RECENT RESEARCH ON OZONE REACTIVITY OF VOCs

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OUTLINE

VOC REACTIVITY AND REACTIVITY-BASED REGULATIONS

PRELIMINARY ASSESSMENT OF VOC REACTIVITY EFFECTS IN REGIONAL MODELS

- BACKGROUND, OBJECTIVES AND APPROACH
- ALTERNATIVE REACTIVITY METRICS
- COMPARISON OF REGIONAL AND EKMA REACTIVITY SCALES
- CONCLUSIONS AND RECOMMENDATIONS

STATUS OF DEVELOPMENT OF NEW CHAMBER FACILITY FOR VOC REACTIVITY ASSESSMENT

- OBJECTIVES
- CURRENT STATUS
- CURRENT PLANS FOR INITIAL EXPERIMENTS

VOC REACTIVITY

GROUND LEVEL O_3 IS FORMED BY PHOTOCHEMICAL REACTIONS INVOLVING VOCs AND NO_x

THE HUNDREDS OF TYPES OF EMITTED VOCs DIFFER IN THEIR EFFECTS ON O_3 (REACTIVITY)

REACTIVITY-BASED VOC CONTROLS MAY BE MORE EFFICIENT THAN REGULATING ALL VOCs EQUALLY

- SOME REACTIVITY-BASED REGULATIONS HAVE ALREADY BEEN IMPLEMENTED IN CALIFORNIA
- THE U.S. EPA IS CONSIDERING EXPANDING REACTIVITY CONSIDERATIONS BEYOND ITS CURRENT “EXEMPT” VS “REACTIVE” POLICY

BUT IMPLEMENTING REACTIVITY-BASED CONTROLS HAS DIFFICULTIES AND UNCERTAINTIES

- EFFECTS OF VOCs ON O_3 DEPEND ON AMBIENT CONDITIONS
- ACCURACY OF CHEMICAL MECHANISMS NEEDED TO PREDICT VOC IMPACTS UNCERTAIN
- REACTIVITY-BASED REGULATIONS ARE MORE COMPLEX AND DIFFICULT TO ENFORCE

EXAMPLES OF WAYS TO DEAL WITH THE DEPENDENCE OF REACTIVITY ON ENVIRONMENTAL CONDITIONS

BASE THE SCALE ON A "REPRESENTATIVE" OR "WORST CASE" EPISODE.

- MAY NOT BE OPTIMUM FOR ALL CONDITIONS.
- UNCERTAIN HOW TO QUANTIFY IMPACTS OVER MULTIPLE REGIONS

BASE THE SCALE ON CONDITIONS WHERE O_3 IS MOST SENSITIVE TO VOC EMISSIONS (**MIR SCALE**).

- REFLECTS URBAN CONDITIONS WHERE VOC CONTROL IS MOST EFFECTIVE
- GIVES GOOD CORRELATIONS TO EFFECTS OF VOCs ON INTEGRATED OZONE EXPOSURE.
- BUT DOES NOT REPRESENT CONDITIONS WHERE HIGHEST O_3 LEVELS OCCUR.
- MAY NOT BE OPTIMUM FOR REDUCING O_3 ON A REGIONAL SCALE

BASE THE SCALE ON VOC IMPACTS ON REGIONAL O_3

- MAY NOT BE OPTIMUM FOR REDUCING URBAN O_3
- CURRENTLY DATA LIMITED ON VOC REACTIVITY EFFECTS IN REGIONAL MODELS

NEED FOR EVALUATION OF RELATIVE REACTIVITIES USING 3-D REGIONAL MODELS

CURRENT REACTIVITY SCALES ARE BASED ON MODELS WITH DETAILED CHEMISTRY BUT WITH VERY SIMPLIFIED REPRESENTATIONS OF AIRSHEDS

TESTS OF REACTIVITY SCALES WITH 3-D MODELS ARE LIMITED MAINLY TO A FEW URBAN AREAS

CONCERN THAT THESE REACTIVITY SCALES MAY NOT BE APPROPRIATE ON REGIONAL SCALE

- LONG-RANGE TRANSPORT, NO_x-LIMITED AREAS, AND BIOGENIC VOCs MUCH MORE IMPORTANT
- SLOWLY REACTING SPECIES HAVE LONGER TIME TO REACT AND FORM O_3

THESE CONCERNS MUST BE ADDRESSED BEFORE REACTIVITY-BASED REGULATIONS WILL BE WIDELY ADOPTED IN THE U.S.

A PRELIMINARY ASSESSMENT USING EXISTING REGIONAL MODEL DATABASES CAN GUIDE POLICY AND NEAR-TERM RESEARCH NEEDS

EVALUATION OF RELATIVE REACTIVITIES USING A 3-D REGIONAL MODEL

OBJECTIVES

ASSESS VOC REACTIVITY EFFECTS USING AN EXISTING REGIONAL MODELING DATABASE REPRESENTING THE EASTERN U.S.

- EASTERN U.S. CHOSEN BECAUSE LONG-TERM TRANSPORT AND BIOGENIC VOCs IMPORTANT
- EFFECTS OF REACTIVITY-BASED STRATEGIES MOST UNCERTAIN IN THIS TYPE OF SCENARIO

ASSESS RELATIVE INCREMENTAL OZONE IMPACTS OF VOC MODEL SPECIES WITH RESPECT TO:

- VARIATION WITHIN THE MODELING DOMAIN
- HOW THE RESULTS ARE USED TO DERIVE MEASURES OF REACTIVITY
- COMPARISON WITH REACTIVITIES CALCULATED USING EKMA MODELS
- PREDICTIONS OF EFFECTS OF SELECTED LARGE SCALE SUBSTITUTIONS

ASSESS APPROACHES FOR DERIVING A GENERAL REACTIVITY SCALE REPRESENTING REGIONAL O_3 IMPACTS

APPROACH

CRC-NARSTO MODELING DATABASE USED

- REPRESENTS JULY 7-15, 1995 EPISODE IN EASTERN UNITED-STATES
- USES CAMx MODEL VERSION 3.01 WITH DDM

CARBON BOND 4 (CB4) CHEMICAL MECHANISM USED

- HIGHLY CONDENSED AND OUT OF DATE, BUT LEAST EXPENSIVE TO USE FOR INITIAL STUDY
- REPRESENTS MOST (BUT NOT ALL) OF THE MAJOR CLASSES OF REACTIVE VOCs. THIS WHICH MAKES IT SUFFICIENT FOR AN INITIAL ASSESSMENT

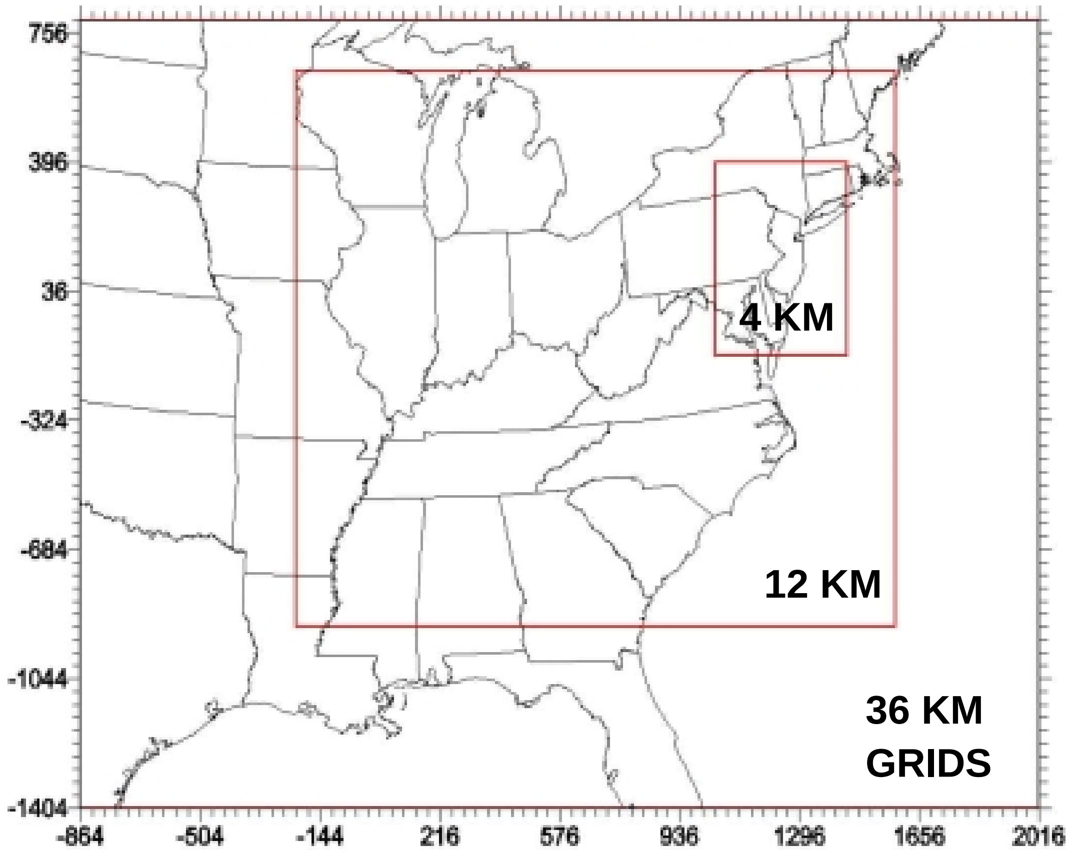
DIRECT DECOUPLED METHOD (DDM) USED TO CALCULATE O_3 SENSITIVITIES (INCREMENTAL REACTIVITIES) FOR

- 8 CB4 VOC MODEL SPECIES, CO AND ETHANE
- TOTAL NO_x, TOTAL VOCs, TOTAL ANTHROPOGENIC VOCs (AVOCs), AND MAJOR AVOC SOURCE TYPES

VARIOUS METHODS WERE USED TO DERIVE REACTIVITY SCALES FROM THE DISTRIBUTION OF SENSITIVITIES IN THE THOUSANDS OF GRID CELLS

A LIMITED NUMBER OF LARGE-SCALE SUBSTITUTION CALCULATIONS WERE CONDUCTED

CRC-NARSTO MODELING DATABASE



MODEL:	CAMx VERSION 3.01 WITH DDM
EPISODE DATES:	JULY 7-15, 1995 (DATA FOR 12th-15th USED IN ASSESSMENT)
EMISSIONS:	EPA NET96
MET DATA:	MM5
MECHANISM:	UPDATED CB4 (ETHANE ADDED)

CARBON BOND MODEL SPECIES WHOSE OZONE SENSITIVITIES WERE DETERMINED

SPECIES	APPROXIMATELY REPRESENTATIVE OF
PAR	CARBONS IN C_4 - C_6 ALKANES
ETH	ETHENE (EXPLICIT)
OLE	PROPENE (PRIMARILY)
TOL	NO SPECIFIC COMPOUND. MAY BE INDICATIVE OF COMPOUNDS WITH VERY NO_x SENSITIVE REACTIVITIES (E.G., PHENOLS, STYRENES)
XYL	XYLENES
FORM	FORMALDEHYDE (EXPLICIT)
ALD2	ACETALDEHYDE (EXPLICIT)
ETOH	ETHANOL (EXPLICIT)
ETHA	ETHANE (EXPLICIT, ADDED FOR THIS STUDY)
CO	CARBON MONOXIDE (EXPLICIT)

OZONE IMPACT METRICS USED

TOTAL OF 126 SEPARATE REGIONAL RELATIVE REACTIVITY SCALES WERE DERIVED, BASED ON:

TWO DIFFERENT METHODS TO QUANTIFY OZONE FORMATION IN A GRID CELL IN AN EPISODE DAY

- DAILY MAXIMUM 1-HOUR AVERAGE O_3
- DAILY MAXIMUM 8-HOUR AVERAGE O_3

SEPARATE SCALES FOR EACH EPISODE DAY:

- 4 DAYS FOR 1-HOUR QUANTIFICATION (12^{th}-15^{th})
- 3 DAYS FOR 8-HOUR QUANTIFICATION (12^{th}-14^{th})

SEPARATE SETS OF SCALES FOR EACH OF THE 3 DOMAINS SIZES

- 36K (FULL EASTERN U.S. DOMAIN)
- 12K (PARTIAL DOMAIN – RESULTS LIKE 36K)
- 4K (AREA AROUND NYC, NEW JERSEY)

SIX METHODS USED TO DERIVE REGIONAL SCALES FOR EACH DAY AND OZONE QUANTIFICATION

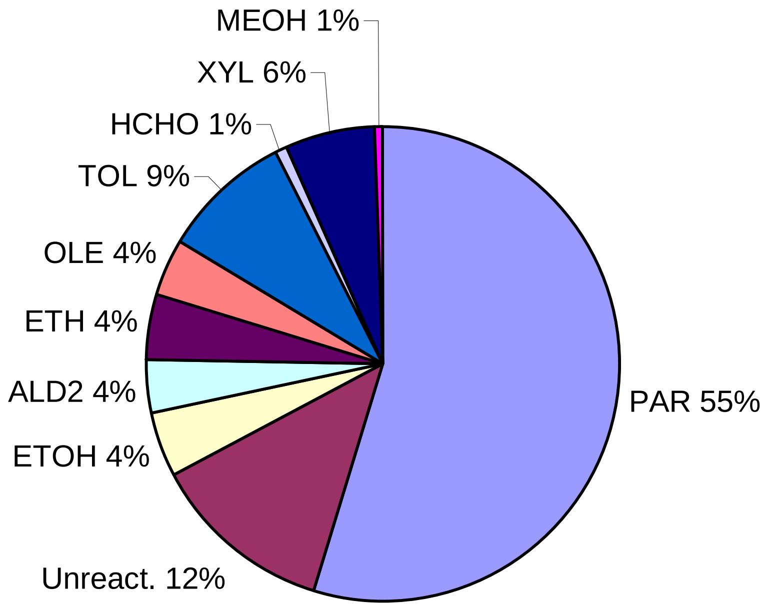
REACTIVITIES DERIVED RELATIVE TO MIXTURE OF TOTAL EMITTED ANTHROPOGENIC VOCs (BASE ROG)

- COMPOSITION FROM A RECENT EPA EMISSIONS DATABASE
- BASE ROG AND TOTAL ANTHROPOGENIC VOC SENSITIVITIES ESSENTIALLY THE SAME

COMPOSITION OF BASE ROG MIXTURE USED TO DERIVE RELATIVE REACTIVITIES

CB4 MODEL SPECIES:

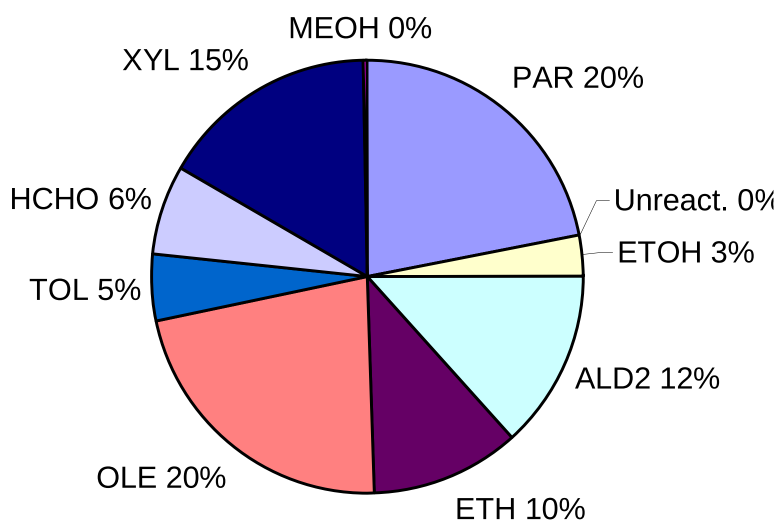
CARBON BASIS



CB4 MODEL SPECIES:

REACTIVITY BASIS

(EKMA MIR SCALE)



(BASED ON EMISSIONS ASSIGNMENTS AS OF 5/02)

APPROACHES CONSIDERED FOR DERIVING REGIONAL REACTIVITY SCALES

1. REGIONAL MAXIMUM OZONE

USE REACTIVITIES AT THE TIME AND LOCATION OF THE HIGHEST DOMAIN-WIDE DAILY MAXIMUM O_3

- ADDRESSES NEED TO REDUCE PEAK O_3
- NOT A TRUE GLOBAL METRIC BECAUSE IT REFLECTS IMPACTS ONLY AT ONE LOCATION

2. REGIONAL MAXIMUM INCREMENTAL REACTIVITY

USE REACTIVITIES AT THE CELL WITH THE HIGHEST SENSITIVITY OF THE DAILY MAXIMUM O_3 TO AVOCs

- REPRESENTS IMPACTS ON REGIONS WHERE O_3 IS MOST SENSITIVE TO VOCs
- COMPARABLE TO THE WIDELY-USED MIR SCALE
- NOT A TRUE GLOBAL METRIC BECAUSE IT REFLECTS IMPACTS AT ONLY ONE LOCATION

3. REGIONAL MIR-MOIR

USE EFFECTS ON AVERAGE DAILY MAXIMUM O_3 IN CELLS WHERE O_3 HAS NEGATIVE SENSITIVITY TO NO_x

- REPRESENTS IMPACTS NEAR SOURCE AREAS WHERE ONLY VOC CONTROLS WILL REDUCE O_3
- REPRESENTS CONDITIONS USED TO DERIVE MIR TO MOIR SCALES
- REPRESENTS 4-7% OF AREA IN FULL DOMAIN

APPROACHES CONSIDERED FOR DERIVING REGIONAL REACTIVITY SCALES

4. REGIONAL AVERAGE OZONE

USE EFFECTS ON AVERAGE OR TOTAL DAILY MAX. GROUND-LEVEL O_3 THROUGHOUT THE DOMAIN

- GLOBAL METRIC THAT WEIGHTS O_3 SENSITIVITIES AT EACH LOCATION EQUALLY
- EFFECTS ON THE WIDESPREAD LOW O_3 AREAS WEIGHED EQUALLY AS EFFECTS ON AREAS WHERE O_3 IS A REGULATORY CONCERN
- GIVES URBAN IMPACTS LEAST WEIGHT OF ALL THE METHODS CONSIDERED

5. REGIONAL AVERAGE OZONE OVER STANDARD

USE EFFECTS ON AVERAGE O_3 IN CELLS WHERE OZONE EXCEEDS U.S. AIR QUALITY STANDARDS

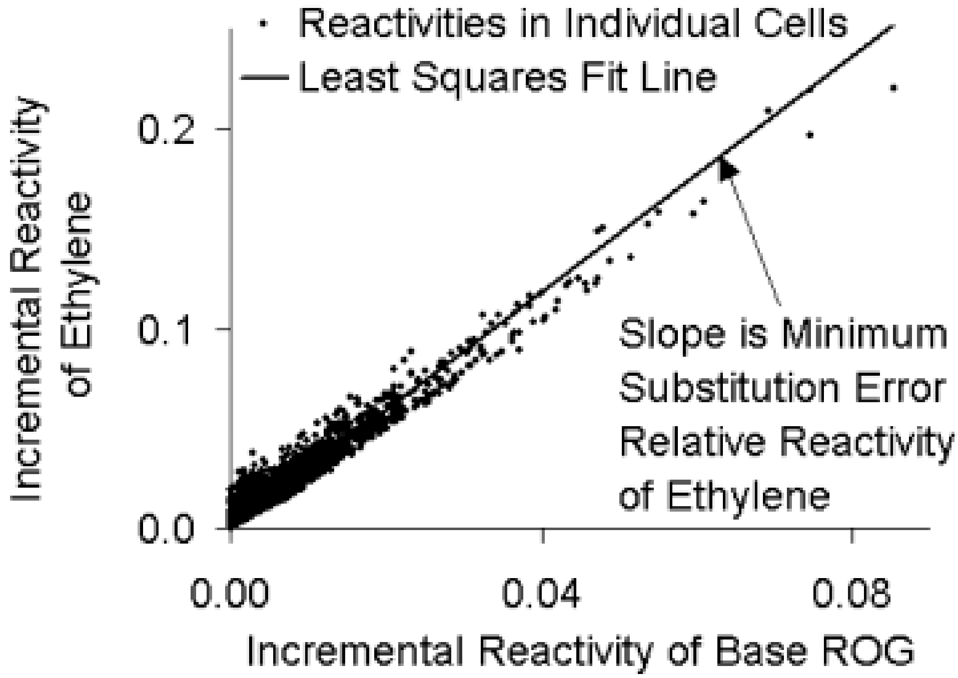
- 0.12 PPM CUTOFF FOR 1-HOUR SCALES, 0.08 PPM CUTOFF FOR 8-HOUR SCALES
- GLOBAL METRIC FOR REGIONS WHERE O_3 AIR QUALITY STANDARDS ARE NOT MET
- BUT DOES NOT ADDRESS IMPACTS IN AREAS WHERE SLIGHT O_3 INCREASES MAY RESULT IN EXCEEDENCES.

APPROACHES CONSIDERED FOR DERIVING REGIONAL REACTIVITY SCALES

6. MINIMUM SUBSTITUTION ERROR

RELATIVE REACTIVITY THAT MINIMIZES THE SUM-OF-SQUARES CHANGE IN O_3 IN A NULL TEST SUBSTITUTION OF THE BASE ROG FOR THE VOC

- A “NULL TEST” IS A SUBSTITUTION THAT THE SCALE PREDICTS WILL NOT CHANGE O_3
- SAME AS SLOPE OF LINE, FORCED THROUGH ZERO, OF SPECIES VS BASE ROG REACTIVITIES



- WEIGHS EFFECTS ON HIGHEST O_3 AND MOST VOC-SENSITIVE AREAS MORE HIGHLY WHILE TAKING EFFECTS ON ALL AREAS INTO ACCOUNT

EKMA REACTIVITY SCALES FOR COMPARISON WITH REGIONAL MODEL REACTIVITIES

SAME SET OF 39 1-DAY EKMA BOX MODEL SCENARIOS AS USED TO DERIVE “CARTER” REACTIVITY SCALES (CARTER, 1994; CARTER, 2000)

SAME VERSION OF CB4 AS USED IN THE CAMx REGIONAL MODEL CALCULATIONS

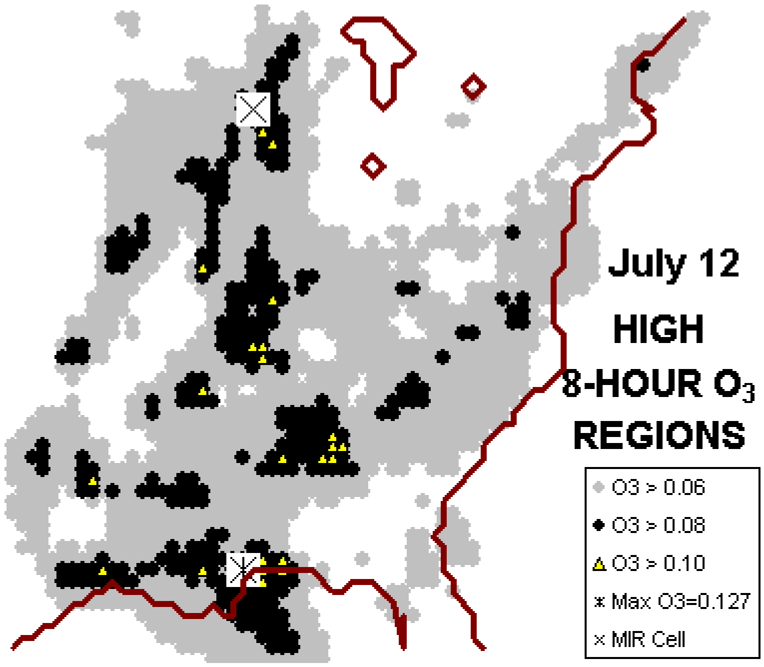
REACTIVITIES RELATIVE TO SAME BASE ROG MIXTURE AS USED FOR REGIONAL METRICS

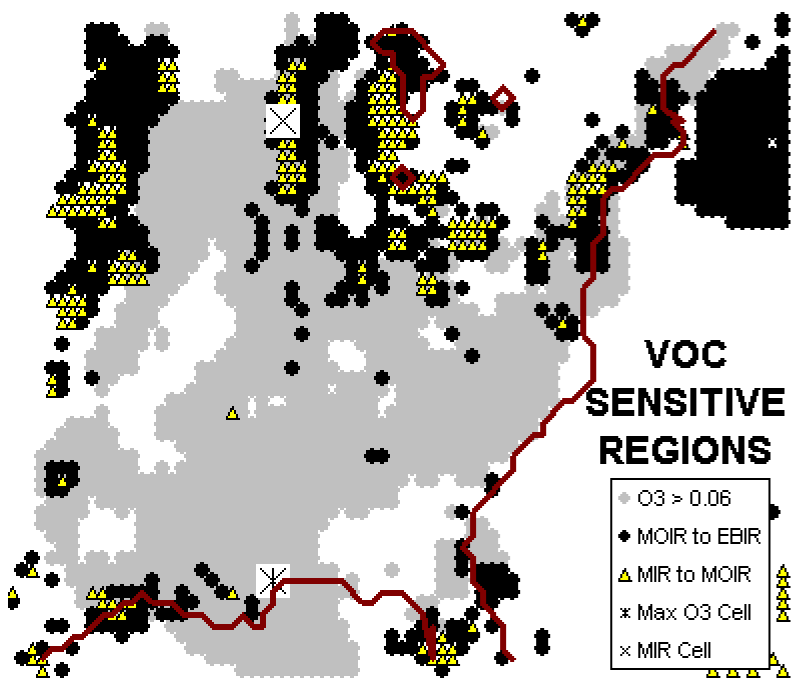
ANALOGOUS METHODS USED TO DERIVE SCALES AS USED WITH REGIONAL MODEL, E.G.

- MIR SCALE IS AVERAGES OF O_3 SENSITIVITIES WHEN NO_x ADJUSTED TO YIELD MAXIMUM BASE ROG REACTIVITY
- AVERAGE O_3 SCALE IS AVERAGES OF O_3 SENSITIVITIES IN THE 39 BASE CASE (UNADJUSTED NO_x) SCENARIOS

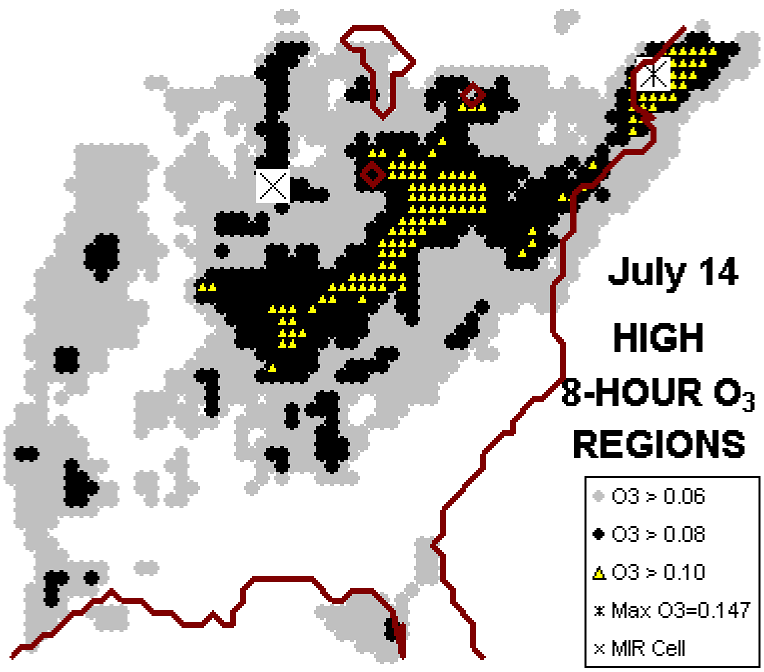
NOTE THAT THE 39 SCENARIOS ARE OUT-OF-DATE AND PREDICT FAR GREATER O_3 THAN CURRENTLY OBSERVED IN THESE U.S. CITIES

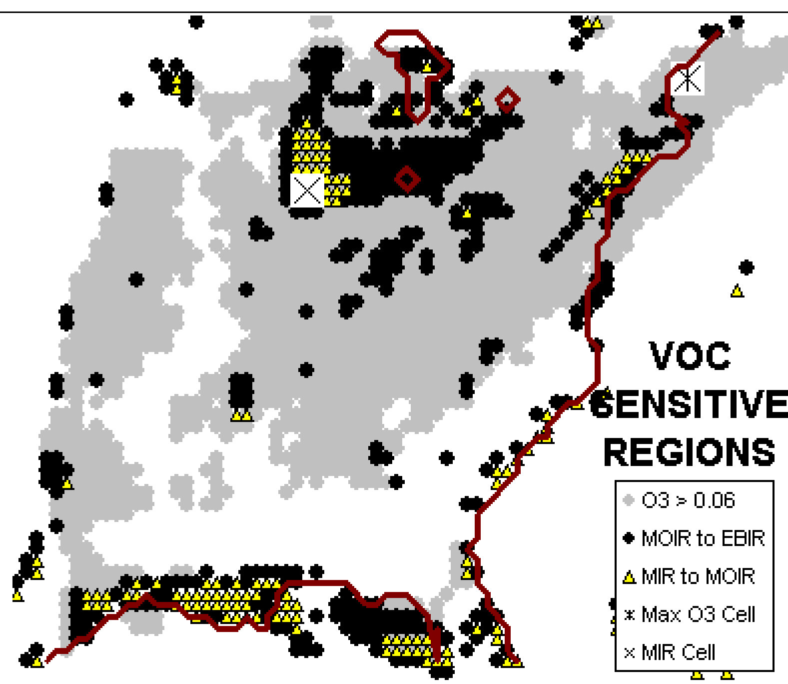
DISTRIBUTION OF HIGH O_3 AND VOC SENSITIVE REGIONS – JULY 12



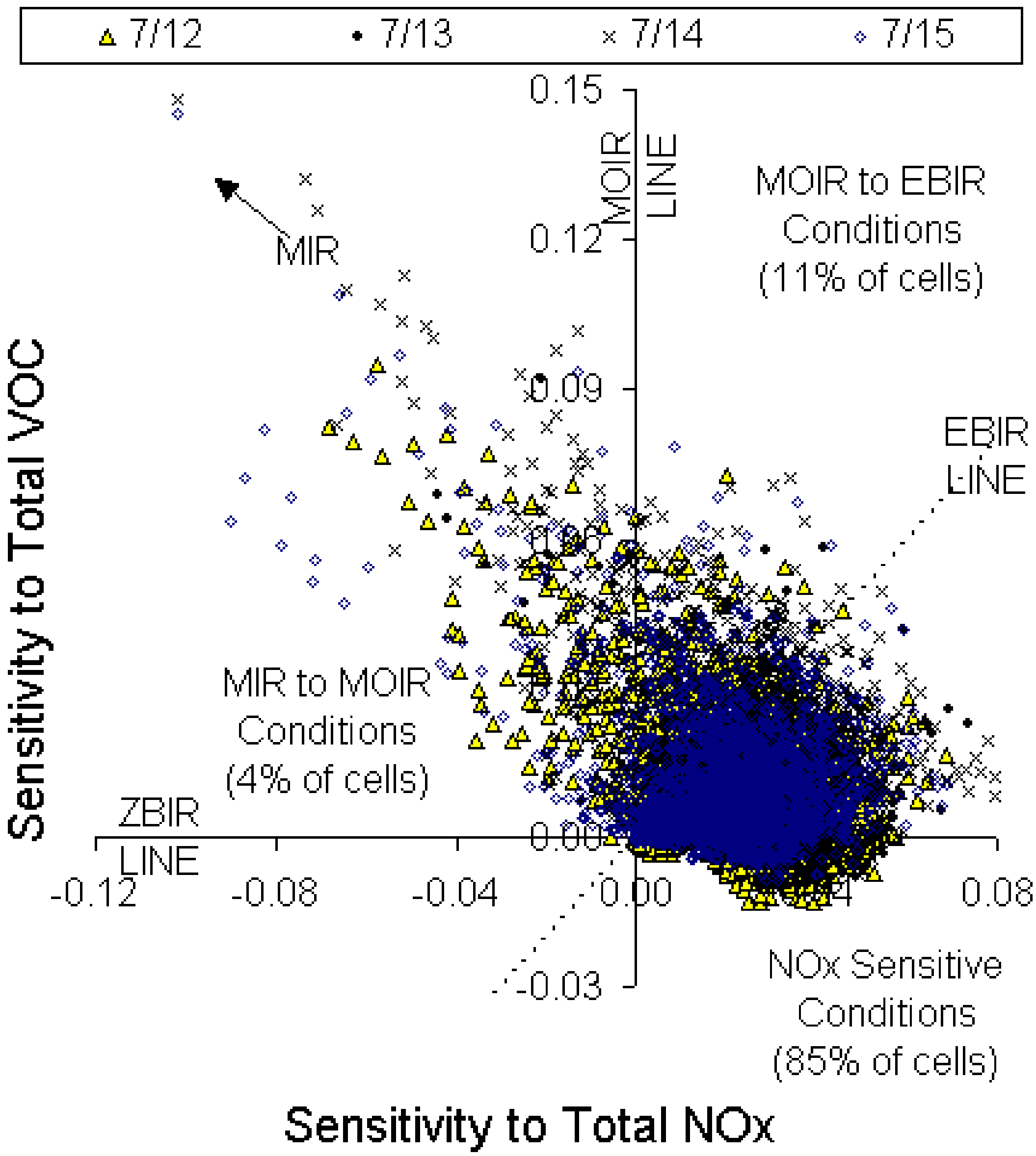


DISTRIBUTION OF HIGH O_3 AND VOC SENSITIVE REGIONS – JULY 14



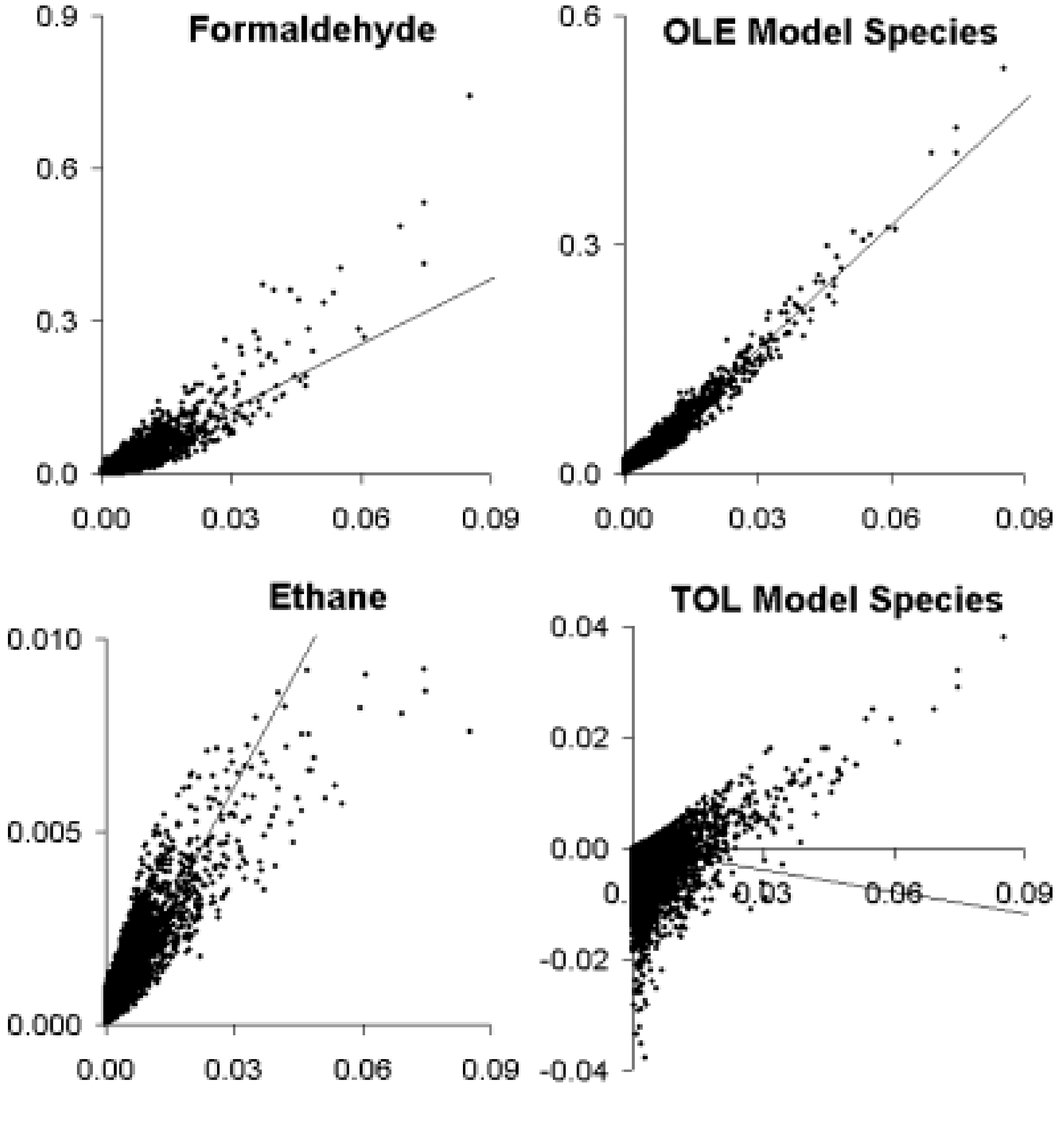


SENSITIVITIES OF MAXIMUM 1-HOUR AVERAGE O_3 TO TOTAL VOC AND NO_x



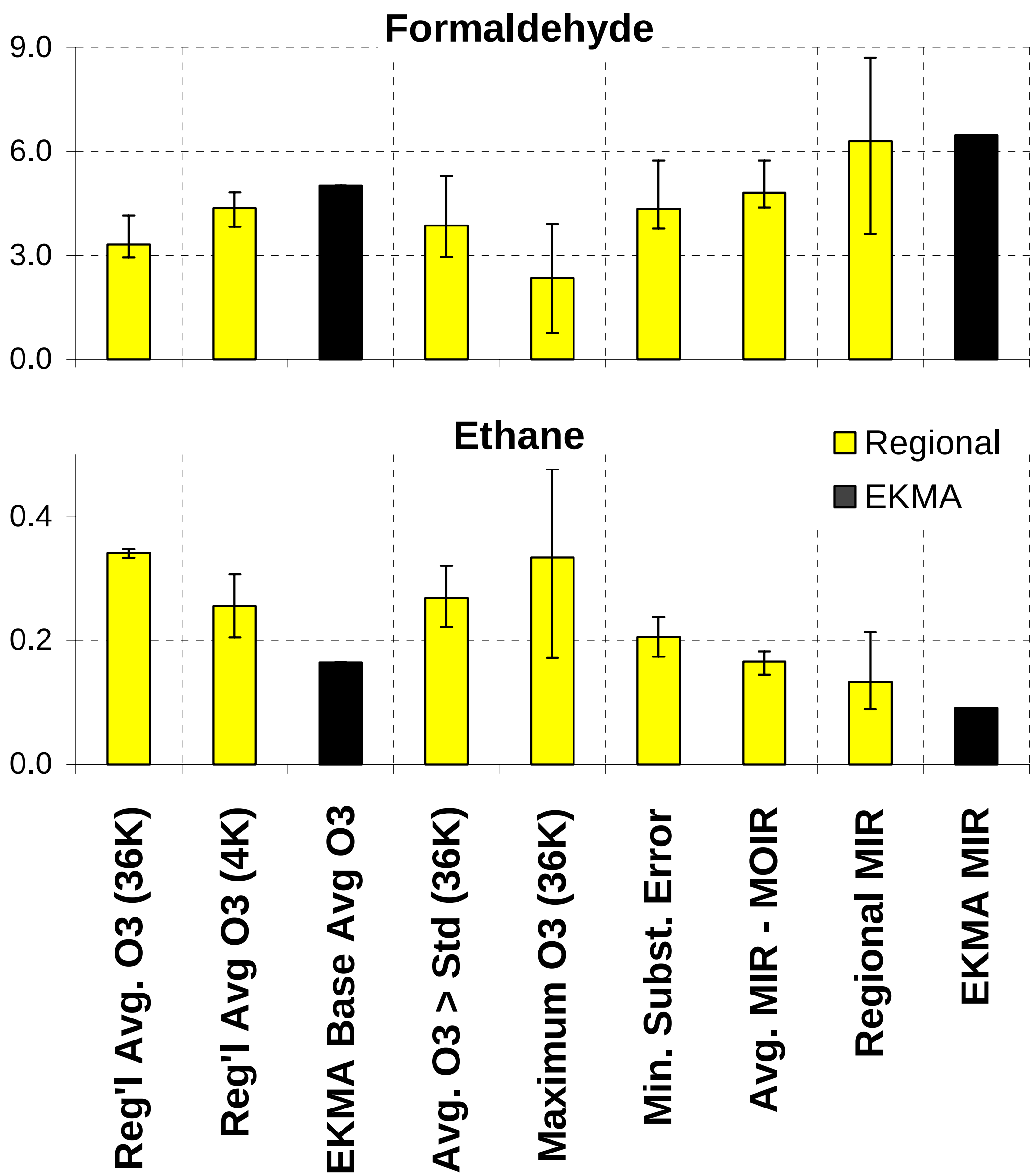
EACH POINT REPRESENTS ONE GRID CELL FOR EACH EPISODE DAY IN THE 36K DOMAIN

PLOTS OF MAXIMUM 1-HOUR AVERAGE O_3 SENSITIVITIES AGAINST SENSITIVITIES TO THE BASE ROG MIXTURE



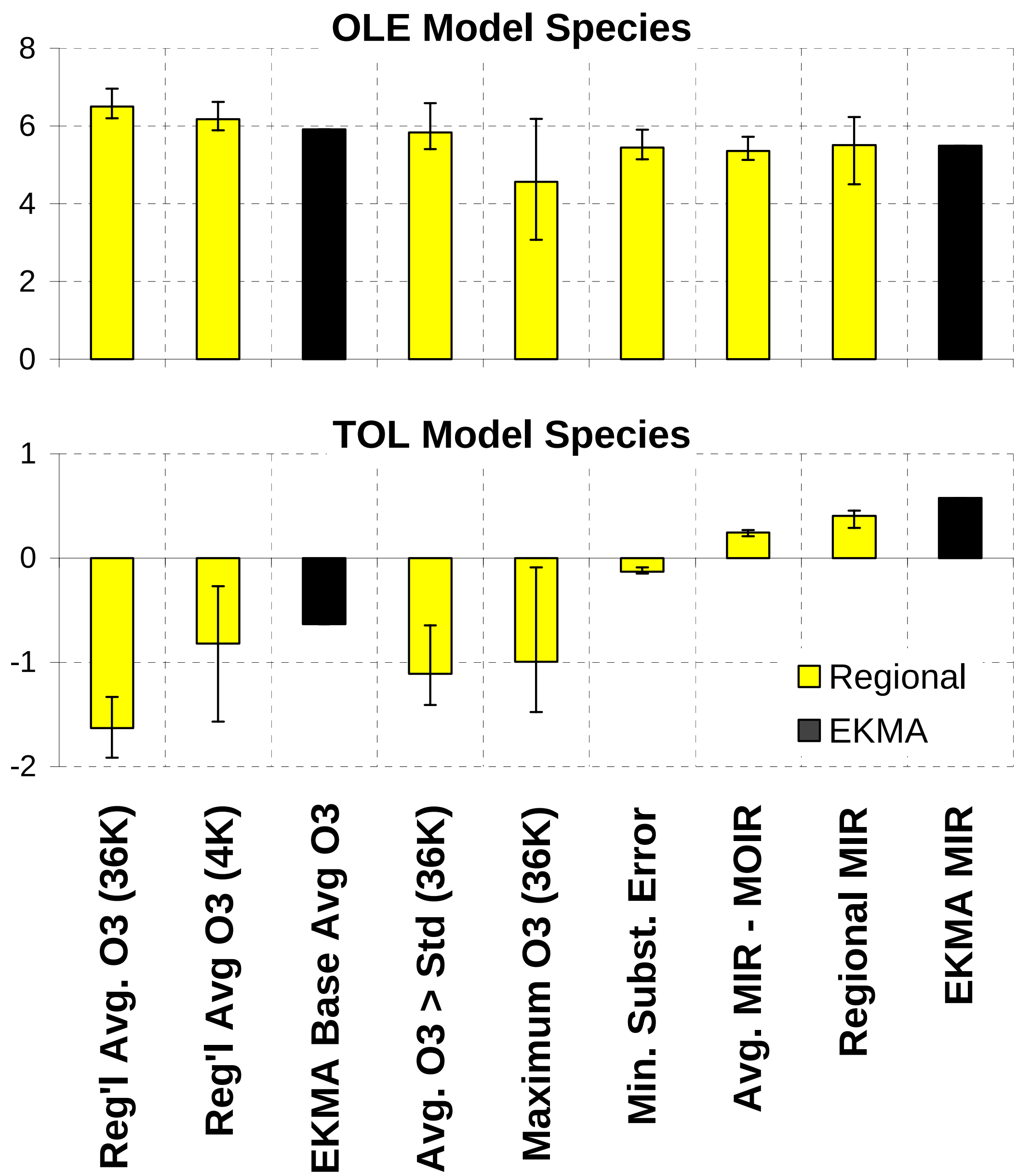
SLOPE OF LINE FORCED THROUGH ZERO IS MINIMUM SUBSTITUTION ERROR REACTIVITY

COMPARISON OF RELATIVE REACTIVITIES FOR FORMALDEHYDE AND ETHANE



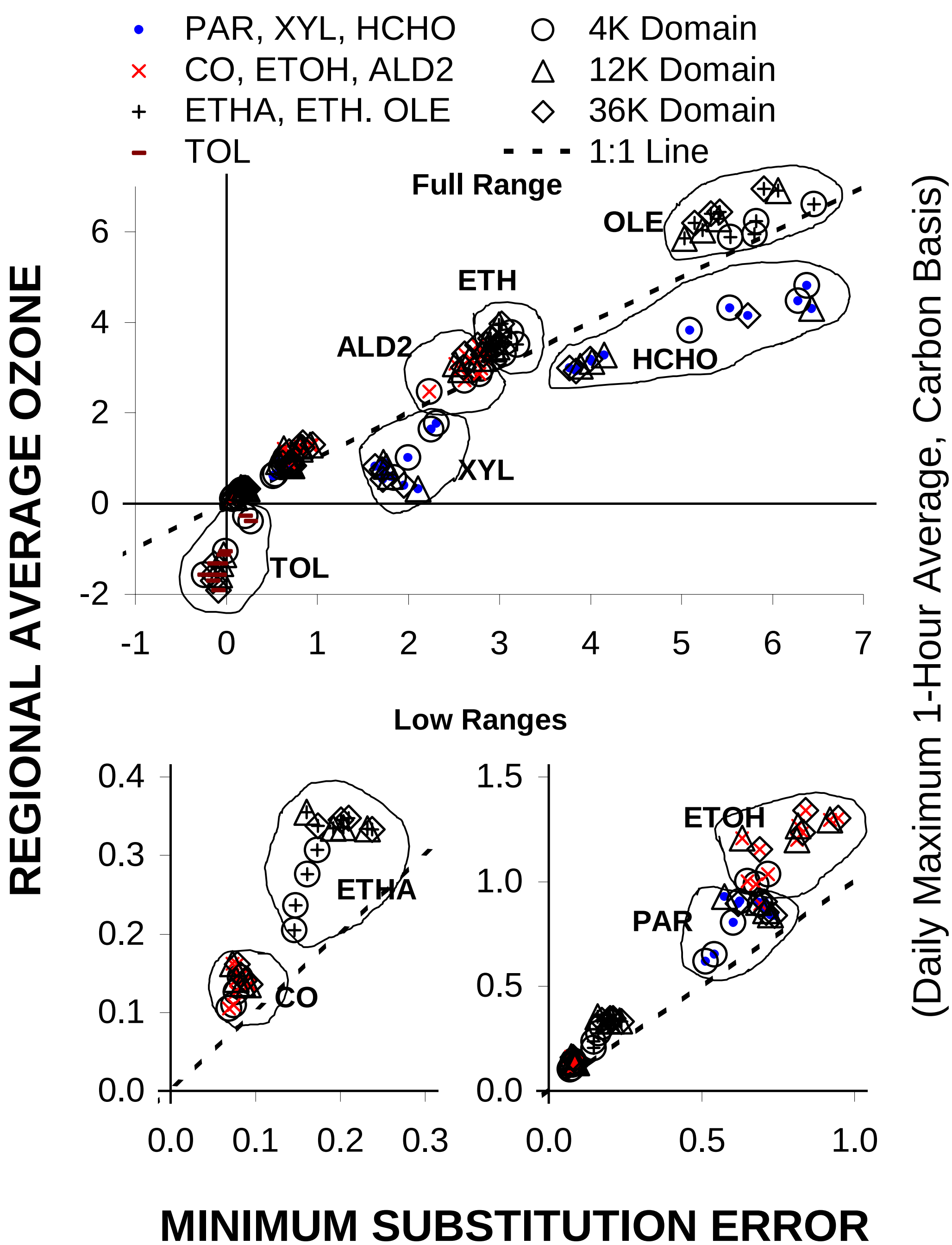
AVERAGES OF EFFECTS ON DAILY MAXIMUM 1-HOUR O_3 FOR 4 EPISODE DAYS ARE SHOWN. ERROR BARS SHOW RANGE BETWEEN MINIMUM AND MAXIMUM.

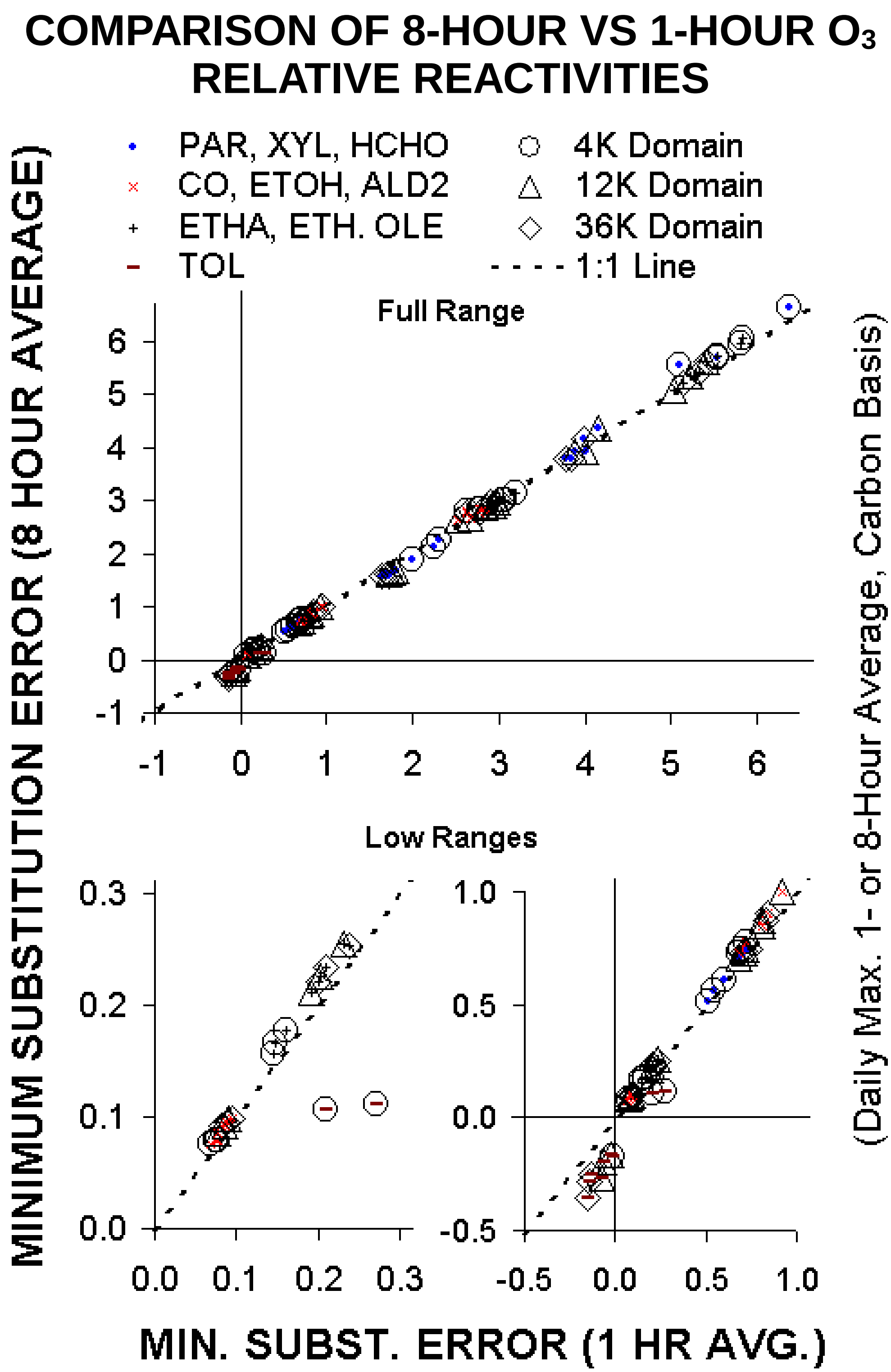
COMPARISON OF REACTIVITY METRICS FOR MOST AND LEAST VARIABLE SPECIES

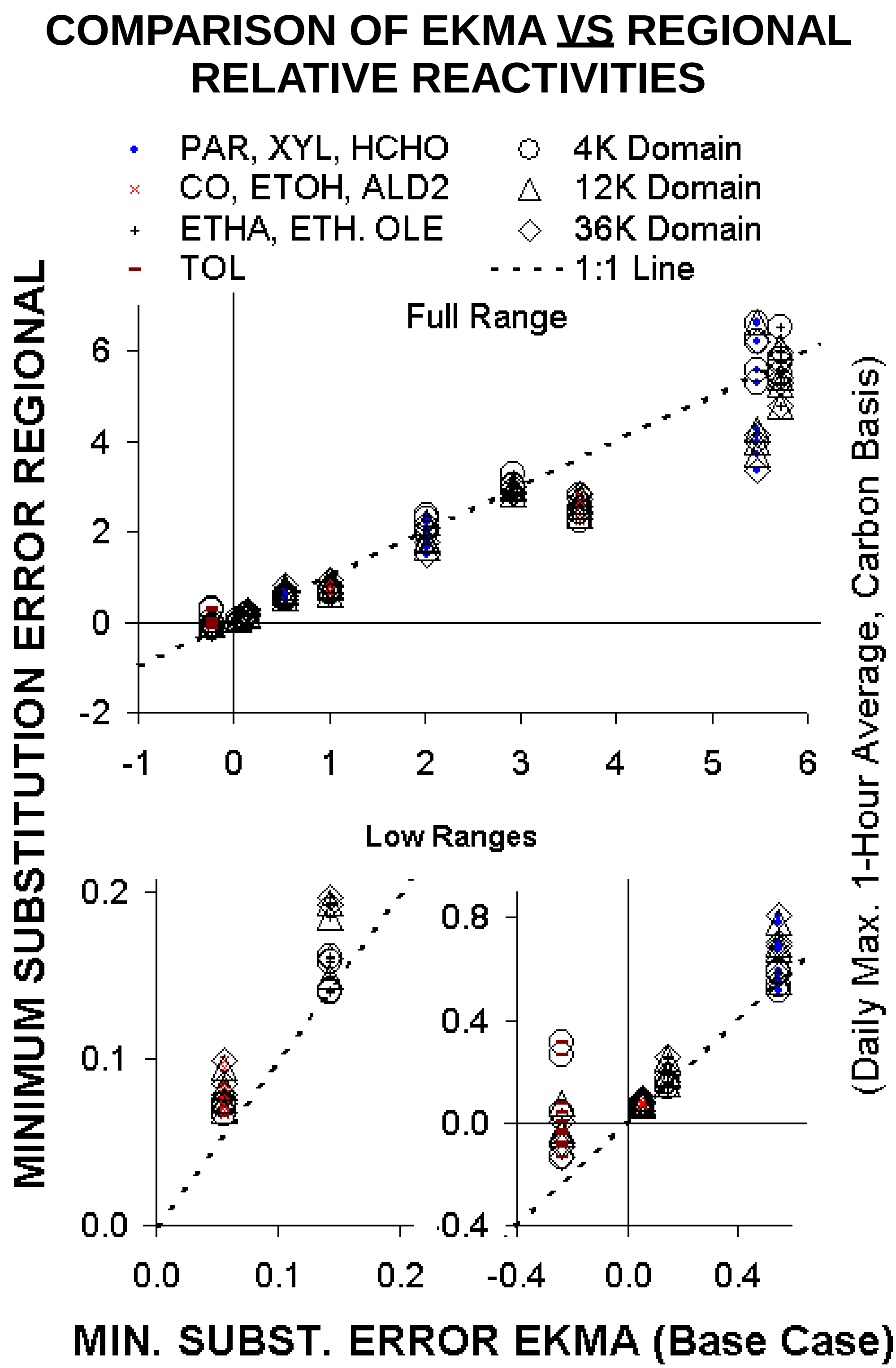


AVERAGES OF EFFECTS ON DAILY MAXIMUM 1-HOUR O_3 FOR 4 EPISODE DAYS ARE SHOWN. ERROR BARS SHOW RANGE BETWEEN MINIMUM AND MAXIMUM

COMPARISON OF AVERAGE O_3 AND MINIMUM SUBSTITUTION ERROR SCALES

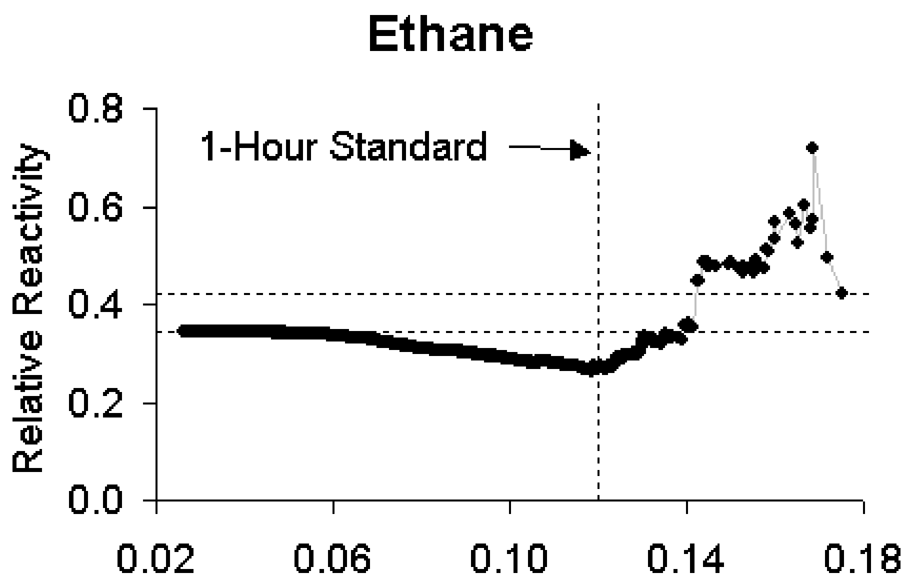


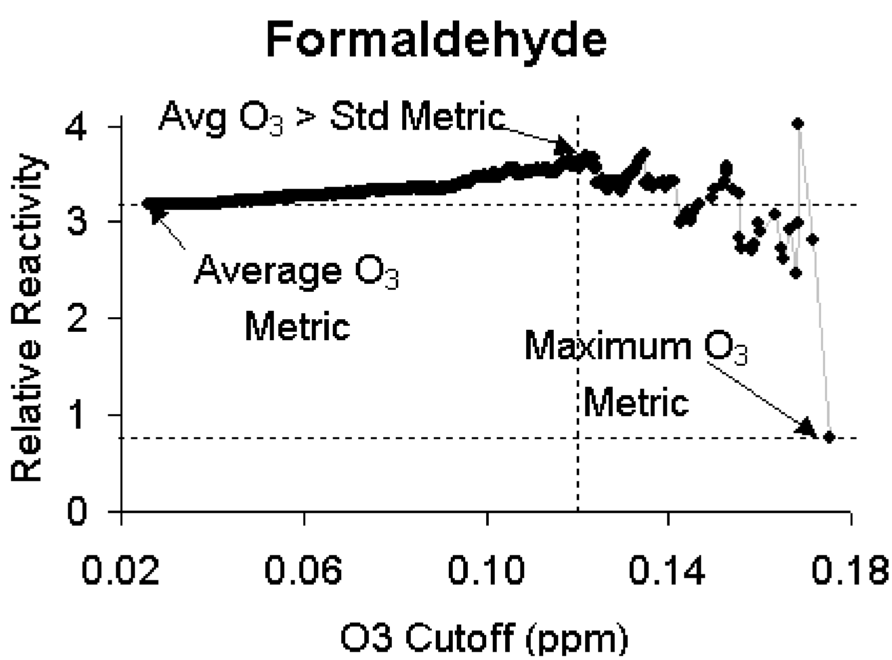

COMPARISON OF 8-HOUR VS 1-HOUR O_3
RELATIVE REACTIVITIES
PAR, XYL, HCHO
CO, ETOH, ALD2
ETHA, ETH. OLE
TOL
4K Domain
12K Domain
36K Domain
1:1 Line
Full Range
Low Ranges
MINIMUM SUBSTITUTION ERROR (8 HOUR AVERAGE)
(Daily Max. 1- or 8-Hour Average, Carbon Basis)
MIN. SUBST. ERROR (1 HR AVG.)


COMPARISON OF EKMA VS REGIONAL
RELATIVE REACTIVITIES
PAR, XYL, HCHO
CO, ETOH, ALD2
ETHA, ETH. OLE
TOL
4K Domain
12K Domain
36K Domain
1:1 Line
Full Range
Low Ranges
MINIMUM SUBSTITUTION ERROR REGIONAL
(Daily Max. 1-Hour Average, Carbon Basis)
MIN. SUBST. ERROR EKMA (Base Case)

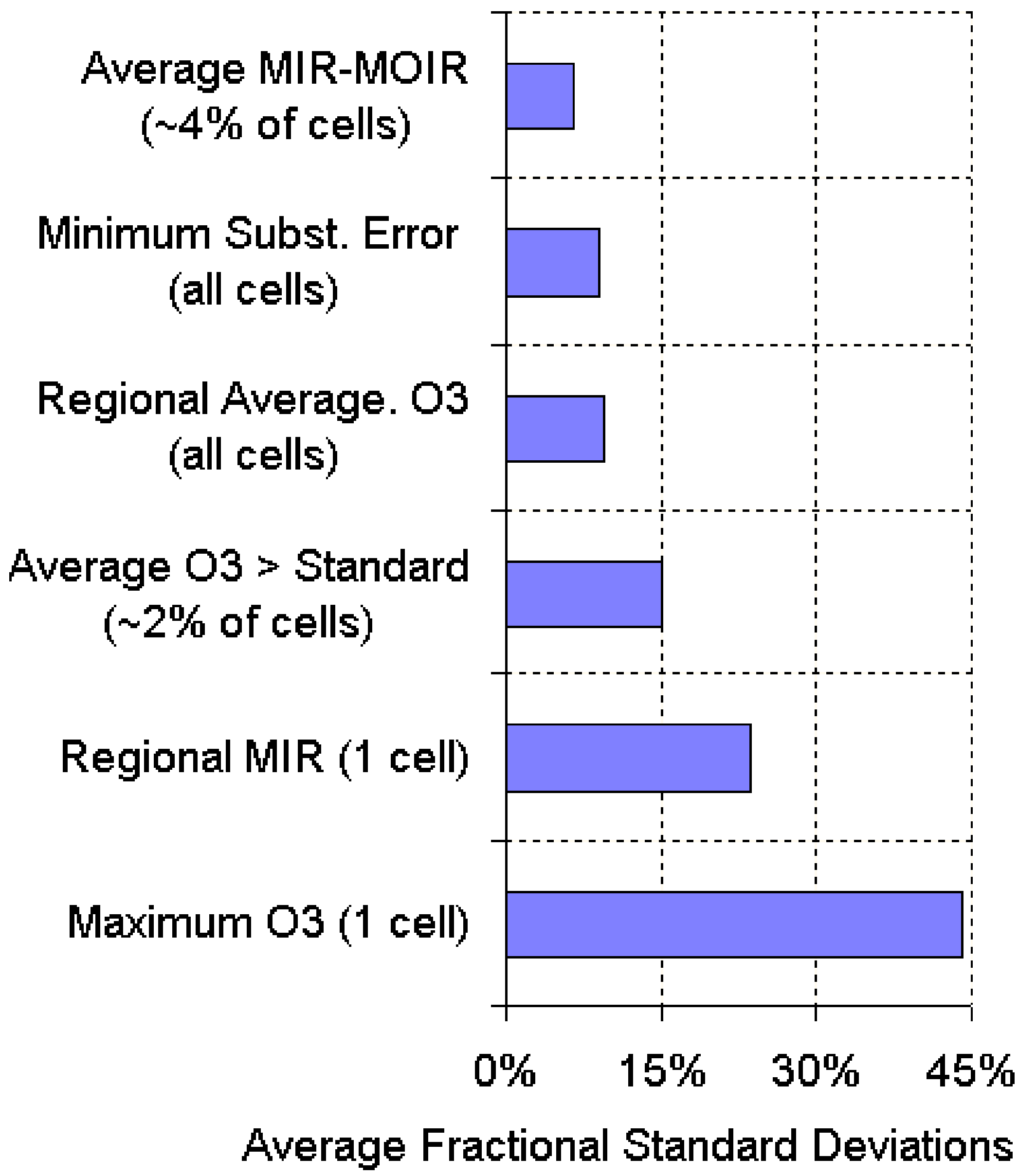
EFFECT OF OZONE CUTOFF LEVEL ON AVERAGE O_3 RELATIVE REACTIVITIES

1-HOUR O_3 QUANTIFICATION
JULY 14, 36K DOMAIN





DAY-TO-DAY VARIABILITY OF REGIONAL REACTIVITY METRICS



DATA SHOWN ARE FOR 1-HOUR O_3 QUANTIFICATION. DATA FOR 8-HOUR QUANTIFICATION ARE SIMILAR

EFFECTIVE RANGE CLASSIFICATION OF REACTIVITY SCALES

THE **EFFECTIVE RANGE** OF A REACTIVITY SCALE IS THE RATIO OF THE MOST REACTIVE TO LEAST REACTIVE NON-NEGLIGIBLY REACTIVE SPECIES

REFLECTS THE MAXIMUM O_3 CHANGE FROM REACTIVITY SUBSTITUTIONS OF NON-EXEMPT VOCs

EFFECTIVE RANGE OF REACTIVITY SCALES USED IN VOC REGULATIONS HAS POLICY IMPLICATIONS

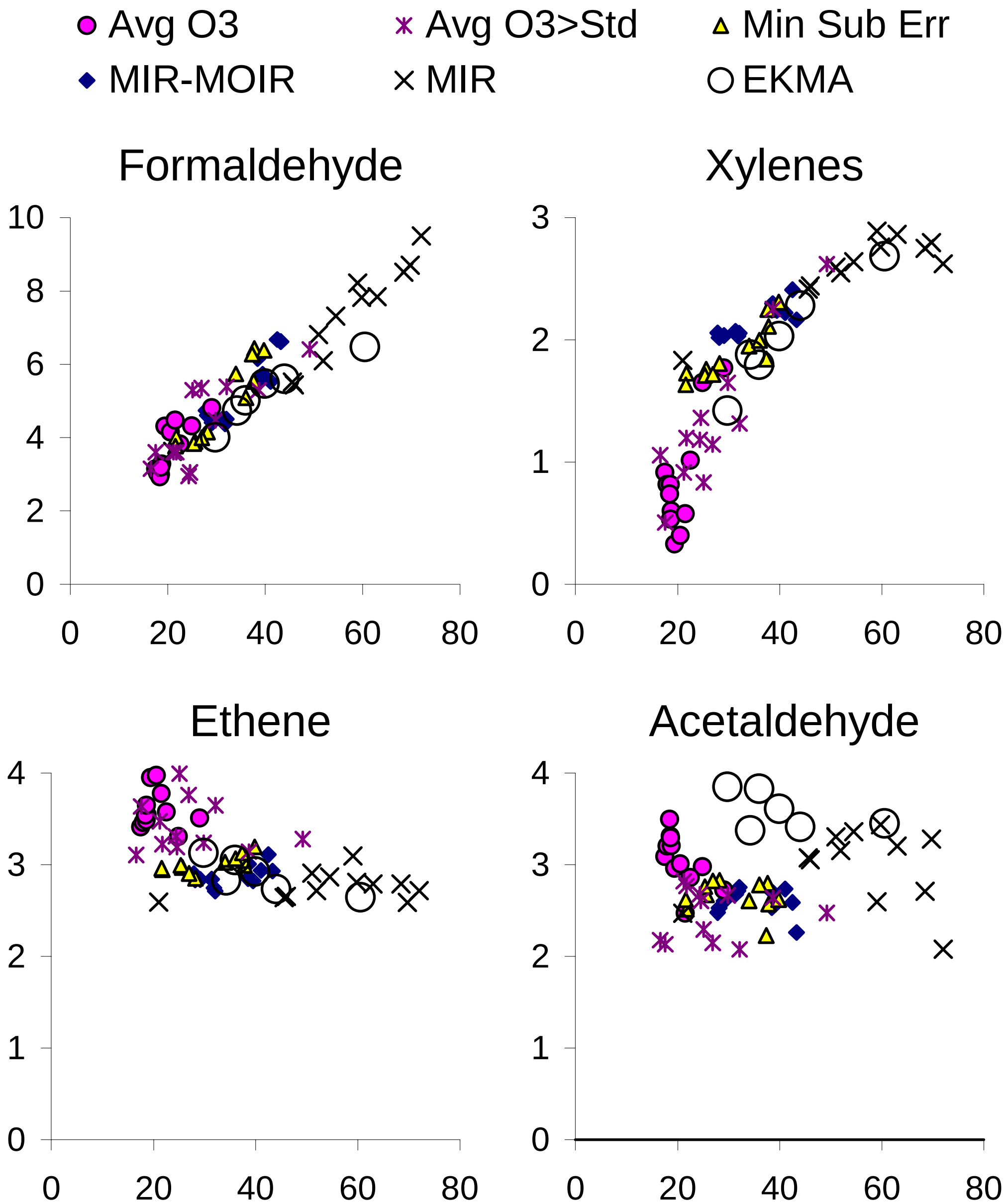
- TOO LOW A RANGE MAY BE INSUFFICIENT TO ENCOURAGE BENEFICIAL SUBSTITUTIONS
- TOO HIGH A RANGE MAY INCREASE O_3 BY ENCOURAGING NON-BENEFICIAL SUBSTITUTIONS

THE **OLE/ETHANE** RATIO CHOSEN TO CALCULATE EFFECTIVE RANGES FOR THE CB4 SCALES

- **ETHANE** IS USED BY THE EPA TO DEFINE THE BORDERLINE OF EXEMPT VS REACTIVE VOCs, SO IS CHOSEN TO DEFINE LOW END OF RANGE
- **OLE** IS THE MOST CONSISTENTLY REACTIVE OF THE CB4 SPECIES ON A CARBON BASIS, SO IS CHOSEN TO DEFINE THE HIGH END OF RANGE

EFFECTIVE RANGES GIVE GOOD INDICATIONS OF RELATIVE REACTIVITIES OF OTHER SPECIES

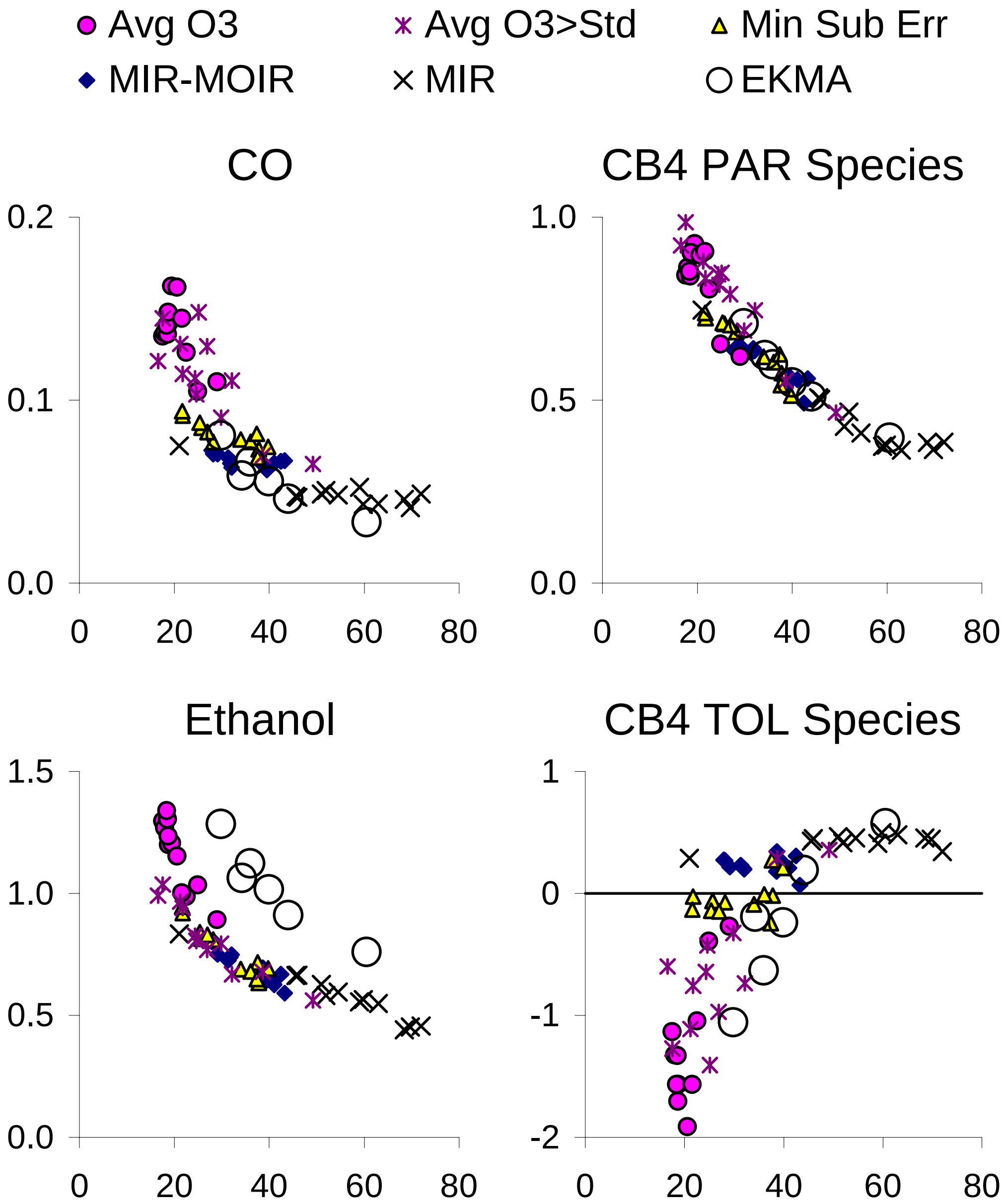
RELATIONSHIP BETWEEN EFFECTIVE RANGE AND RELATIVE REACTIVITIES FOR HIGH REACTIVITY SPECIES



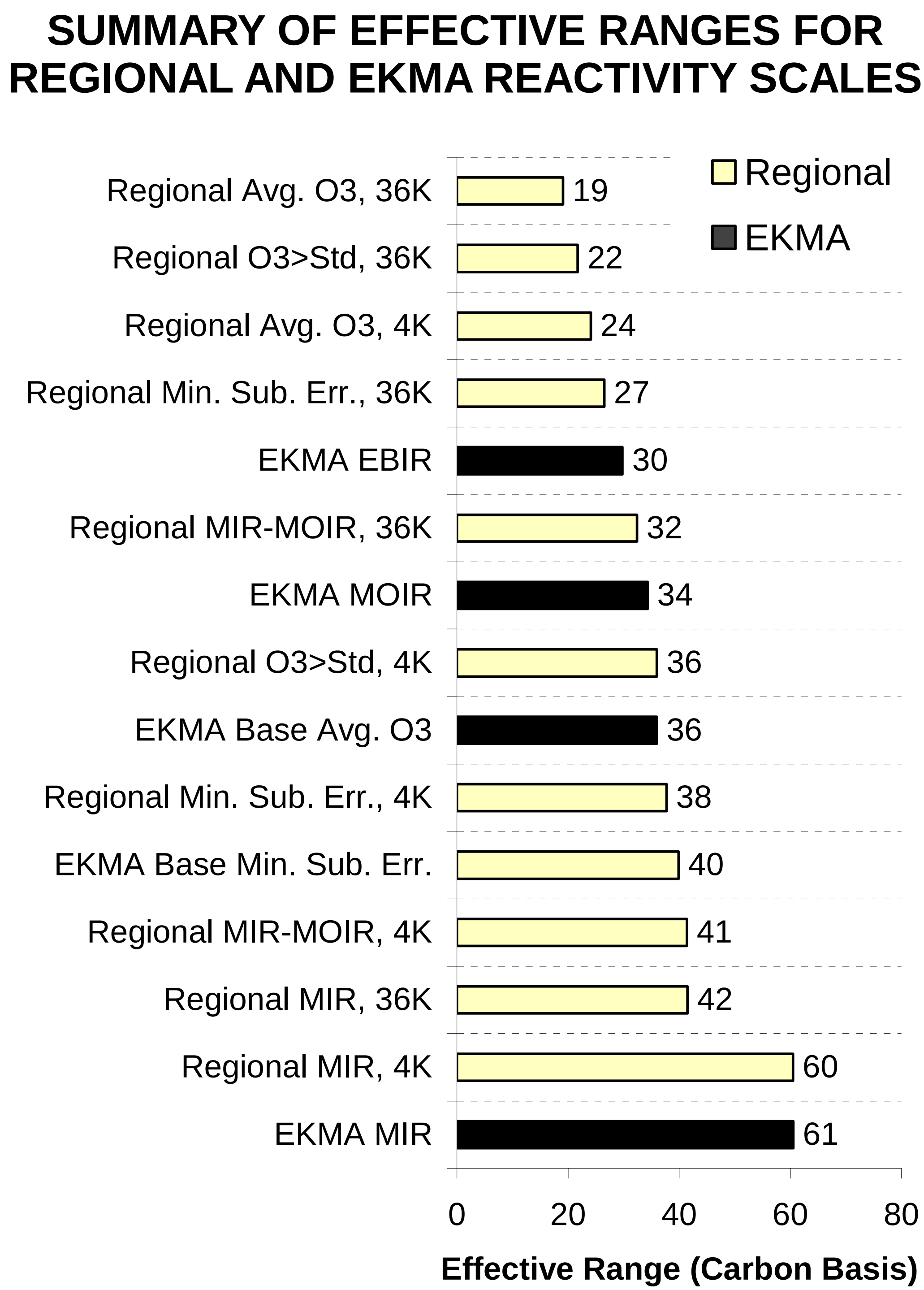
RELATIVE REACTIVITY VS EFFECTIVE RANGE

(CARBON BASIS)

RELATIONSHIP BETWEEN EFFECTIVE RANGE AND RELATIVE REACTIVITIES FOR LOW REACTIVITY SPECIES



RELATIVE REACTIVITY VS EFFECTIVE RANGE
(CARBON BASIS)


SUMMARY OF EFFECTIVE RANGES FOR
REGIONAL AND EKMA REACTIVITY SCALES
Regional
EKMA
Regional Avg. O3, 36K
19
Regional O3>Std, 36K
22
Regional Avg. O3, 4K
24
Regional Min. Sub. Err., 36K
27
EKMA EBIR
30
Regional MIR-MOIR, 36K
32
EKMA MOIR
34
Regional O3>Std, 4K
36
EKMA Base Avg. O3
36
Regional Min. Sub. Err., 4K
38
EKMA Base Min. Sub. Err.
40
Regional MIR-MOIR, 4K
41
Regional MIR, 36K
42
Regional MIR, 4K
60
EKMA MIR
61
0
20
40
60
80
Effective Range (Carbon Basis)

CONCLUSIONS FROM EVALUATION OF RELATIVE REACTIVITIES USING A 3-D REGIONAL MODEL

REGIONAL AND EKMA MODELS GIVE DIRECTIONALLY CONSISTENT REACTIVITY RANKINGS BY MOST METRICS FOR THE MAJOR TYPES OF REACTIVE VOCs

AVERAGING TIME FOR DAILY MAXIMUM O_3 DOES NOT SIGNIFICANTLY AFFECT RELATIVE REACTIVITIES

THE **EFFECTIVE RANGE** PROVIDES A USEFUL MEANS TO CLASSIFY RELATIVE REACTIVITY SCALES

- REFLECTS PREDICTED MAXIMUM BENEFIT OF REACTIVITY-BASED SUBSTITUTIONS
- CORRELATED TO RELATIVE REACTIVITIES OF MOST SPECIES

EFFECTIVE RANGES OF SCALES CAN VARY BY UP TO A FACTOR OF ~3 DEPEND ON HOW IMPACTS IN DIFFERENT TYPES OF REGIONS ARE WEIGHTED

- SCALES DOMINATED BY URBAN OR VOC-SENSITIVE REGIONS GIVE HIGHEST EFFECTIVE RANGES (UP TO ~60 ON CARBON BASIS)
- SCALES WEIGHTING IMPACTS THROUGHOUT LARGE REGIONS MORE EQUALLY GIVE THE LOWEST EFFECTIVE RANGES (DOWN TO ~20)

EKMA AND REGIONAL MODEL SCALES GIVE SIMILAR RESULTS FOR SIMILAR REGIONS AND METRICS

RECOMMENDATIONS

INFORMATION SHOULD NOW BE SUFFICIENT FOR POLICY DECISIONS TO BE MADE CONCERNING:

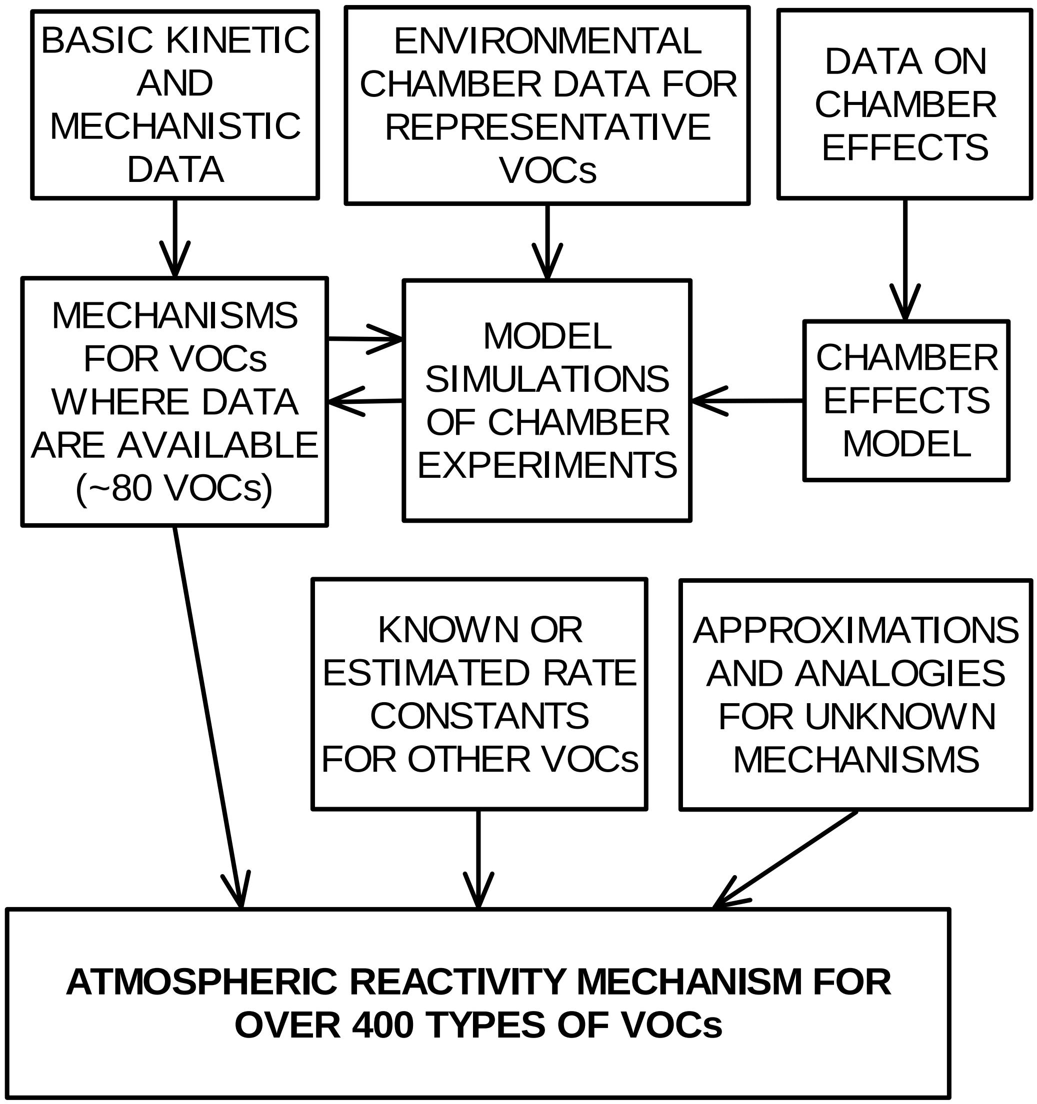
- WHETHER REACTIVITY-BASED REGULATIONS ARE WORTH THE COMPLEXITIES INVOLVED
- HOW TO WEIGH REGIONAL VS URBAN EFFECTS WHEN DERIVING A REGULATORY SCALE
- WHETHER IT IS BEST TO USE A SCALE WITH LOW OR HIGH EFFECTIVE RANGES

MODELING RESEARCH SHOULD FOCUS ON HOW BEST TO DERIVE A REACTIVITY SCALE FOR THE HUNDREDS OF EMITTED VOCs

- UP-TO-DATE, EXPERIMENTALLY TESTED, *DETAILED* MECHANISMS REQUIRED (NOT CB4!)
- MODELS USED MUST REPRESENT RANGE OF RELEVANT CHEMICAL CONDITIONS
- USE OF APPROPRIATE EKMA MODELS MAY BE SUFFICIENT, BUT RESEARCH IN IMPROVING EKMA SCENARIOS IS NEEDED

RESEARCH IS STILL NEEDED TO REDUCE CHEMICAL MECHANISM UNCERTAINTIES IN REGIONAL MODEL PREDICTIONS

DEVELOPMENT OF AN ATMOSPHERIC CHEMICAL MECHANISM TO CALCULATE VOC REACTIVITIES



NEED FOR IMPROVED CHAMBER FACILITY FOR REDUCING CHEMICAL MECHANISM UNCERTAINTY

MANY VOCs REPRESENTED USING PARAMETERIZED MODELS ADJUSTED TO FIT RELATIVELY HIGH CONCENTRATION CHAMBER DATA.

NONLINEAR CHEMISTRY MAY NOT ALWAYS EXTRAPOLATE TO LOWER CONCENTRATIONS.

LOWER URBAN POLLUTANT LEVELS BECOMING MORE COMMON AS CONTROLS ARE IMPLEMENTED.

CONCERN THAT COSTLY REGULATIONS BASED ON REDUCING O_3 AT HIGH URBAN NO_x LEVELS MAY NOT BE IMPROVING AIR QUALITY IN OTHER AREAS.

MOST CHAMBERS NOT WELL SUITED FOR EVALUATING VOC IMPACTS OTHER THAN ON O_3.

INFORMATION NEEDED TO VERIFY PREDICTIONS ON HOW TEMPERATURE AFFECTS VOC IMPACTS.

NEW U.C. RIVERSIDE CHAMBER FACILITY

OBJECTIVES OF EPA PROJECT

- DESIGN AND CONSTRUCT NEW FACILITY TO ADDRESS MECHANISM EVALUATION NEEDS NOT ADDRESSED BY CURRENT CHAMBERS
- DETERMINE WHETHER PREDICTIONS OF EFFECTS OF VOC AND NO_x ON O_3 AND AEROSOLS ARE APPLICABLE AT LOWER POLLUTANT LEVELS.
- ASSESS O_3, AEROSOL, AND OTHER IMPACTS OF VOCs UNDER LOW NO_x CONDITIONS
- DETERMINE EFFECTS OF TEMPERATURE ON VOC REACTIVITY, AEROSOL FORMATION AND OTHER IMPACTS
- EVALUATE USEFULNESS OF INDICATOR SPECIES FOR ASSESSING SENSITIVITIES OF AMBIENT ATMOSPHERES TO EMISSIONS CHANGES
- PROVIDE A FACILITY TO TEST EQUIPMENT FOR AMBIENT MONITORING

OBJECTIVES OF CALIFORNIA ARB PROJECT

- CONDUCT CHAMBER EXPERIMENTS TO EVALUATE O_3 IMPACTS OF ARCHITECTURAL COATINGS VOCs
- EXPERIMENTS WITH TEXANOL® (2,2,4-Trimethyl-1,3-pentanediol monoisobutyrate) AND PETROLEUM DISTILLATES CURRENT PRIORITY

U.C. RIVERSIDE CHAMBER FACILITY PROGRESS AND CURRENT STATUS

EXPERIMENTS WERE CONDUCTED TO INVESTIGATE AND MINIMIZE BACKGROUND EFFECTS USING SMALLER (~3000-LITER) REACTORS

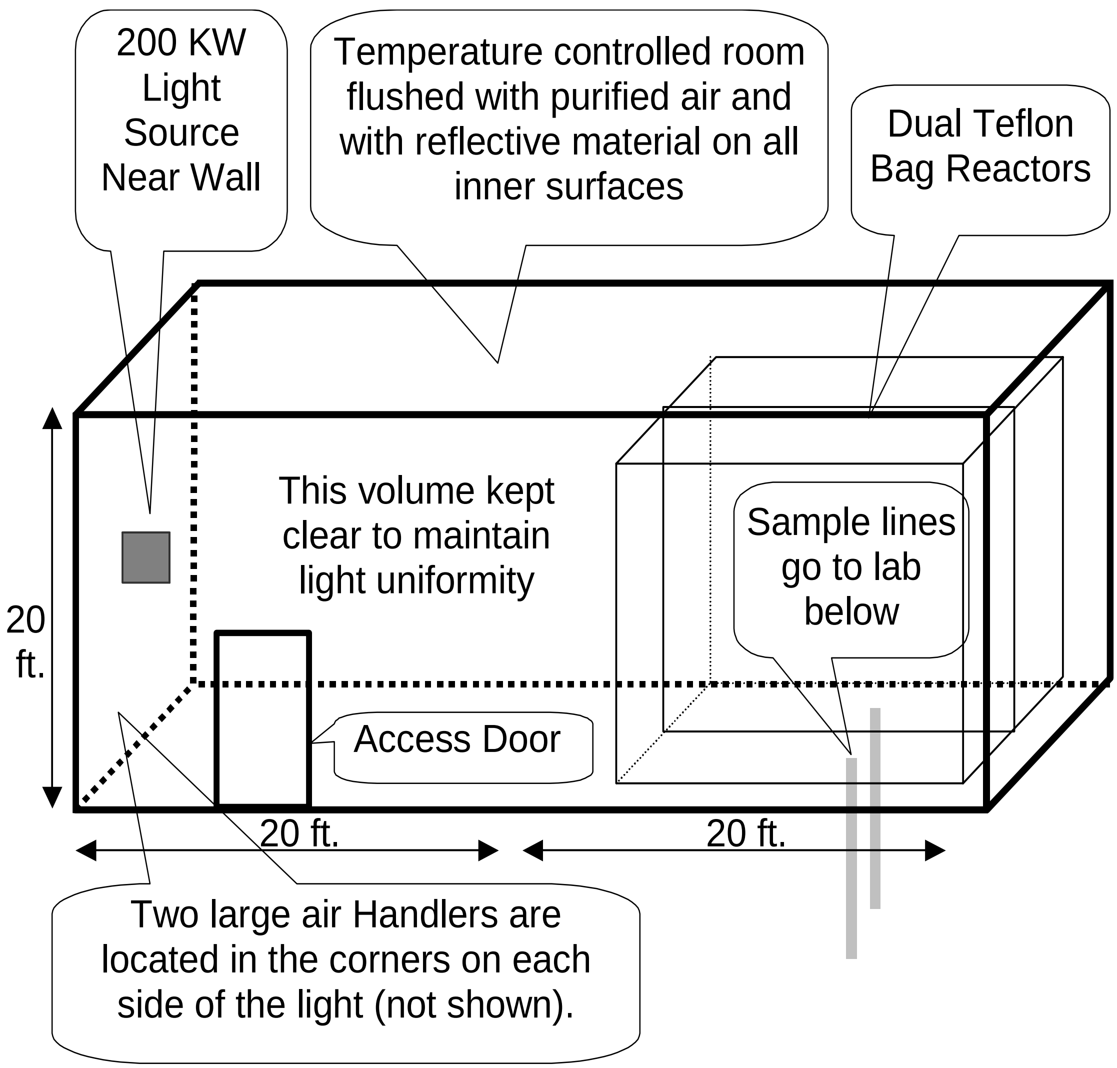
- MINIMUM BACKGROUND NO_x INPUT ~1 PPB/DAY

NEW INDOOR CHAMBER FACILITY CONSTRUCTED

- DESIGN AND CONSTRUCTION TOOK MUCH LONGER THAN ANTICIPATED
- NEW BUILDING NEEDED TO HOUSE FACILITY NOT COMPLETED UNTIL JULY 2001
- REACTORS IN “CLEAN ROOM” ENCLOSURE WITH 4 - 50^{o}C TEMPERATURE CONTROL
- 200 KW ARGON ARC LIGHT TO SIMULATE SOLAR SPECTRUM AND INTENSITY INSTALLED
- FIRST OF TWO DUAL ~75 M^3 SEMI-RIGID TEFLON REACTORS INSTALLED AND BEING EVALUATED
- CURRENTLY WORKING ON LEAK PROBLEMS

BECAUSE OF THE DELAYS, THE RESEARCH PLAN FOR THE EPA PROJECT WILL NEED TO BE CUT BACK IF ADDITIONAL FUNDING NOT OBTAINED

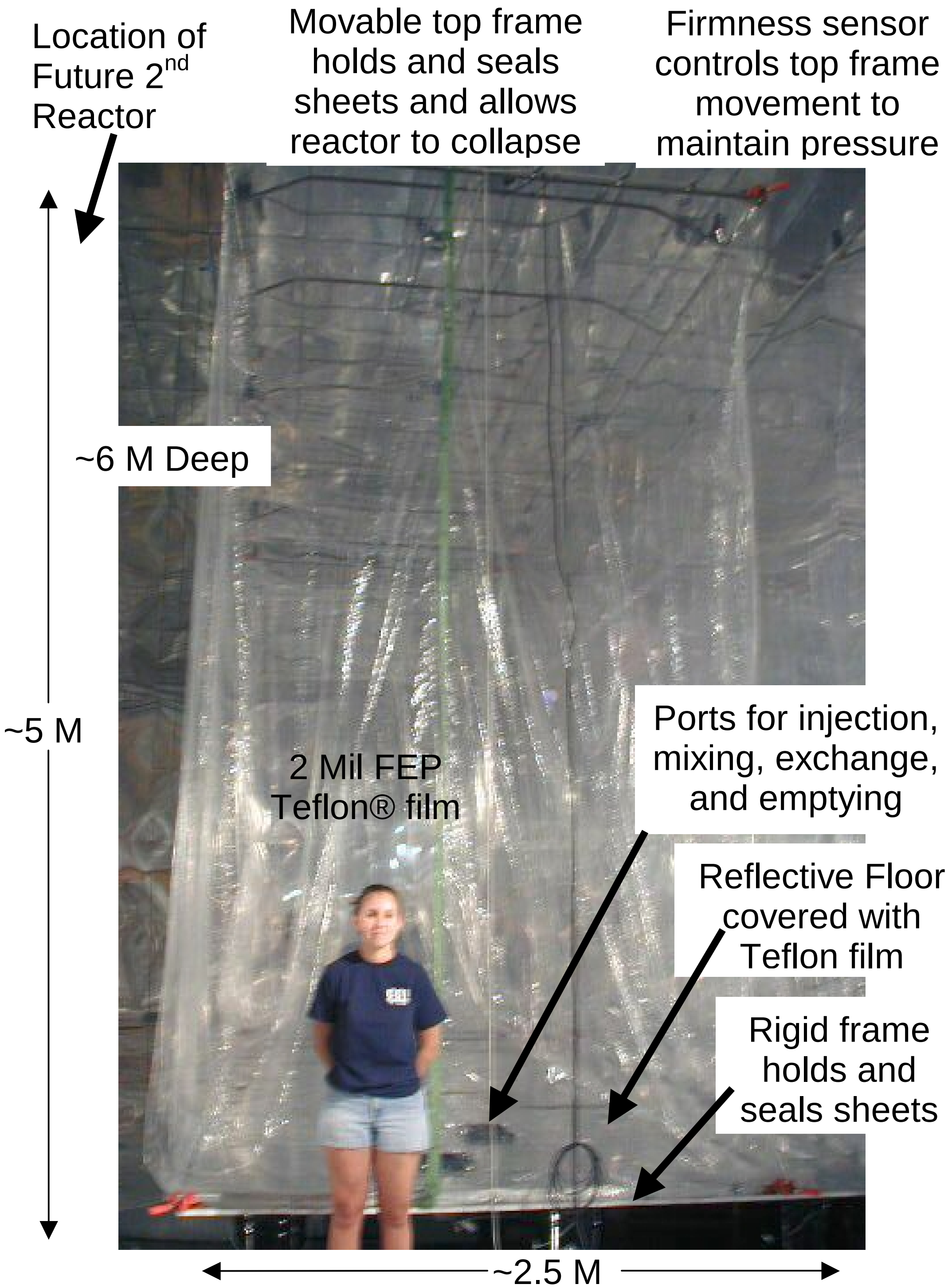
DIAGRAM OF ENVIRONMENTAL CHAMBER AND TEMPERATURE-CONTROLLED ENCLOSURE



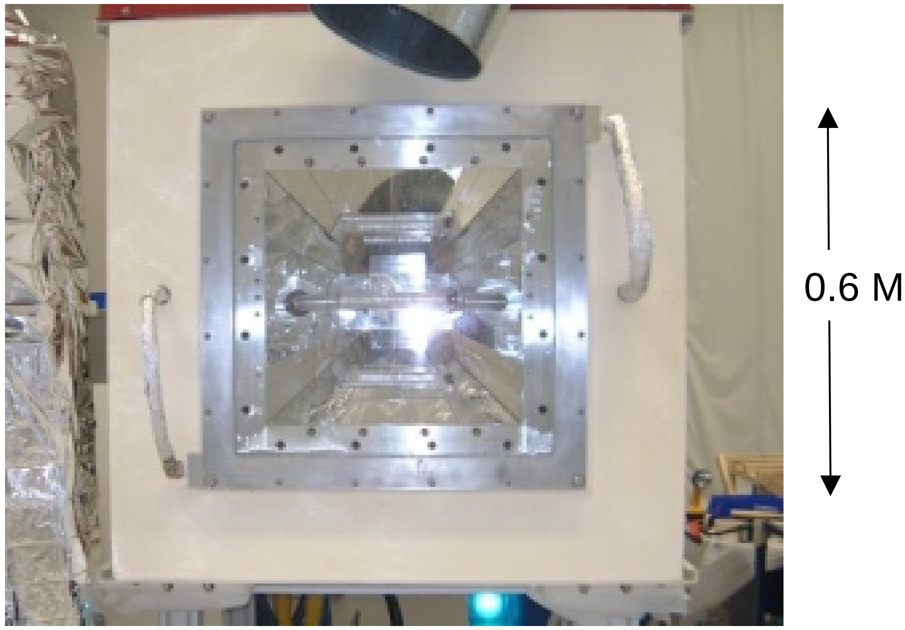
CHAMBER BUILDING AND LABORATORY

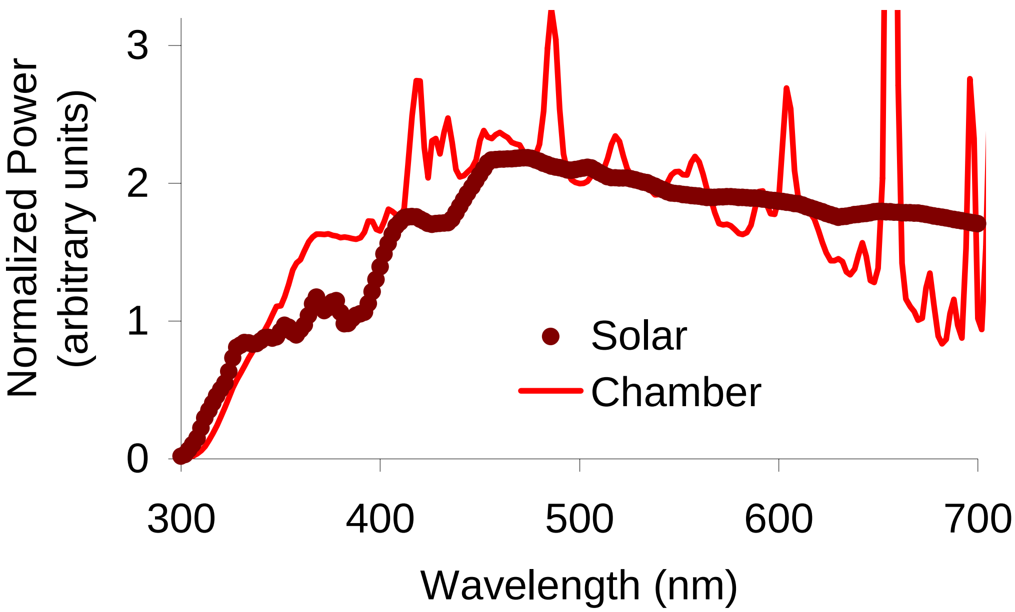
CHAMBER ENCLOSURE AS OF 8/01

PICTURE OF CURRENT REACTOR



ARC LIGHT SOURCE AND SPECTRUM





INITIAL PRIORITY EXPERIMENTS FOR NEW UCR EPA CHAMBER

LOW NO_x MECHANISM EVALUATION

- SELECTED SIMPLE CHEMICAL SYSTEMS TO EVALUATE MEASUREMENTS, CHAMBER EFFECTS MODEL, AND BASIC MECHANISM COMPONENTS
- INITIAL FOCUS WILL BE AROMATICS, WHERE LOW NO_x MECHANISM IS MOST UNCERTAIN
- SURROGATE - NO_x EXPERIMENTS TO EVALUATE OVERALL LOW NO_x MODEL PERFORMANCE

LIMITED TEMPERATURE EFFECTS STUDIES

- INITIAL FOCUS WILL BE ON AROMATIC AND REALISTIC SURROGATE - NO_x SYSTEMS

VOC REACTIVITY ASSESSMENT

- PRIORITY WILL BE ARCHITECTURAL COATINGS VOCs AS REQUIRED FOR CARB PROJECT
- EXPERIMENTS WITH OTHER SELECTED VOCs TO COMPARE WITH PREVIOUS STUDIES
- EXPERIMENTS WITH AROMATICS IF OTHER EXPERIMENTS INDICATE MECHANISM PROBLEMS

INITIAL EXPERIMENTS TO DEMONSTRATE CAPABILITY OF CHAMBER FOR PM EVALUATION

- NEEDED TO SUPPORT PLANNING OR PROPOSALS FOR ADDITIONAL PM STUDIES