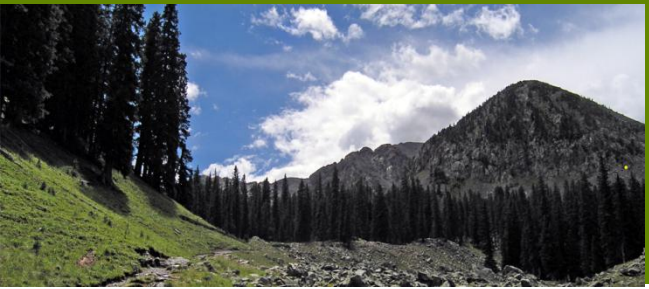




Understanding Today's CAA Permitting Programs: Air Quality Modeling Update



Gale F. Hoffnagle, CCM, QEP
Air Quality Consulting Practice Leader
TRC Companies, Inc.

Guideline on Air Quality Models

- Mandated by the 1977 Amendments
- Codified in 40CFR Part 51, Appendix W
- Requires open Modeling Conference every 3 years (last in March 2012) in order to keep the modeling up to date and adopting the State-of-the Science.
- The guidance is intended to be used for PSD permitting and attainment demonstrations for single sources.
- For State SIP demonstrations other guidance is used
- For Class I demonstrations the Federal Land managers Air quality Guidance (FLAG) is used.

Guideline on Air Quality Models (cont)

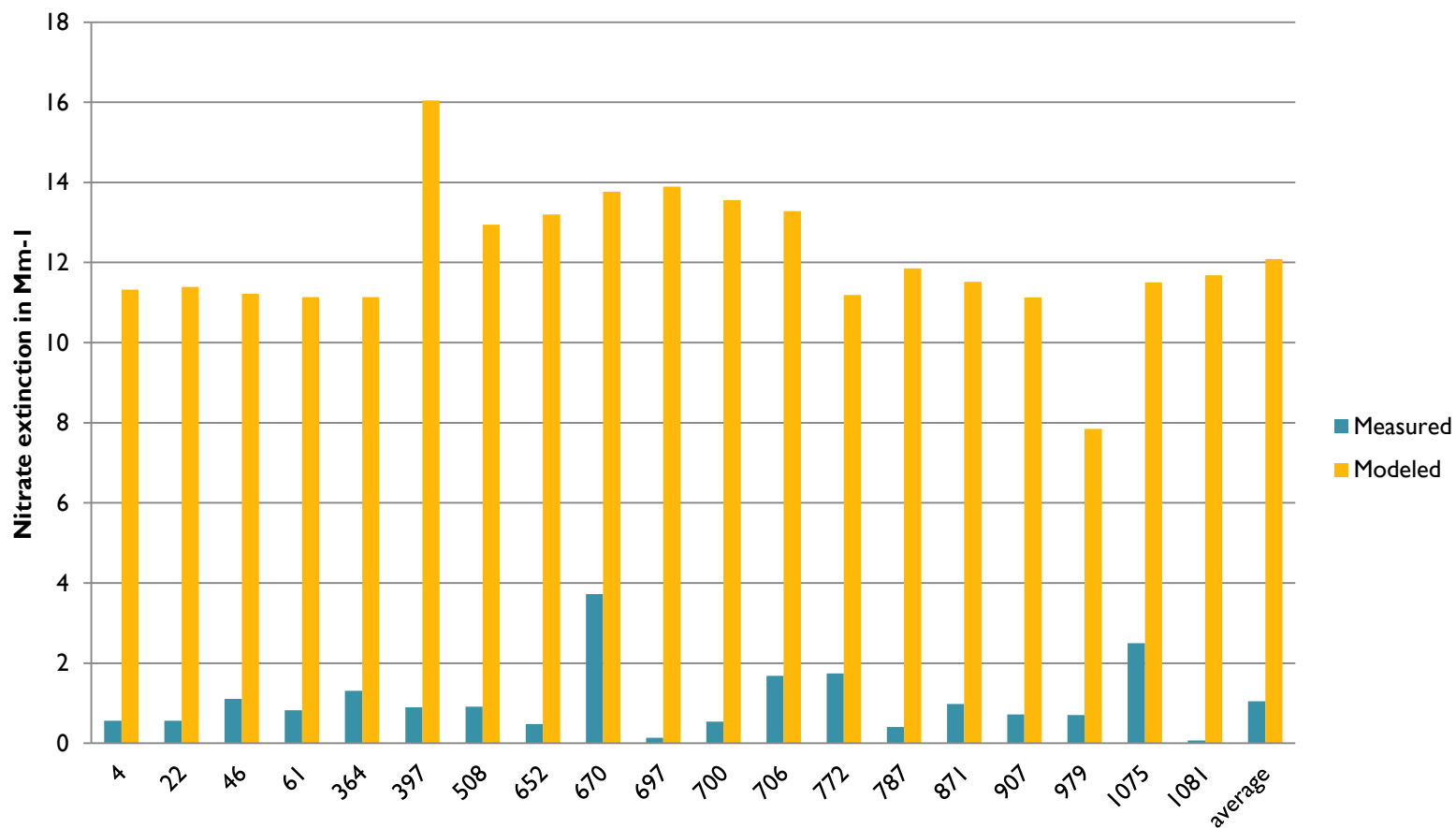
- Since adoption of AERMOD to replace ISC in 2005, EPA has been taking a stronger and stronger position that AERMOD is preferred above all other models. Insists that AERMOD must be used within 50 kilometers of the source.
- CALPUFF is preferred for distances beyond 50 kilometers.
- EPA is in no hurry to adopt or approve for use more advanced modeling techniques into the Guideline.

Do the Models Work

- No
- CAMx and CMAQ models for ozone and PM2.5 may be “adjusted” by use of the monitoring data.
- Guideline modeling is not allowed to be adjusted or calibrated without rigorous model comparisons.
- An example from the BART modeling is instructive.
 - BART modeling requires CALPUFF to be used in a specified and conservative way
 - BART modeling does not consider comparison to actual data

Simultaneous Nitrate Days

**Nitrate Exinction: Measured versus Modeled Days:
Mount Zirkel 2001-2003**



Day in period 2001-2003

The New NAAQS

- Modeling issues for the New NAAQS
 - Sulfur Dioxide (2010) 1 Hour Average (3,24 and Annual)
 - Nitrogen Dioxide (2010) 1 Hour Average (Annual only)
 - PM_{2.5} (2006) Reduced 24 Hour Average (1/2)
Reduced Annual Average (12/15)

These combined make existing and new sources subject to tremendous pressure on emissions.

NO₂ NAAQS

- Compliance with the old annual average NAAQS (100 $\mu\text{g}/\text{m}^3$ or 0.053 ppb) was hard enough for isolated sources. This standard is retained. Modeling often required extended fence lines and arguments about atmospheric chemistry.
- New NAAQS is 188 $\mu\text{g}/\text{m}^3$ (or 100ppb) but for a 1 hour average. Depending upon the meteorology of the site this results in a **6.6** times lower threshold to meet. It therefore will be substantially harder to meet.

NO₂ NAAQS

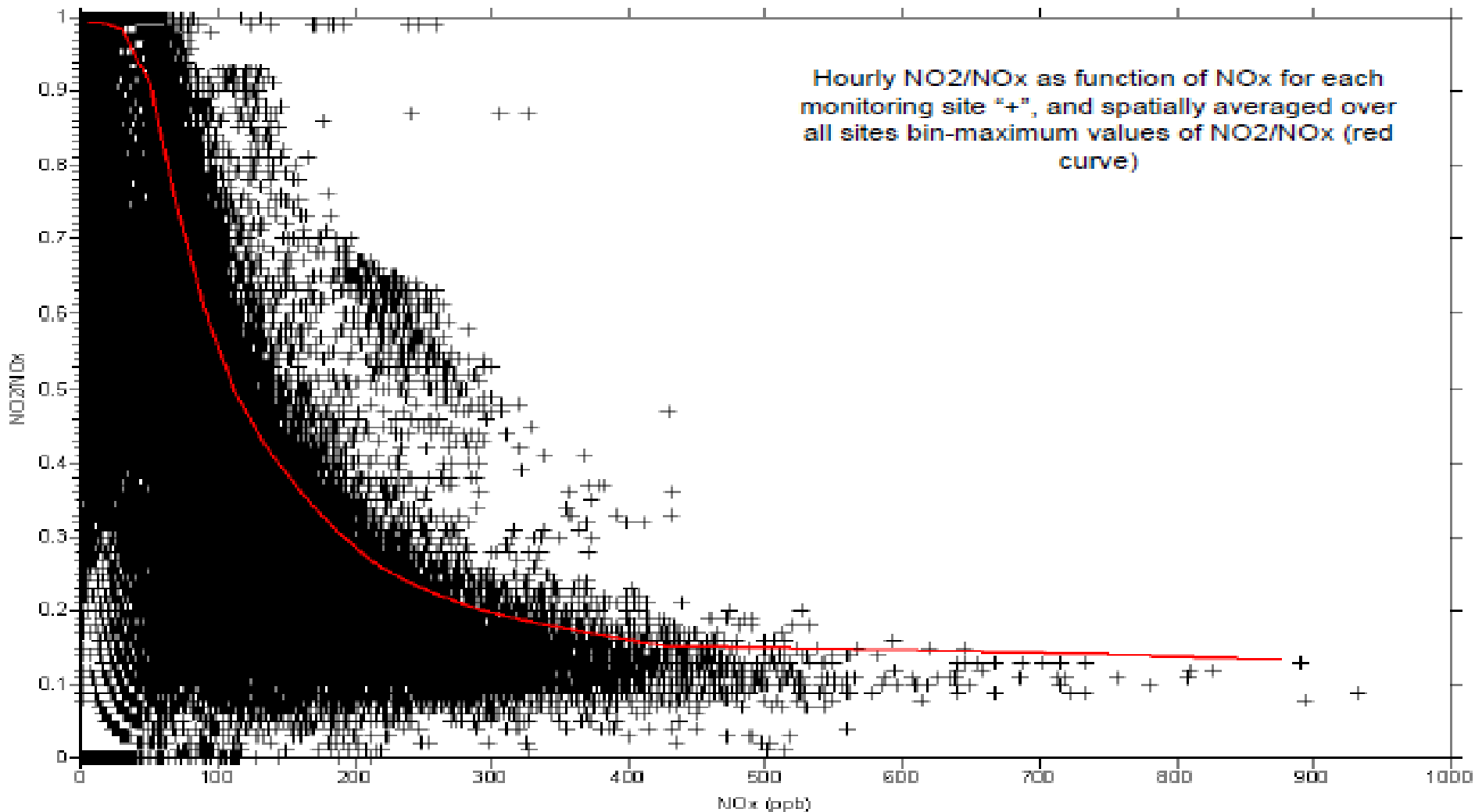
- Compliance is determined by the 98% of the days over 3 years, i. e. each day with a concentration over 188 µg/m³ counts as an exceedance day. The eighth exceedance day is a violation for that year. The 24th exceedance day in 3 years is non-attainment.
- EPA has provided Guidance that you combine the 98% background from monitored data with the 98% modeled result, making compliance much harder. This is equivalent to a 99.995% chance that the observed will be less than the predicted.

NO₂ NAAQS “Guidance”

- Guidance: June 28, 2010, June 29, 2010 and March 1, 2011
 - Issue of what is Nitrogen Dioxide (NO₂) and subject to the NAAQS and what is Nitrous Oxide (NO) and not subject to the NAAQS
 - Memo describes a three Tier approach
 - Tier 1: Assume it is all NO₂
 - Tier 2: Assume that NO₂/NO_x ratio is .80
 - Tier 3: Use 1979 Ozone Limiting Method or PVMRM as detailed screening technique. Calculates that NO_x is converted to NO₂ based on the concentration of ozone. Methods already in AERMOD not acceptable. Assume 50% of what exits stack is NO₂.
 - Tier 3 requires case-by-case determinations (database)

HOURLY NO₂/NO_x Ratio

Hourly NO₂/NO_x [325 station x 8760 hours = 2847000 points]



NO₂ NAAQS Guidance (cont)

- Emergency generators do not need to be modeled when primary source is off, later amended to never need to be modeled because of the three year average nature of the NAAQS.
- Start-ups and shutdowns may be exempt under the same philosophy. Malfunctions are unmentioned.
- Interim Significant Impact Limit (SIL) of 4 ppb (7.53 µg/m³)
- No increments, monitoring limits (monitoring may be required), etc.

NO₂ NAAQS Guidance (cont)

- If the PSD new emissions model above the SIL, then only the receptors (assuming a sufficient receptor grid) need to be included in the “cumulative analysis”.
- The analyst may also eliminate those days when the new source is not contributing to the cumulative impact at the SIL receptors.
- Determining the “background” concentration:
 - 98th percentile of measured data: $(1/365) \times 0.02 = 0.000055$ is the probability that the actual concentration will be higher. 86th percentile of both is correct statistically to get to 98th percentile.

NO₂ NAAQS Guidance (cont)

- EPA indicates that if the max modeled NO₂ is during the day, perhaps max measured during the day could be used (or seasonal peaks)
- EPA provides for analysis of the “concentration gradient” of NO₂ concentrations to indicate whether measured values are appropriate.
- Modelers have traditionally used the hour by hour measured data to match with the simultaneous hour-by-hour modeled results. The guidance discourages this type of analysis but new AERMOD has routines to do this analysis.

AERMOD model

- EPA is providing a new version of AERMOD (12345) which it says will calculate:
 - 8th highest concentration in a year (and others)
 - Variable background function
 - Ability to enter ozone concentrations
 - Correct bugs in NO₂ calculation methods
 - PM_{2.5} model guidance implementation
 - Revisions to urban stability calculations
- user's manual available

SO₂ NAAQS

- Compliance with the old secondary NAAQS (1300 µg/m³ 3-Hour average [500 ppb], High Second High) was difficult enough. This NAAQS is retained as the secondary.
- New primary NAAQS of 196 µg/m³ (75 ppb) as a 1 Hour average results in a 7.7 times more restrictive standard. New standard is 99% over three years.
- The old 24 Hour and Annual Average NAAQS have been deleted.

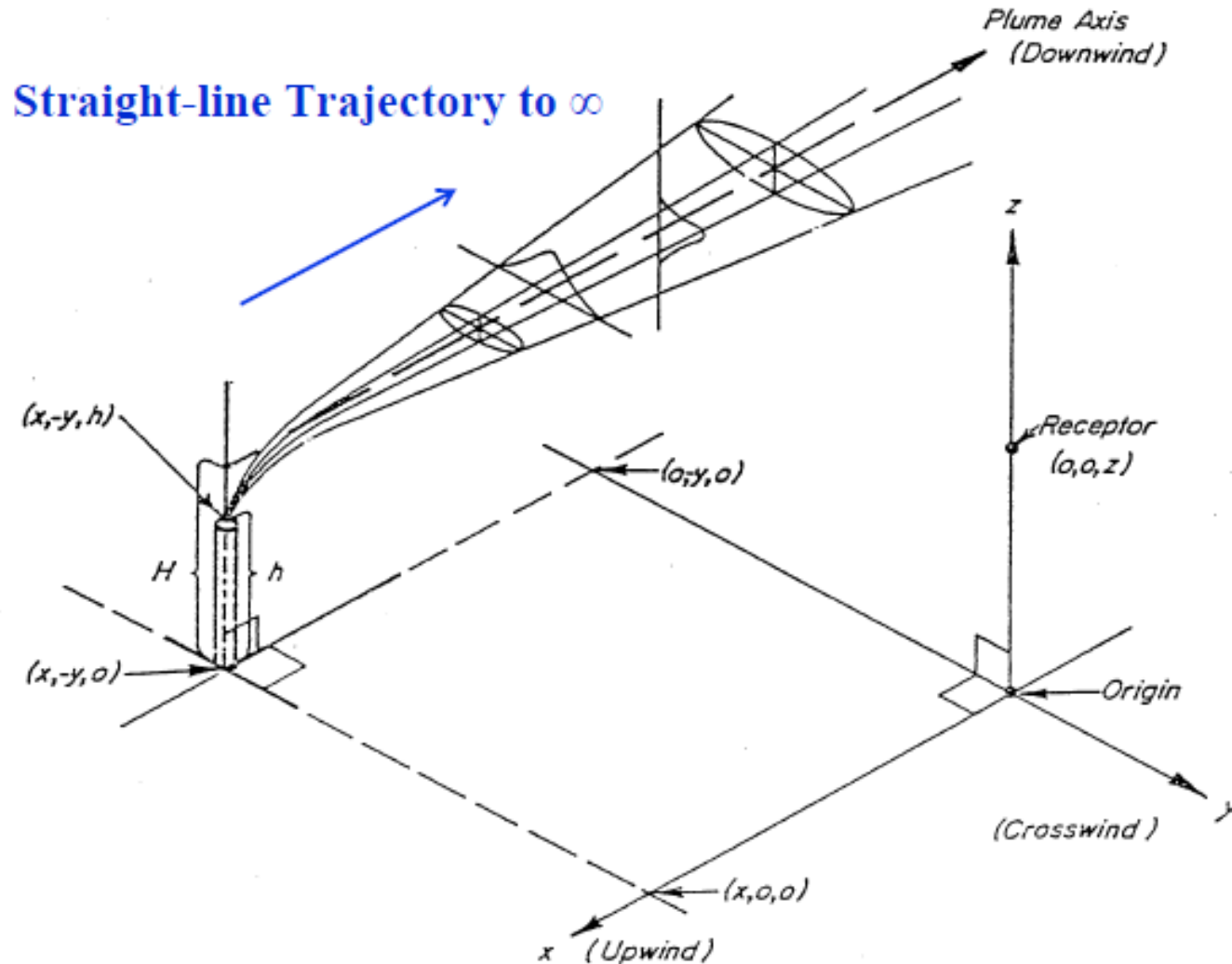
SO2 NAAQS

- This NAAQS is the 99% of the days with at least 1 hour above the level of the NAAQS, i.e. 4th highest value over three years.
- Focus of attainment demonstrations to be on **modeling**, which is a continuation of past policy with enhanced use.
- EPA says March 1, 2011 guidance applies?
- August 23, 2010 Guidance:
 - 4 hour half-life in urban areas
 - Tier 1 is use highest measured 1 hour data as background. Tier 2 Guideline technique
 - Interim SIL: 3 ppb (7.84 $\mu\text{g}/\text{m}^3$)

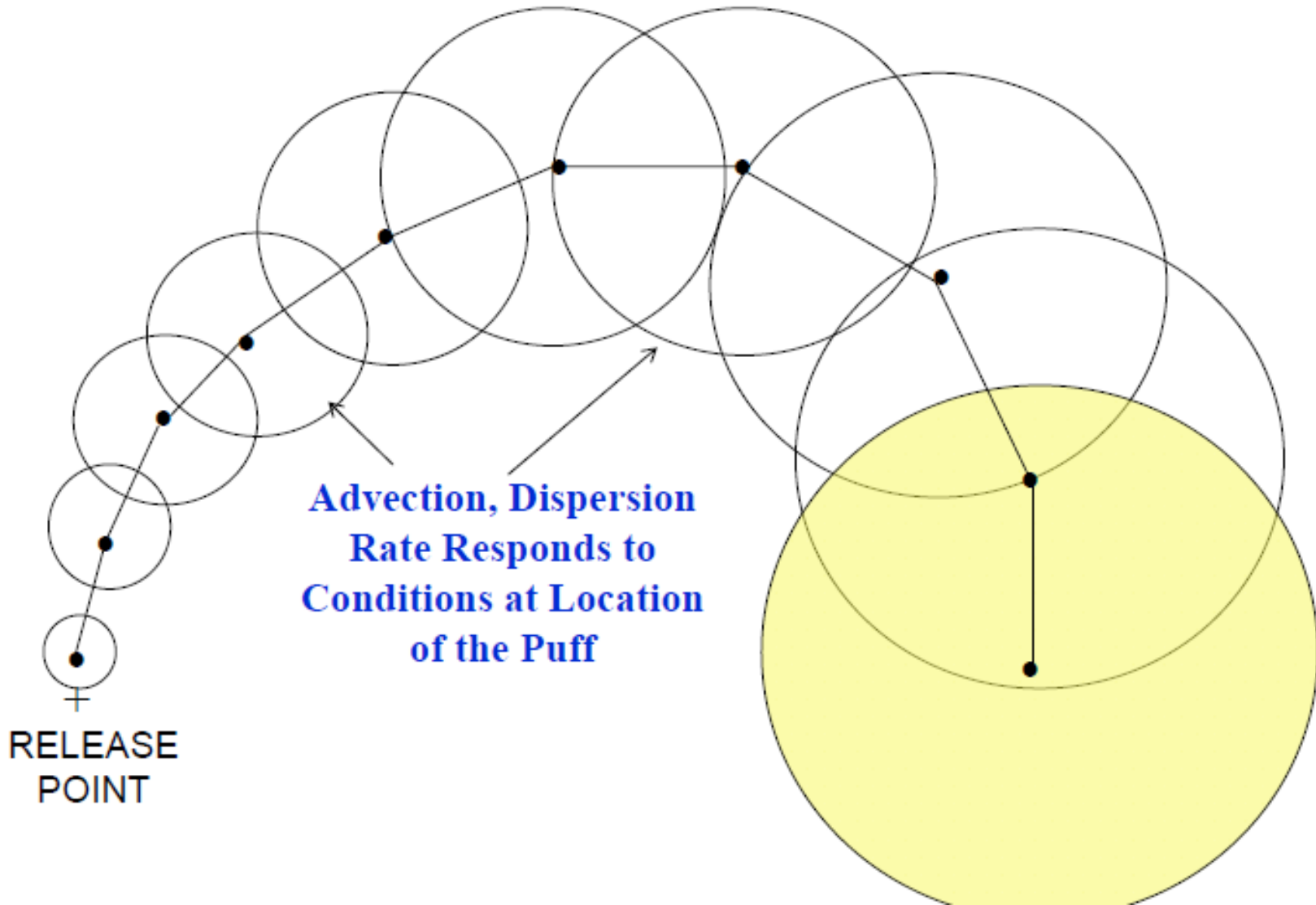
SO2 NAAQS

- DRAFT Guidance issued for comment in October
 - Repeats verbatim most of the NO₂ Guidance
 - Establishes the supremacy of modeling over monitoring in compliance determinations
 - Hundreds of comments received
 - Stakeholders meetings in June, 2012
 - Draft working protocols for modeling and monitoring approaches issued May of 2013.

Steady-state Plume Modeling



Non Steady-state Plume Modeling



Model Hints

Tall Stack



Mid Day

Maxium

Model Hints

Short Stack



Steady Winds

Model Hints

**Ground
Source**

Stable Nighttime

EPA Working Group Results

- For NO₂ (no background added):
 - Steel Mill 3.2 times NAAQS
 - Ethanol Plant 12.9 times NAAQS
 - Natural Gas Turbine 4 times NAAQS
 - Coal Power Plant 2.4 times NAAQS
 - Refinery 1.9 times NAAQS
 - Fuel Oil Turbine 4.8 times NAAQS
 - Asphalt Plant 4.7 times NAAQS
 - Natural gas Compressor 16.7 times NAAQS
 - Biomass facility, Landfill gas turbine passed

EPA Working Group Results

- For SO₂ (no background added):
 - Ethanol Plant 2.9 times NAAQS
 - Pulp and Paper 4.7 times NAAQS
 - Coal Power Plant 4.6 times NAAQS
 - Fuel Oil Turbine 1.3 times NAAQS
 - Flare 1.7 times NAAQS
 - Refinery 1.4 times NAAQS
 - Asphalt Plant 19.3 times NAAQS
 - Cement kiln and landfill gas passed!

EPA 10th Modeling Conference

- Conference held in March 2012
- Many negative comments from public
 - No advancement of the state-of-the-science
 - No proposals to revise the Guidance
 - Negative response to change in calculation of Good Engineering Stack Height
 - Negative reaction to lowering the wind speed at which AERMOD calculates concentrations
 - Many suggestions about better ways to determine true background concentrations

Model Accuracy

If Emissions and Meteorology Correct:

- Annual Average \pm 20%
- Maximum One Hour Average \pm 50% but not at the same place and/or the same time
- Comparisons to measured data always useful to the public and “decider”, but not accepted by EPA
- Use of bright line standards conflicts with realities of modeling

Modeling for PM_{2.5}

- Requires application of “academic” atmospheric chemistry grid models (CAMx or CMAQ). Draft Guidance issued march 25, 2013.
- New version of CALPUFF with updated chemistry is not approved by EPA.
- Modeling is expensive and time consuming especially when dealing with huge data files.

Modeling for PM_{2.5}

- | • CASE | PM _{2.5} | NO _x &SO ₂ | Primary | Secondary |
|--------|-------------------|----------------------------------|---------|-----------|
| • 1 | <10 TPY | <40 TPY | None | None |
| • 2 | >10 TPY | <40 TPY | AERMOD | None |
| • 3 | >10 TPY | >40 TPY | AERMOD | Analysis |
| • 4 | <10 TPY | >40 TPY | None | Analysis |
- Analysis means either a Qualitative, Hybrid, or full quantitative photochemical grid modeling.

Ozone NAAQS

- Currently stands at 0.075 ppb as an 8 hour average (98%).
- The administration has been trying to reduce this concentration, but has finally put it off until 2013.
- NOx emissions are “contributors” to the ozone non-attainment.

Class I Area Impacts

- The Federal Land Managers have a new air quality Guidance document: FLAG II
- It changes the rules on impact analysis for Class I areas.
- It does, however, provide a little equation that helps in strategic analysis:
 - Tons of increased SO₂, NO_x and PM divided by the distance to the nearest Class I area in kilometers: if this is greater than 10 an analysis must be performed.
 - They are interested in visibility in the Class I area and deposition of sulfates and nitrates.