CASANZ
Clean Air Society Of Australia and New Zealand

U.S. Environmental Protection Agency
Mail Code: 28221T
Attention Docket ID No. EPA-HQ-QAR-2015-0310 : A-and-R-Docket@epa.gov
1200 Pennsylvania Avenue, NW.
Washington, DC 20460

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Re: Comments on US EPA's July 29, 2015 Proposed Rules: Revision to the Guideline on Air Quality Models: Enhancements to the AERMOD Dispersion Modeling System and Incorporation of Approaches to Address Ozone and Fine Particulate Matter [80 FR 45339].

To Whom It May Concern

The Clean Air Society of Australia and New Zealand, through its Modelling Special Interest Group (CASANZ ModSIG) thanks the US EPA for the opportunity to comment on the above-referenced proposed rule regarding updates and enhancements to the AERMOD modeling system and methodologies to address secondary formation of ozone and $PM_{2.5}$.

CASANZ ModSIG is the primary grouping within Australia and New Zealand representing the professional interests of air quality modelers in the consulting, government and industry sectors. Following a recent biennial workshop of ModSIG, we the undersigned represent concerns from the group regarding several elements of the proposed rules. We have submitted this letter to address some of these issues in detail.

Our primary concern is the removal of the CALPUFF model from Appendix W as an official guideline model. This letter addresses several issues that relate to the importance of CALPUFF in the wider International community. The following topics are discussed.

- Why CALPUFF is a designated guideline model outside of the US.
- The importance of CALPUFF as a near-field model for complex flows.
- Two studies are signaled for discussion:
  - The ETEX tracer study
  - MMIF vs CALMET.
- New AERMOD algorithms and enhancements/changes.

Internationally CALPUFF is an important guideline model used primarily for both the near- and far-field where the non-steady state assumption of AERMOD is not applicable. In most parts of Australia and New Zealand, CALPUFF is a commonly used (and in some cases the most commonly used) dispersion model for regulatory applications. The overwhelming majority of such applications of CALPUFF is for short-range dispersion issues.

1. CALPUFF AS A GUIDELINE MODEL OUTSIDE THE US

CALPUFF was designated a US EPA Appendix A Guideline model in 2003[1]. The wording of this original document is that CALPUFF was to be allowed to be used for all regulatory applications involving long range transport (> 50 km) and on a case-by-case basis in situations involving the near-field complex flow situations or non-steady-state situations (coastal, stagnation, fumigation, complex terrain).

As well as being a guideline model in the US, CALPUFF is used in more than 100 different countries[2]. CALPUFF has been accepted for use in both near-field and far-field applications by many International Environmental agencies around the world, including not only parts of Australia and New Zealand but also Canada and countries in Africa, Europe, Iceland, South America and the Middle East. There are several reasons why CALPUFF has been designated as a guideline model for countries outside the US which include:

- the extensive, multi-year model assessment and evaluation process that CALPUFF underwent
- the numerous evaluations of model performance relative to observations
- the specific requirements on the CALPUFF model documentation, model access and model codes
- the open public review process at public hearings in Washington, DC
- the formal peer review committees created by the U.S. EPA, and professional organizations such as the AWMA and private industry groups such as API and EPRI

CALPUFF, like the ISC model before it has undergone rigorous testing, model evaluations and multiple peer reviews. The testing continued for more than a decade before it was promulgated to US EPA guideline status. This lengthy, dedicated, state-of-science and transparent process occurred under the scrutiny of the AQMG within the US EPA. The amount of resources invested by the US EPA AQMG to persist with a model to guideline status is large. It is an effort beyond the means of modeling communities in most, if not all, other countries.

From our perspective, it is therefore difficult to understand that after the length of time and effort spent to get CALPUFF to this stage, it appears to be so readily discarded. It is further difficult to appreciate why the EPA has not chosen to name a replacement model, nor has the EPA awarded CALPUFF the customary phase out period. The reasons provided by the EPA for CALPUFF's removal as a guideline model appear to be due to perceived management issues with the model code rather than any genuine technical reasons.

In the July 29, 2015, Proposed Rules of the Federal Register, Volume 80. No 145, the US EPA[3] provides wording to support the removal of CALPUFF as an EPA-preferred model. On page 9 of this document the US EPA cites the reasons for this as "concerns about the management and maintenance of the model code given the frequent change in ownership of the model code since promulgation". This has not been our experience.

Since the early 2000's, the principal CALPUFF model developer (Joe Scire) has given more than 15 three-day Introductory, and four-day Advanced Training courses around Australia and New Zealand[4], plus attended ModSIG Workshops on CALPUFF model development in Brisbane, Auckland, Sydney and Perth[5]. A key component of each of the training courses was the provision of the latest Version of CALMET, CALPUFF and CALPOST.

Although the majority of model updates addressed model bug fixes, they also included the latest technical enhancements and model developments. Further, the Beta versions of the models and their related source codes have always been readily available, at no cost, on the CALPUFF website (http://www.src.com/calpuff). Model users in Australia and New Zealand have always been encouraged by the model developers to use the latest versions of the model that were also the most technically advanced. Any bugs that were discovered were isolated and fixed with detailed updates to in-code documentation and version and level number

journaling. Model Change Bulletins were updated. By using the latest versions of the model all known bug errors were addressed and modelers got to use the well documented enhancements that were published at the 9th and 10th Conferences on Air Quality[6, 7].

The change in CALPUFF's ownership does not seem to have affected the distribution or access to the model or to training in Australia and New Zealand, despite two changes in the ownership organization. The Atmospheric Studies Group who maintained and managed the model has not changed in the last 15 years or more. And, in our opinion, CALPUFF satisfied all the requirements listed in Section 3.1.b of the Guideline for EPA-preferred models.

It is our understanding that many countries in the world, including Australia and New Zealand, have been using the Version 6.4 of the model without experiencing difficulty or concerns about the management and maintenance of the CALPUFF model.

2. CALPUFF AS A NEAR-FIELD MODEL

The CALPUFF model was designed for near-field modelling applications and is suitable for fence line impacts as well as for long range transport[2]. CALPUFF, like AERMOD, includes the same essential near-field algorithms such as stack tip downwash, building downwash, turbulence-based dispersion coefficients, plume rise as well as sub-grid scale effects for coastline and complex terrain and the ability to model visible plumes.

In Australia and New Zealand, two key questions are addressed by model users when choosing which model to use for their application. The two choices are either a simple steady-state Gaussian plume model such as AERMOD, or a more advanced Lagrangian Puff model such as CALPUFF. The questions are[9];

- Is the steady-state assumption in the plume model valid for the application?
- Do the technical parameterizations in the plume model adequately treat the situation to be modeled?

We have more flexibility in our rules that allow us to tailor the modeling to fit the problem at hand. In a complex environmental situation the choice is to use the model with the best physics to suit the problem, hence CALPUFF is actively promoted for the following situations;

- Complex terrain and non-steady state conditions.
- Coastal effects.
- High frequency of stable calm conditions.
- Odor applications.

These situations include flow channeling, inversion break up fumigation, shoreline fumigation and stagnation. The benefits of using the 'best model to suit the problem' has permitted industry and consultants to employ state-of-science practice and has ultimately lifted the performance of modeling in Australia and New Zealand. The New South Wales state guideline document on 'Optimum CALPUFF Model Settings'[10], especially with respect to CALMET, has provided the necessary support to modelers to choose the best switch settings.

The use of CALPUFF in 'complex winds' became established in Australia and New Zealand based on the ruling in Section 7.2.8 of the EPA Guideline on Air Quality Models as published as Appendix W to 40 CFR Part 51. In this ruling the US EPA guideline permits the use of CALPUFF for near-field regulatory applications involving 'complex winds'. The Guideline states, 'the purpose of choosing a modelling system like CALPUFF is to fully treat the space and time variations of meteorology effects on transport and dispersion'. In the new proposed rules of July 29, 2015, we noticed that the wording pertaining to CALPUFF in the complex wind sections of Appendix W has now been removed.

The Australian and New Zealand modelling community is comfortable with the choice to use the model best suited to the problem and stakeholders are aware of the situations when the choice of the steady-state approach of AERMOD is not suitable. These include [9, 11, 12]

- Complex terrain, where the straight-line trajectory assumption of AERMOD is unable to handle the curved flow associated with terrain channeling.
- Coastal effects. AERMOD is unable to consider large changes in meteorological conditions that can occur over short distances across a coastline.
- High frequency of stable calm conditions. Pollutants can accumulate under such conditions. AERMOD is unable to handle calm conditions effectively
- AERMOD has no memory of the previous hour's weather conditions and each hour is treated independently of the next and material is carried away instantaneously to the edge of the grid even if very light winds are prevailing.
- AERMOD is not suitable for odors in the near-field because of its inability to handle calms and stagnation events, which are typically the most critical conditions.
- AERMOD is not suitable for assessing cumulative effects when sources are not co-located as the homogenous wind field ensures that the plumes from different sources will never overlap.

3. ETEX AND CAPTEX

As a modelling community we have concerns with respect to the EPA / Environ ETEX Tracer Experiment and the differences in model performance results between the CALPUFF model developers as presented at the 10th Model Conference [13], the AWMA CPANS Conference in Calgary[14], the AWMA Annual Conference in TX[15] and at the Visibility and Air Pollution Specialty Conference in Whitefish, MT[16] with those presented by the EPA / Environ in their 2012 reports[17, 18] and presented at the 10th Model Conference[19] and AWMA Calgary Conference[20].

For those of us outside the US who follow the US Air Quality Modelling Conferences, the ETEX (European Tracer Experiment, PCMH tracer release October - November 1994)[21] is worth mentioning.

A presentation at the 10th Modelling Conference in RTP, North Carolina by R Morris of Environ[19] presented the results from the CAPTEX tracer evaluation data that is detailed in the EPA / Environ (2012) report [18]. In this study CALPUFF was considered one of the worst performing models of several analyzed (CAMX, SCIPUFF, HYSPLIT, FLEXPART, and CALPUFF). Scire in his presentation at the same conference titled, 'Assessment of EPA's ETEX Evaluation Study' [13] indicated he had to request the data using the 'Freedom of Information Act' and it took almost a year to receive it. Significant errors in the CALPUFF model setup were identified including:

- Incorrect stack diameters – 1 m in EPA simulation vs. correct diameter of 0.023 m
- Inconsistent datums - Meteorology used a spherical earth Datum NWS-84 whilst dispersion assumed a non-spherical earth WGS-84
- Incorrect tracer release period –the run was started an hour earlier than it actually started and assumed the tracer release ran for an hour longer than it actually did
- Incorrect averaging periods – because of the incorrect tracer release, the 3 hourly averaging periods were being averaged to different periods than those measured.
- Inappropriate puff release rate. One puff was released at the start of each hour, 13 puffs in total.

Meteorological errors or deficiencies included

- MM5 data that failed performance tests for winds

- Wind direction error near the release site
- The use of MMIF vs CALMET
- Incorrect use of puff splitting

In addition to these errors, the performance statistics were also flawed. The Figure of Merit in Space favors diffusive Eulerian models and not so much the Lagrangian approach of CALPUFF. This is because the performance measures are highly dependent on time-space paired puff overlap.

The models were simply ranked on 'best' to 'worst' scores without considering the statistical differences between the models. In addition, EPA only allowed testing to be done on the early CALPUFF v 5.8.

Scire and Morris presented their results again at the AWMA Canadian Conference in April 2012 and Scire presented the results a third time at the AWMA Annual Conference in Texas[17]. The Environ paper was withdrawn (personal communication Joe Scire), and in September 2012 in Whitefish, MT, Popovic *et al*. 2012 presented performance statistics on the CAPTEX[16] results showing that CALPUFF's performance was one of the best.

The management of this study by the EPA seems unusual. The approach to model errors, flaws in the performance statistics, retention of data from the model developers, testing of an older Version of CALPUFF and lack of engagement with the model developers during the evaluation process does not appear to be best practice. Since this study, as far as we understand EPA has not retracted its results, nor issued a statement correcting the results. From afar, this is somewhat surprising given the available facts.

4. MMIF VS CALMET

The CALMET meteorological model is an integral component of the CALPUFF modelling system and is regularly used in most regulatory applications in Australia and New Zealand, especially in complex flow environments such as moderate terrain and coastal areas and, when there are few nearby observations available. There are multiple ways to run CALMET, such as with Observations Only, No Observations (NOOBS) and Hybrid approach. The NOOBS and Hybrid approach combines the gridded 3-dimensional coarse data from mesocale models with the fine-scale terrain and land-use of the CALMET simulation. (CALMET is a compliment to CALPUFF which can still be run in isolation of CALMET using 2-dimensional meteorological data of the format for AERMOD and CTDMPLUS, as well as 1-dimensional AUSPLUME and ISC meteorological data sets).

Sophisticated mesoscale models such as WRF cannot practically be run with fine enough resolution over large areas and for long periods as required by air quality applications. Hence the NOOBS and hybrid approach feeds coarse resolution MM5 or WRF 3-dimensional data to the CALMET model as the initial guess wind field. CALMET is then usually run at a much finer resolution, producing a very efficient way to run meteorological models at fine resolutions which would otherwise not be possible.

The rationale for the development of Mesoscale Model Interface (MMIF)[23] (Environ 2011) was borne out of concerns over CALMET, largely that too many options are available. The EPA IWAQM reassessment report found that the CALMET Step 1 diagnostic effects and Step 2 Objective Analysis procedures can degrade the MM5/WRF winds. Further the IWAQM reassessment report noted that options used in some past CALMET applications were selected based on obtaining a desired outcome rather than based on good science. Consequently, the 2009 IWAQM reassessment recommended CALMET settings that would 'pass through' MM5/WRF fields into CALPUFF. Further testing of CALMET by the EPA CALPUFF workgroup found that the recommended CALMET settings in the May 2009 IWAQM reassessment report did not achieve the intended desired result to 'pass through' as much as possible the MM5\WRF variables as CALMET still re-

diagnosed some and modified other meteorological variables. Because EPA could not achieve pass-through of MM5 winds with CALMET, the Mesoscale Model Interface (MMIF) tool was developed to map WRF and MM5 output directly to CALPUFF to avoid CALMET and its problems[18]. However what can be seen in Joe Scire's 10th model conference slides[13] is that MMIF, which was developed to pass the WRF winds directly to CALPUFF without any alteration at all, actually in fact **always does spatial interpolation** of the MM5 winds whereas CALMET configured in its proper 'pass through' mode does not change the MM5 winds at all. Graphical plots showing the degradation of winds by MMIF vs. CALMET are shown in Scire's 2010 paper[13]. The same graphs were presented at the 4-day advanced CALPUFF training course in Sydney in 2013.

The MMIF program was used in the ETEX program to introduce 36 km MM5 winds to CALMET. The model showed significant enhancement when finer-resolution MM5 runs were used and pass directly through CALMET.[13]

The other topic of much international debate is the choice of CALMET switches. Anderson at the 2007 Regional/State/Local Modelers Workshop in Virginia gave a presentation on 'Illustration of meteorological issues – CALMET diagnostic meteorological model'[24]. In this presentation poor 'bulls eye' wind plots were shown. In response at the 9th Model conference in 2008 Joe Scire[6] explained that bulls eye features are a result of MM5 winds not matching observations, and provided three ways in which CALMET could have been run to eliminate the bulls eye plots. The methods included a pure NOOBS mode using only MM5 files, a pure observation mode and a hybrid mode using small R values which weighted the obs close by and not further afield.

It is our view that the poor wind fields of the type shown by Mr Anderson are largely due to poor model configuration choices. Regular CALMET training and 'Optimum Model Switches' guidance (Appendix A) such as that developed by the New South Wales Office of Environment and Heritage has meant that the modelling community is largely wary of creating 'bulls eye' techniques and that they occur due to poor modelling practice rather than any technical issue with the model algorithms.

We can see the virtue of using a 'pass-through' approach to transfer MM5 and WRF meteorological data directly to CALPUFF and AERMOD in order to bring a higher level of consistency to the review process. However, for moderate and complex terrain applications we believe that the fine scale terrain and land use effects produced by CALMET are a more suitable tool.

5. NEW AERMOD ALGORITHMS AND ENHANCEMENTS/CHANGES

Proposed Buoyant Line Source Option in AERMOD

The new changes to the proposed rulings include the removal of Buoyant Line and Point Source (BLP) and CALINE3 as guideline models. Both these models have been incorporated into AERMOD.

The AERMOD BLP report of July 2015[25] which summarizes the comparison of the revised version of AERMOD with BLP shows many unexplained differences. This is despite the preamble[3] where the language suggests that AERMOD is an exact replacement of BLP and that it can "handle unique modeling problems associated with aluminum reduction plants and other industrial sources where plume rise and downwash effects from stationary buoyant line sources are important".

A key consideration is what happens when the wind is calm. Can AERMOD behave the same way as BLP under these conditions?

Additional supporting documentation and further comparative studies are necessary before such claims can be made about AERMOD's capabilities of simulating BLP.

Incorporation of Surface Friction Velocity (u*) Adjustment
The surface friction velocity adjustment is currently incorporated as a beta option in AERMET Stage 3.

Incorporation of Low Wind Options
Options for accounting for low wind conditions are currently incorporated as beta options in AERMOD.

Removal of CALINE as a guideline model
It may be worth noting here that Version 7 CALPUFF TNG includes a new algorithm for modelling road line sources which will be suitable for calm conditions and complex flows. Although the CALINE model has been a regulatory model for years the approach in Australia and New Zealand is moving away toward more sophisticated treatment of roadway sources such as the Lagrangian Particle Model GRAL that can model the jet effect from tunnel portals simultaneously with extensive roadways and tunnel vents.

Potential for Building Downwash for Stacks above GEP
We are concerned as to the proposed language requiring consideration of potential building downwash effects for stacks at or above GEP height.

The change described in MCB #4 (2-28-2011)[26] states: "*Subroutine WAKFLG was modified to no longer ignore potential downwash effects for stack heights that equal or exceed the EPA formula height. The determination of whether building downwash effects apply is based on the criterion implemented within the PRIME downwash algorithm*".

The previous policy has always been to model downwash effects for stacks less than GEP formula height.

Schulman and Scire at the 10th Modeling Conference[27] showed that changes made to the downwash code with AERMOD V11059 leads to significant, unverified increases in predicted concentrations for wide buildings. A critical concern is that the PRIME downwash equation was developed using data from buildings with a width to height ratio of < 4.4 and sub-GEP stacks.

For such a significant change, we are concerned why EPA has not allowed any public comment or review. Further, no consequence analyses have been provided by the EPA.

The change in GEP stack height rules now means that modeling for potential downwash at existing sources can cause problems for existing sources with stack heights and emission controls which have been based on prior modeling.

CONCLUSION

The questions and comments in this letter reflect a widespread concern among Australian and New Zealand modelers about the fate of CALPUFF as a regulatory model in the USA. EPA's decisions relating to CALPUFF are difficult to reconcile with our understanding of the science incorporated into the model, the results of model performance studies, the experiences of users in accessing information and updates, and the experiences of users in validation studies.

CALPUFF has been - and remains - a commonly, and in many places the most commonly used, dispersion model in Australia and New Zealand because of its versatility across both near- and far-field applications. The recent biennial workshop of ModSIG expressed concern about the direction of US EPA decisions about CALPUFF. One of the undersigned was also present at the 2015 annual meeting of A&WMA, where

considerable dissent was also evident among assembled US modelers during a session on EPA Modeling Guidance updates.

We appreciate that as non-US practitioners our views may carry less weight. However, our views and concerns are based on a detailed evaluation of the model and of the sequence of events and decisions that have unfolded in recent years. We wish to register our sincere concerns regarding the fate of CALPUFF, and that its demotion is most unfortunate given the US EPA's long-term reputation as a leading international agency concerned with good science.

Yours sincerely,

Robin Ormerod – ModSIG Convenor

Peter D'Abreton – ModSIG Deputy Convenor

Alison Radford - ModSIG Deputy Convenor

Jennifer Barclay - ModSIG Member

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