U.S. Environmental Protection Agency
Science Advisory Board
Reduced-Form Tools Review Panel

Summary Minutes for the Public Meeting held on
05/28/2020 to 05/29/2020

Meeting Participants:

SAB Reduced-Form Tools Review Panel Members*

Dr. Jay Turner, Chair	Dr. Richard Belzer
Dr. James Boylan	Dr. Louis Anthony (Tony) Cox, Jr.
Dr. Allison Cullen	Dr. Sabine Lange
Dr. Anne Smith	Dr. Richard Smith

*For the full SAB membership see Roster[i]

Designated Federal Officer (DFO)
Dr. Suhair (Sue) Shallal, Designated Federal Officer (DFO) for the SAB Reduced-Form Tools Review Panel

Other Attendees
See Attachment A.

Meeting Summary:

THURSDAY MAY 28, 2020

Meeting convened
The Science Advisory Board (SAB) Reduced-Form Tools (RFT) Review Panel convened for a public video/teleconference on 05/28/2020 to 05/29/2020.

Dr. Shallal, DFO for the Panel, convened the meeting at approximately 12:00 noon (eastern daylight time) under the Federal Advisory Committee Act (FACA). Dr. Shallal opened the meeting indicating that this is the first day of a 2-day meeting. She explained that the panelists will be meeting virtually using the ZOOM videoconferencing platform. Dr. Shallal then indicated no public commenters registered and she provided contact information for anyone requesting to make a public comment during the meeting or wishing to provide written comments at a later time. Dr. Shallal provided notification of the posting of meeting materials to the meeting website. She described the membership of the panel stating that panelists are special government employees (SGE) and they are subject to ethics laws. She then explained that ethics information for all panelists had been reviewed and that it was determined that all panel members have no conflict of interest or appearance of a lack of impartiality concerns.

Dr. Shallal reminded those listening to the ZOOM conference call that they can view the deliberations on a livestream video by following the link provided on the meeting webpage. She

indicated the meeting would proceed as published in the meeting agenda on the SAB website with the exception that there were no public commenters to present.

Mr. Thomas Brennan, Director of the Science Advisory Board Staff office provided welcoming remarks and thanked the panelists for their service.

Dr. Jay Turner, Chair, noted the review and advisory activity was worthy of the panel and thanked panelists for their activity. Dr. Turner invited the panelists to introduce themselves providing a short statement of background. All panelists did so (see published biosketches on website).

Dr. Turner reviewed the agenda[ii] indicating two, 5-hour, periods for deliberations. He indicated that EPA would speak first, providing an overview presentation by Dr. Erika Sasser and Dr. Kirk Baker. The presentation would be followed by a period of questions and answers with interaction between the panel members and the EPA presenters.

Dr. Turner then walked through the charge questions [iii]given to the panel to consider during their review. He also restated that there were no public comments for today. He indicated his aspirational goal for the first day was to deliberate upon the first three charge questions. He stated the panel would break for the day and reconvene tomorrow to address remaining charge questions and go over a summary of points to include in the report the panel is preparing.

Dr. Turner discussed the panel's report creation process. He indicated the panel would deliberate publicly then writing teams would draft responses to specific charge questions. Next, the DFO and Chair would synthesize these sections into a draft report then provide the report publicly for the panel to review and deliberate upon during a subsequent public discussion. Based upon that discussion, the report would then be revised and sent to the chartered SAB to be finalized and transmitted to the EPA.

Dr. Turner asked the panelists if they had any questions. None were heard. Dr. Turner then addressed how he planned to conduct the meeting using the Zoom videoconferencing platform and his preferences for managing the discussion.

Dr. Turner then invited Dr Erika Sasser, Director of OAQPS HEED to provide introductory comments.

Dr. Sasser started at 12:22 PM EDT by thanking the panel. She presented from slides[iv] posted to the meeting website. She indicated the purpose of the panel review is to critically compare different aspects of reduced form modeling tools for calculating air quality and health benefits relative to the full form versions of the air quality and health benefits models the EPA conventionally uses.

Dr. Sasser turned the discussion over to Dr. Kirk Baker who provided more details, as indicated in the slide presentation posted to the meeting website as a meeting material, regarding the project and summary of key findings.

Questions from the Panel for EPA
Several panelists had clarifying questions to ask of the EPA staff presenters.

The panel asked about the choice of industry emission scenarios used in the EPA's report. EPA indicated that the scenarios were selected to provide diversity in geography and emissions, that were available recently and made sense for the comparison in the EPA's report. EPA indicated that several of the runs were available from the Tier 3 (mobile source) rulemaking and Clean Power Plan rulemakings where full-form models were applied to conduct analysis. These scenarios were then modified with the hypothetical emission reduction scenarios for this study and CMAQ and CAMx were rerun to complete a full suite of scenarios for evaluating the reduced-form tools. The exception was the Tier 3 CAMx run which was old enough that it was not rerun due to resource and logistical implications.

The panel then sought clarification regarding the presentation of results by model, scenario and geographic aggregation level. The panel also asked about the presentation of error and bias in the EPA's report and the representation of uncertainty (pointing to page 2-16 of the EPA's report as an example). EPA responded that choices were difficult to make regarding the inclusion of different levels of aggregation and error because of structural differences in the models and their outputs; the goal was to achieve as fair and similar comparison between the various models and scenarios as possible.

The panel asked about chemically speciated data used in the evaluation and especially the treatment of primary particulate matter (PM). EPA responded that they believed going into the analysis that the crustal component would be the simplest to interpret, however that did not turn out to be the case because of different treatments amongst the models.

The panel asked a question regarding the authorship of the report. EPA responded that they engaged a contractor and there was considerable interaction between EPA and the contractor in preparing and finalizing the draft report. EPA indicated that the panel should consider the report an EPA report for its review purposes.

Public comments
There were no public comments.

SAB RFT Panel Discussion and Deliberation

At 1:52 PM EDT the panel began discussion of charge questions.

Question 1:
Please comment on the evaluation approach developed by EPA to compare reduced-form models to full-form equivalents. Please comment on whether the emissions reduction scenarios used in the proposed evaluation approach provide enough diversity to adequately assess reduced-form performance over a range of possible applications (e.g., magnitude, type, and spatial variations of emissions reductions). Please discuss whether the specific assumptions that EPA made to apply each tool as consistently as possible (e.g., emissions, meteorology, use of direct vs.

BenMAP estimates, etc.) are appropriate and clearly explained. Please assess whether the report's description of its limitations is complete.

Scenario representativeness

The panel began its discussion noting that the evaluation approach is clearly organized and has a basis in other model comparison analyses that are done often and are a general practice in the community. The important point for comparison was to have clarity on "what is being compared to what." The report was intending to compare models and the EPA selected an assortment of scenarios to reflect a variety of regulations, emission sectors and across a reasonable range to provide some qualitative comparisons of models.

The panel discussed the representativeness of the scenarios and concluded that it still had questions about the choices. The panel discussed an alternative approach that relies on constructing scenarios intentionally to provide a more controlled experimental design. The approach would utilize scenarios that, perhaps, would be at best semi-realistic emission scenarios but would provide a more complete matrix of emissions variability for comparison of model performance.

The panel discussed the Full Form Model (FFM) that was used for comparison purposes (i.e., CMAQ and CAMx). The discussion evaluated what, if any, impact this may have on the results of the evaluation, and whether it implies a bias or judgement about what is "true". The discussion explored alternatives such as comparison against each other (model to model) for a given type and amount of pollution change and that limitations of using a base FFM for comparison should be recognized up front.

Test of air quality features

The panel discussed the underlying assumptions embodied in the overall comparison framework and the EPA's choice to focus on chronic mortality. The panel discussed the consequences of the choices for holding the benefits analysis model and concentration response functions, as well as the value of a statistical life (VSL), constant. The choices made in the model inputs can limit the ability, or result in a loss of the ability, to evaluate sensitivities to variations in the Concentration-Response (C-R) relationships, resulting in a fundamental limitation of the approach and the evaluation. The panel also indicated that to vary the VSL and C-R functions would result in evaluating a different science question, perhaps desirable in itself but different than what is operationally an attempt to evaluate the RFT for producing different air quality surfaces.

Presentation of Results in EPA's Report

The panel discussed the presentation of results in the EPA report and noted that, for example in table 3.1, the comparison of benefits as presented may not be appropriate given the purpose of the analysis. The results should be focused on presenting model differences and not focus on scenario differences nor offer opinions on the scenarios themselves in a policy context. It was also noted that there were no results for the CAMx Tier 3 emission scenario which introduces some fundamental limitations in understanding the conclusions of the EPA's evaluation.

Question 2:
Please comment on the results of the reduced form tool evaluation in Section 3, considering both the quantitative and qualitative aspects of the model intercomparison. Was the information clearly presented and informative? Were EPA's conclusions reasonable? Are there other results which would be useful to include in the comparison?

Evaluating Results
The panel discussed attempts to reproduce results and made comments on the presentation of results in the EPA's report. Evaluation of national level results may not be sufficient, and the tools should be evaluated at a more granular level, perhaps by species and by geographic region.

Missing information in the report
The panel noted that more information about the time and effort needed to prepare RFT model inputs is needed. It would be helpful to have something to compare that level of effort when evaluating RFTs against FFMs.

The panel expressed concern that some important information was missing regarding experimental design considerations such as scenario choices, modeling choices, inclusion of multivariate sensitivity analysis, and consideration of extreme cases. They added that reporting of distribution, error, predictive analytical methods, and statistical comparative methods should be applied and included.

Regional Results
The panel discussed the need for a finer level of result presentation and were particularly interested in regional results. The panel asked EPA about the availability of regional results. The EPA explained the obstacles in producing comparable regional results across the models. The discussion led to insight regarding the source apportionment methods underlying benefits per ton (BPT) calculations. The EPA clarified that benefits and sources responsible for those benefits are not necessarily in the same geographical subset and the panel concurred that this poses challenges to comparing results at the regional level. As a result, the comparison between the models at the regional level as opposed to the national level may be unfair and/or invalid.

Evaluation of Primary PM
The panel discussed the primary PM results and the elemental and organic components and the implications for the analysis. Several questions were raised about the various treatments of elemental, crustal, and primary emitted PM; along with nitrate, sulfate, and other constituents of $PM_{2.5}$.

Question 3:
Exhibit ES-4 "Ratio of National Avoided Premature Mortality Benefits Estimates," shows how different reduced-form tools generated different estimates as compared to full-scale air quality models.

> *3a. Does the report provide a clear and thorough explanation for why some tools under- or over-estimated $PM_{2.5}$ health benefits as compared to the full-scale air quality modeling? Please add any additional explanations for the pattern of results observed.*

Documenting "how" different but seeking "why" different
The EPA's report documents the comparison results ("how" different) but with little explanation or analysis to probe the underlying reasons ("why" different). The panel agreed that separating the "how" from the "why" for purposes of the report was an appropriate approach but indicated a desire for more on what differs *and* why should be included in the report.

Full Form Model Use Information
The full form models are typically used in a regulatory framework in a relative sense, not directly using the results as predicted by the model. This use was not discussed in the report and the panel was unclear if the RFT were evaluated for performance in the relative sense and how that comparison would look if conducted.

May 28th, 2020, day one, concluded at 5:01 PM EDT. The DFO, Dr. Sue Shallal recessed the meeting.

FRIDAY MAY 29, 2020

Day two was convened at 12:05 EDT on May 29th, 2020 by the DFO, Dr. Sue Shallal. Dr. Shallal noted that this was the second day of the panel's meeting and provided background information, meeting access information, and said no public speakers had registered. She reiterated that ethics requirements were reviewed, and no appearances or actual conflicts were identified for any panel members.

Dr. Turner, panel chair, welcomed everyone back and provided the approach for the day. He then indicated that the panel would first hear from EPA responding to two questions from the previous day and then proceed with the discussion of the charge questions.

EPA provided answers to the questions regarding the outputs of various tools. For example, which models provide air quality surfaces? EPA also answered the questions regarding the relative reduction factor approach used for regulatory analysis and the relevance to the exercise under evaluation in this panel. EPA indicated for the RFT model looked at changes in predicted air quality.

SAB RFT Panel Discussion and Deliberation- continued

> *3b. How do the results of this study inform our understanding of the suitability of these tools for regulatory economic analyses in their current form?*

No one RFT is clearly "the best"
The panel agreed that, based on the information presented in the report, no RFT clearly is an acceptable alternative to FFM and that one should be very cautious before substituting for FFM. The panel discussed where in an analysis process RFTs could be helpful or informative, perhaps early in the process for screening scenarios for later FFM analysis.

Application to Economic Analyses
The panel discussed their difficulty in reproducing results presented in the EPA's report. The panel noted that the modeling systems represented multiple models coupled together, including, emission models, meteorological models, air quality models, health benefit models, and cost calculation models. Given this complexity, the panel observed that it is difficult to identify where differences may originate or manifest when predictions are made using generalized data. In general, more granular site-specific information produces more reliable predictions.

> *3c. Can any of the reduced-form tools explored in this report easily be modified to allow quantifying the extent to which the total health benefits accrue to specific geographic areas (e.g., by state, or where ambient concentrations are above or below the NAAQS)?*

Fine level spatial scale desirable
The panel noted the absence of regional level results and the desirability of obtaining this level of detail for the evaluation. The panel reemphasized higher spatial resolution was desirable. The EPA's report does not present information to directly evaluate model performance in geographic areas above or below NAAQS.

Question 4:
Since 2008 EPA has used SA-BPT to estimate the health impacts of numerous regulations. Under the scenarios examined in this report, EPA's SA-BPT approach over-estimated $PM_{2.5}$-related health benefits by between 10 and 30 percent, depending on the sector. To ensure BPT estimates correspond to full-form results as closely as possible, the report recommends updating the underlying emissions inventories and air quality modeling used to inform the EPA SA-BPT approach over time.

> *4a. In the interim, how might EPA improve its characterization of results derived from the 2005 SA-BPT approach, specifically the potential degree of over- or underestimation in BPT-based results for a particular regulatory scenario?*

Include more scenarios
The panel revisited the discussion of the desirability to include more scenarios in the analysis and comparison.

Systematic Bias
The panel appreciated the difficulty in assessing the source of differences given the high level of aggregation for the model output evaluation. The panel also discussed systematic bias - how to identify if it is present, and how to address it.

> *4b. What criteria (e.g., geographical scale, regulated sector, pollutants/precursors) should EPA examine to determine the potential for divergence between SA-BPT results vs full-form air quality modeling results (resulting in over- or under-estimation)?*

The panel discussed, along with Question 4a's response, answers to this question that included discussions of the following: constrained evaluation; performance assessment by source category; geographic scales; and emission precursors and disaggregated results by species.

4c. Based on the results of this study, does the panel have any additional recommendations about BPT-based approaches?

Other Details Discussed
The panel noted that benefits per ton (BPT) seems to have been a key metric in the study. The panel questioned if it was an appropriate metric and said it was not well defined. The panel concluded that EPA's draft report should be augmented by adding discussion of uncertainties and limitations.

Question 5:
How do the results of this study inform the future development of reduced-form tools that are capable of providing reliable estimates of impacts associated with different sectors, across a variety of spatial scales, and for different portions of the air quality distribution? Are there other, less resource intensive approaches than full-scale air quality modeling for informing the public about the size and distribution of PM health benefits associated with alternative regulatory scenarios?

Additional Scenarios
The panel discussed a need for clarification on scenario selection. The panel indicated that typically, in an EPA context, "sector" means different types of industry (electricity, farming, marine emissions). EPA used five scenarios and five sectors to conduct the analysis, but it was not readily apparent if results may apply across other sectors. The panel observed that RFT seems to perform better in some sector-specific scenarios. The panel concluded that additional scenarios should be carefully selected to test the models' performance and the generalizability of the approach.

Guidelines for how to use multiple models
The panel discussed integrating multiple models into the analysis and combining results for drawing conclusions. A few methods were discussed such as model results used to set the boundaries for an assessment, using a mean or average, or ensembles of results. The discussion reemphasized the value of looking at multiple versions of a scenario, perhaps with different levels of emissions. There was reference to the extensive literature in the atmospheric sciences on combining models and model outputs for assessment which the panel noted may be helpful.

Use of RFT and 'Readiness'
The panel discussed the importance of information quality criterion in applying or evaluating the approach and results. EPA should be cautious in suggesting a single approach is preferred over all others and the panel recommended EPA develop performance standards rather than favor the best-performing model in the absence of such standards.

Additional discussion for Clarifications with EPA and the Panel
The panel engaged with EPA on several clarifying questions. EPA indicated that ABACUS is an integrated assessment framework linking multiple decision tools together such as an air quality component and cost model; however, it is not an apple-to-apple comparison to the models in the EPA report under review. It is not a reduced form tool for comparison even though it has an air quality option embedded within it.

Lead author summaries
The panel's lead authors then summarized key points (as presented above) for each charge question.

The panel chair asked the full panel at the conclusion of the summaries if anything was missed. Nothing was suggested.

Dr. Shallal then provided a slide summarizing next steps regarding the report writing process. Dr. Shallal reiterated the need for discussions to remain limited to subgroup members only. She also reminded members to include her on correspondence where discussion of responses to the charge questions was taking place.

Meeting adjourned
The DFO, Dr. Sue Shallal, adjourned the meeting at approximately 4:30 PM EDT May 29, 2020.

Respectfully Submitted and Certified as Accurate,

/s /	/ s/
Suhair Shallal, Ph.D. DFO	Jay Turner, Ph.D. Reduced Form Tools Review Panel Chair

NOTE AND DISCLAIMER: The minutes of this public meeting reflect diverse ideas and suggestions offered by committee members during the course of deliberations within the meeting. Such ideas, suggestions, and deliberations do not necessarily reflect definitive consensus advice from the panel members. The reader is cautioned to not rely on the minutes to represent final, approved, consensus advice and recommendations offered to the EPA. Such advice and recommendations may be found in the final advisories, commentaries, letters, or reports prepared and transmitted to the EPA Administrator following the public meetings.

Attachment A: Additional meeting participants in attendance or who requested the teleconference call-in number.

	NAME	AFFILIATION
1.	Sue Shallal	EPA/SAB
2.	Tom Brennan	EPA/SAB
3.	Aaron Yeow	EPA/SAB
4.	Bryan Bloomer	EPA/SAB
5.	Shaunta Hill-Hammond	EPA/SAB
6.	Edlynzia Barnes	EPA
7.	Tyler Fox	EPA
8.	Jill Inahara	Oregon DEQ
9.	Stuart Parker	IWP News
10.	Nathalie Simon	EPA
11.	Carolyn Kilgore	EPA/SAB
12.	Lisa Thompson	EPA
13.	Stefani Penn	Industrial Economics, Inc.
14.	Robert J. Wayland,	EPA
15.	Henry Roman	Industrial Economics, Inc.
16.	Peter J Adams	Carnegie Mellon University
17.	Bujin Bekbulat	University of Washington
18.	Lindsey Jones	EPA
19.	Pat Dolwick	EPA
20.	Darryl Weatherhead	EPA
21.	Christopher Tessum	University of Illinois
22.	Garima Raheja	University of Washington

23.	Christine Davis	EPA
24.	David A Evans	EPA
25.	Carolyn Kilgore	EPA
26.	Sainath Babu	TCEQ
27.	YUZHOU WANG	University of Washington
28.	Maninder Thind	University of Washington
29.	Jiawen Liu	University of Washington
30.	Margaret Zawacki	EPA
31.	Sumil Thakrar,	UMN
32.	Julian Marshall	University of Washington
33.	Michael Honeycutt	TCEQ,
34.	Amy Lamson	EPA
35.	Serena Chung	EPA
36.	Elizabeth Chan	EPA
37.	Neal Fann	EPA
38.	Kirk Baker	EPA
39.	Erika Sasser	EPA
40.	Fang Guo	University of Washington
41.	Cindy Roberts	EPA

Materials Cited:

The following meeting materials are available on the SAB website (http://www.epa.gov/sab) at the page for the May 28 and 29, 2020 meeting.
https://yosemite.epa.gov/sab/sabproduct.nsf/MeetingCal/E16B3B52FEC72CD485258550004BF7A8?OpenDocument

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[i] Roster
[ii] Agenda
[iii] Charge Questions
[iv] EPA powerpoint slides- An overview of EPA's draft report titled, "Evaluating Reduced-Form Tools for Estimating Air Quality Benefits