Equipment-based emission factors and emission estimates for Uinta Basin Conventional Oil and Gas Model

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Abstract
The Uinta basin suffers from high ozone air quality problems in the winter months. Industrial activities of the oil and gas industry in the basin appear to be a significant source of hydrocarbon emissions that are linked to ozone production in winter months. Previous work completed by the University of Utah for the Utah Division of Air Quality (UDAQ) led to the creation of a software tool that can be used to forecast oil and gas development in the Uinta Basin, from which emissions can be estimated using emission factors. The existing model uses activity-based (drilling, production, transport, etc.) emission factors that were collected from a literature survey, however UDAQ will ultimately need to use equipment-based (pumps, tanks, pipes, etc.) emission factors. The objective of this proposal is to modify the portion of the existing model responsible for estimating emissions to support both types of emission factors.

Introduction
Work at the University of Utah has developed a production model for the oil and gas industry in the Uinta basin in Utah. This model has been developed using historical data the Utah Division of Oil, Gas and Mining (UDOGM) and the U.S. Energy Information Administration (EIA). The model analyzes the supplied data from UDOGM and EIA through a variety of methods to (primarily distribution fitting and regression analysis). Results from the data analysis can then be used to run Monte-Carlo (MC) simulations of possible oil and gas development outcomes. The major steps in the model are:

1. Randomly pick an oil and gas price path based on EIA's Annual Energy Outlook forecasts and the observed error in EIA's forecasts.
2. Calculate the number of new wells drilled in the Uinta Basin in response to the selected price paths.
3. Calculate production from all wells using decline curve analysis.
    a. New wells estimate their production from decline curve equations with randomly selected coefficients drawn from probability distributions based on past decline curves.
    b. Existing wells calculate their production by extrapolating curves fit to every well in the Uinta Basin.
4. Calculate the emissions impact of drilling and production activity using activity-based emission factors that are randomly selected from a normal distribution whose mean and standard deviation are determined from literature survey values.

By iterating the MC simulations many times the full range of possible outcomes can be estimated. The model has been cross-validated against actual production and drilling records from the Jan. 2010 to Dec. 2014 time period, and the model estimates have closely agreed with observed values.

The objective of this work is to update Step (4) of the model to create additional options for estimating emissions.

Work Plan

Work on this contract will utilize the skills of Mr. Jonathan Wilkey who is presently a PhD student in the Department of Chemical Engineering at the University of Utah. Jon is expected to finish his thesis in the Fall Semester of 2015. Work on this project will engage Jon as a Post Doc Associate for the period of the contract, which is expected to be January 2016 – April 2016. The work is to be broken down into the following tasks associated with modifications to the present model:

1. A new set of data analysis functions will be written to support the expected format of the new emissions source data. Specific steps include:
    a. Importing UDAQ's equipment-based emissions database into R
    b. Developing probability distribution functions that describe the range of equipment-based emission factor values.
2. Any required changes to the data analysis functions will be made after the actual new emissions source data is released in February 2016.
3. The existing MC emission calculations will be modified to:
    a. Allow the user to specify what type of emission factor to use (equipment or activity based) for every category of emissions source.
    b. Accommodate the new equipment-based emission factors.
    c. Have the capability of differentiating between existing and new wells for the purpose of allowing emissions rules to be applied only to new wells.
4. A new function will be written to handle emission reductions as the result of NSPS or other rules. The formatting of the rule reductions will be standardized so that UDAQ can write their own rules.
5. Update the model's User Manual to cover the changes in the emissions data analysis and MC simulation functions.
6. Provide training to UDAQ staff on how to use and work with the changes in the model.

Gantt Chart for the Tasks in this project

Task	Mo. 1	Mo.2	Mo.3	Mo.4
1	X	X		
2		X	X	
3	X	X	X	
4			X	X
5				X
6				X

Budget

The budget considers a start date for the project of January 1, 2016 with a duration of 4 months. The project budget consists of Jon Wilkey's salary as a post doc and his supervision. It also includes employee benefits and a 10% facilities and administration charge. The total budget is $37,180.

Faculty Salary	$	4,000.00
Post-doc Fellow	$	22,000.00
Benefits	$	7,800.00
Direct Costs		33,800.00
F&A (10%)		3,380.00
TOTAL		**37,180.00**