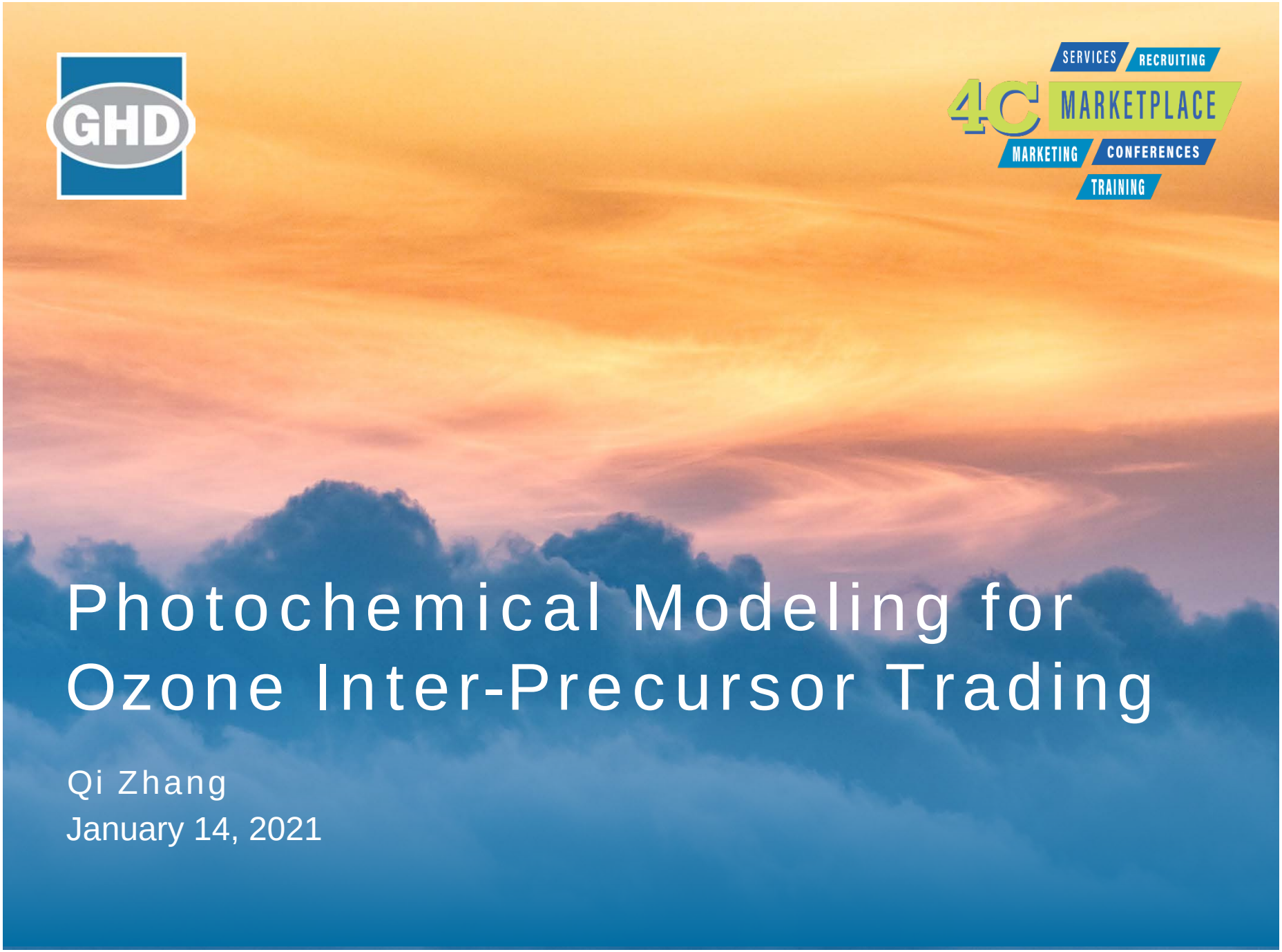

Photochemical Modeling for Ozone Inter-Precursor Trading

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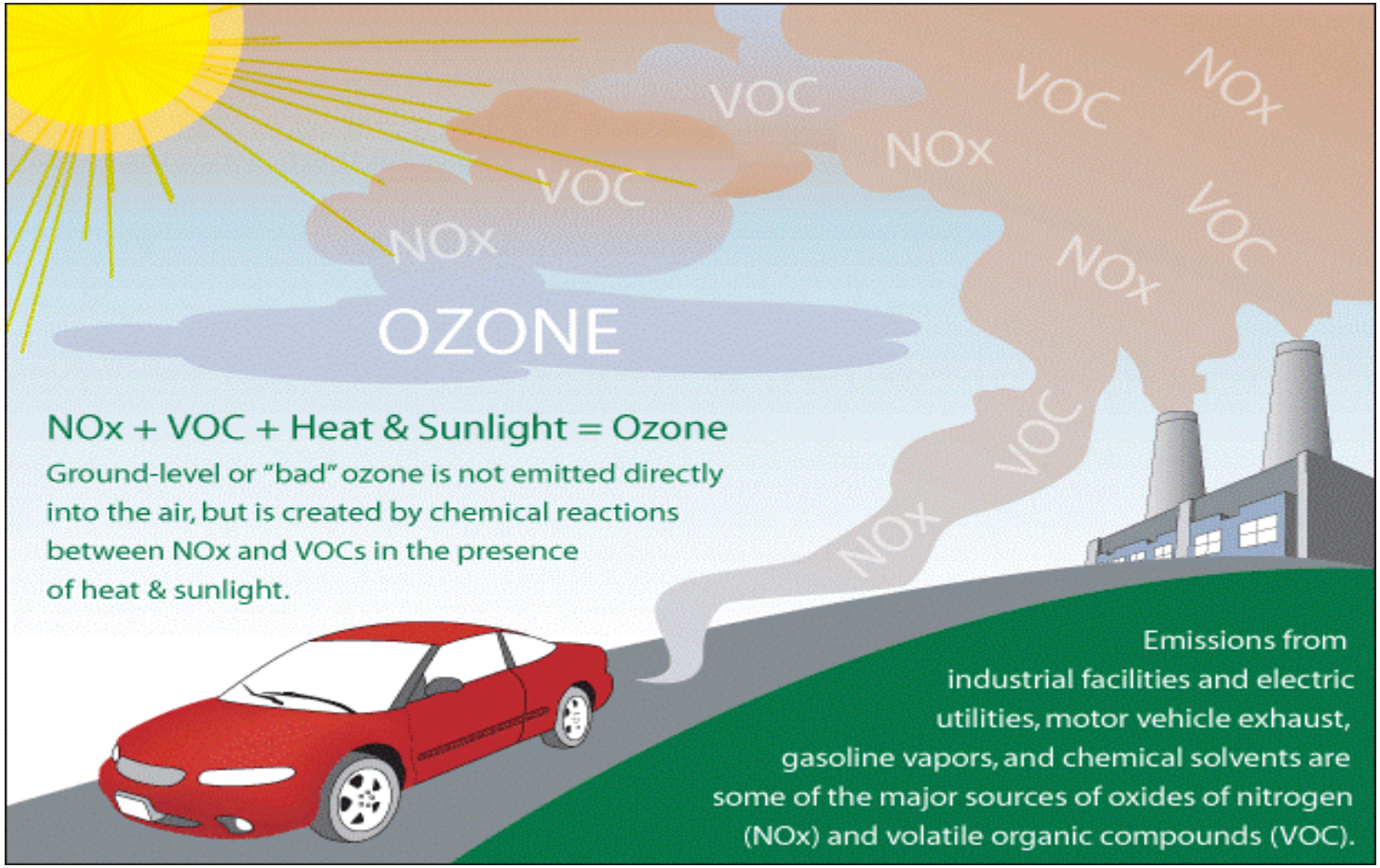
January 14, 2021

Overview

1. What is inter-precursor trading?
2. Why inter-precursor trading is conducted?
3. Why modeling for inter-precursor trading?
4. How to conduct such a modeling analysis?
5. How to analyze the model results?

Precursor of Ozone Formation



Source: US EPA, https://www.airnow.gov/index.cfm?action=aqibasics.ozone

HGB Ozone Nonattainment Status

- 2015 Eight-Hour Ozone Standard – 0.070 ppm
  - *Marginal Nonattainment – August 3, 2018*
- 2008 Eight-Hour Ozone Standard – 0.075 ppm
  - *Marginal Nonattainment – July 20, 2012*
  - *Moderate Nonattainment – December 14, 2016*
  - *Serious Nonattainment – September 23, 2019*
  - *Severe Nonattainment – ?*
- Major Source Threshold – 50 TPY NO_x/VOCs *(25 TPY if severe)*
- Net-Out Threshold – 25 TPY NO_x/VOCs
- Netting Threshold – 5 TPY NO_x/VOCs
- Offset Ratio – 1.2 to 1

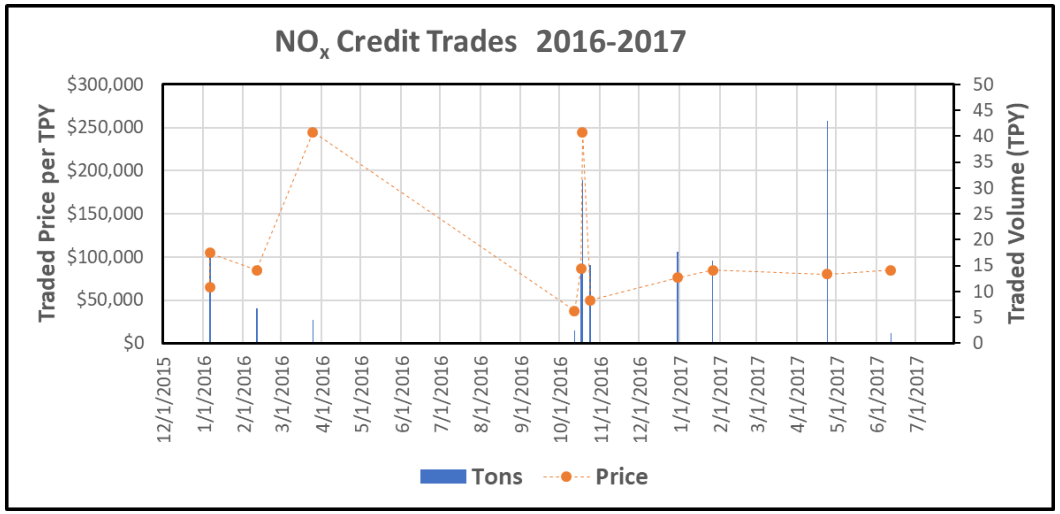
Ozone Design Values – HGB Area

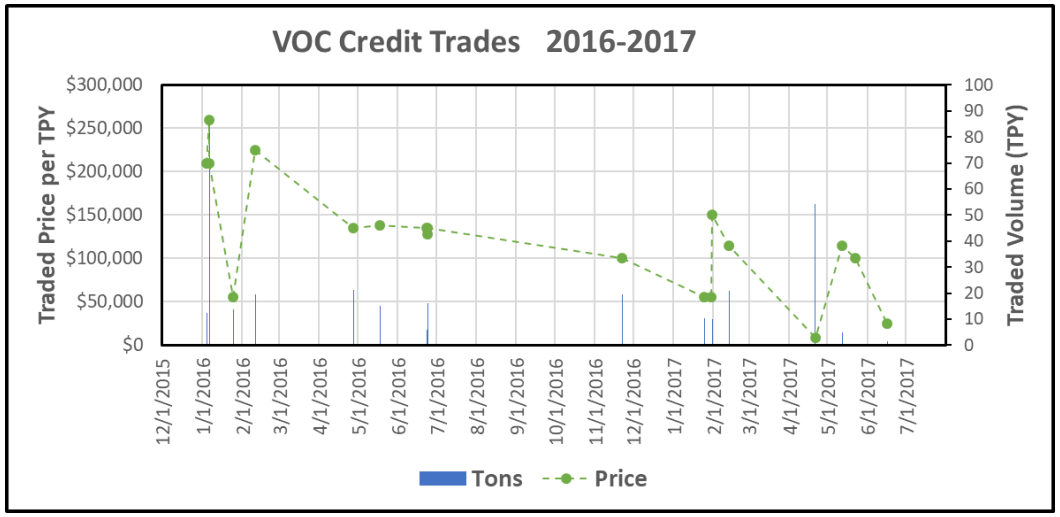
Monitor	POC	2017	2018	2019	2020	17-19 Avg	18-20 Avg
Seabrook Friendship Park C45	1	67	82	64	64	71	70
Houston Westhollow C410	1	71	69	73	66	71	69
Hou.DeerPrk2 C35/235/1001/AFH139FP239	1	66	85	76	**73**	75	**78**
Houston North Wayside C405	1	68	66	67	61	67	64
Houston Monroe C406	1	59	68	71	62	66	67
Conroe Relocated C78/A321	1	79	75	74	**75**	**76**	74
Houston East C1/G316	2	70	82	70	67	74	73
Channelview C15/AH115	3	65	79	67	62	70	69
Lake Jackson C1016	1	65	67	63	65	65	65
Baytown Garth C1017	1	73	81	69	66	74	72
Park Place C416	1	72	77	72	70	73	73
Houston Croquet C409	2	67	70	75	66	70	70
Houston Aldine C8/AF108/X150	2	74	88	81	68	**81**	**79**
Houston Bayland Park C53/A146	1	74	77	80	**73**	**77**	**76**
Clinton C403/C304/AH113	3	77	68	73	71	72	70
Northwest Harris Co. C26/A110/X154	2	74	77	73	71	75	73
Manvel Croix Park C84	1	77	71	79	70	75	73
Lang C408	2	70	74	75	69	73	72
Galveston 99th St. C1034/A320/X183	1	73	76	79	68	**76**	74
Lynchburg Ferry C1015/A165	1	46	74	68	61	62	67

What is Inter-Precursor Trading?

- Nonattainment New Source Review
  - *Title 30 Texas Administrative Code (TAC) §101.302(a) and §101.372(a) allow the use of emission credits (EC) and discrete emission credits (DEC) of one ozone precursor (i.e., nitrogen oxides [NO_x] or volatile organic compounds [VOC]) to meet the requirements for the other ozone precursor.*
- Ozone inter-precursor trading
- NO_x credits for VOC emissions, or the other way around
- Current market trends NO_x is the less expensive (now may need to consider the NO_x limiting factors)

Why Inter-Precursor Trading? (2016 – 2017 Data)





Average Price of Credits Weighted by Trade Volume*

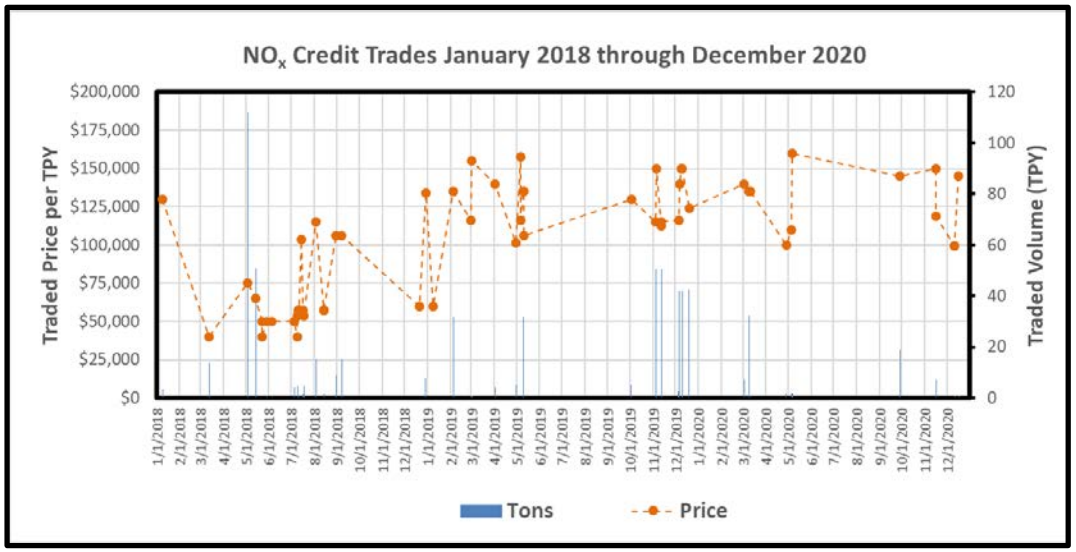
	NO_x	VOC
2016-17	$114,766	$146,686
2016 Only	$132,985	$190,266
2017 Only	$ 81,470	$ 54,518**

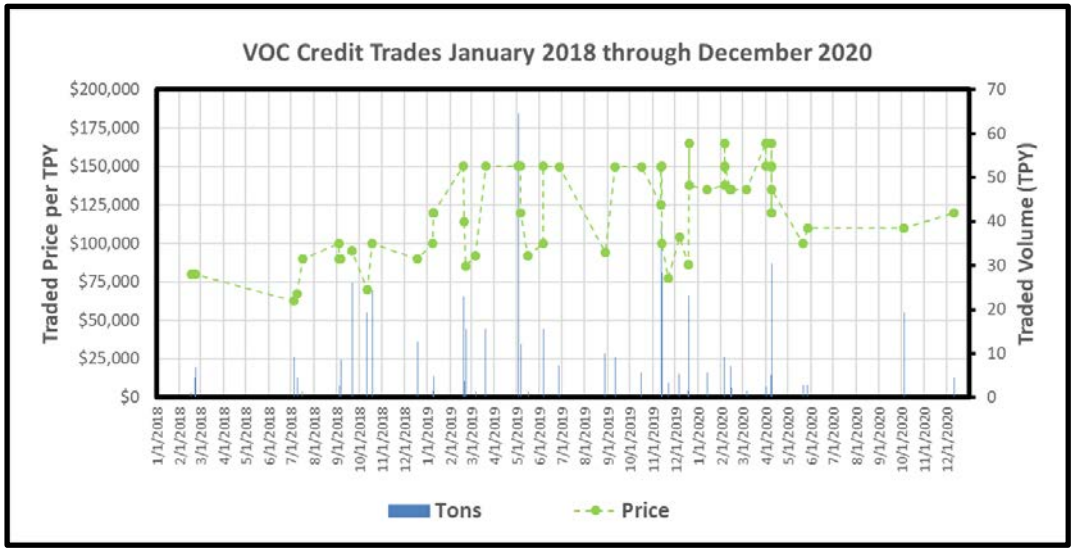
Notes:

*Trades less than $1 per ton are excluded. Swaps are excluded or adjusted.

**When excluding an outlier trade with $8,300 per ton at 54.2 tons, the average comes to $106,165.

Why Inter-Precursor Trading? (2018 – 2020 Data)





Average Price of Credits Weighted by Trade Volume*

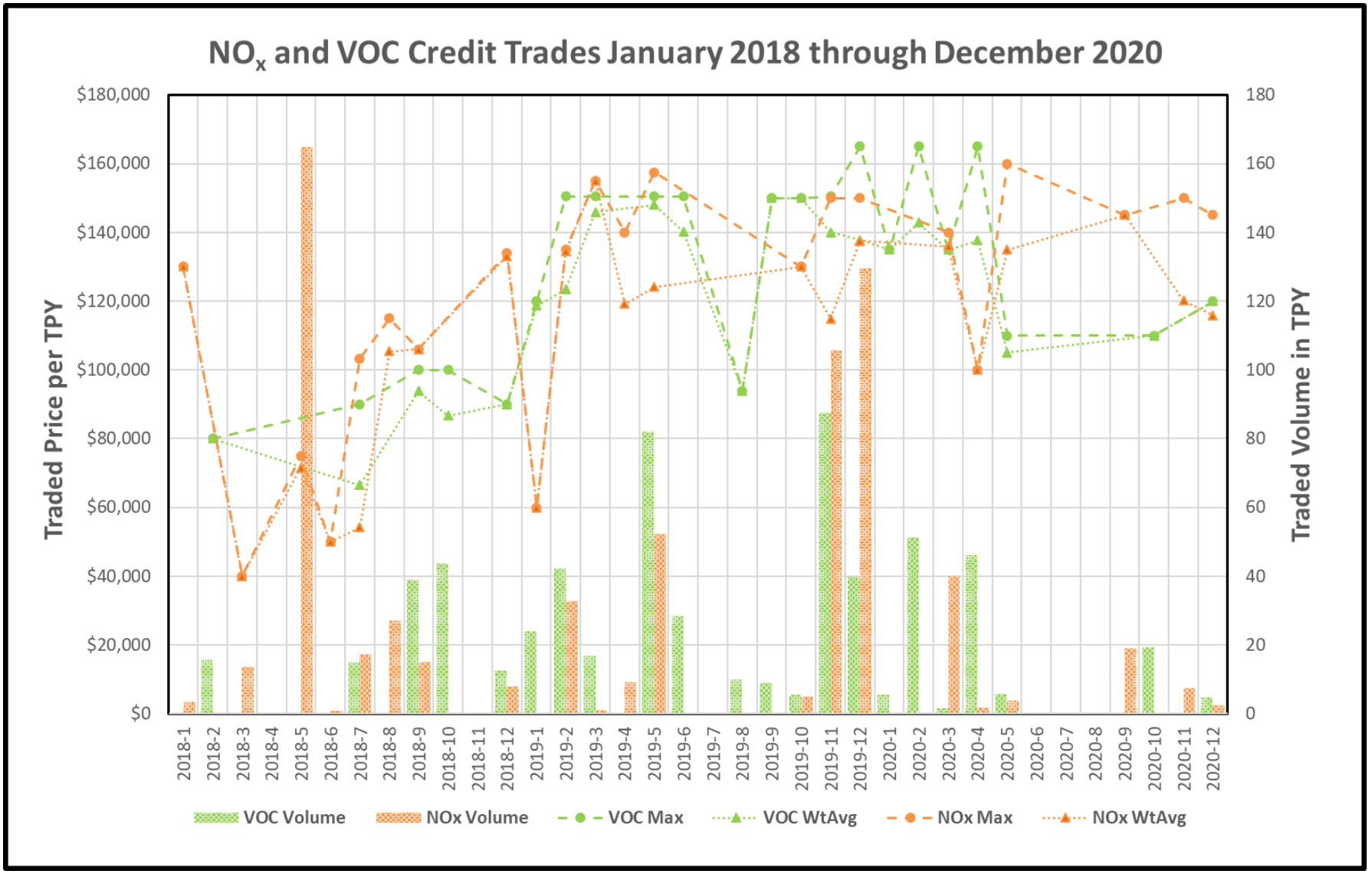
	NO_x	VOC
2018-2019	$105,950	$123,759
2018 Only	$ 77,157	$ 86,031
2019 Only	$127,374	$137,553
2020 Data	$135,027	$133,467

Notes:
*Trades less than $1 per ton are excluded. Swaps or possible barters are excluded or adjusted. Only includes HGB trades.

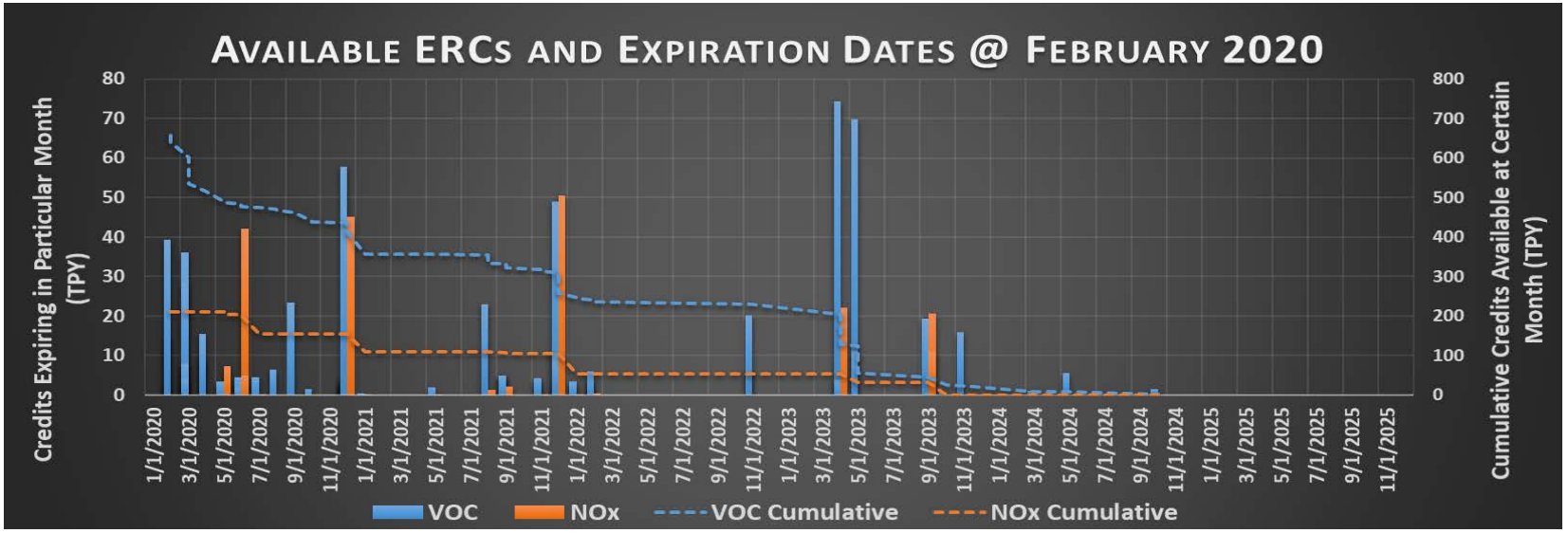
Other Observations:

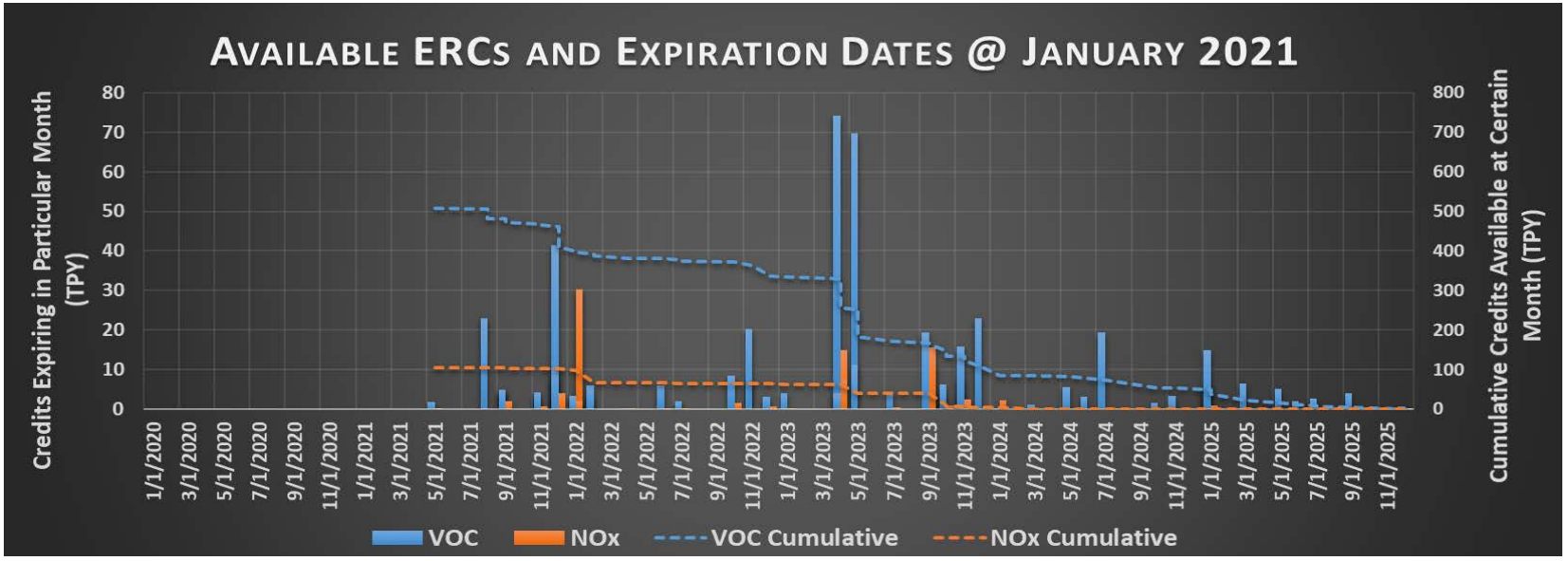
- Price stabilized towards the end of 2019
- Price slightly increased in 2020
- Broker price NO_x ~$115K (’19) to $145K (’20)
- Broker price VOC ~$150K (’19) to $165K (’20)
- Price gap between NO_x and VOC are smaller, even reversed in 2nd half of 2020 (due to a big non-broker deal)

Why Inter-Precursor Trading? (2018 – 2020 Data)



ERCs Available for Trading (HGB Only)





Why Modeling for Inter-Precursor Trading?

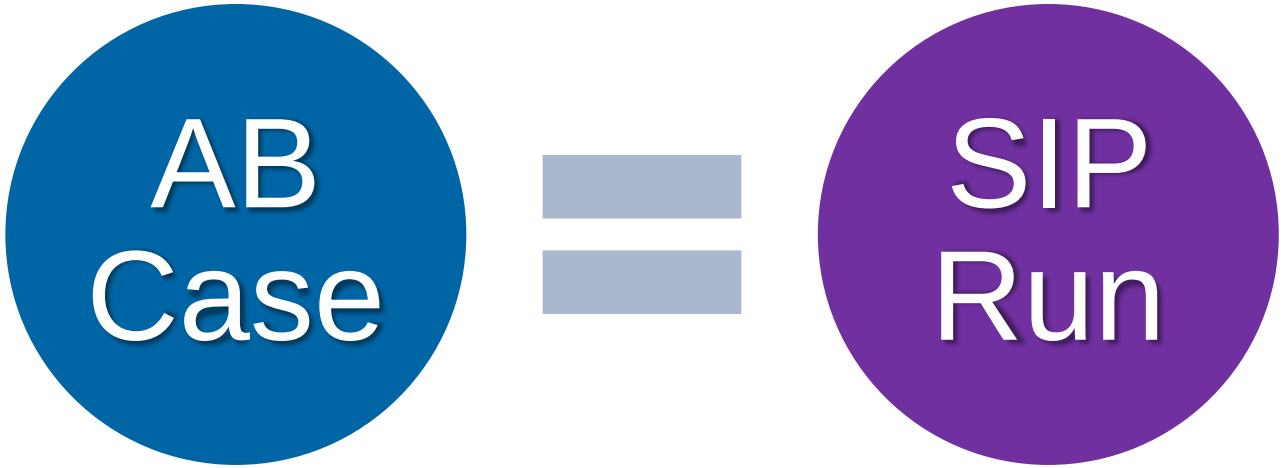
To make sure that by retiring one precursor's emission reduction credits for another precursor's new emissions does not negatively affect air quality.

> *… inter-pollutant (IP) use of credits requires a photochemical modeling demonstration and the approval of both the Texas Commission on Environmental Quality (TCEQ) and the United States Environmental Protection Agency (EPA)." – Guidance on the IP Use of Credits for NNSR Offsets, TCEQ, updated June 2019."*

How to Conduct an IPT Model?

- Typical Photochemical Grid Models
  - CAMx – Comprehensive Air Quality Model with Extensions
  - CMAQ – Community Multiscale Air Quality Model
- 3 Model Runs
  - Attainment Baseline (AB) Case
  - Credit Baseline (CB) Case
  - Project Baseline (PB) Case
- Comparative Analysis

Setup Model Runs

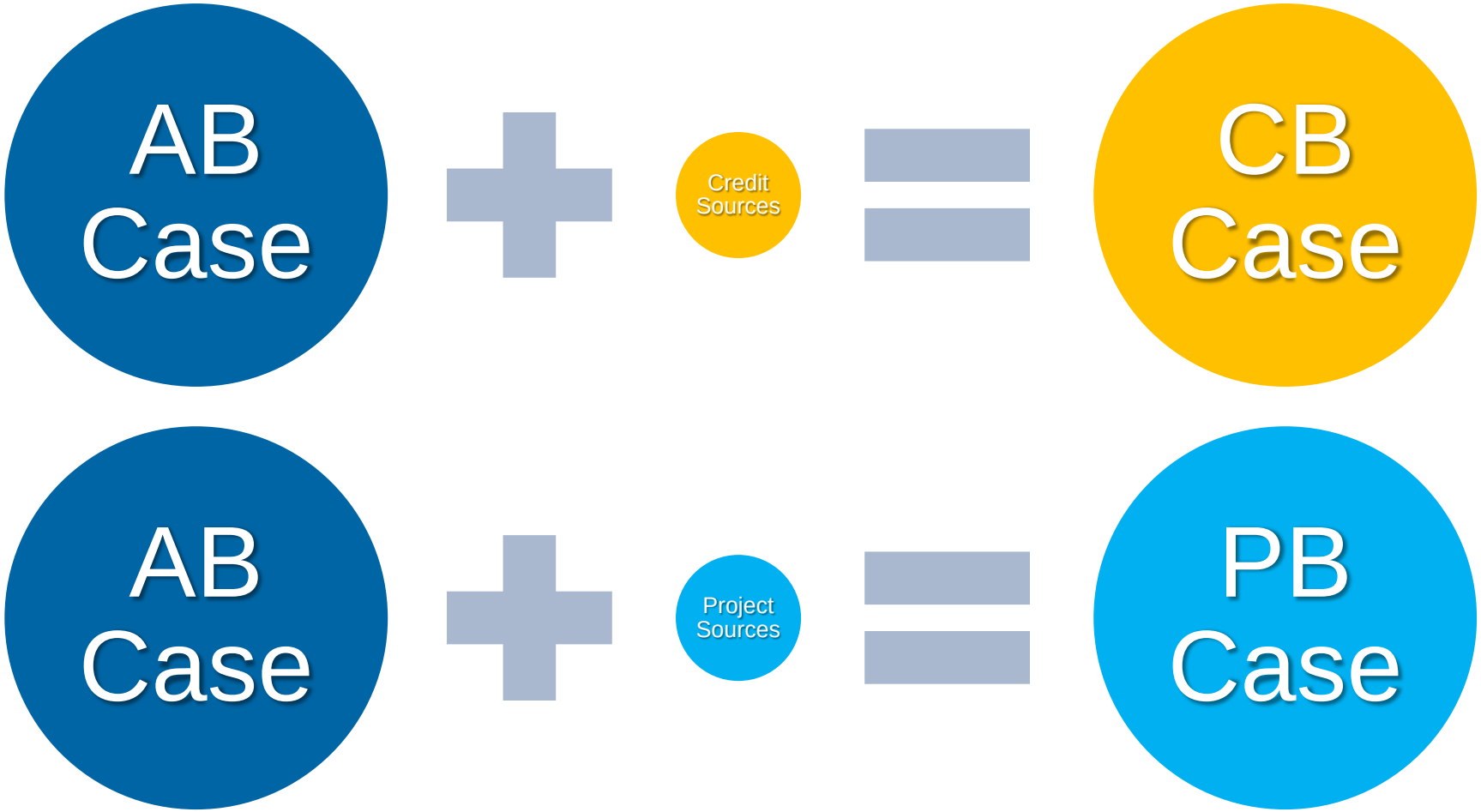


AB Case = Duplicate SIP run

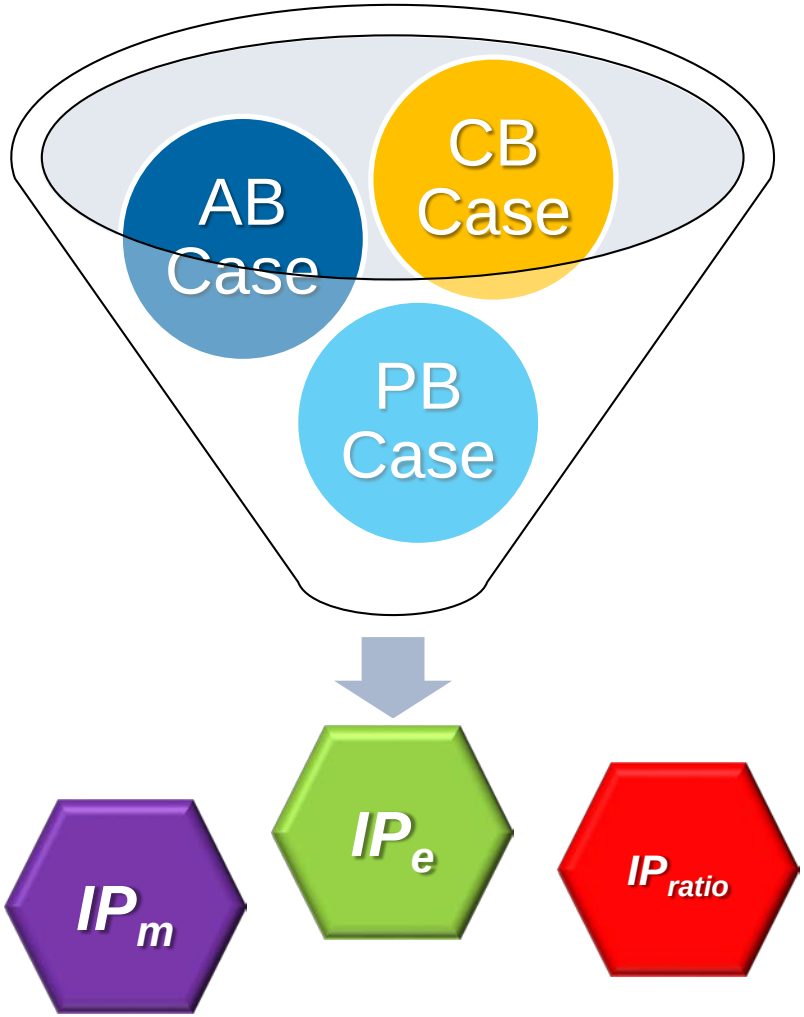
Identical results? Close enough results?

Difference of each grid cell-day <= 0.1 ppb

Setup Model Runs



How to Analyze the Results?



Define Grid Cell-Day

You modeled 6 grid cells and modeled 3 days, how many grid cell-days are there total? It's a 4D time-space concept.

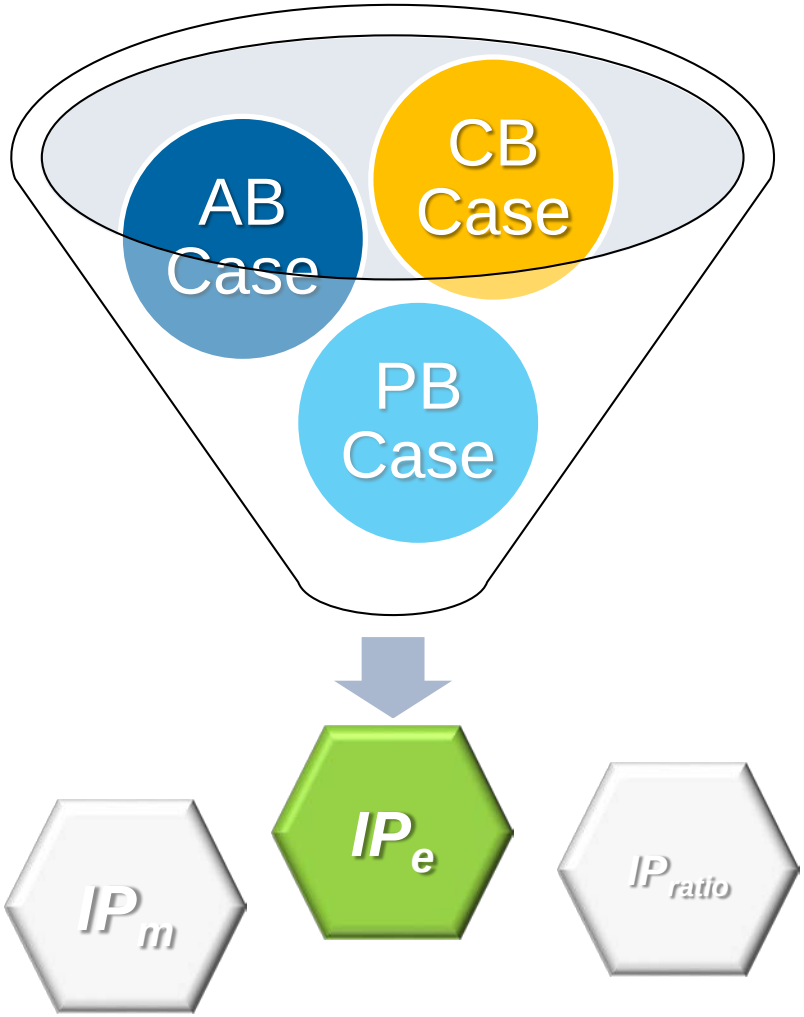
Modeled Dates:

Day 1
Day 2
Day 3

Model Domain:

(1,1)	**(1,2)**	**(1,3)**
(2,1)	**(2,2)**	**(2,3)**

Overall Air Quality – IP_e



Overall Air Quality Effect – IP_e

Identify all **grid cell-days** that the model predicts an ozone concentration > 65 ppb (5 ppb less than the standard), denote as *n*.

The ozone concentration of the grid cell-day *n* is:

- OA_n – AB Case
- OC_n – CB Case
- OP_n – PB Case

Quick Illustration – AB Case

48.5	**50.6**	**55.1**
49.6	**58.2**	**66.9**

Day 1

64.5	**70.6**	**75.1**
69.6	**78.2**	**82.9**

Day 2

73.1	**55.6**	**55.1**
49.6	**51.2**	**62.9**

Day 3

How many grid cell-days to be considered?

Quick Illustration – PB Case

48.5	50.6	55.1
49.6	58.2	66.9

64.5	70.6	75.1
69.6	78.2	82.9

73.1	55.6	55.1
49.6	51.2	62.9

AB Case

49.5	51.6	56.1
50.6	59.2	67.9

65.5	71.6	76.1
70.6	79.2	83.9

74.1	56.6	56.1
50.6	52.2	63.9

PB Case

Day 1 Day 2 Day 3

Which grid cell-days to be considered?

Overall Air Quality Effect – IP_e

Impact of the Credit Base Case:

- $E_C = \sum_{n=1}^{N}(OC_n - OA_n)$

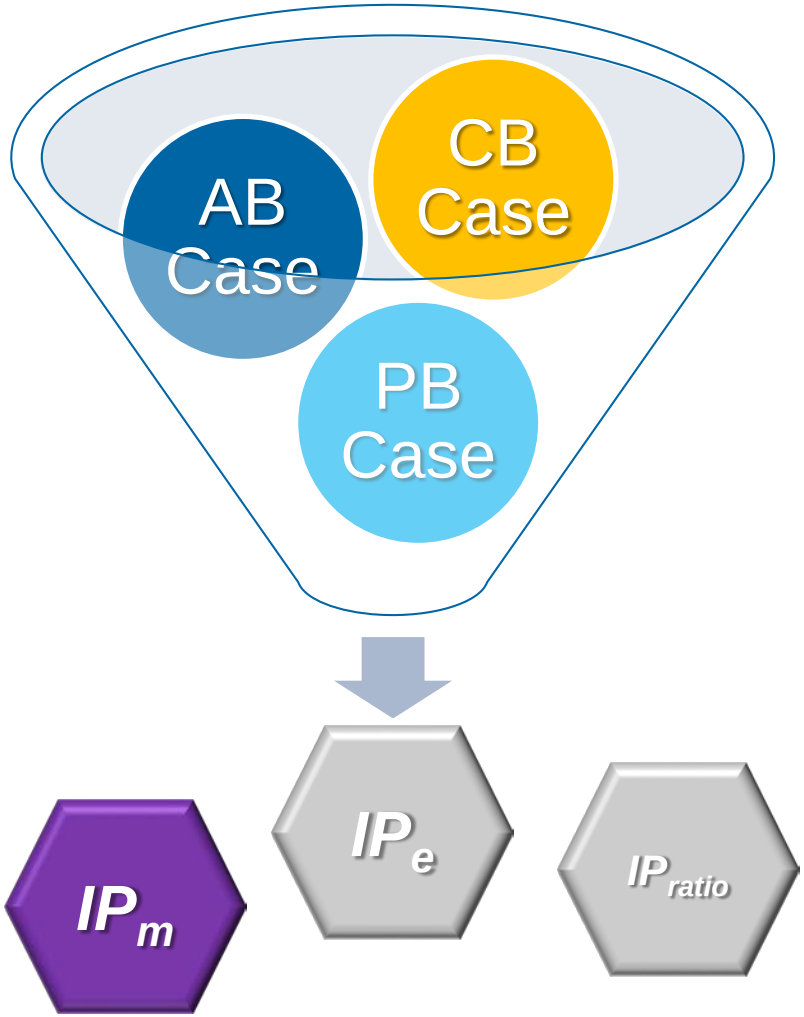
Impact of the Project Base Case:

- $E_p = \sum_{n=1}^{N}(OP_n - OA_n)$

Overall effect of the inter-precursor trade:

- $IP_e = E_c - E_p$
- Goal is: $IP_e \geq 0$

Monitor Design Values – IP_m



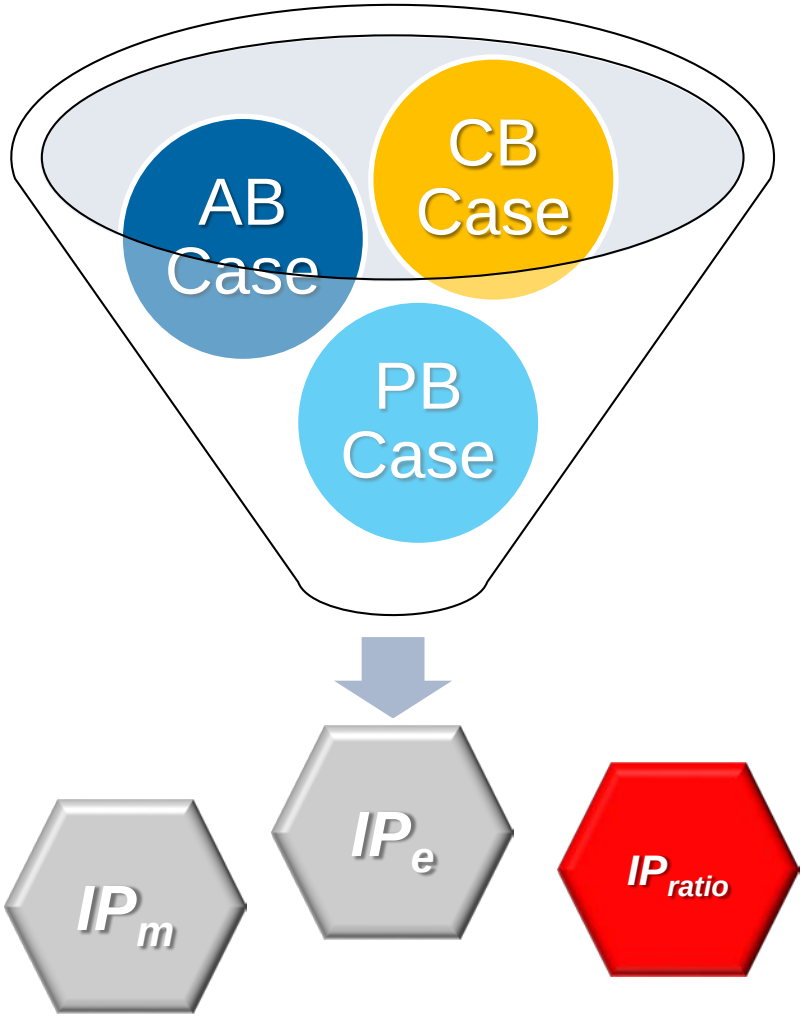
Monitor Design Values – IP_m

For each monitor within the nonattainment area:

- DVC_m – Predicted CB Case Design Value
- DVP_m – Predicted PB Case Design Value

- $IP_m = DVC_m - DVP_m$
- Goal is: $IP_m \geq 0$

Trading Ratio – IP_{ratio}



Trading Ratio – IP_{ratio}

$$IP_{ratio} = \frac{CB_{ei}}{PB_{ei}}$$

- CB_{ei} – Credit to surrender, tpy
- PB_{ei} – Project emissions, tpy

- This ratio is fixed before the model run, instead of being determined after the model run.
- Minimum trading ratio? – Depending on state agencies
- December 2018, for the first time a trading ratio < 1 is approved, i.e., 1 ton of NO_x used to offset 2.4 tons of VOCs in Texas

Inter-Basin Trading and Modeling?

- There had been inter-basin trading of credits, e.g., using DFW credits to offset HGB emissions.
- Modeling had shown very minimal (if at all) benefits of credits retired in DFW to the HGB area, not surprising considering the distance.
- Used to be modeled in a inter-precursor (in the same basin) and inter-basin combination project, but the inter-precursor part does the majority of the job.
- Now that trading ratio < 1 could be allowed, do we still need inter-basin trading and modeling?

Summary

1. Different limiting mechanisms for ground level ozone formation provides the justification to use IPT

2. Cost difference between VOCs and NO_x credits creates an arbitrary opportunity. Market activities tend to close (had closed?) the gap between VOCs and NO_x credits, but IPT modeling opportunity still exists as IP_{ratio} is always case-by-case.

3. 4-Step IPT modeling, including AB, CB, PB runs and comparative analysis, demonstrates the project has no negative impact to the air quality by evaluating IP_e, IP_m, and determines IP_{ratio}.

Questions

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