# O3 Risk Sensitivity to Better Exposure/Response Models


## Will Ollison[1], Jim Capel[2], Ted Johnson[3]

[1]API, Washington, DC, [2]Consultant, Durham, NC, [3]TRJ Environmental, Inc., Chapel Hill, NC


## Implications

- **New $FEV_1$ response models that better fit the clinical data should be used in EPA risk & benefit assessments.**
- **$O_3$ assessments adjusted for ME $O_3$ monitoring error, altitude, and urban NO titration substantially reduce assessed exposure & risk.**
- **$O_3$ network photometer upgrades are cheap & needed to lower monitor bias -** http://www.twobtech.com/model_GPT.htm


## Abstract

We evaluate the sensitivity of EPA's current ozone ($O_3$) exposure model (APEX) to (1) alternative pulmonary function response models, (2) attainment AQ rollback approach, (3) altitude effects, (4) newly measured $O_3$ penetration rates, and (5) microenvironmental (ME) factors, corrected for $O_3$ measurement error. Results are provided for Denver AQ scenarios representing 2006 conditions and the attainment of the 75 ppb $O_3$ standard. We test recently published 1-sec forced expiratory volume ($FEV_1$) pulmonary function models[1-3] that incorporate $O_3$ response thresholds and response variability proportional to response level. A CAMx rollback model adjusts 2006 Denver AQ and accounts for NOx control-related increases in urban and background $O_3$ levels resulting from reduced NO-$O_3$ titration that is not addressed by EPA's quadratic rollback approach. Inhaled $O_3$ mass was adjusted to account for reduced $O_3$ inhalation[4-6] in acclimated Denver residents. Newly measured[7-8] indoor $O_3$ penetration rate effects on modeled responses are compared to current APEX model values. APEX ME factors are adjusted to recent values[6] from new interference-free $O_3$ photometers[9-11]. Impacts of these upgraded APEX components are compared to those of the current APEX model.


## APEX Simulations

Pilot APEX sensitivity testing runs simulated daily behaviors for 120 people (aged 12-88) over a 204 day $O_3$ season (24,480 person-days). The same pseudo-random number seed was used to minimize Monte Carlo stochastic error. APEX outputs include four median personal maximum 1h/8h daily exposure & dose metrics, a daily average dose, a block-hour daily dose (BH), and four response metrics, a median maximum daily event-level forced 1-second expiratory volume ($FEV_1$) decrement ($dFEV_1$), and the percent of responses ($\%dFEV_1$) above 5%, 10%, & 15% decrements. The tested exposure model parameters (Figure 1) include an altitude adjustment, alternative quadratic/CAMx AQ model rollback approaches, and humidity control (2B 205 monitor)/interference minimization (2B 211 monitor) corrections using re-measured $O_3$ ME & indoor penetration factors. The tested $O_3$ $FEV_1$ response models (Figure 2) include comparisons of the original[3], threshold[2], and a new threshold-proportional variance $FEV_1$ model[1] (T/PV) that best fits the clinical data.

## Results

- 10-25% drop in exposure/dose (E/D) metrics from altitude & quadratic rollback adjustments; small CAMx rollback changes likely stem from reduced urban NO titration following requisite NOx emission controls.
- 10-40% drop in E/D metrics from re-measured ME factor corrections; 8-h metrics are the most affected.
- 5-30% drop in E/D metrics from re-measured indoor mass-balance model penetration factor corrections; 8-h metrics are the most affected.
- 5% E/D metric drop for newly measured detached home penetration factors[7]; 10-30% E/D metric drop for apartments[8] (preliminary data), likely from relatively smaller external surface areas.
- Minimal change in median pulmonary function event-level decrement values for original & threshold FEV response models but a 35% drop for the T/PV model.
- 10-15% drop in $\%dFEV_1 > 10\%$; 80% rise in $\%dFEV_1 > 15\%$ for the T/PV FEV model, likely due to its larger variances at higher exposures.
- 85% altitude & 65% quadratic rollback drops in $\%dFEV_1 > 10\%$ by threshold FEV model; 70% altitude & 45% quadratic rollback drops for T/PV model.

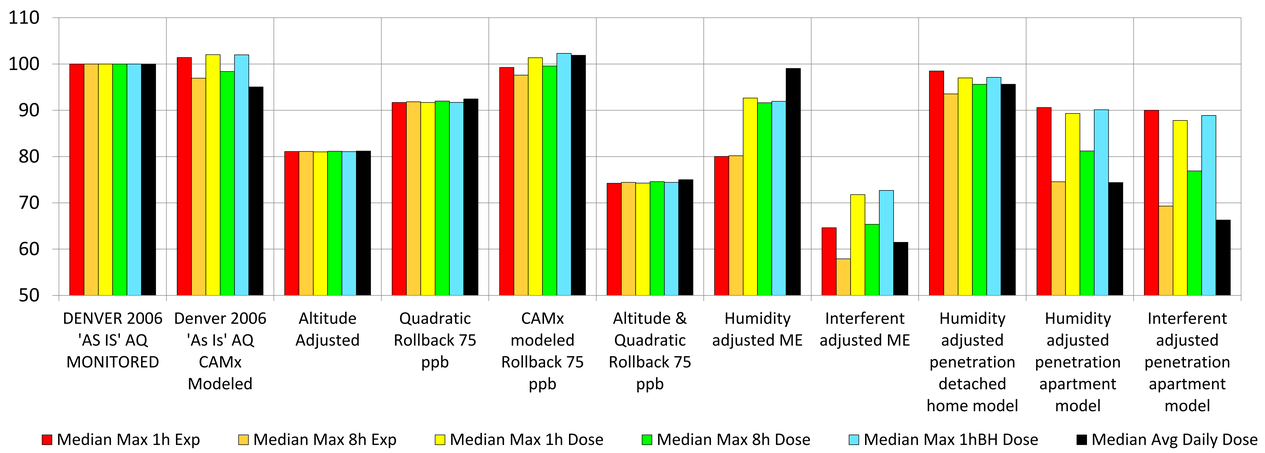


Figure 1. Exposure Impacts - Normalized effects on 2006 Denver population exposure & dose metrics of tested APEX model assumptions concerning altitude adjustment, quadratic/CAMx standard attainment rollbacks, and ME/indoor-penetration factor corrections for $O_3$ monitoring interferences.

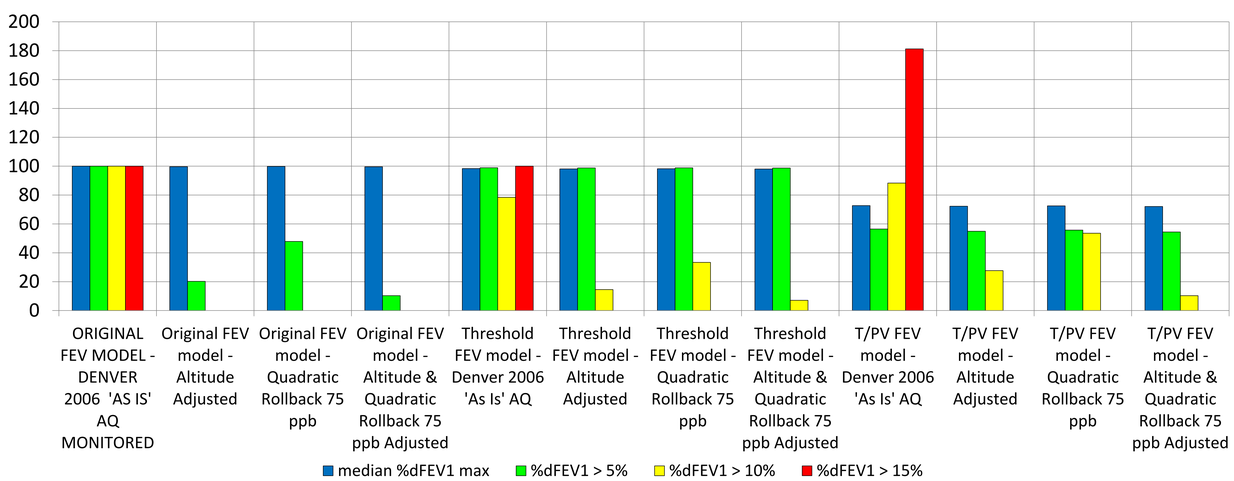


Figure 2. Health (dFEV1) Impacts - Normalized effects on 2006 Denver population pulmonary function decrements (**$dFEV_1$**) of APEX FEV model choice, altitude, and quadratic rollback adjustments.

## Definitions

Max1hExp – Daily maximum event-averaged hourly exposure
Max8hExp – Daily maximum event-averaged 8-hour exposure
Max1hDose - Daily maximum event-averaged hourly dose
Max8hDose - Daily maximum event-averaged 8-hour dose
Max1hBHDose – Daily maximum event-averaged hourly dose
AveDailyDose – Daily 24-hour average dose
$\%dFEV_1Max$ – Daily maximum event-level $\%dFEV_1$ calculation

## References


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