Wyoming Pond Emissions Calculator (WYPEC)

2023 AAPCA Best Practice

September 27, 2023

Andrew Keyfauver, Wyoming Air Quality Division

The Council of State Governments

BACKGROUND & INTRODUCTION

WYPEC MODEL BASIS – EARLY BACKGROUND

Background

- Exceedances of the 8-hr NAAQS for ozone in the Upper Green River Basin
- Facilities perform crude emission estimates for emissions inventories

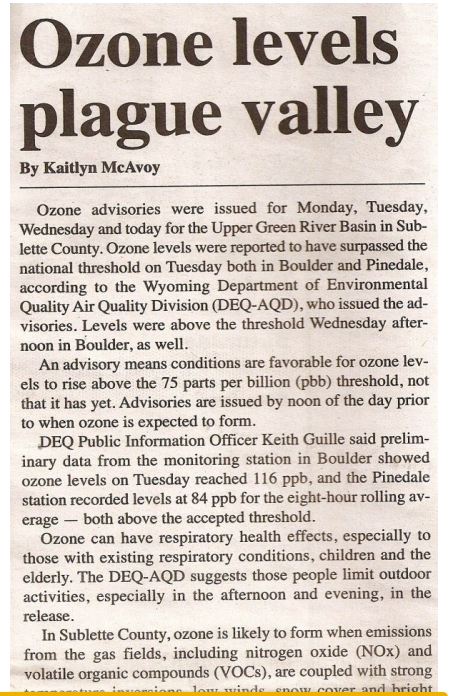
Need

- WDEQ desired technically sound emission estimation methodology

Objective

- Establish correlation between pond VOC content and airborne concentrations to estimate future emissions

OUTCOME: Develop easy-to-use software tool to predict air emissions from disposal pit water concentrations



Ozone levels plague valley

By Kaitlyn McAvoy

Ozone advisories were issued for Monday, Tuesday, Wednesday and today for the Upper Green River Basin in Sublette County. Ozone levels were reported to have surpassed the national threshold on Tuesday both in Boulder and Pinedale, according to the Wyoming Department of Environmental Quality Air Quality Division (DEQ-AQD), who issued the advisories. Levels were above the threshold Wednesday afternoon in Boulder, as well.

An advisory means conditions are favorable for ozone levels to rise above the 75 parts per billion (pbb) threshold, not that it has yet. Advisories are issued by noon of the day prior to when ozone is expected to form.

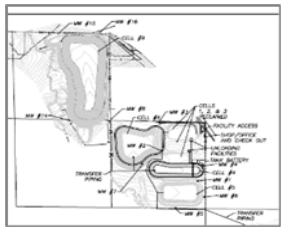
DEQ Public Information Officer Keith Guille said preliminary data from the monitoring station in Boulder showed ozone levels on Tuesday reached 116 ppb, and the Pinedale station recorded levels at 84 ppb for the eight-hour rolling average — both above the accepted threshold.

Ozone can have respiratory health effects, especially to those with existing respiratory conditions, children and the elderly. The DEQ-AQD suggests those people limit outdoor activities, especially in the afternoon and evening, in the release.

In Sublette County, ozone is likely to form when emissions from the gas fields, including nitrogen oxide (NOx) and volatile organic compounds (VOCs), are coupled with strong

MODEL DEVELOPMENT - *Technical Approach*

1 Data Collection: *Air/water sampling events at multiple facilities.*



Flux Chambers

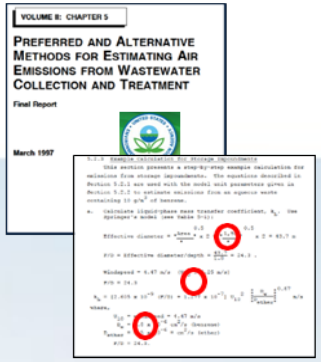
Open Path FTIR

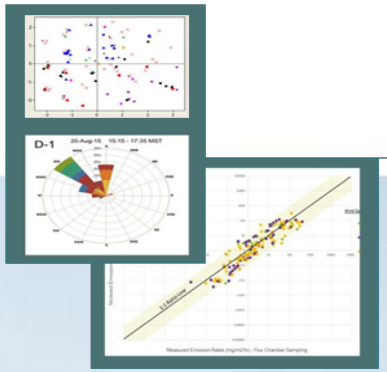
Air Sampling

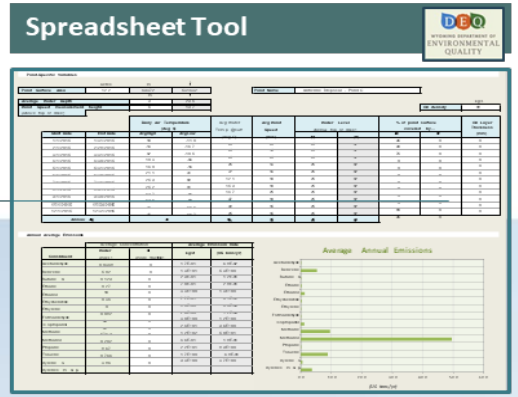
Water Sampling

On-site Meteorology

2 Predictive Model Development







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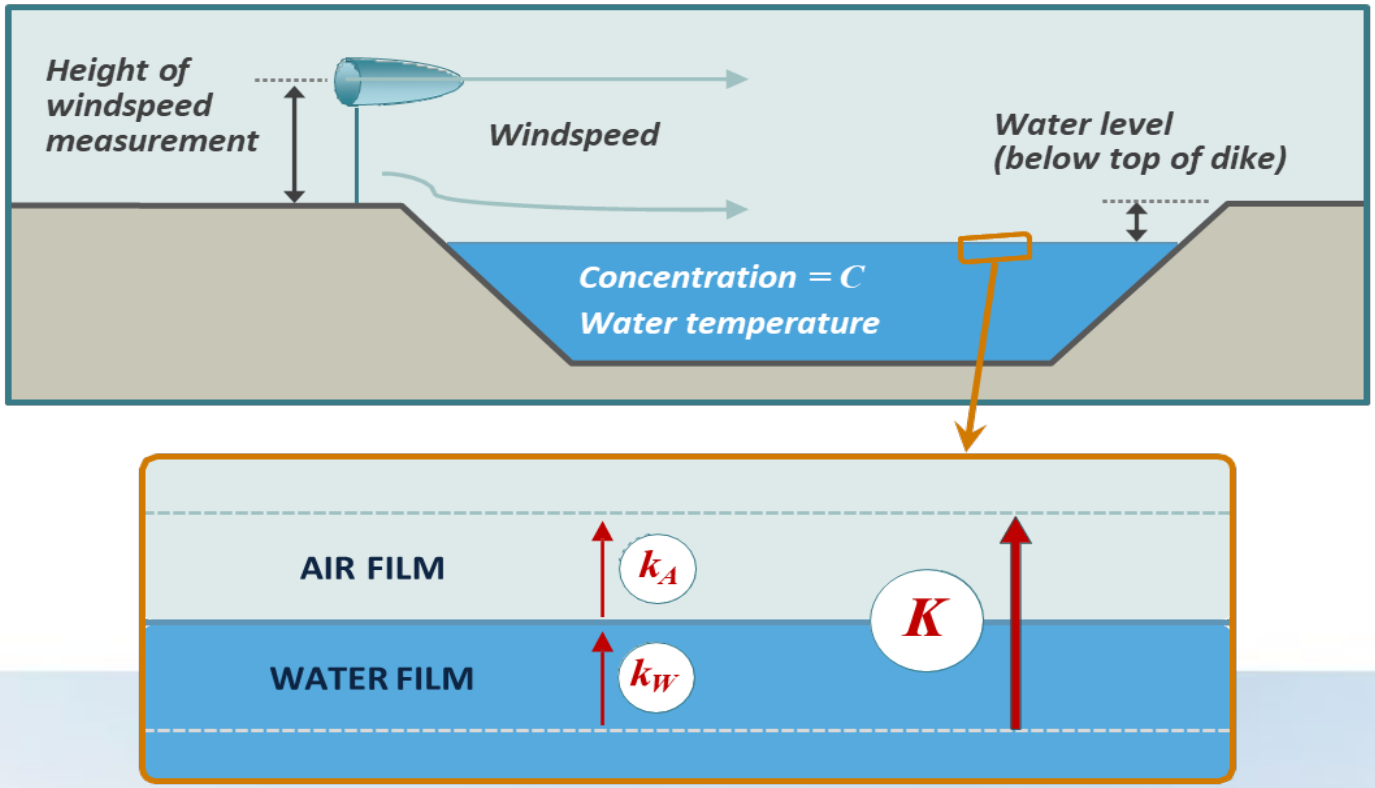
TWO-FILM EMISSION MODELS



k_W and k_A depend on chemical species, meteorology, etc.

Emission flux is proportional to concentration:

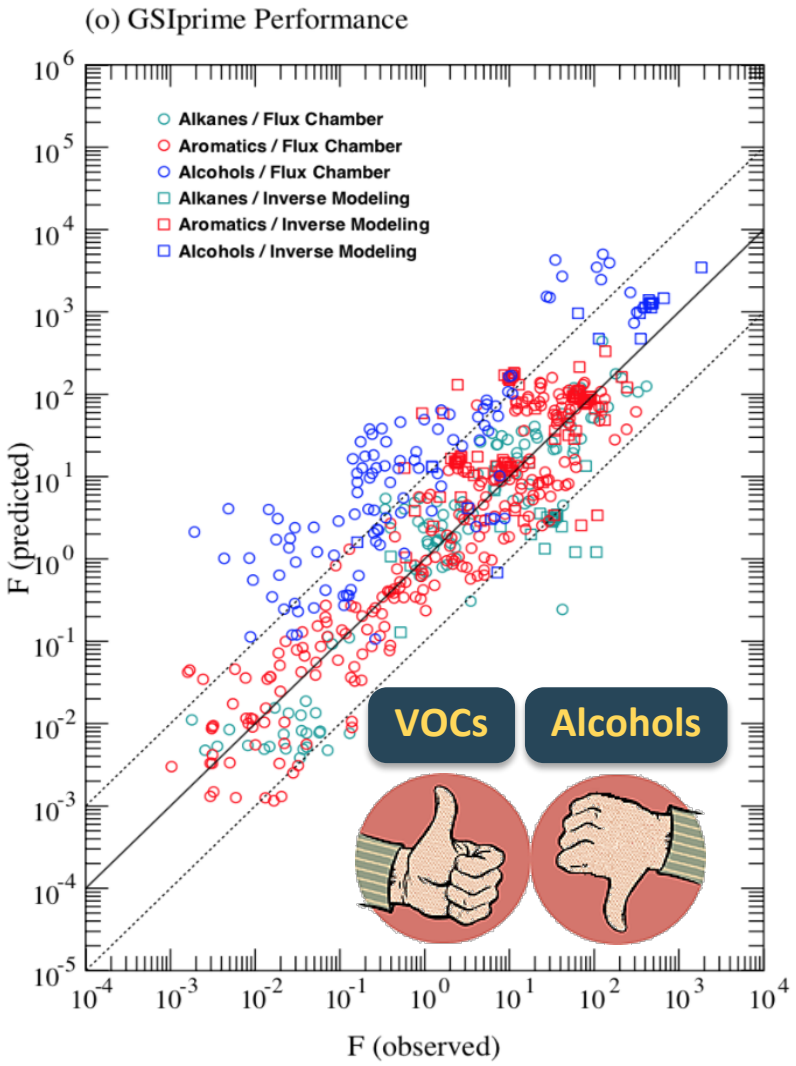
$$F = K \cdot C$$

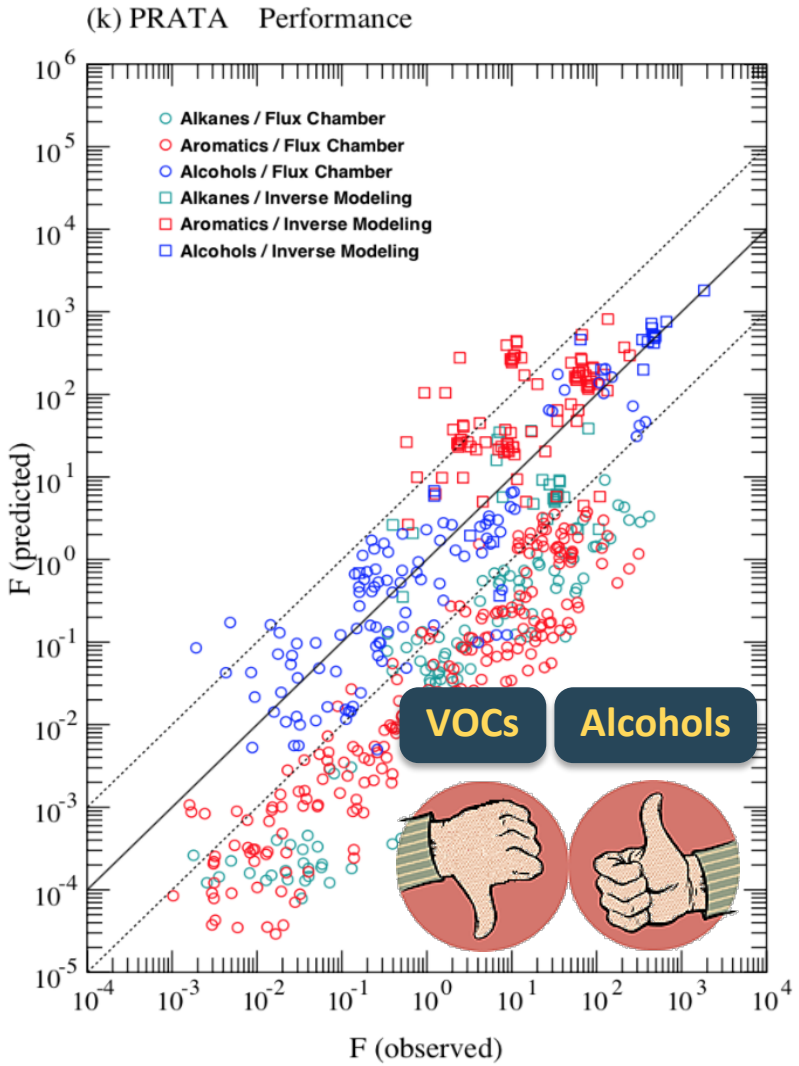
K depends on Henry's Law and combination of mass transport coefficients across a water film, k_W, and air film, k_A

$$\frac{1}{K} = \frac{1}{k_W} + \frac{1}{Hk_A}$$

OILFIELD WASTE DISPOSAL POND MODEL ANALYSIS

Best-Performing Models for Different Chemical Classes





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Measurements vs. Predictions

Alkanes	**Methane, ethane, propane, n-butane**
Aromatics	**Benzene, toluene, o-xylene, m- & p-xylene, ethylbenzene, 1,2,3-trimethylbenzene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene**
Alcohols	**Methanol, ethanol, isopropanol**

Parameter	Model
k_A	PRATA
k_W	GSI-prime

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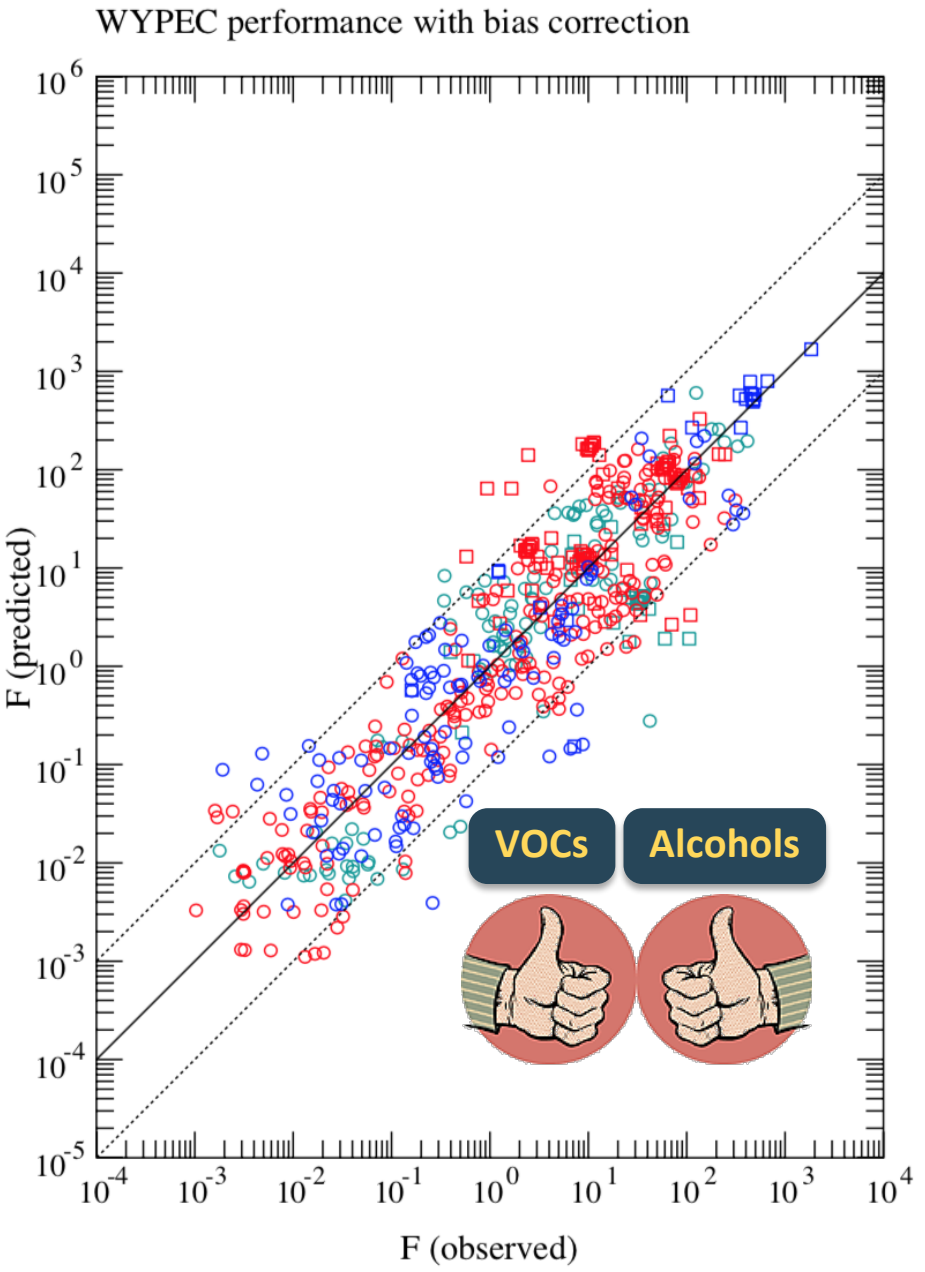

WYPEC SPREADSHEET SOFTWARE

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WYPEC INPUTS

INPUT: Pond-Specific Variables

	Start Date (mm/dd/yy)	End Date (mm/dd/yy)	Avg Water Temp at Surface (deg C)	Avg Wind Speed (m/s)	Water Level (below top of dike) (m)	Surface Area (m^2)	% Covered by Ice (%)	Salinity or TDS (mg/L)
2	01/01/14	01/31/14	4.0	3.3	2.5	49372	0	40000
	02/01/14	02/28/14	4.0	3.8	2.5	49372	0	40000
	03/01/14	03/31/14	4.0	4.7	2.5	49372	0	40000
	04/01/14	04/30/14	4.0	4.9	2.5	49372	0	40000
	05/01/14	05/31/14	8.1	4.4	2.5	49372	0	40000
	06/01/14	06/30/14	12.4	4.8	2.5	49372	0	40000
	07/01/14	07/31/14	18.3	4.2	2.5	49372	0	40000
	08/01/14	08/31/14	14.9	3.9	2.5	49372	0	40000
	09/01/14	09/30/14	11.8	3.9	2.5	49372	0	40000
	10/01/14	10/31/14	5.8	4.1	2.5	49372	0	40000
	11/01/14	11/30/14	4.0	5.1	2.5	49372	0	40000
	12/01/14	12/31/14	4.0	3.2	2.5	49372	0	40000
		Time-Weighted Average	***8.0***	***4.2***	***2.5***	***49372***	***0.0***	***40000***

INPUT: Pond Water Concentrations

	Start Date	End Date	Acetaldehyde	Benzene
				(mg/L)
3	01/01/14	01/31/14		1.0E+1
	02/01/14	02/28/14		1.0E+1
	03/01/14	03/31/14		1.0E+1
	04/01/14	04/30/14		1.0E+1
	05/01/14	05/31/14	1.0E+0	1.0E+1
	06/01/14	06/30/14	1.0E+0	1.0E+1
	07/01/14	07/31/14	1.0E+0	1.0E+1
	08/01/14	08/31/14	1.0E+0	1.0E+1
	09/01/14	09/30/14	1.0E+0	1.0E+1
	10/01/14	10/31/14	1.0E+0	1.0E+1
	11/01/14	11/30/14	1.0E+0	1.0E+1
	12/01/14	12/31/14	1.0E+0	1.0E+1
	Time-Weighted Average (kg/d)		***1.00E+00***	***1.00E+01***

Acetaldehyde
Benzene
Butane
Cyclohexane
Cyclopentane
Decane
Ethane
Ethanol

Interface simultaneously estimates emissions for:

- ***12 time periods (e.g. monthly) - individual and aggregate***
- ***15 individual chemicals (among 50 in database)***

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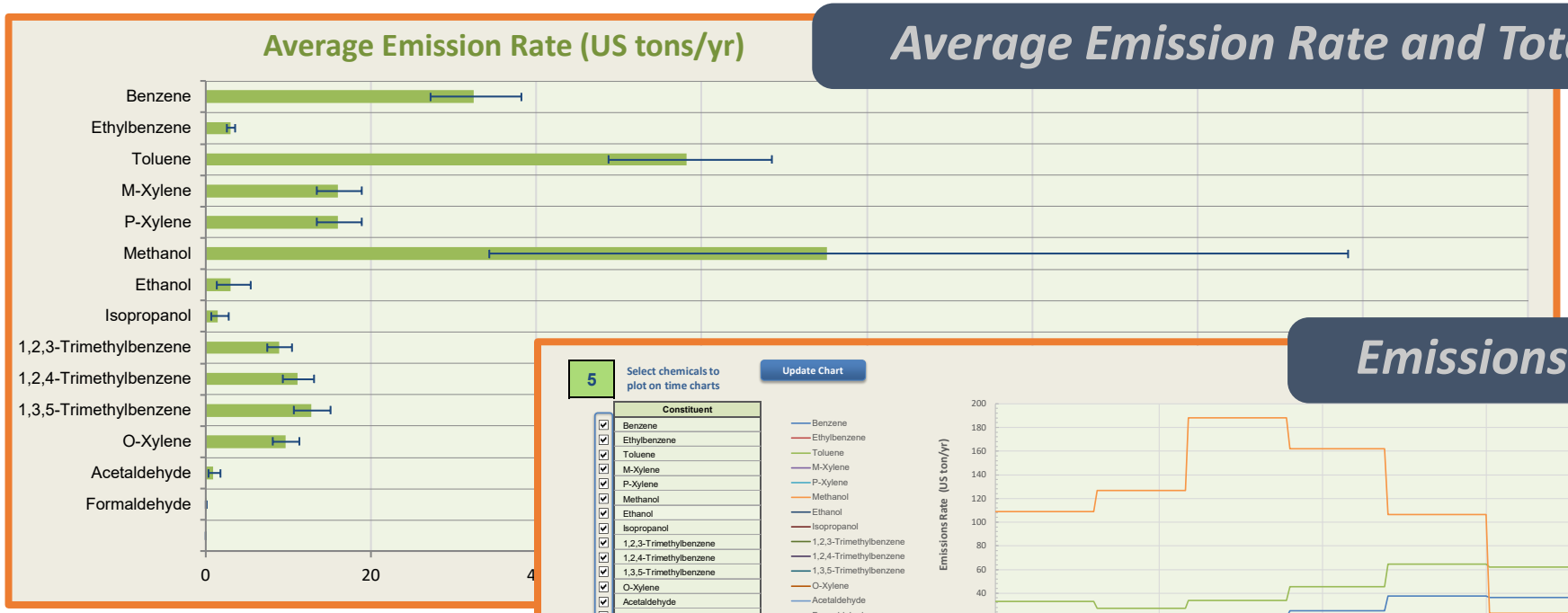
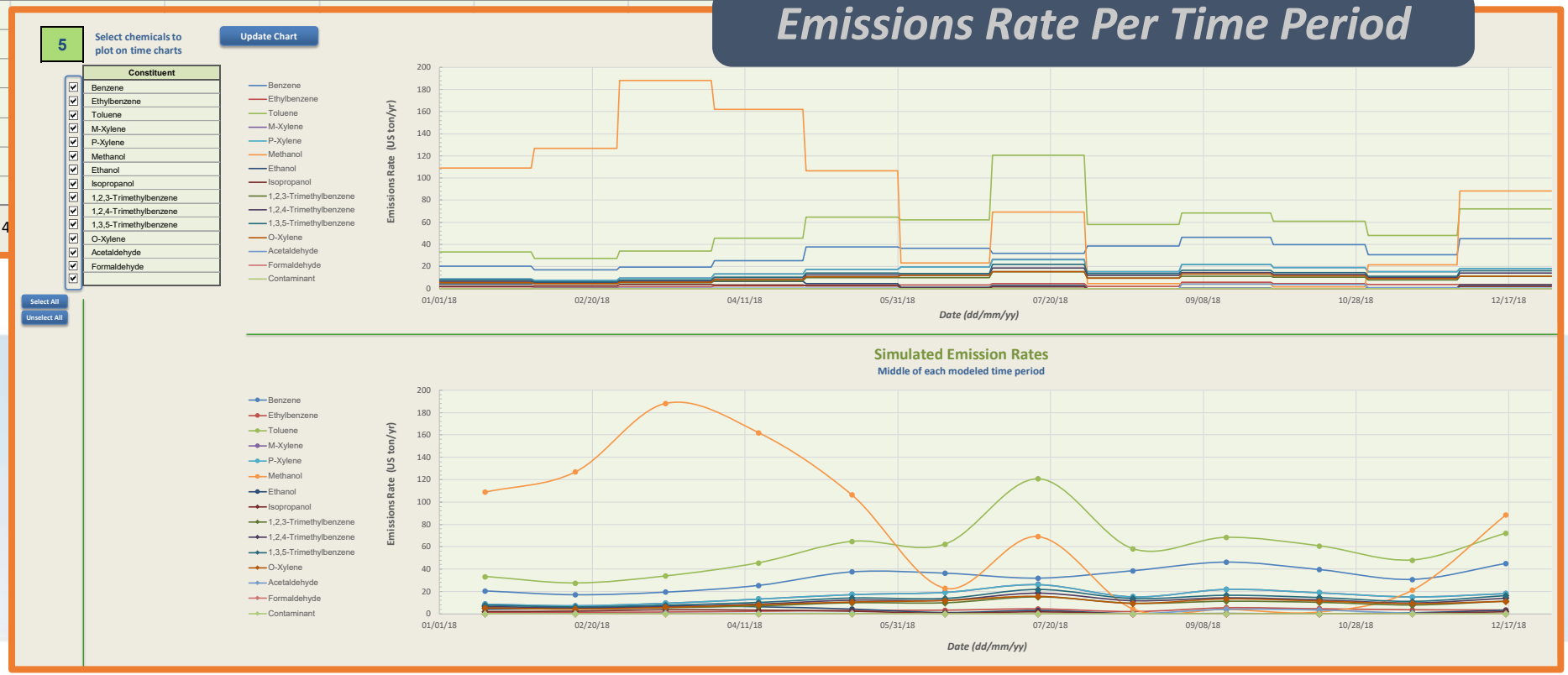
WYPEC OUTPUT

Average Emission Rate and Total Mass



Emissions Rate Per Time Period



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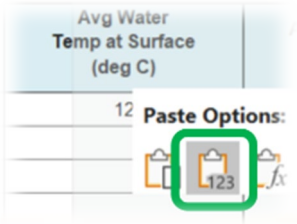
LIMITATIONS

- Wind speed: 0-50 m/s
- Monthly ranges recommended
- Maximum 15 compounds at a time – database of 50
- Must enter data in correct units (select metric or US)
- Highly dependent on Henry's Law – constants can vary substantially
- Some compounds not included in calibration

- *Watch outs with Excel*
  - Macros must be enabled
  - Copying/Pasting *values* from other workbooks
  - Automatic vs. manual calculation
  - Update time series charts after adding/removing chemicals



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Questions ?


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