Combined Review of the Validation Report of DNDC v11.0.0 of September 1, 2023, with the CAR DNDC Validation Report – addendum for N_2O C3AS of December 18, 2023 According to the Requirements and Guidance for Model Calibration, Validation, Uncertainty, and Verification For Soil Enrichment Projects Version 1.1a

Reviewer: Brian McConkey, PhD, Viresco Solutions, December 19, 2023

(last updated March 14, 2024)

1. Summary

This review is for the combination of the Validation Report of DNDC v11.0.0 of September 1, 2023 (MVR) with the CAR DNDC Validation Report – addendum for N_2O C3AS of December 18, 2023 (Addm). The Addm adds validation of the Crop Functional Group (CFG) of C4AS that includes cotton. Since validation for the emission source (EC) of N_2O is across the entire domain, the Addm validation for N_2O supersedes that of the MVR. Thus, this review assesses the adequacy of validation of the ES of SOC and CH_4 based on the MVR and for the ES of N_2O based on the Addm according to the Requirements and Guidance for Model Calibration, Validation, Uncertainty, and Verification for Soil Enrichment Projects Version 1.1a (Validation Guidance).

This Model Validation Report with the addendum was for Type2 or Option 2 validation, i.e., generalized validation to demonstrate overall performance of the model without specific project.

The documentation and methods all conformed to the requirements of the Validation Guidance

The requirements for DNDC V11.0.0 was deemed to be met for the full domain of Practice Categories (PC), Major Land Resource Regions (LRR) and Crop Functional Group (CFG) described in the validation report with the following restrictions:

a) The acceptable domain for the ES of CH_4 is only for flooded CFG of C3AF for the PC of inorganic N management, organic amendments, water management, and cropping.
b) Since the LRR of Atlantic and Gulf Coast Lowland Forest (T) had no validation for non-flooded CFG, the acceptable domain for this LRR only includes flooded CFG of C3AF for the PC of inorganic N management, organic amendment, water management, and cropping.

There are several ES by CFG that were deemed validated based on the assessment of MVR+Addm, but for which the validation could be significantly improved if more validation data could be included. These were SOC for C3AF for the PC of water management, SOC for C4P, and N_2O for C3P. However, it is recognized that suitable validation data for all the above are limited so this validation effort cannot be criticized for having few validation sites. This note is primarily a call to research funders to support

provision of more data on the greenhouse gas emissions and removals across underrepresented practice changes, crop types, and geographies.

2. Background

The MVR builds on a previous 2022 Validation report and the Addm adds additional validation of N_2O for the CFG of C3AS. Several changes to the MVR were made including adding flooded rice, proper calculation of PMU, and adoption of exponential gap-filling to derive season/annual N_2O emissions. This review is MVR with the Addm. The Addm adds validation of the Crop Functional Group (CFG) of C4AS that includes cotton for N_2O that was not included in the MVR. Based on CAR decision of October 22, 2021, included in Appendix C of the MVR, the option of validation across the entire domain for any ES is allowed. Regrow has used that validation option for both the MVR and the Addm. Therefore, this review of the validation is based on the MVR for the ES of SOC and CH_4 while based only on the Addm for the ES of N_2O.

2.1 Calibration

Calibration was done for several parameters related to CH_4 emissions from flooded rice. Other parameters were not calibrated. There was a splitting of available data between a validation and calibration set. The splitting was done before calibration and study selection was deliberate to have good representation of the domain for both the calibration and validation data sets. Care was taken that the validation data was not used for any sort of calibration of any parameters. The calibrated parameter values were the same across the whole domain.

The calibration method fully met the requirements under the Validation Guidance.

Using the calibration data to increase the number studies used to calculate the PMU was a good idea to increase the number of studies contributing the calculation of the PMU and does not affect the integrity of the validation process.

The method to describe validation data by studies, study-sites, treatments, and treatment pairs is useful and improves understanding of the methods.

2.3 Documentation

Required documentation:

a) Model version was specified.
b) Description of the model calibration process
c) Same parameters are for all LRRs
d) Justification for splitting data into calibration and validation data sets was provided.

Also, required to be available if requested by verifier was provided in the MVR+Addm:

e) The calibration data set and references

There is rigorous archiving of version 11.0.0 is followed including all parameters. The archive includes the data and version used for this validation report and is available upon request to future Verifiers.

3. Validating and Reporting Model Performance and Uncertainty

3.1 Practice Categories

The practice categories were described, and the data used for validation for each practice category and the LRR included in the validation data for each practice category. Each PC had at least one study that included the practice change independently without be stacked with other practice changes. The PC have validation data over a range of geographical locations for SOC and N_2O (with the exception of water management) covering at least four diverse areas represented by different LRR plus non-US locations. For N_2O and CH_4 for water management there were 3 diverse areas represented by different LRR plus non-US locations.

Regarding the general practice of irrigation, the validation data included both non-flooded and flooded (paddy rice) irrigation. Therefore, based on section 3.3.1 of the Validation Guidance, DNDC V 11.0.0 is suitable for the ES of SOC and N_2O for projects having irrigation and, for CH_4, suitable for CFAF in flooded irrigation systems.

Table 1 summarizes the validation domain of PC for CFG and ES.

Table 1. Description and domain of Practice Categories.

Practice Category	Practices included	ES: CFG
Tillage and residue	Tillage, residue management	SOC: all except C3AF
		N_2O: all except C3AF
		CH_4: none
Inorganic N	Rate, form (including enhanced efficiency) , and timing	SOC: all
		N_2O: all
		CH_4: C3AF
Organic amendment	Rate, form, and depth of manure application	SOC: all
		N_2O: all
		CH_4: none
Water management	Irrigation timing, alternate wetting and drying, and amount	SOC: all
		N_2O: all
		CH_4: C3AF
Cropping	Cover crop, crop species, crop rotation	SOC: all
		N_2O: all
		CH_4: C3AF

3.2 Validation Domain

3.2.1 Crop Functional Groups (CFG)

The validation was performed for the CFGs of C4 annuals (C4A), C3 annual herbaceous (C3A), C3 annual N-fixing herbaceous (C3AN), C3 annual shrub (C3AS), C4 perennial (C4P), C3 perennial (C3P), C3 perennial N fixing (C3PN), and C3 annual herbaceous flooded (C3AF).

Table 5 shows the CFG that have no validation data by ES. The perennial crops have limited validation data. There are no data for CFG of C4P for ES of SOC or for CFG of C3P for ES of N_2O. This is because perennials are much less studied than annual crops. Consequently, the problem of validating these crops is fundamental. There are several arguments for lumping various herbaceous perennials into a

single perennial group and assessing model performance across that group. The first, but critical reason, is to have enough validation data for a sound model validation. Another important reason is that these perennial crops are often be grown in mixtures C3 and C4 and/or N fixing with non-N fixing. Therefore, there may be lumping required for model application for a project. A third reason is that this is consistent with the CAR decision that allows validation across PC and CFG. When perennials lumped there is reasonable coverage across LRR and CFG. Within each ES of SOC and N_2O, there are at least three LRR (10 for SOC and 11 for N_2O) and so meets that general guidance for LRR coverage within the Validation Guidance. Arguably, the distinction between N fixing and non-N fixing is most important for emissions and these two general types are including in each lumped perennial group for each ES. Thus, the validation for lumped herbaceous perennial covers what this reviewer believes is and acceptable range of perennial types and a range of geography. Therefore, this reviewer considers that data requirements for each ES of SOC and N_2O across PC and CFG is acceptable for all herbaceous perennials.

For ES of CH_4, only C3AF has validation data. Therefore, the ES of CH_4 is restricted to that CFG. This would be on the CFG for which agricultural management would produce important differences in soil fluxes.

3.2.2 Domain

3.2.2.1 Major Land Resource Regions

Validation LRR of California Subtropical Fruit, Truck, and Specialty Crop Region (C), Rocky Mountain Range and Forest Region (E), Northern Great Plains Spring Wheat Region (F), Western Great Plains Range and Irrigated Region (G), Central Great Plains Winter Wheat and Range Region (H), Northern Lake States Forest and Forage Region (K), Lake State Fruit, Truck Crop, and Dairy Region (L), Central Feed Grains and Livestock Region (M), East and Central Farming and Forest Region (N), Mississippi Delta Cotton and Feed Grains Region (O), South Atlantic and Gulf Slope Cash Crops, Forest, and Livestock Region (P), Atlantic and Gulf Coast Lowland Forest and Crop Region (T).

In addition, to provide more studies where validation data was limited in the US, sites in China, Italy, and Germany were also included.

There is no requirement under Validation Guidance that every LRR in the declared domain is included within the validation data as long as the minimum number of three LRR are represented for a domain of this validation. Nevertheless, having relevant validation data in all LRR in the domain provides additional confidence regarding the adequacy of the validation. In this regard, all LRR were included for the ES of N_2O, and ten were included for the ES of SOC. The ES of CH_4 was limited to three LRR but climate essentially limits the production of this CFG to those LRR within the validation domain. Regarding PC, there were at least three distinct geographical regions represented including validation data from outside the US. Regarding CFG, there were also at least three LRR included with the exception of C3P and C4P for which there were one LRR included in the validation for each. This latter weakness in validation data is inherent for those CFG. Considering all perennials as a crop group, four LRR were included in the validation data set.

The validation data for the ES of SOC did not include LRR of Lake State (L) but this LRR was included in validation for the ES of N_2O. All the land borders of LRR (L) to the north, east, south and west are with

LRR that were included in validation of the ES of SOC. Hence, this reviewer has no concern about the adequacy DNDC 11.0.0 to accurately estimate SOC changes in this LRR.

LRR T is part of the domain but only had validation for CFG of C3AF (i.e., rice). Obviously, the emission conditions of a flooded crop are fundamentally different than those for a non-flooded upland crop. Since this was the only crop grown under flooded conditions, it would not follow that validation for this crop in that LRR would extend to other CFG grown under non-flooded conditions within this LRR. Further, this LRR lies at the southern and southeastern extreme of the declared domain. While this LRR is largely bordered by other LRR in the domain, it not entirely bordered by the domain and it also extends farther south than rest of the domain. Therefore, considering that there are no upland crops in the validation data set for this LRR and that the validation for this LRR for non-flooded crop can be considered a geographical extrapolation from validation elsewhere in the domain, for LRR T only, the validation domain is limited to the C3AF CFG. This restriction to the domain needs to be applied until some other validation studies for LRR T for any non-flooded CFG other than C3AF is included in the validation.

Commercial production of some crops is naturally limited by climate to some LRR, in particular, C3AF (rice) and C3AS (cotton). These CFG were well included in validation sites for three LRR each so their complete absence from validation data for many LRR is neither unexpected nor a problem. The other CFG are generally more evenly distributed among LRR.

3.2.2.2 Soils

The soil texture classes and their clay contents were listed. The necessary range of 15% clay was well exceeded for each ES of SOC, N_2O, and CH_4.

The domain includes all USDA textural classes except silt, loamy sand, and sand.

3.2.2.3 PC and EC

Although there was no validation data for the PC of organic amendment for the CFG of C3AF, such data is scarce. The Validation Guidance recognizes this and allows validation for the annual crops in the validation data to extend to all annuals. The Addm strengthens the validation for annual by adding validation data for this PC for C3AS. Therefore, the PC of organic amendment was deemed satisfactorily validated for all annuals.

Table 2 summarizes the validation domain in terms of PC, CFG, and ES for the LRR.

Table 2. Domain of LRR

LRR	PCs	ES:CFG
C, E, F, G, H, K, L, M, N, O, and P.	Tillage and residue	SOC: all CFG except C3AF
		N_2O: all CFG except C3AF
		CH_4: none
	Cropping, Inorganic N, Water management, Organic amendment	SOC: all CFG
		N_2O: all CFG
		CH_4: C3AF only

T	Cropping, Inorganic N, Water management, Organic amendment	SOC: C3AF only
		N_2O: C3AF only
		CH_4: C3AF only

3.3 Validation Data

The full description of data requirements to initialize and run the model are provided. The approaches to fill in missing data was also provided.

The method of study-sites and treatment pairs was a useful way to organize the validation data. A link to the data sources was provided rather than a classic citation but the link suffices. The number of observations (treatment pairs) by ES was listed. All the validation data is stated as peer-reviewed so meets the Validation Guidance requirements.

The necessary site data for the validation was provided in MVR Appendix B and Addm Section 6.

The time periods for SOC change for each site were not documented but these would not affect the validation for SOC as invariably it is a multiyear period, so this reviewer sees no strong rationale for documenting each time period for SOC. The change described that avoids overlapping validation periods improves the validation robustness since increases the independence of SOC change data.

The MVR Appendix D provides the studies that have measurements for more than 310 days and also notes, in some northerly study-sites, the entire non-frozen period can be less than 310 days. This reviewer is satisfied that the number of studies with sufficiently long N_2O measurements is adequate to validated DNDC for the entire year and, thus, for entire crediting period. Although, there is only one study with more than 310 days for CH_4, that restriction is from lack of long duration validation data for that emission. N_2O emissions can be highly episodic over the year so that long-term duration of measurement is necessary to capture the effect of those emission episodes. CH_4 emissions are less episodic so gap filling over long periods is acceptable. Therefore, this reviewer accepts that the validation data is adequate for annual CH_4 emissions.

The types of measurement techniques allowed for validation were included. This reviewer judged all these techniques as acceptable for purposes of differences within treatment pairs.

The measurement depths varied from 10 to 30 cm across study-sites while the validation was for dSOC was compared with the model estimate to 30 cm. The MVR Figure 7 (section 3.5) and Appendix E show that there was no significant effect of measurement depth on the difference between measured and modeled indicating that, for the studies that had <30 cm measurement, the dSOC was accurately covered by modeling SOC change to 30 cm. Therefore, this reviewer is satisfied that the selection of data with their varied depths was acceptable for the validation over this domain. The MVR Figure 15 shows that the plurality of sites was for 30 to 30.4 cm depth so the model prediction error for SOC is appropriate for 0-30 cm.

3.4 Assessment of Bias

The validation report adequately describes the procedures used to derive the PMU. The report provides an example derivations of PMU as required by the Validation Guidance. The validation studies and number of treatment pairs is provided to derive the PMU were provided. A single PMU was provided for each ES consistent with the CAR ruling that validation can be across the whole domain.

The Climate Action Reserve has given permission for a deviance that validation of the DNDC model can be conducted across Practice Categories (PC) and Crop Functional Groups (CFG) for each emission source (ES), rather than by CFGxPCxES (Appendix C of the MVR) Based on this, the DNDC model V11.0.0 effectively met the bias requirement being less than the pooled measurement uncertainty (PMU) and the error requirement that 90% of measurements fell with the 90% model prediction interval. There was a very minor deviation for ES of CH_4 that only 89.47% of the measured values fell within the 90% model prediction interval. The Pooled Measurement Uncertainty for CH_4 was the largest among the ES (0.4999 tCO2e/acre/yr) so it is not unexpected that there would be more variation in the measured values. Further, there were fewer data points for CH_4 so each misfit is more influential than for the other ES. As the Validation report states, had one more of the measured CH_4 emission values fell with the 90% prediction interval, then the 90% criteria would have been met.

The required histograms of residuals between measured and modeled showed an approximate symmetrical distribution of residuals around zero. The required study specific bias (Appendix G) echoes this as, for all three ES, there was about equal negative and positive biases across the studies with a range in magnitudes from large to small. Hence there was no indication of structural model problem based on the biases.

The MVR Appendix H and Table 3 and 4 of the Addm provides more insight of the DNDC performance for across each PC and CFG. For assessing bias, the PMU is conservative. For a large sample size of 28, the 90% confidence interval of measurement uncertainty would be 1.7 times the PMU, while, for a sample size of three, the 90% confidence interval would be 2.325 times the PMU. Although a bias falling within the confidence limits of the measurement uncertainty is not a criteria for acceptance under the Validation Guidance, it provides a way to distinguish a bias that is larger than the PMU but which is expected given the confidence limits from those that are more concerning because they lie outside those confidence limits.

The average study bias and mean residual were less the PMU for all individual PC for ES of SOC. This condition was also met for CH_4 for all PC included for that ES.

For SOC, the lumped perennials (C3PN and C3P), the average bias for the 3 studies (0.514 tCO2e/acre/yr) was higher than PMU (0.425 tCO2e/acre/yr) but well within the 90% measurement confidence interval so not alarming given so few studies. The mean residual across all pairs provides another estimate of bias that represents of all treatment pairs. The mean residual was less the PMU.

For N_2O, the overall validation for N_2O across CFG and PC (Figure 2, Addm) showed excellent performance as the mean study bias was a small fraction (0.21) of the overall PMU. The average study bias, but not the mean residual, for water management exceeded the PMU (Table 3, Addm). For N_2O, the average study bias also greater than the PMU for CFG of C3AN, C3AF, and lumped perennials (C4P and C3P). However, these were all well within the 90% measurement confidence limits so it is not an alarming discrepancy.

There were fewer studies and treatment pairs for perennial than annual CFG, with the exception of C3AF, and that undoubtedly an important reason why the performance of DNDC, as indicated by bias, was often higher for the perennial CFG than annual CFG since less averaging out of calculated biases for perennials.

For SOC, there was practically no available data for validation as water management within irrigated systems is not considered to have an important effect on SOC so SOC change is measured rarely. The report notes that the one validation study that involved SOC change under a flooded condition did not compare practice changes in water management. Nevertheless, this reviewer notes that DNDC did provide low bias for that substantial study (MVR Appendix G 0.0419 tCO2e/acre/yr), involving 8 different sites across two climate regions of China, showing that the interaction of the other practice changes effects on SOC with flooded irrigated conditions was well captured. Given the apparent absence of relevant data of SOC change for water management, this reviewer accepts that DNDC V11.0.0 is valid for water management PC for both flooded and unflooded irrigation for SOC.

Hence, all the SEP requirements for assessment of are effectively met for the validation domain of PC described in this review's section 3.1 and geography and CFG described in section 3.2 of this Review.

3.5. Derivation of Model Prediction Uncertainty

All required material was provided: i) graphs of modeled vs. measured are provided that demonstrate that 90% of measurements fall with the 90% prediction intervals ii) scatterplots of model predictions vs. measurements were provided, and iii) histograms of residuals between predictions and measurements.

The model prediction error is stated as the difference between ES with practice changes and without practice changes. This is acceptable as it is the error assumed for the equations is SEP Appendix D.2.

The validation method is most consistent with application of the Monte Carlo method of error propagation under SEP Appendix D.2. The validation report meets the requirement of Validation Guidance that the required distributions of the model hyperparameters, delta and sigma, are provided. For ES of SOC and CH_4 , delta distribution is shown in Figure 2 in MVR Section 3.4 and the sigma distribution in MVR Figure 5 in Section 3.5 and Addm Figure 1). The delta and sigma distributions for N_2O were unchanged from the MVR because, as explained in the Addm, those distributions were sufficient (conservative) for the uncertainty in these new studies. Other model parameters were constant for this validation and are provided with the archived model. Therefore, the requirements to apply SEP Appendix D.2 are met.

Annex. Review Requests and Regrow Responses during validation Report Review Process

Item No.	**Type of feedback (Nonconformance; Request for Clarification; Opportunity for Improvement)**	**Description of item**	**Outcome**
1	Clarification	The wording about standard error and standard deviation is unclear.	Resolved
2	Clarification	Sensitivity analysis states that sensitive input and model parameters were identified. Done like that it will be necessary to also state that the calibration only refers to internal model parameters. It is also a requirement to document which parameters are calibrated.	Resolved, Calibrated parameters identified with all parameters in Appendix A.
3	Opportunity for improvement/clarification	CAR has ruled in past that analysis across all the CFG and PC for an ES is satisfactory (Appendix C). This reviewer agrees that this is sensible and that CFGxPCxES was too granular. Nevertheless, some stakeholders are concerned that this could allow some weaknesses for some practices or CFG to be hidden within the overall assessment across CFG and PCs. Obscuring any weaknesses was certainly not the intent of the CAR ruling (Appendix C). Being clear about capabilities of DNDC is particularly relevant since this is an option 2 generalized validation of the model for the US. This reviewer suggests that potential bias is the greatest concern amongst stakeholders. Therefore, a separate analysis of residuals by CFG for each ES and by PC for each ES compared to PMU would be provide greater transparency.	Resolved. Appendix G added providing the analysis requested.

Item No.	**Type of feedback (Nonconformance; Request for Clarification; Opportunity for Improvement)**	**Description of item**	**Outcome**
4	Clarification	Figure 7 shows the residuals for dSOC. The intent of the Figure is to show that if there is no bias for using shallower depths for measured dSOC. However, it is not stated that the modeled values are for 30 cm regardless of the depth of the measured.	Resolved. Evidence provided in revised MVR that the model error is not substantively affected by depth.
	Further clarification after REGROW response of 06-13	Using depths other than 30 cm was allowed, considering justification in Appendix E, to extend the number of studies available. Based on the box plots, Figure 7 shows that most of the data used for the validation was for depths shallower than 30 cm. The model prediction error needs to be for 0-30 cm as that will be what will be predicted when DNDC will be applied to projects. Figure 7 does not clearly show that the model error is equal across depths. In fact, it may indicate that model error is smaller for depths of 15 cm and less that deeper depths. This would mean the model prediction error for 0-30 cm would be underestimated. To make an assessment and to show that report appropriate, there needs to be a Table that shows the depth for SOC for the validation studies. It should also show the specific practice changes (see item 7) for those data.	Resolved. Depths and specific practices are reported in Appendix B. Summary of depths in Table 15. Depths of 30 to 30.4 cm represent the plurality of depths. Thus, the model prediction error can be considered valid for the 0-30 cm depth.
5	Clarification	What is included under the water management practice change? This reviewer would not consider prolonged	Resolved. Information is provided in Appendix B.

Item No.	**Type of feedback (Nonconformance; Request for Clarification; Opportunity for Improvement)**	**Description of item**	**Outcome**
		flooding within the treatment pair that produces anaerobic soil conditions to belong to the same category of practice change as irrigation that does not involve prolonged water saturation of the soil within the treatment pair.	
6	Nonconformance	The number of observations that fall outside the 90% prediction interval for CH_4 is slightly less than the required 90%. The Validation Guidance allows for this. Nevertheless, I would like to see that there are no major outliers among the validation data that could indicated a structural problem.	Resolved. The coverage was 89.47%, so was accepted as substantively meeting the 90% threshold. Additional information in Appendix G shows that there are no validation studies for CH_4 are outliers with an alarming large bias compared to the PMU.

Item No.	**Type of feedback (Nonconformance; Request for Clarification; Opportunity for Improvement)**	**Description of item**	**Outcome**
7	Clarity or nonconformance	The Validation Guidance requires binning the practice changes within PC. This is part of declaring the domain. Just declaring the PC. An example of the problem of what practices are included was Item 5 above. I want a table that specifies what practice changes are included within each PC. I recommend that these be itemized and labeled with an abbreviation, mnemonic, or number so these can also be used in listing of studies in Appendices A and D, e.g., by indicated the included practice changes for the PC in parentheses. The table should also make clear for which CFG the practice changes included are validated. The verifier needs that information to check that model was not used beyond its validated scope.	Resolved. Information has been provided in Appendix B.

Item No.	**Type of feedback (Nonconformance; Request for Clarification; Opportunity for Improvement)**	**Description of item**	**Outcome**
8	Nonconformance	The mean bias is calculated from the mean residual of model minus observed (Fig 3.1 & 3.2). Therefore, using the mean value of the delta hyperparameter is not in compliance with the Validation Guidance. Based on the data in Appendix G, the mean residual across the ES, averaged across studies as required in the Validation Guidance, is less than the PMU. Therefore, this should not affect the model validation. It is good practice to include delta hyperparameter with the mean residual to show that they have similar values as delta since delta is used to estimate model prediction uncertainty.	Resolved. Argument accepted that delta parameter is acceptable alternate to the mean study bias. The average study bias is now also provided in Appendix G and so meets the Validation Guidance requirement.
9	Clarification	Provide information on the studies with practice change that are not stacked with other practice changes to meet requirement that at least one practice change without stacking is used for each PC.	Resolved. Information added to Appendix B.
10	Nonconformance	Add histogram of emission by ES as required by the Validation Guidance	Resolved. Figure 3.
11	Clarification	Please specify the data sources used for calibration	Resolved. References provided.

Item No.	**Type of feedback (Nonconformance; Request for Clarification; Opportunity for Improvement)**	**Description of item**	**Outcome**
12	Clarification	The Validation Guidance says that the PMU is calculated from data used in the Validation Report. This reviewer interprets that as the data used for validation. However, Table 12 shows that data from the calibration data set was used. This is allowable as the Validation Guidance allows "When PMU cannot be reasonably obtained, a default replacement value may be used for PMU that is based on typical measurement error for a given measurement technique, per approval of the Registry". Adding the obviously relevant data used for calibration to calculate the PMU is an excellent approach to providing more highly relevant support for PMU. Therefore, this reviewer concurs with this but, as per the Validation Guidance, this does need CAR approval.	Resolved. CAR approved using calibration data sets for calculation of the PMU (Appendix C, July 23, 2023).
13	Clarification	To provide better data coverage, some studies for validation were from outside the US. These represented 1/3 of validation data for CFG of C3AF (rice). Although allowed under the Validation Guidance, it would be good to get confirmation from CAR for using data from outside the US for validation.	Resolved. CAR confirmed that fully acceptable to use non-US sites for validation (Appendix C, July 23, 2023).

Item No.	**Type of feedback (Nonconformance; Request for Clarification; Opportunity for Improvement)**	**Description of item**	**Outcome**
14	Nonconformance	Add figures showing the distribution of model parameters sigma and delta for N_2O validation (Addm)	Resolved, the distributions of sigma and delta for N_2O were provided in the Addm, along with rationale that these were unchanged from the distributions in the MVR because they were found sufficient (conservative) for the added validation studies.