Alberta's Air Quality Model Guideline:
draft update 2020

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Air Policy

Alberta Environment and Parks

Alberta's Air Quality Model Guideline: draft update 2020

Outline

Alberta's Air Quality Model Guideline: Draft Update 2020

Copy:
https://www.alberta.ca/air-quality-modelling-overview.aspx

Comments:
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Closing date for comments:
Midnight, October 2, 2020

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AQMS Overview

Modelling Approach

- **Tiering**
- **Scenarios**
- **Source Types**
- **Terrain, receptors and modelling domain**
- **Meteorology**

Model Output

- **Sub/super-hourly averaging times**
- **Baseline concentrations**
- **Chemistry:**
  - **NO_2/NO_x conversion**
  - **Other chemistry**
  - **TRS**
- **Acid Deposition**

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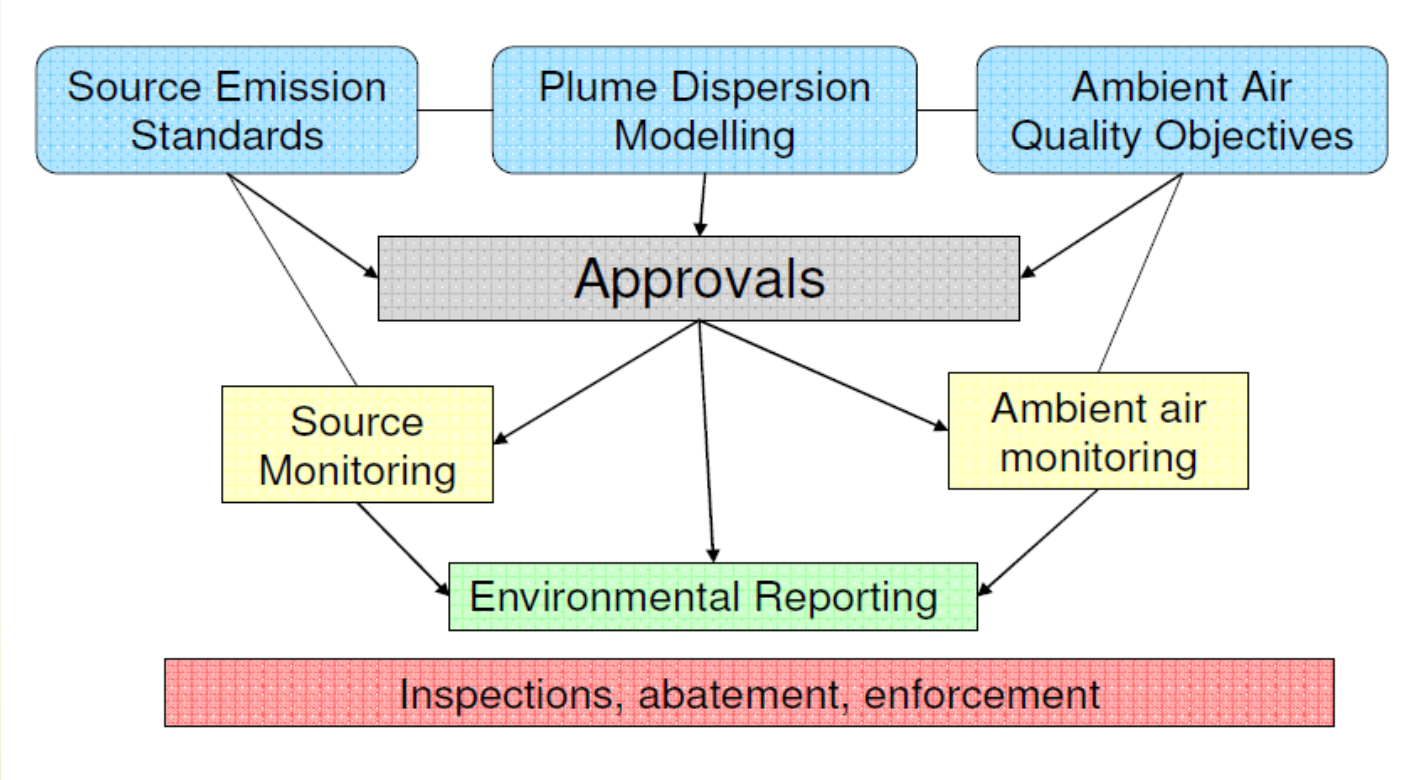
AQMS Overview



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Modelling Approach

Tiering

Screening – simple cases/preliminary look at problem/nearby sources

Refined/Advanced – consider terrain/alternate switches

Alternate – specialized/one of

Table 1 Assessment Level and Corresponding Acceptable Air Quality Model(s)

Air Quality Assessment	Approved Air Quality Model	Restrictions			
		Switches	Model Domain	Meteorology	Other
Screening	AERSCREEN		≤ 50 km	MAKEMET	Few sources; simple terrain.
Refined	AERMOD	Appendix D	≤ 50 km	Regulatory Mesoscale + onsite (if available)	Simple terrain; okay for particle deposition assessment but not acid deposition assessments
	CALPUFF	Appendix D	≤ 200 km	Regulatory Mesoscale + onsite (if available)	Complex and simple terrain
Advanced	AERMOD	Written approval of Director before modelling; side by side comparison with Refined model required	≤ 50 km	Regulatory Mesoscale + onsite (if available)	Simple terrain; okay for particle deposition assessment but not acid deposition assessments
	CALPUFF	Written approval of Director before modelling; side by side comparison with Refined model required	≤ 200 km	Regulatory Mesoscale + onsite (if available)	Complex and simple terrain
Alternate	Other	Written approval of Director and AEP before modelling; side by side comparison with Refined model required		Regulatory Mesoscale + onsite (if available)	Open source; deprecated regulatory models are not allowed

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Modelling Approach (Refined/Advanced)

Scenarios

Max = Typical – model max

Max ≠ Typical – more complicated:

Max due to infrequent event – model infrequent event: more tolerant stats (1% of time, 1.5 AAAQO); model typical

Max due to other – model max; model typical: usual stats (0.1% of time, AAAAQO)

New – estimated rates

Renewal/Amendment – historical average

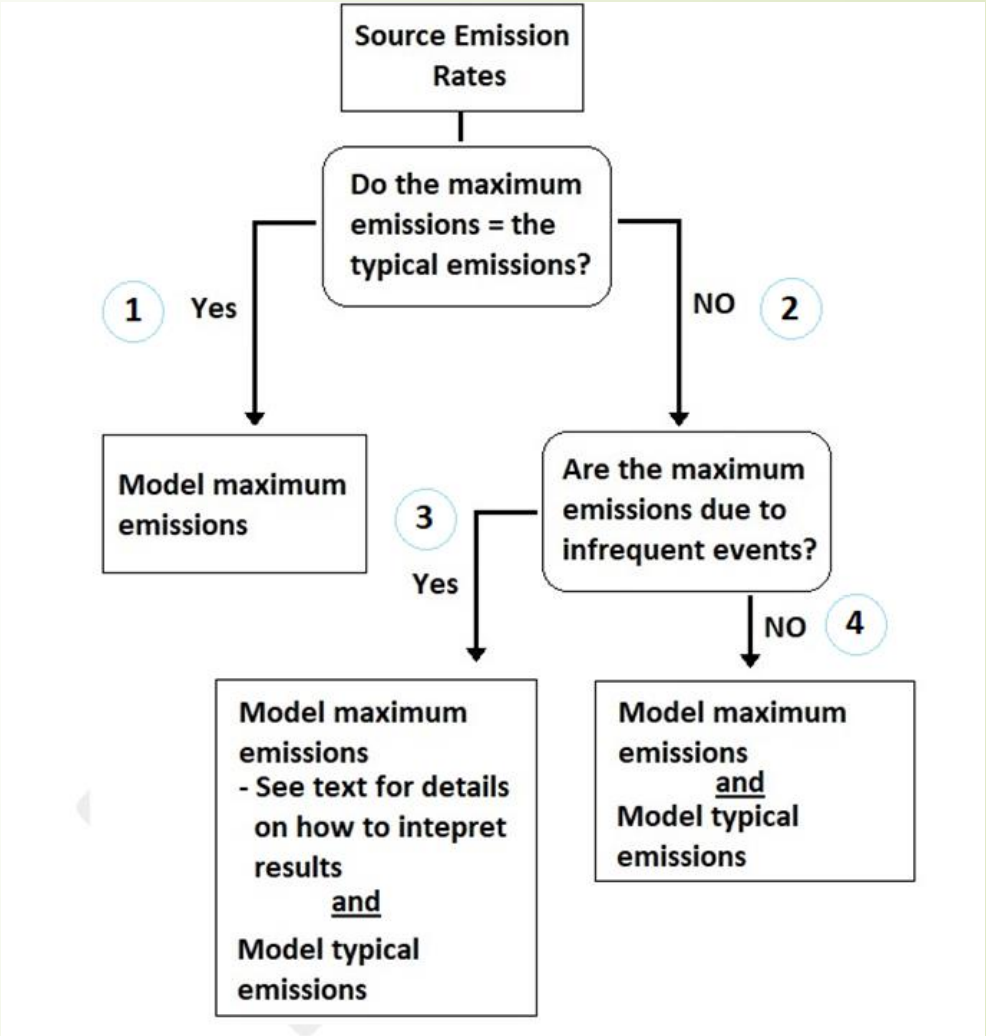

Figure 3. Generic logic for the selection of emission scenarios required for a modelling assessment. The logic is applicable to new, renewal and amendment applications (see text below for details).

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Modelling Approach

Source Types

Merged Stack Sources

- EPA formulation (EPA 1992)
  - Similar stack parameters
  - Merged sources can be used for screening model
  - Must consider nearby sensitive receptors
  - Must consider downwash

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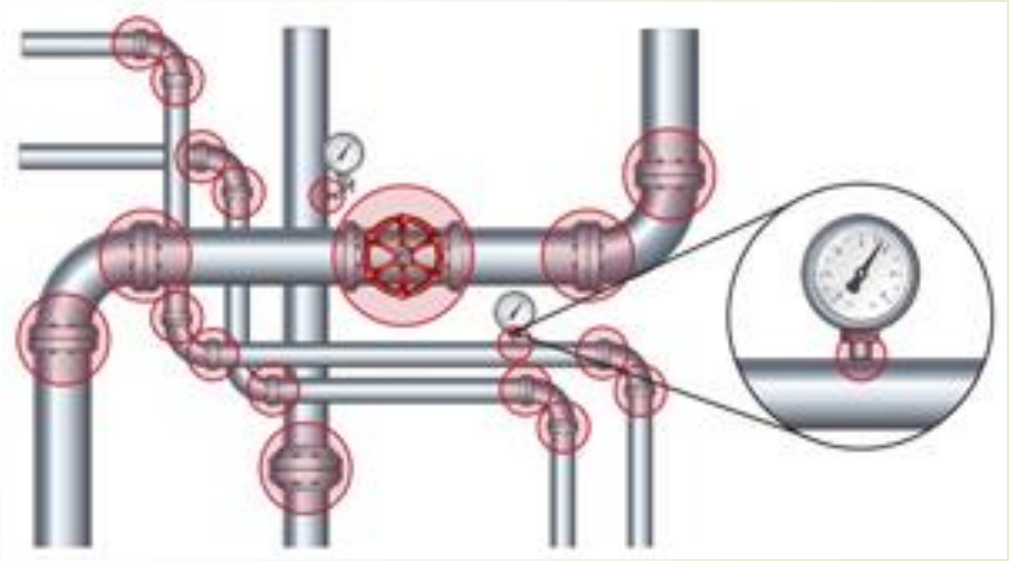
Modelling Approach

Source Types

Fugitive Emissions

- AP42



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Modelling Approach

Source Types

Flaring

- Use AER flaring tools to generate pseudo-parameters for all flare modelling
  - Continuous – only pseudo-parameters
  - Non-routine – AER risk-based approach

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Modelling Approach

Source Types

Non-vertical releases and caps

- EPA default algorithm

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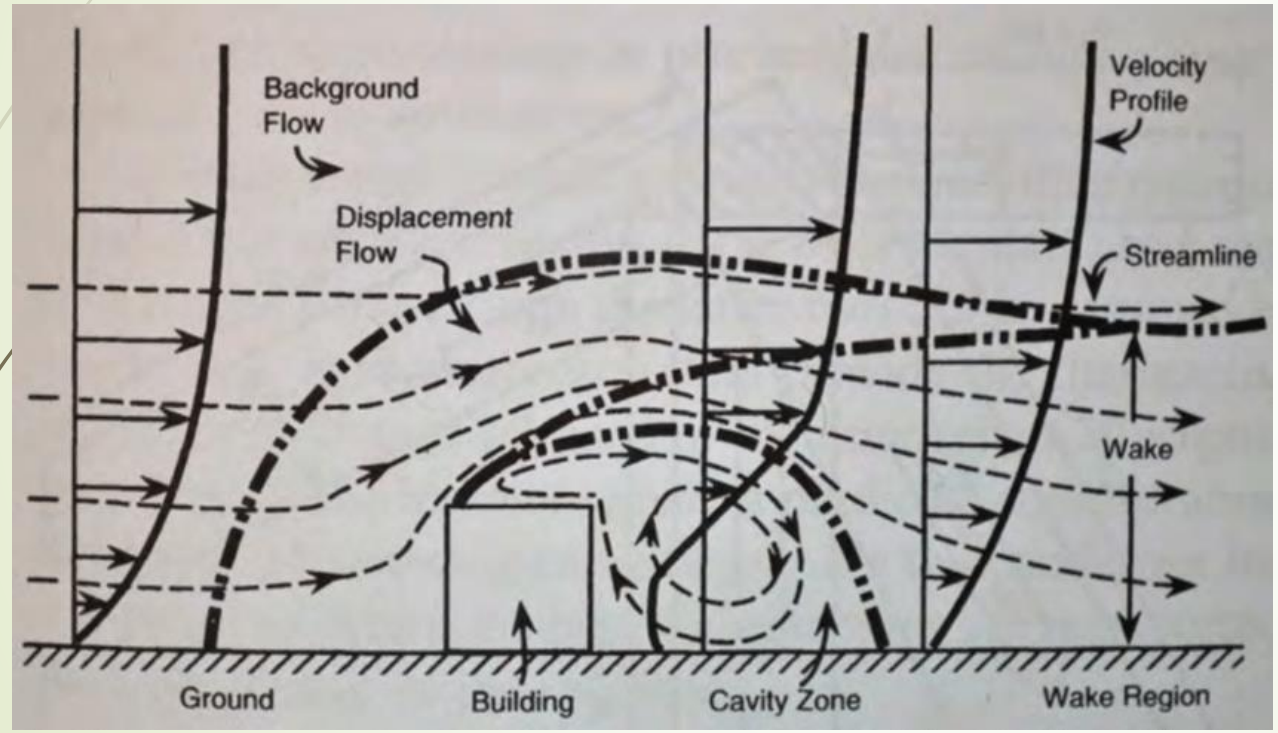

Modelling Approach

Source Types

Building down wash

Several formulations allowed

- Prime
- ISCST3 (under certain configurations)

Alternate

- ORD
- Prime2/AWMA

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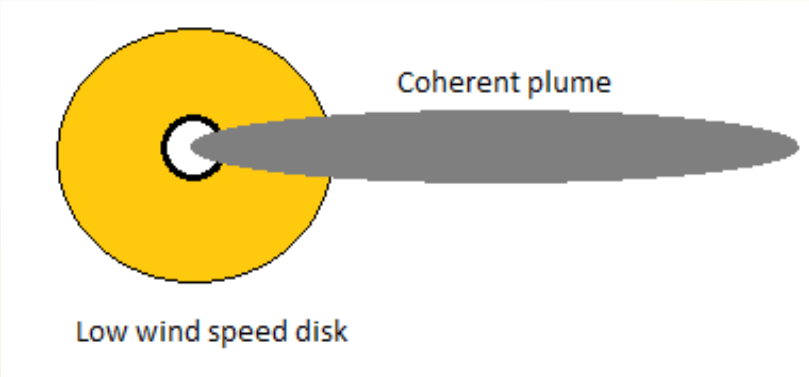
Modelling Approach

Source Types

Low-wind options (AERMOD)

- Use EPA default option at moment
- If EPA sets new parameterization then use these



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Modelling Approach

Source Types

Particulate emission (TSP) from stack surveys

- Distribute emissions per bin
- Aerodynamic profiling for correct transportation

Example:
Create the appropriate input to model TSP and $PM_{2.5}$ from a pulp and paper source that is emitting 10 g/s of TSP. From the AEIR Standard (Alberta Environment and Parks, 2018) a pulp and paper source has ($PM_{2.5}$/TSP) = 0.560 and (PM_{10}/TSP) = 0.737 (recall that PM_{10} is cumulative and includes the $PM_{2.5}$ mass fraction).

AERMOD Solution:

To set up AERMOD it is necessary to first define the mass fraction. For this problem a table of input values for particulate deposition modelling is as follows:

PM Species	Mean Particle Diameter (μm)	Mass Fraction*	Particle Density (g/cm^3)	Mass (g)
P1 (PM2.5)	0.625	0.1400	1	1.400
P2 (PM2.5)	0.875	0.1400	1	1.400
P3 (PM2.5)	1.125	0.1400	1	1.400
P4 (PM2.5)	1.875	0.1400	1	1.400
P5 (PM10)	4.250	0.0885	1	0.885
P6 (PM10)	8.000	0.0885	1	0.885
>PM10	20.000	0.2630	1	2.630

* The mass fraction is assumed to be distributed uniformly amongst the different diameter bins associated with a particular PM species.

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Modelling Approach

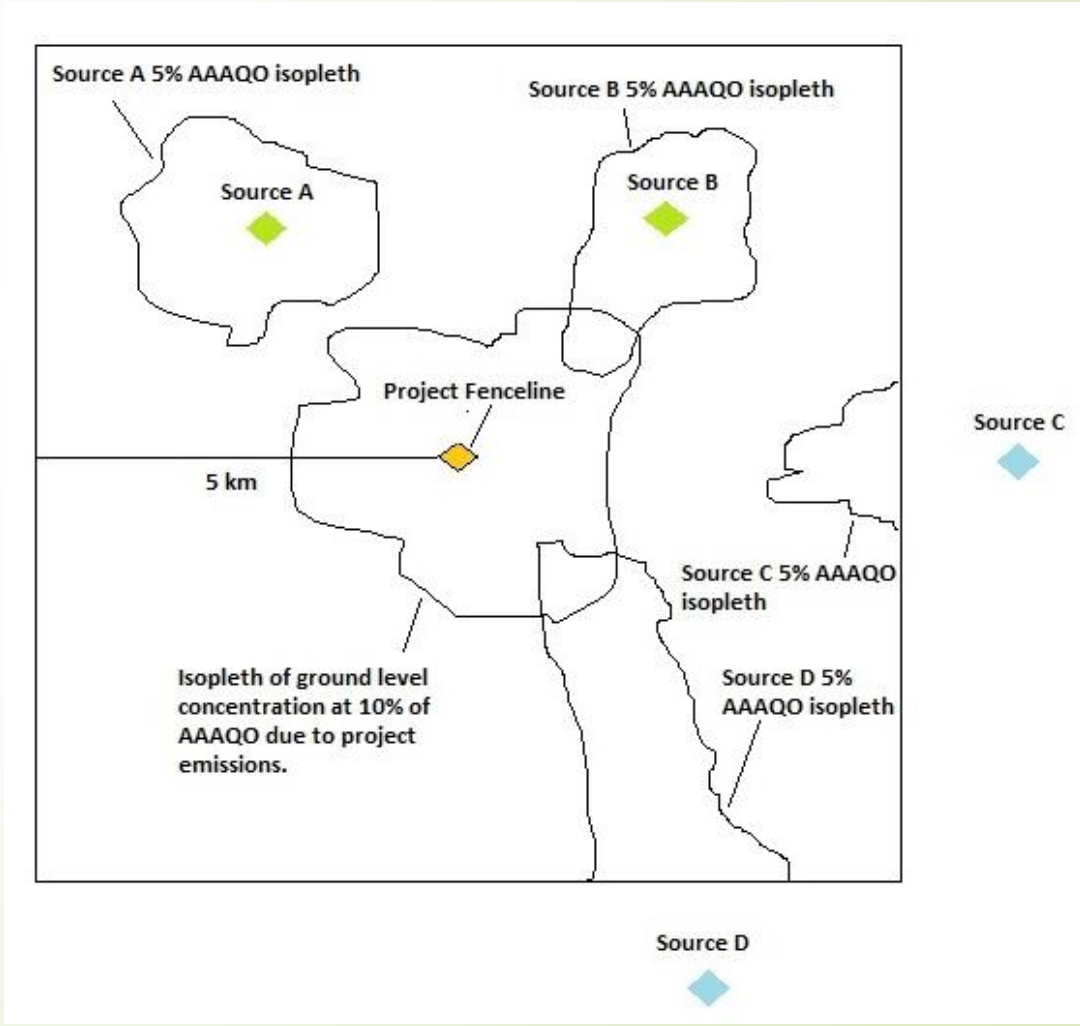
Terrain, receptors and modelling domain

Receptors – standard distribution: 20 m nearby, 50 m further away, etc.

Exception: facilities with large boundaries (mines) – relax if no sensitive receptors nearby

Modelling domain – 5 km minimum from fence line, larger domain if cumulative impact

- can be determined from screening



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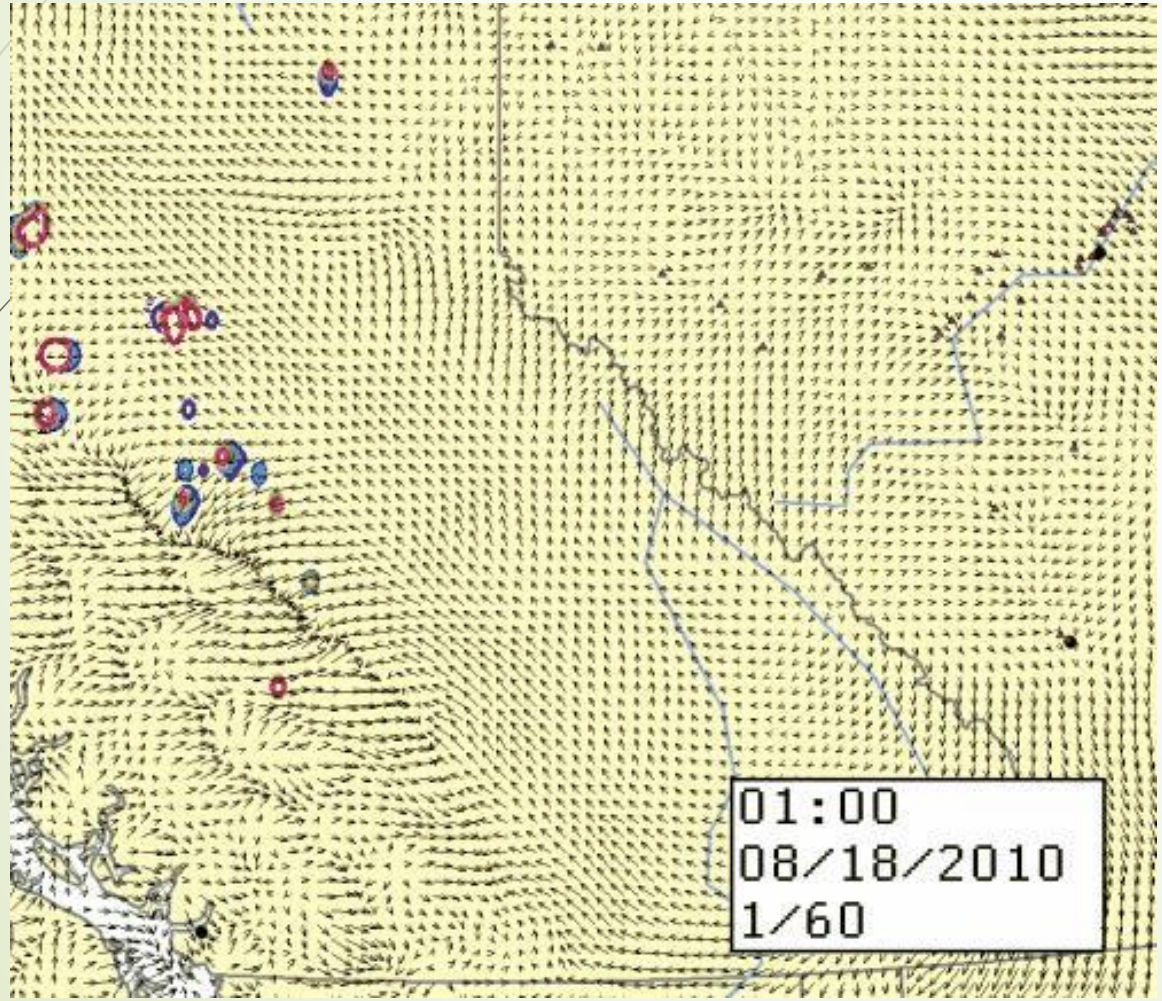

Modelling Approach

Meteorology

No change at this time:

- MM5
- 5 years (2002 – 2006)
- 12 km resolution

(will be updated in near future)

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Modelling Output

Hourly

- May exclude top 8 values (top 0.1%)

Super-Hourly

- Must include all hourly values
  - 8-hour average remove top value
  - 24-hour average and longer no removal allowed

Modelling Output

Sub-Hourly

- Restricted to odour management AAAQGs
- 30 minute average period
- Must be based on include all hourly values
  - May exclude top 0.5% (based on Ontario guidance) – exclude top 44 "sub-hourly" values based on hourly data

$$C_{sub\text{-}hour} = C_{hour} \times (\text{sub-hourly time/hour})^{-0.28}$$

$$= C_{hour} \times 1.21$$

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Modelling Output

Baseline concentrations

- Averaged over last three years
- Check for analyzer changes (do not average if noticeably different – jumps, waves, other discontinuities)
- Each year must be 75% complete
- Screening: 99.9% value; Refined/advanced: 90%

Example: Pollutant with hourly AAAQO.

- Last three years: 93%, 97% and 83% complete.

Hourly:

First and Second year: Remove top 8 hourly values

Third year: Remove top 7 hourly values

Baseline hourly value: Average of remaining top values from three years

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Model Output

Chemistry

NO_2/NO_x

1. Total Conversion Method (always)
2. PVMRM/OLM (AERMOD)/ OLM: use in-stack ratios if available

If $[O_3]_{ambient} > 0.9*[NOx]_{predicted,i}$ then $[NO_2]_{predicted,i} = [NOx]_{predicted,i}$

otherwise $[NO_2]_{predicted,i} = [O_3]_{ambient} + ISR_i*[NOx]_{predicted,i}$

For each i^{th} source determine predicted NO_2. Sum all sources at each receptor.

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Model Output

Chemistry

NO_2/NO_x

3. RIVAD/ISORROPIA (CALPUFF): Use Alberta default NH_3 and H_2O_2 values if no better available

4. ARM (AERMOD and CALPUFF): Use downwind monitoring ratios

   Default value = 0.7

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Model Output

Chemistry

NO_2/NO_x

5. ARM2 (AERMOD and CALPUFF):

   Use current EPA methodology
   if $NO_{2\ (project,\ total)}$ <= 200 ppb use as is
   if $NO_{2\ (project,\ total)}$ > 200 ppb modify based on ISR.
   If <u>all</u> project ISR < = 0.2 then use default
   If <u>any</u> project ISR > 0.2 then use stack ISRs

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Model Output

Chemistry

NO_2/NO_x

In Stack Ratios (ISRs):

1. Stack testing
2. Manufacturer's data
3. EPA list of acceptable ISRs
4. Default values if no better information available:

    Project ISRs = 0.5

    Non-project = 0.2

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Model Output

Other chemistry

SO_2, SO_4, etc. (acid deposition)

Use CALPUFF or other AEP recommended model (not AERMOD)

Use RIVAD/ISORROPIA chemistry (CALPUFF): Use Alberta default NH_3 and H_2O_2 values if no better available

TRS

Reported as TRS, use as is

Reported as mix (e.g., H_2S, CS_2, etc.), then form simple mass sum

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Model Output

Acid Deposition

When required:

1. The proponent's combined emissions of SO_2, NO_x, and NH_3 are greater than 0.175 t/d of H^+ equivalent, i.e.,

   Total H^+ equivalent (t/d) =
   $2*(SO_2\ t/d)/(64)+1*(NO_x t/d)/(46)+1*(NH_3\ t/d)/(17)$, (5)

   or

2. There is evidence that regional soil and surface water is more sensitive to acidification than is estimated in the provincial framework, or

3. There is existing deposition and/or acidification impact monitoring that indicates a potential concern if acid deposition increases.

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Model Output

Acid Deposition

Acidifying deposition from assessment used as input into Acid Deposition Management Framework (ADMF) to determine if critical load is exceeded

Base Cation Deposition: Incorporated into ADMF already (do not add it to acidifying deposition)

Meteorology: Use median average deposition value based on five year regulatory data set

Questions?

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