure Research Laboratory has been developing the Community model for near-PORT applications (C-PORT) intended to provide users with the capability to estimate changes in the concentration of air pollutants in the community resulting from changes in emissions from traffic and port activities. C-PORT is designed for users interested in conducting screening-level, near-source assessments of air quality in order to inform decision-making about the implications of alternative future scenarios, or the need for additional assessment, risk mitigation, or exposure reduction actions.

C-PORT has the following features to facilitate its application:

1. C- PORT is designed to be a flexible and user-friendly screening tool to conduct rapid scenario assessments, modify current sources of emissions consistent with proposed changes, and view potential local air quality impacts under alternative scenarios.
2. The dispersion algorithms in C- PORT are similar to other dispersion models, but have been constrained to reduce computational time and enable quick access to results.
3. C- PORT provides default initial emission values for 21 seaports based on EPA's National Emissions Inventory (NEI 2011), and these can be updated with future NEIs and spatial analysis of sources. C-PORT also includes local National Weather Service data for initial parameterization.
4. Because C- PORT is designed to be an interactive web-based tool that is broadly accessible, the description of the inputs/outputs and the model's functionality is provided using online help rather than through traditional model documentation.

The C-PORT model was reviewed with a panel peer consultation on January 19-20, 2017. The University of North Carolina at Chapel Hill, Institute for the Environments (UNC IE) assembled four scientific experts with expertise in dispersion modeling and community assessments. The reviewers met in RTP, NC for two days to evaluate the scientific integrity of EPA's C-PORT modeling system, its functionality and adequacy of the default model inputs. EPA scientists presented the C-PORT project overview to the reviewers, the C-PORT live demo, and descriptions of the C-PORT model formulations, emission/meteorology inputs, and software technology. EPA scientists also presented C-PORT case studies and participated in clarifying discussions, as requested, with the panel members. Afterwards, each reviewer provided individual written responses to a set of charge questions. The four reviewers were screened by UNC IE for scientific qualifications and any conflicts of interest. The peer consultation followed procedures specified in EPA's Peer Review Handbook, 4th edition. EPA prepared a written response to the peer consultation. The four selected reviewers are listed below.

Steven Hanna, Ph.D., Hanna Consultants and Harvard School of Public Health.
David Carruthers, Ph.D., Cambridge Environmental Research Consultants
James Sadd, Ph.D., Occidental College
Elena Craft, Ph.D., Environmental Defense Fund

This EPA document contains the EPA response to the independent peer reviewers' comments. Comments were prepared by the EPA Office of Research and Development C-PORT Project Team:

Vlad Isakov, Ph.D.
Timothy Barzyk, Ph.D.
Betsy Smith, Ph.D.

II. CHARGE TO REVIEWERS:

EPA's Office of Research and Development asked the reviewers to address the following aspects of C-PORT in their comments:

- The primary role of C-PORT in conducting simulations to assess the impact of emission changes on air quality under alternative future scenarios.
- The simplifications in the dispersion algorithms in C-PORT to reduce computational demands with minimal changes in model accuracy.
- The default inputs for community-scale modeling applications.
- The tool's flexibility and user-friendliness.
- The role of C-PORT in raising awareness of potential impacts to vulnerable populations and exploring actions that could mitigate impacts.
- The online documentation in C- PORT.
- The training video used to provide information on applying the tools to create alternative scenarios.
- The caveats and qualifiers provided to dissuade misuse of C- PORT.

Charge questions

Question 1. The dispersion algorithms in C-PORT are similar to those in dispersion models used by regulators and research scientists, but have been constrained to reduce computational time and enable quick access to results. **Do the modified algorithms in C-PORT provide a sufficient level of accuracy for community air quality screening applications and is their evaluation adequate?**

Question 2. C-PORT provides default emission values based on EPA's National Emissions Inventory (NEI 2011, but these will be updated to future NEI's) and spatial analysis of sources. **Given that this model is designed to evaluate the impact of *future* emissions sources, do these default inputs provide an adequate level of resolution to screen for potential community-scale impacts under a variety of alternative scenarios? If not, what additional improvements are necessary? Is there a danger of elevating concerns beyond what is reasonable if users use the default input parameters?**

Question 3. Because C-PORT is designed to be an accessible web-based tool, the description of the inputs/outputs and model's functionality is provided by online help rather than by traditional model documentation. **Does the online documentation in C-PORT provide enough information for the model users and is it easy to understand? Does the training video provide enough information on how to create alternative scenarios? What additional information might be helpful? Are there sufficient caveats and qualifiers provided to dissuade miss-use of C-PORT?**

Question 4. The C-PORT screening tool is intended to provide users with the capability to estimate changes in the concentration of air pollutants within the community in response to user-defined changes in emissions from traffic and port activities. This type of screening assessment can inform and focus additional more refined analysis, if deemed necessary. C-PORT is designed to evaluate air quality impacts of proposed expansion or modernization scenarios, as well as to explore options for mitigating any potential impacts. **Does the model's accessibility and ease-of-use provide an effective means to screen for potential changes in air quality associated with changes in port operations or freight movement? Is C-PORT effective in raising awareness of potential impacts to vulnerable populations and exploring actions that could reduce impacts?**

Question 5. C-PORT is designed to be a flexible and user-friendly modeling tool to enable rapid assessment, evaluate user-defined scenarios reflecting changes in emissions and view potential local impacts associated with such changes. **Does C-PORT fill a need for this type of local-scale screening assessment? Is the mapped output for C-PORT, including the option to map differences among scenarios, sufficient and understandable? Does the export option support additional analyses that might be needed? Are there additional output options that would make C-PORT more useful?**

III. REVIEWER RESPONSE TO CHARGE QUESTIONS:

[In the following text, the Peer Review Report is provided as written (un-edited).]

C-PORT Peer Reviewers Responses to EPA Charge Questions were prepared by Steven Hanna, David Carruthers, James Sadd, and Elena Craft. The panel responses were originally drafted on 19 January following the first day of the RTP peer review, intended for focusing the discussions on 20 January with the EPA scientists. The original written responses have been modified based on the discussions on 20 January, a conference call among Drs. Hanna, Carruthers, Isakov, Arunachalam, and Venkatram on 1 February, and two rounds of revisions and additions by the peer reviewers. On 3 February, the EPA provided us with a written summary of discussions and conclusions from the 1 February conference call, which focused on boundary layer and dispersion components of C-PORT.

The panel points out that this report is not intended to be a consensus report. It is a collection of our individual responses to the charge questions. There are no differences of opinion regarding the main report. In the appendix to the main report below, we include a few individual comments addressing specific details

EPA Charge Question 1)
The dispersion algorithms in C-PORT are similar to those in dispersion models used by regulators and research scientists, but have been constrained to reduce computational time and enable quick access to results. **Do the modified algorithms in C-PORT provide a sufficient level of accuracy for community air quality screening applications and is their evaluation adequate?**

Peer Review Panel Response 1)

The dispersion algorithms in C-PORT are sufficient for a screening model with an intended purpose of calculating differences in annual averaged concentration patterns and relative contributions of various source categories over the spatial domain within about 10 km of the port.

It should be stressed that, as currently configured, the model cannot be used to model specific hours (e.g., using meteorological data from 1 pm on 20 January 2017). It can be used to model 'representative' hours, but the purpose and limitations of these calculations are not clearly stated.

The endpoints of the calculations (e.g., annual averaged concentration differences) should be more clearly defined. The calculations of exposure and health effects should be downplayed or cut, to avoid potential misapplications of this new publicly-available on-line model system.

While adequate for screening purposes, some of the dispersion model algorithms could be improved (such as the addition of a building downwash algorithm, care in use of mixing heights in stable conditions, accounting for ship movement, and accounting for variable background and contributions from nearby major sources not treated by C-PORT).

The evaluations that are presented are sufficient for a screening model. However, since the model is mainly intended to be used to calculate annual averages, it would be good to find annual averaged concentration observations for a variety of port scenarios.

We request that the computer screen format include a summary near the top (or some other prominent place) of user defined parameters. This is needed to assure that the figures and tables can stand-alone (i.e., be legible and completely understood by readers) if copied and used in a report or presentation. Similarly, we suggest that C-PORT output images use color ramps with a standard data range when producing images that might be used for

comparisons, to avoid misinterpretation (and improve the comparison) when two or more maps are being compared side-by-side.

We note that the current practice of defining a 50 by 50 point grid (no matter what the size of the domain) and special near-road receptors can lead to splotchy patterns of concentration outputs. Perhaps a way can be devised so that concentration patterns are smoother.

EPA Charge Question 2)

C-PORT provides default emission values based on EPA's National Emissions Inventory (NEI 2011, but these will be updated to future NEI's) and spatial analysis of sources. **Given that this model is designed to evaluate the impact of *future* emissions sources, do these default inputs provide an adequate level of resolution to screen for potential community-scale impacts under a variety of alternative scenarios? If not, what additional improvements are necessary? Is there a danger of elevating concerns beyond what is reasonable if users use the default input parameters?**

Peer Review Panel Response 2)

The emissions values based on NEI are adequate for the intended purpose (investigating relative differences in annual-averaged concentrations over the domain around the port).

Additional ports in the U.S. should be added to the list of ports in C-PORT, which currently focuses only on the southeast U.S. and two ports in the Pacific Northwest. The largest and most likely ports to experience expansion in the near future are in California. It would also be very helpful to many users if suitable local port emissions sources and data could augment the nationally consistent data sources already built into the model, and even become part of the model once suitable QA/QC is performed.

Caveats should be added about the national default NEI data to point out that the focus is on calculating differences in concentrations and not absolute concentrations.

EPA Charge Question 3)

Because C-PORT is designed to be an accessible web-based tool, the description of the inputs/outputs and model's functionality is provided by online help rather than by traditional model documentation. **Does the online documentation in C-PORT provide enough information for the model users and is it easy to understand? Does the training video provide enough information on how to create alternative scenarios? What additional information might be helpful? Are there sufficient caveats and qualifiers provided to dissuade miss-use of C-PORT?**

Peer Review Panel Response 3)

The online documentation describing how to use C-PORT is very good in general. However, the descriptions of the model purpose and limitations need some work; in particular, there is a need for caveats and qualifiers to clearly point out that it is the difference in annual averaged concentrations that is the main application of C-PORT. The model cannot be used to calculate concentrations at specific locations for specific hours.

The training video is useful (but also needs caveats and qualifiers to define the limits of "alternative scenarios").

Caveats should be repeated in many places so that persons using this publicly-available, easy-to-use online model do not choose scenarios outside of its stated range of applicability.

EPA Charge Question 4)

The C-PORT screening tool is intended to provide users with the capability to estimate changes in the concentration of air pollutants within the community in response to user-defined changes in emissions from traffic and port activities. This type of screening assessment can inform and focus additional more refined analysis, if deemed necessary. C-PORT is designed to evaluate air quality impacts of proposed expansion or modernization scenarios, as well as to explore options for mitigating any potential impacts. **Does the model's accessibility and ease-of-use provide an effective means to screen for potential changes in air quality associated with changes in port operations or freight movement? Is C-PORT effective in raising awareness of potential impacts to vulnerable populations and exploring actions that could reduce impacts?**

Peer Review Panel Response 4)

Yes, and this "charge question" should be moved up to the beginning, since our earlier recommendation is that use of the model be restricted to studying the relative effects of changes in emissions.

Regarding "potential impacts to vulnerable populations", it should be pointed out that C-PORT does not currently include population data. Population and SES data from the US Census or American Community Survey could be added later if appropriate, or convenient links to EJScreen or US Census Social Explorer could be provided.

EPA Charge Question 5)

C-PORT is designed to be a flexible and user-friendly modeling tool to enable rapid assessment, evaluate user-defined scenarios reflecting changes in emissions and view potential local impacts associated with such changes. **Does C-PORT fill a need for this type of local-scale screening assessment? Is the mapped output for CPORT, including the option to map differences among scenarios, sufficient and understandable? Does the export option support additional analyses that might be needed? Are there additional output options that would make CPORT more useful?**

Peer Review Panel Response 5)

C-PORT does fulfil a need, within the limits defined earlier (e.g., within 10 km of a port, relative annual averaged concentrations). The mapped output is good. The reviewers suggested additional options for exporting outputs for use in a GIS or Google Earth. For example, there might be quantitative concentration differences output, or population distributions. The reviewers also suggested that the option to export output aggregated to census blocks be reassessed or even eliminated. It is possible that inexperienced users may misinterpret the results because aggregation by area-weighting does not take into account variations in the spatial distribution of population, and a primary goal of C-PORT results is to assess or estimate population exposures. To improve usability and relevance to many potential users, it is also suggested that a more intuitive integration be developed with EJScreen and Google Earth, such as an automatic or user-triggered option to adjust the map extent of these two applications to match that of the current C-PORT map display.

EPA should discuss how they might include C-tools such as C-Line and C-PORT in their set of operational atmospheric dispersion models on SCRAM (AERMOD etc.). C-PORT could be considered by OAQPS.

Appendix – Individual panel members' detailed comments on a few points:

Steven Hanna –

Hanna 1. *Stable mixing depth*. I recommend that formulations be avoided that yield shallow mixing depths z_i of order 1 to 10 m. Such low values will result if parameters such as u* and L are directly included on hours with wind speed approaching zero. This will result in constricting the ground-based pollutant plume to the layer from the ground to z_i. Thus concentrations will be proportional to $1/z_i$. I think it is better to not constrict the plume using z_i in stable conditions when the calculated $z_i < 100$ m. Instead, just assume no z_i and the plume will be naturally restricted by the stable σ_z formula.

Hanna 2. *Overwater dispersion*. It is well known that the boundary layer over water does not follow standard overland stability relations. The over water stability is mainly determined by the difference between the water and air temperature, and the wind speed (see OCD or CALPUFF formulations, or see Herman Wong's recent overwater AERMOD formulation). The EPA should consider accounting for these differences if the plume from a C-PORT source has a significant trajectory over water.

Hanna 3. *Ship plumes*. If the ship is moving, the resultant wind speed (actual wind and ship motion) will control the plume rise and dispersion. This may be too complicated for C-PORT but should be considered.

Hanna 4. *Background*. Most ports are surrounded by many other sources (industrial, traffic, etc) and it is unclear how these are being accounted for in C-PORT. Also, how is the farther upwind background being estimated? More discussion is needed. On the other hand, if C-PORT is being used only to assess differences in concentrations due to C-PORT sources, there is less need to account for upwind sources and background.

David Carruthers –

Carruthers 1. *User guide* -

The details of how to use the model (page 4 onwards) are fine. However, the Introduction needs to describe the purpose and limitations of the model more clearly. So, in the second paragraph of the Introduction I would suggest the following alterations (original is in italics and suggested revision is not in italics):

> *The Community modeling system for near-PORT (C-PORT) is a web-based* screening model *that estimates local air quality impacts due to port-related activities (Arunachalam et al, 2014, 2015; Isakov et al, 2016). C-PORT uses a reduced-form modeling approach appropriate for a screening-level model.* The intended purpose is for calculating differences in annual averaged concentration patterns and relative contributions of various source categories over the spatial domain within about 10 km of the port. *The source sectors modeled with C-PORT include on-road mobile, off-road including rail, shipping (both while hotelling and during transit to ports), and activities at port terminals and railyards. The input data for C-PORT are from national datasets such as the National Emissions Inventory (NEI) from the U.S. Environmental Protection Agency (EPA). Modeling results are displayed on a map for better visualization.*

Also add a box before this paragraph stating the intended purpose of the model.

The last two paragraphs of the introduction should be expanded so that the modifications to R-LINE and AERMOD and the consequences of the modifications are more fully described. For example, in the following paragraphs there is no mention of AERMOD while the use of 'optimized' may be misinterpreted. In order to

help avoid misuse of the model the simplifications that have been made (e.g. no building downwash etc.) and their implications need to be stated very clearly (all consistent with a screening model).

> *Dispersion calculations combine the calculated emissions with the meteorological conditions at the emissions sources to compute air quality concentrations for the selected location and time period. The dispersion routines are based on the analytical version of R-LINE that is described in Snyder, et al. (2013), but optimized for use in C-PORT.*
>
> *C-PORT calculates concentrations and human health risk (cancer and non-cancer) for select pollutants. Concentrations may be calculated either for one hour of meteorological conditions that you select, or for an annual average of meteorological conditions at the selected locale. To compute annual averages, C-PORT uses the METeorologically-weighted Averaging for Risk and Exposure (METARE) approach described in Chang et al. (2015), wherein dispersion is modeled for 100 explicit hours and then a weighted average is computed using those explicit 100 hourly concentrations and the frequency of occurrence of those conditions during the entire year. Cancer risk and non-cancer health effects may be estimated for toxic air pollutants using annual average concentrations.*

Carruthers 2. *Model algorithms*

These are satisfactory for a screening model as has been stated in the main review, but equally they could be improved, as also stated in the main review. I am concerned that the fixed number of line sources used to represent an area source is rigid and may lead to odd concentrations patterns especially for a large source. In the background literature it would be useful to present some examples showing the differences between AERMOD and C-PORT for point sources (as has already been done between R-LINE/AERMOD and C-PORT for line and area sources).

James Sadd and Elena Craft – No additional detailed comments

IV. ORD RESPONSE TO PEER REVIEW COMMENTS

All distinct comments from the external peer reviewers have been captured in the table below to enable a more clear response from the C-PORT authors. Please refer to the original external peer review panel report in Section III of this document for the responses in their original format.

Main report – Charge Question 1	
Peer Review Comments	**EPA Response**
The dispersion algorithms in C-PORT are sufficient for a screening model with an intended purpose of calculating differences in annual averaged concentration patterns and relative contributions of various source categories over the spatial domain within about 10 km of the port.	We agree and will clarify the on-line documentation to make this clear. We are reviewing the entire tool and will add caveats and explanations throughout.
It should be stressed that, as currently configured, the model cannot be used to model specific hours (e.g., using meteorological data from 1 pm on 20 January 2017). It can be used to model 'representative' hours, but the purpose and limitations of these calculations are not clearly stated.	We agree and will clarify the on-line documentation to make this clear. Additionally, we are renaming the "hourly" estimates to "representative short-term (1hr)".
The endpoints of the calculations (e.g., annual averaged concentration differences) should be more clearly defined.	We agree and will clarify the on-line documentation to define the endpoints of the calculations: "Representative Short-term (1hr)" and "Long-term (Annual average)", and add language explaining what these mean.
The calculations of exposure and health effects should be downplayed or cut, to avoid potential misapplications of this new publicly-available on-line model system.	We agree and we will remove cancer/non-cancer risk options from C-PORT.
While adequate for screening purposes, some of the dispersion model algorithms could be improved (such as the addition of a building downwash algorithm, care in use of mixing heights in stable conditions, accounting for ship movement, and accounting for variable background and contributions from nearby major sources not treated by C-PORT).	We agree that some of the dispersion model algorithms could be improved: 1) addition of a building downwash algorithm, 2) better representation of vertical mixing in stable conditions, and 3) accounting for ship movement in computing plume rise. Until we develop a better model for mixing heights during stable conditions, we will set a minimum z_i to avoid the low mixing heights and the resulting high concentrations produced by the current model. We will account for the effect of the motion of the ship on plume rise by computing the horizontal velocity of the plume relative to the ship. We will add a background, which would allow C-PORT to estimate total air quality as well. The background will be based on the annual average observations from the nearest AQS site, but we will also provide options to

	add custom user data for the background and add "Background" column to the list of model runs. These modifications will be incorporated in C-PORT Version 4.0 or 5.0 depending on functional requirements and available resources. We will assess the feasibility of adding the building downwash algorithm and providing the building parameters in next version of C-PORT V5.0. In the meantime, we will provide clarification that the absence of a building downwash in C-PORT algorithm will result in uncertainty in concentration estimates close to docked ships and stationary sources affected by buildings.
The evaluations that are presented are sufficient for a screening model. However, since the model is mainly intended to be used to calculate annual averages, it would be good to find annual averaged concentration observations for a variety of port scenarios.	We will explore if there are any field study data available that include annual averaged concentration observations for a variety of port scenarios to extend our model evaluation.
We request that the computer screen format include a summary near the top (or some other prominent place) of user defined parameters. This is needed to assure that the figures and tables can stand-alone (i.e., be legible and completely understood by readers) if copied and used in a report or presentation.	We plan to add a title and summary of the model scenario in the viewing window of model run results to assure that the figures and tables can stand-alone if copied and used in a report or presentation, as suggested by the reviewers.
Similarly, we suggest that C-PORT output images use color ramps with a standard data range when producing images that might be used for comparisons, to avoid misinterpretation (and improve the comparison) when two or more maps are being compared side-by-side.	We plan to explore options for the color ramps in the C-PORT output images. The improvements are planned for the next version of C-PORT 5.0.
We note that the current practice of defining a 50 by 50 point grid (no matter what the size of the domain) and special near-road receptors can lead to splotchy patterns of concentration outputs. Perhaps a way can be devised so that concentration patterns are smoother.	For annual average calculation, we have only a 50x50 uniformly spaced receptor grid to optimize model runtimes. We will explore options for improving the spatial resolution in C-PORT to avoid the splotchy patterns of concentration outputs. These improvements are planned for the next version of C-PORT 5.0.
Main report – Charge Question 2	
The emissions values based on NEI are adequate for the intended purpose (investigating relative differences in annual-averaged concentrations over the domain around the port)	Thank you

Additional ports in the U.S. should be added to the list of ports in C-PORT, which currently focuses only on the southeast U.S. and two ports in the Pacific Northwest. The largest and most likely ports to experience expansion in the near future are in California	We acknowledge that providing additional ports in C-PORT is important. We will consider adding other ports that have local emissions data available to move ahead on this recommendation. We have contacted the EPA Regional Office (Region 9) to solicit their recommendations for priority ports to be included in C-PORT. We may be constrained by available funding to add many new ports, but will prioritize those ports that are considered priorities by our Regional clients. We plan to provide the following additional ports in the new version of C-PORT 5.0: 1) Houston, 2) Chicago, 3) Memphis, 4) Oakland, CA. In the future, we will develop a more formalized process for prioritizing future additions to C-PORT involving input from key internal and external stakeholders.
It would also be very helpful to many users if suitable local port emissions sources and data could augment the nationally consistent data sources already built into the model, and even become part of the model once suitable QA/QC is performed	The ability to manipulate the inputs is a primary feature in C-PORT in order to evaluate alternative scenarios or evaluate the upper-lower range of results, for example. Users are currently able to upload their own emission datasets for ports, but not to augment the national dataset. It is beyond the scope of C-PORT to allow users to manipulate the national datasets, even if they are solely used for C-PORT. However, users are welcome to share their local port inventories with other users, which could be facilitated with the use of an online wiki or user group forum.
Caveats should be added about the national default NEI data to point out that the focus is on calculating differences in concentrations and not absolute concentrations	We agree that caveats should be added about the national default NEI data. We will add additional caveats both in the introduction and in the pop-up information on data used to initially parameterize the model and clarifying statements about the use of NEI data and its limitations
Main report – Charge Question 3	
The online documentation describing how to use C-PORT is very good in general. However, the descriptions of the model purpose and limitations need some work; in particular, there is a need for caveats and qualifiers to clearly point out that it is the difference in annual averaged concentrations that is the main application of C-PORT. The model cannot be used to calculate concentrations at specific locations for specific hours	We agree with the reviewers that the descriptions of the model purpose and limitations should be better described. In particular, we will clarify that the model should not be used to calculate concentrations at specific locations for specific hours (e.g., using meteorological data from 1 pm on 20 January 2017). Instead, we will recommend using C-PORT as a "diagnostic" tool to explore the impact of emission sources on a nearby community for a range of pre-selected meteorological conditions for shorter time periods, i.e. for a single hour which is considered to

	be representative of classic meteorological conditions that are conducive (or not) for dispersion of air pollutants. These meteorological conditions are based on hourly observations from the nearest NWS stations. We plan to add a feature in the next version of C-PORT 5.0 to indicate the locations of meteorological stations with pop-up labels to show both WMO and ICAO IDs. In addition, we plan to add an option in C-PORT 5.0 to allow the user to upload their own meteorological inputs. We will also incorporate the suggested changes to the text recommended specifically by Dr. Carruthers in the appendix. We will come up with a different name for the typical hourly estimates under specific met conditions that are currently estimated by C-PORT and add pop-up metadata that clearly describes this metric such that it is not misinterpreted.
The training video is useful (but also needs caveats and qualifiers to define the limits of "alternative scenarios"). Caveats should be repeated in many places so that persons using this publicly-available, easy-to-use online model do not choose scenarios outside of its stated range of applicability.	We will carefully review the entire C-PORT application, including the training video, and identify places where additional information on the limitations of the use of this tool for future scenario analyses would be appropriate
Main report – Charge Question 4	
Yes, and this "charge question" should be moved up to the beginning, since our earlier recommendation is that use of the model be restricted to studying the relative effects of changes in emissions.	We agree.
Regarding "potential impacts to vulnerable populations", it should be pointed out that C-PORT does not currently include population data. Population and SES data from the US Census or American Community Survey could be added later if appropriate, or convenient links to EJScreen or US Census Social Explorer could be provided.	We will explore linkages to, and integration with other tools that include population data and will expand these linkages as funding allows. In the next version of C-PORT V5.0, we plan to overlay population demographics as pop-up on Census block group in the "inspect" mode
Main report – Charge Question 5	
C-PORT does fulfil a need, within the limits defined earlier (e.g., within 10 km of a port, relative annual averaged concentrations).	We agree.
The mapped output is good. The reviewers suggested additional options for exporting outputs for use in a GIS or Google Earth. For example, there might be quantitative concentration differences output, or population distributions.	We acknowledge that exporting outputs for use in a GIS or Google Earth would be a good option. We plan to investigate export options that would allow users the most flexibility for subsequent analysis using other software, such as Arc GIS or Google

	Earth and include them in Version 4.0 or 5.0 depending on functional requirements and available resources. We agree that the ability to use the data outside of C-PORT is a necessary feature, as users may have other data to incorporate or overlay. Since not all users may be familiar with model outputs and results (such as in tabular format), we are approaching this diligently so as to provide outputs that are usable with minimal risk of misinterpretation.
The reviewers also suggested that the option to export output aggregated to census blocks be reassessed or even eliminated. It is possible that inexperienced users may misinterpret the results because aggregation by area-weighting does not take into account variations in the spatial distribution of population, and a primary goal of C-PORT results is to assess or estimate population exposures.	We are reconsidering the export of the aggregated output to census blocks and hope to replace that function with a map that better represents the spatial variation in dispersion that is critical to understanding the potential impacts to vulnerable populations. Ideally, we will be able to develop a more representative export option that could be incorporated into a number of other tools that can facilitate the visualization and quantification of potential impacts.
To improve usability and relevance to many potential users, it is also suggested that a more intuitive integration be developed with EJScreen and Google Earth, such as an automatic or user-triggered option to adjust the map extent of these two applications to match that of the current C-PORT map display.	As we mention in our response to the peer review response to question 4, we are actively exploring a more functional integration with EJScreen.
EPA should discuss how they might include C-tools such as C-Line and C-PORT in their set of operational atmospheric dispersion models on SCRAM (AERMOD etc.). C-PORT could be considered by OAQPS.	We we will look into this suggestion and we would welcome collaboration with OAR if there is interest in adding C-PORT to SCRAM.
Appendix: Individual Comments – Steven Hanna	
Hanna 1. *Stable mixing depth*. I recommend that formulations be avoided that yield shallow mixing depths z_i of order 1 to 10 m. Such low values will result if parameters such as u* and L are directly included on hours with wind speed approaching zero. This will result in constricting the ground-based pollutant plume to the layer from the ground to z_i. Thus concentrations will be proportional to $1/z_i$. I think it is better to not constrict the plume using z_i in stable conditions when the calculated $z_i < 100$ m. Instead, just assume no z_i and the plume will be naturally restricted by the stable σ_z formula.	We agree and will explore ways to improve the dispersion under stable conditions. Until we develop a better model for mixing heights during stable conditions, we will set a minimum z_i to avoid the low mixing heights and the resulting high concentrations produced by the current model. These modifications will be incorporated in C-PORT V4.0.

Hanna 2. *Overwater dispersion*. It is well known that the boundary layer over water does not follow standard overland stability relations. The over water stability is mainly determined by the difference between the water and air temperature, and the wind speed (see OCD or CALPUFF formulations, or see Herman Wong's recent overwater AERMOD formulation). The EPA should consider accounting for these differences if the plume from a C-PORT source has a significant trajectory over water.	We agree and will explore options for improving the overwater dispersion algorithms for situations when the plume has a significant trajectory over water. We will consider the modifications in next version of the modeling system, C-PORT V5.0.
Hanna 3. *Ship plumes*. If the ship is moving, the resultant wind speed (actual wind and ship motion) will control the plume rise and dispersion. This may be too complicated for C-PORT but should be considered.	We will account for the effect of the motion of the ship on plume rise by computing the horizontal velocity of the plume relative to the ship. These modifications will be incorporated in C-PORT V4.0
Hanna 4. *Background*. Most ports are surrounded by many other sources (industrial, traffic, etc) and it is unclear how these are being accounted for in C-PORT. Also, how is the farther upwind background being estimated? More discussion is needed. On the other hand, if C-PORT is being used only to assess differences in concentrations due to C-PORT sources, there is less need to account for upwind sources and background.	We plan to add regional background estimates in C-PORT Version 4.0 or 5.0 (depending on functional requirements and available resources), which would allow C-PORT to estimate total air quality as well. The background will be based on the annual average observations from the nearest AQS site, but we will also provide options to add custom user data for the background and add "Background" column to the list of model runs.
Appendix: Individual Comments – David Carruthers	
User guide - The details of how to use the model (page 4 onwards) are fine. However, the Introduction needs to describe the purpose and limitations of the model more clearly. So, in the second paragraph of the Introduction I would suggest the following alterations (original is in italics and suggested revision is not in italics): *The Community modeling system for near-PORT (C-PORT) is a web-based* screening model *that estimates local air quality impacts due to port-related activities (Arunachalam et al, 2014, 2015; Isakov et al, 2016). C-PORT uses a reduced-form modeling approach appropriate for a screening-level model.* The intended purpose is for calculating differences in annual averaged concentration patterns and relative contributions of various source categories over the spatial domain within about 10 km of the port. *The source sectors modeled with C-PORT include on-road mobile, off-road including rail, shipping (both while hotelling and during transit to ports), and activities at port terminals and*	We agree and will revise the language to clarify these issues.

railyards. The input data for C-PORT are from national datasets such as the National Emissions Inventory (NEI) from the U.S. Environmental Protection Agency (EPA). Modeling results are displayed on a map for better visualization	
User guide - Also add a box before this paragraph stating the intended purpose of the model	We agree and will revise the language to clarify these issues.
User guide - The last two paragraphs of the introduction should be expanded so that the modifications to R-LINE and AERMOD and the consequences of the modifications are more fully described. For example, in the following paragraphs there is no mention of AERMOD while the use of 'optimized' may be misinterpreted. In order to help avoid misuse of the model the simplifications that have been made (e.g. no building downwash etc.) and their implications need to be stated very clearly (all consistent with a screening model). *Dispersion calculations combine the calculated emissions with the meteorological conditions at the emissions sources to compute air quality concentrations for the selected location and time period. The dispersion routines are based on the analytical version of R-LINE that is described in Snyder, et al. (2013), but optimized for use in C-PORT.* *C-PORT calculates concentrations and human health risk (cancer and non-cancer) for select pollutants. Concentrations may be calculated either for one hour of meteorological conditions that you select, or for an annual average of meteorological conditions at the selected locale. To compute annual averages, C-PORT uses the METeorologically-weighted Averaging for Risk and Exposure (METARE) approach described in Chang et al. (2015), wherein dispersion is modeled for 100 explicit hours and then a weighted average is computed using those explicit 100 hourly concentrations and the frequency of occurrence of those conditions during the entire year. Cancer risk and non-cancer health effects may be estimated for toxic air pollutants using annual average concentrations.*	We agree and will revise the language to clarify these issues.
Model algorithms - These are satisfactory for a screening model as has been stated in the main review, but equally they could be improved, as also stated in the main review. I am concerned that the fixed number of line sources used to represent an area	We ran sensitivity tests to compare C-PORT with AERMOD. The results are comparable, but there are some differences close to the source boundary. Since the emissions representing activities in the port terminal (modeled as area source) are uncertain, the

source is rigid and may lead to odd concentrations patterns especially for a large source. In the background literature it would be useful to present some examples showing the differences between AERMOD and C-PORT for point sources (as has already been done between R-LINE/AERMOD and C-PORT for line and area sources)	algorithm provides adequate estimates. However, if errors are noticeable in future applications of the model, we propose to incorporate Richardson extrapolation to "infinite number of line sources" using three values of the integral corresponding to different number of line sources. This approach would limit the error rather than the number of line sources used in the extrapolation; however, controlling the error to a small value results in a large computational burden close to an area source.
Appendix: Individual Comments – James Sadd	
No additional detailed comments	No response required
Appendix: Individual Comments – Elena Craft	
No additional detailed comments	No response required