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To: Patrick Barickman, Whitney Oswald, Brock LeBaron  
From: Jon Wilkey  
Date: June 30, 2016  
RE: June 2016 monthly report on integrating equipment-based emission factors into the R model

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During the month of June, work on the R model has focused finishing the model features discussed during the June 6<sup>th</sup> project meeting. Detailed change notes are given below. At this point, I believe that all coding work on the model is finished. The User Manual will be updated to reflect the final revisions and will be delivered by July 15, 2016, along with ownership of the R model's version control repository.

## Change Log

### 1. User input options:

- a. Revised save/load options. If specified in the options file, the entire R workspace (comprised of results from the data analysis, Monte-Carlo simulation, and post-processing) is saved at the conclusion of the model run, and can be reloaded at a later time.
- b. Implementation dates of emissions reductions can now be specified using calendar dates (in "YYYY-MM-DD" format) instead of using model time steps.
- c. Emission reductions
  - i. Added the following selection criteria as built-in options (for each piece of equipment):
    1. Date that a well is drilled
    2. Implementation date of the emissions reduction
    3. Well type – oil, gas, or both
    4. Jurisdiction (i.e. surface lease owner) – can be Federal, State, Fee, Indian, or all of the above
    5. County – Uintah, Duchesne, or both
    6. Annual emissions thresholds (for each type of equipment and pollutant)
    7. Maximum monthly production rate (for both oil and gas). Goal here is that you can select only those wells capable of producing  $\geq n$  barrels of oil or MCF of gas.
  - ii. Finally, reductions now only apply to wells with uncontrolled sources (accidental double-reductions are no longer possible)
  - iii. Only the records that meet all specified selection criteria have reductions applied to them.

## 2. Post-processing

- a. Excel export includes worksheets showing total emissions by species.

Several other features were implemented with the following changes:

## 3. Calculate tanks emissions by operator.

- a. Issue: I've found that picking the operator is redundant. Ultimately, the model calculates the ratio  $r = (\text{mass of VOCs emitted}) / (\text{volume of fluid produced})$ . The fluid produced is oil or condensate (there was no relationship between water throughput and tank VOC emissions). In the data analysis performed last month there is clear evidence that the value of  $r$  varies by operator. However if we randomly pick the operator for new wells, and then use the  $r$ -value fitted to that operator (which so far has always been a straight line with an intercept of zero and a slope of  $r$ ), then really we're still randomly picking  $r$ . Since the frequency with which a given operator/ $r$ -value occurs is identical, we're just adding an additional data analysis and simulation step.

Another potential reason to go with individual operators would be to differentiate between  $r$ -values for oil and condensate throughput (as most entries in the OGEI database are either all oil or all condensate throughput). However, DOGM doesn't track this difference, and simply reports oil and condensate production together as "oil" production. Consequently, the rest of the R model uses the same approach, and doesn't differentiate between the two fluid types either.

- b. Revision: The Monte-Carlo simulation picks the  $r$ -value directly. I sum together oil and condensate throughput volumes in the OGEI database when determining  $r$ -values. Any results that predict emission rates higher than the maximum emissions reported in the OGEI tanks database are capped at that maximum value.

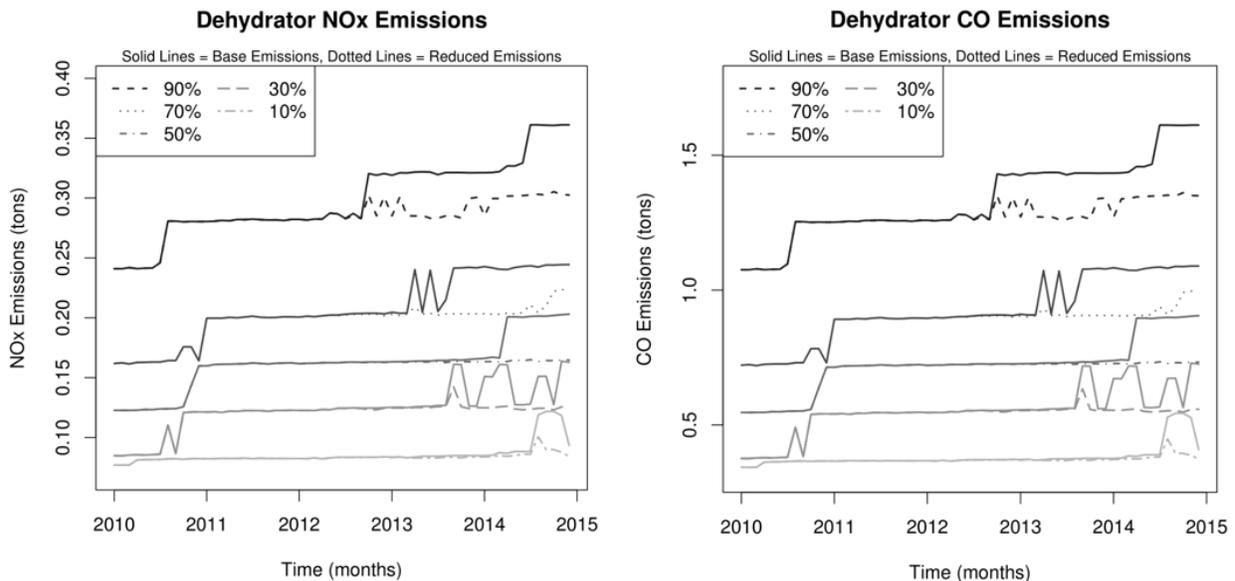
## 4. Use actual entries in OGEI database for prior wells instead of randomly drawing from cumulative probability tables (CPT).

- a. Issue: There are many complications to matching prior wells with rows in the OGEI database. Many wells do not have matching rows in the OGEI database for each type of equipment. Additionally, some wells are associated with multiple facilities in the OGEI database (and therefore have multiple matching rows in the CPTs). For example, the well API # 4301330403 (operator ID # 22, facility ID # 5277) is associated with two different entries in the RICE & turbines table (RICE ID # 960 and 961), which have substantially different emissions. In order to implement this feature, we'd need to:
  - i. Match wells that have a single matching entry in the OGEI database (before starting the Monte-Carlo simulation)
  - ii. Randomly draw from the CPTs for prior wells without matches in the database
  - iii. Randomly select between entries in the database for prior wells with multiple matches

- b. Revision: There isn't enough time left to implement this feature. Also, given how much random selection already occurs for prior wells with no/multiple matches, I think that there's limited value in finishing this feature. I've commented out the code used to find matching rows in the function that performs the data analysis of the OGEI database (but it's still there in case anyone wants to try tackling this issue in the future).

Finally, the following bugs were fixed/investigated:

- 5. Confirmed that 6 ton/yr VOC emissions threshold rate was working as intended for tanks. Only 5.92% of tanks in the OGEI database have VOC emissions  $\geq$  6 ton/yr, which is why there appears to be almost no reduction in VOC emissions from tanks when that emissions threshold is applied to the model's emissions reductions criteria.
- 6. Why are the plots of for emissions from dehydrators so odd?
  - a. Plots of CO and NOx emissions from dehydrators look very strange:



However after digging through the code I found that 99.89% of results for dehydrator NOx and CO emissions are  $\leq 0$  (dehydrator NOx and VOC emissions are solely from combustor and combustor pilot light activity). So what we're really seeing is a bunch of noise around the very few results that are non-zero. By comparison, the VOC emissions from dehydrators are normal:

### Dehydrator VOC Emissions

