IDA

Comparison of Over-Land Atmospheric Dispersion (OLAD) Field Test Data to HPAC Predictions

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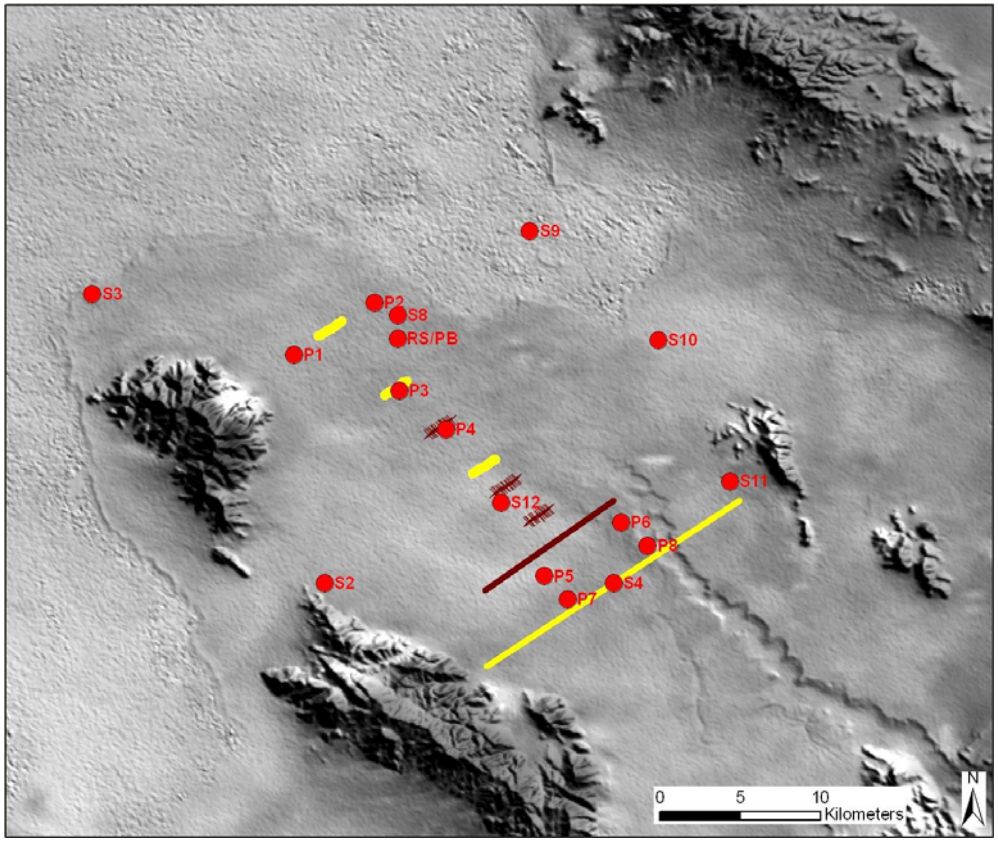
IDA | Introduction

- The Defense Threat Reduction Agency (DTRA) is developing a maintenance build of its Hazard Prediction and Assessment Capability (HPAC) software.
  - First official revision of the HPAC model since HPAC 5.0 SP1 (Build 82).
  - Includes changes to HPAC modules, such as the SWIFT meteorological pre-processor, that were made during development of JEM 1.1.
  - The maintenance build of HPAC 5 (Build 125) is currently undergoing independent verification and validation (IV&V).
- Questions were raised about dispersion predictions in non-urban areas during JEM 1.1 IV&V efforts (Chang and Tang, 2009).
  - Significant differences between HPAC Build 82 and 99 predictions for the OLAD and Dipole Pride 26 field trials.
- IDA has carried the JEM work forward to Build 125.

IDA | Over-Land Alongwind Dispersion (OLAD) Field Trials

- Series of continuous line releases conducted at Dugway Proving Ground on 8 – 25 September 1997.
  - Releases from **truck** or **aircraft** moving perpendicular to the prevailing wind.
  - Considered atmospheric transport and dispersion (AT&D) at distances of 2 – 20 km.
  - Dispersion measured at three crosswind sampling lines and one aircraft.
  - 14 total releases, 12 produced useful data.
  - All releases were conducted in the morning.



Layout of the OLAD Trial. Long lines denote line source releases (aircraft – yellow, truck – brown). Short lines denote the three sampler lines corresponding to each release mode. Red circles indicate locations of meteorological stations (PWIDS – "P", SAMS – "S", and radiosonde and pibal balloons – "RS/PB").

IDA | Methods

- OLAD projects for HPAC 5 were extracted from JEM projects received from Joe Chang.
  - Meteorological inputs were a vertical profiler and surface measurements.
  - Changes were made to the conditional averaging input and to the time reference for the meteorology.
- HPAC predictions for each OLAD release were obtained in each of three software builds
  - Build 82: Last official HPAC 5 release
  - Build 99: Unreleased developmental build of JEM 1.1
  - Build 125: New maintenance build of HPAC 5
- The predictions from each build were compared against each other to see how much they changed with each build.
- The predictions were also compared against observations using a two-dimensional measure of effectiveness.

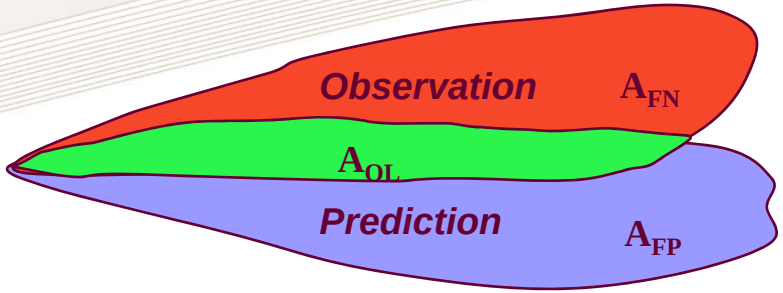
IDA | Comparisons of Predictions Across Model Builds

- Some differences in predictions were seen across model builds.
- The differences were significant for less than half of the releases.

	Build 82 vs. 99		Build 99 vs 125		Build 82 vs. 125	
Release	FAC2	FAC10	FAC2	FAC10	FAC2	FAC10
S253	100%	100%	100%	100%	99%	100%
S254	57%	96%	56%	98%	100%	100%
S260	48%	100%	52%	97%	70%	100%
S267	67%	67%	14%	14%	14%	14%
All Aircraft Releases	68%	91%	56%	77%	71%	79%
S251	33%	47%	34%	57%	39%	59%
S252	100%	100%	100%	100%	100%	100%
S255	46%	84%	59%	100%	67%	79%
S258_1	100%	100%	100%	100%	100%	100%
S258_2	100%	100%	100%	100%	100%	100%
S258_3	100%	100%	100%	100%	100%	100%
S261	74%	92%	75%	100%	95%	100%
S268	100%	100%	0%	100%	0%	100%
All Truck Releases	82%	90%	71%	95%	75%	92%
All Releases	77%	90%	66%	89%	74%	88%

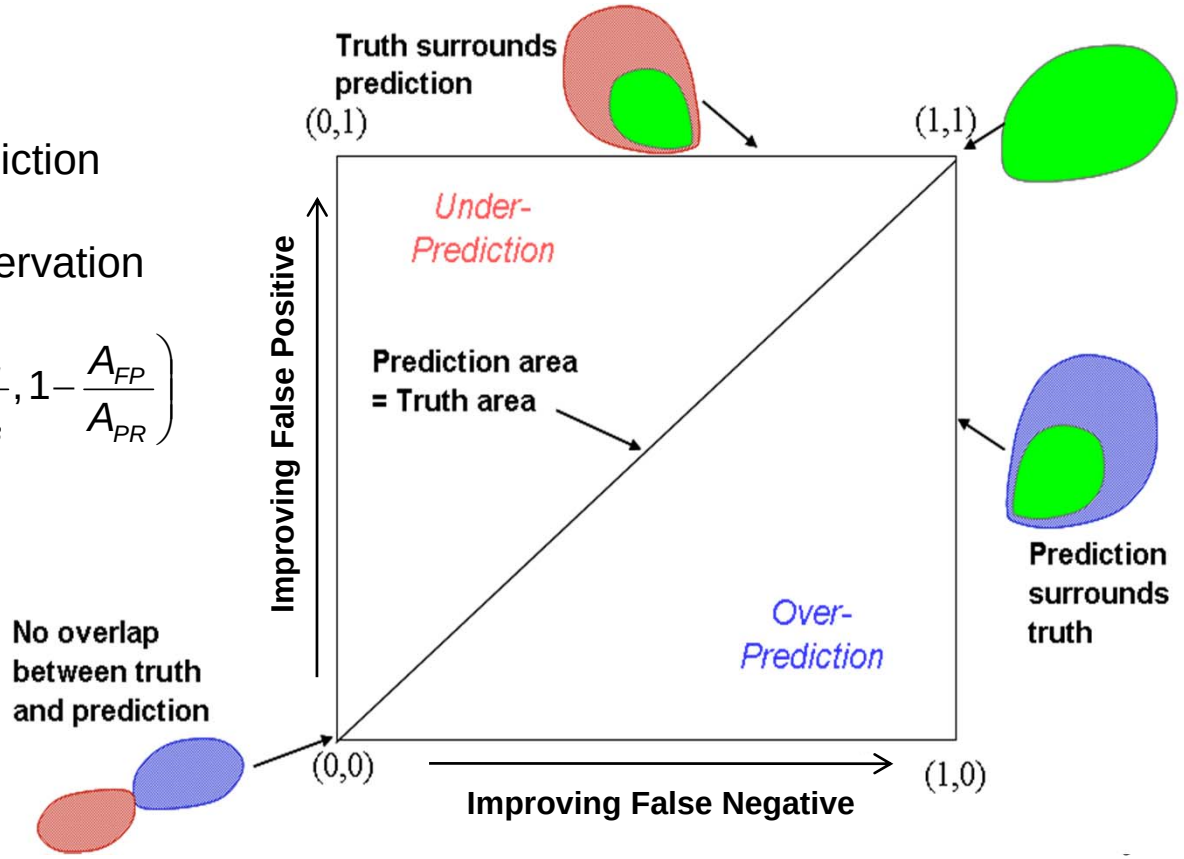
User-Oriented Measure of Effectiveness

Point-to-Point Comparisons



A_{FN} = Region of False Negative
A_{OL} = Region of Overlap
$A_{PR} = A_{OL} + A_{FP}$ = Region of Prediction
A_{FP} = Region of False Positive
$A_{OB} = A_{OL} + A_{FN}$ = Region of Observation

$$MOE(x,y) = \left(\frac{A_{OL}}{A_{OB}}, \frac{A_{OL}}{A_{PR}} \right) = \left(1 - \frac{A_{FN}}{A_{OB}}, 1 - \frac{A_{FP}}{A_{PR}} \right)$$

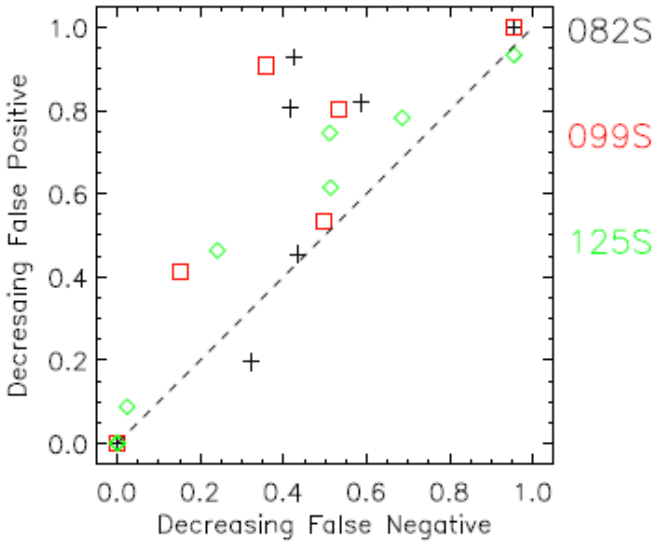


IDA | OLAD Threshold-Based MOEs (200 ppt)

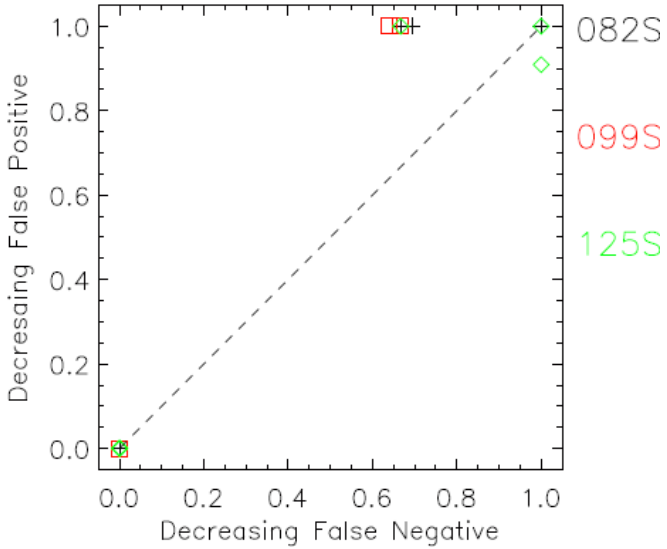
Individual MOEs

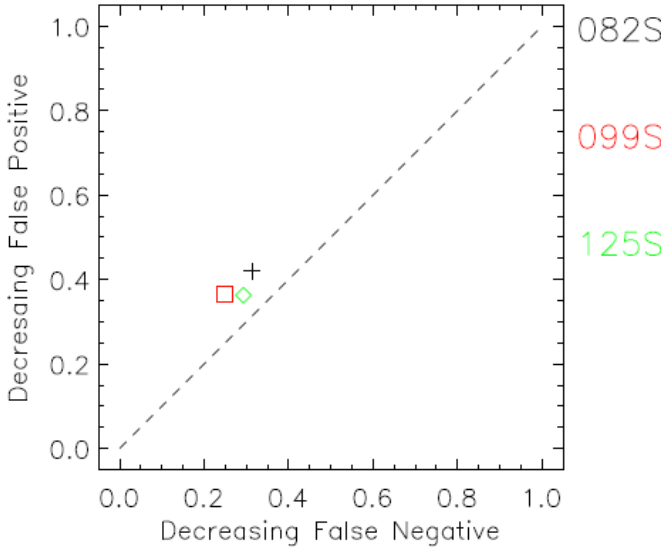
Averaged MOEs

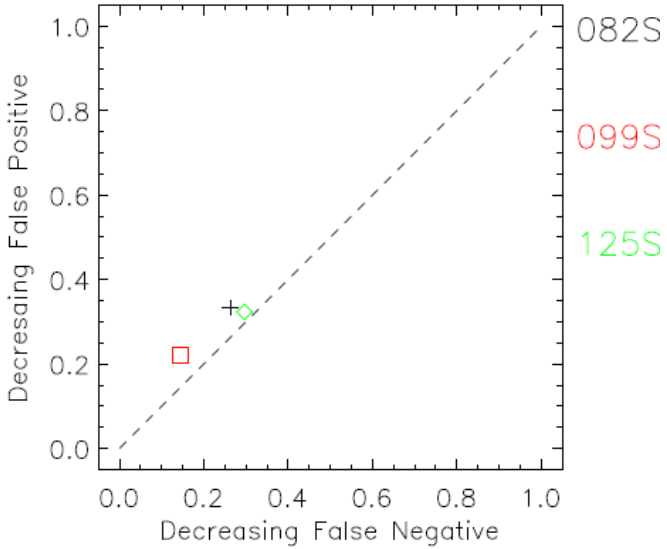
15-min Averaged Concentration



180-min Averaged Concentration





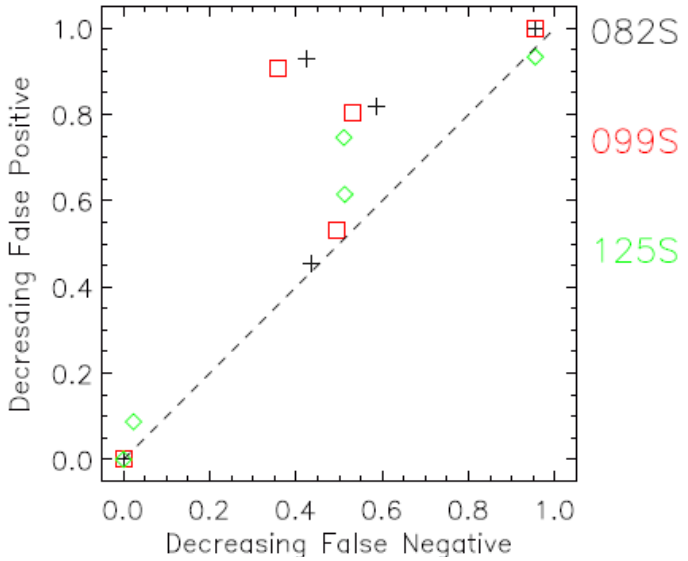


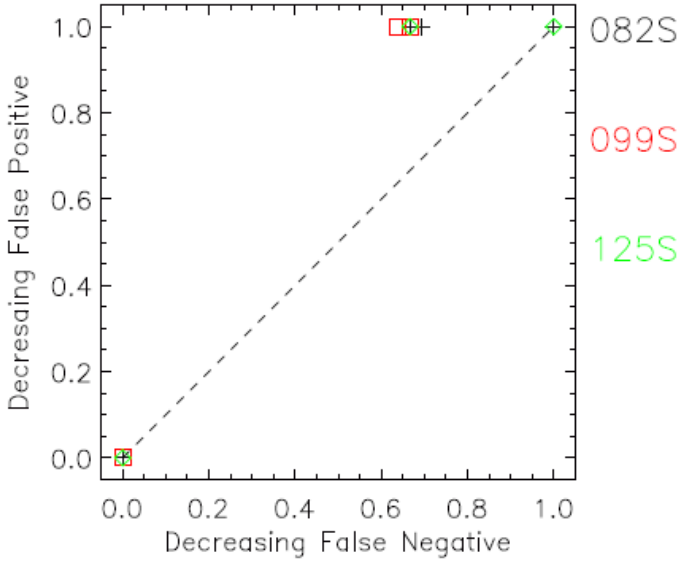
IDA | OLAD Individual Threshold-Based MOEs (200 ppt)

15-min Averaged Concentration

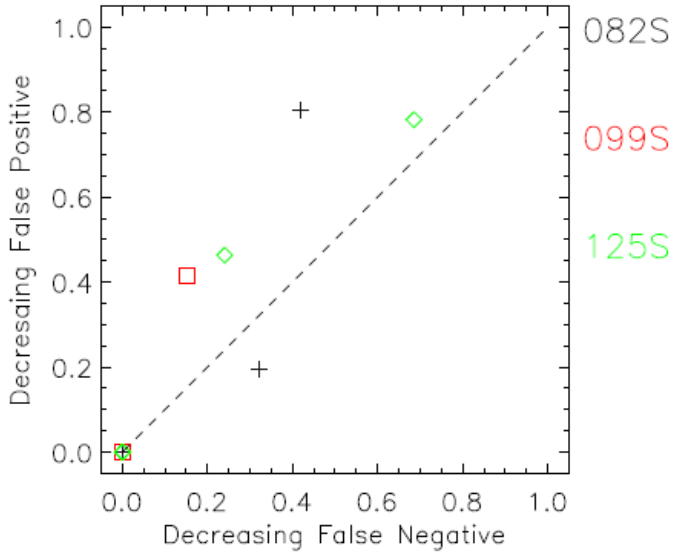
180-min Averaged Concentration

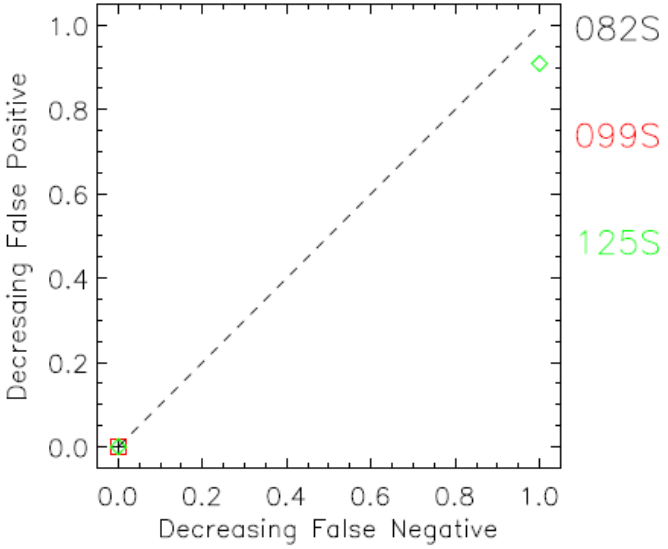
Truck Releases





Aircraft Releases



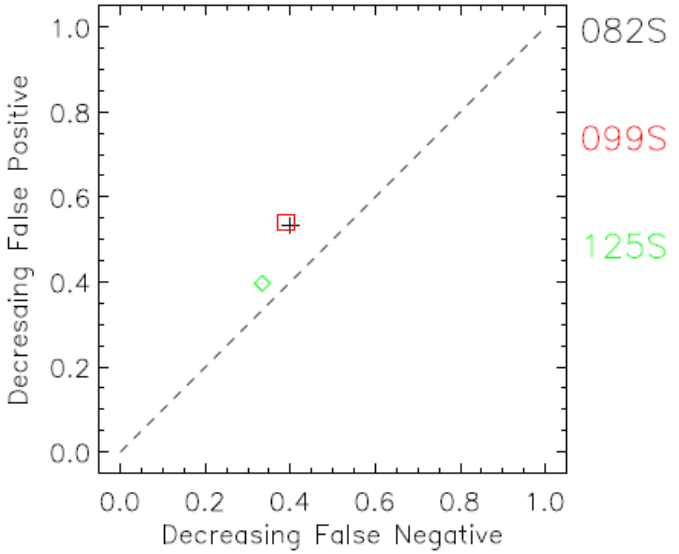


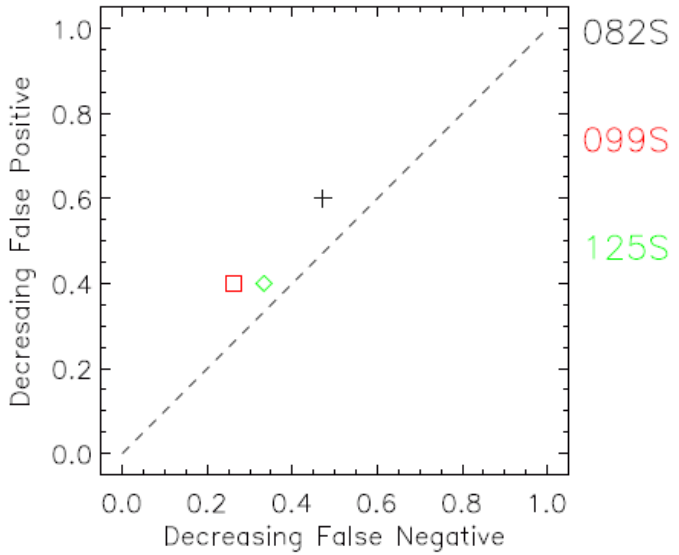
IDA | OLAD Averaged Threshold-Based MOEs (200 ppt)

15-min Averaged Concentration

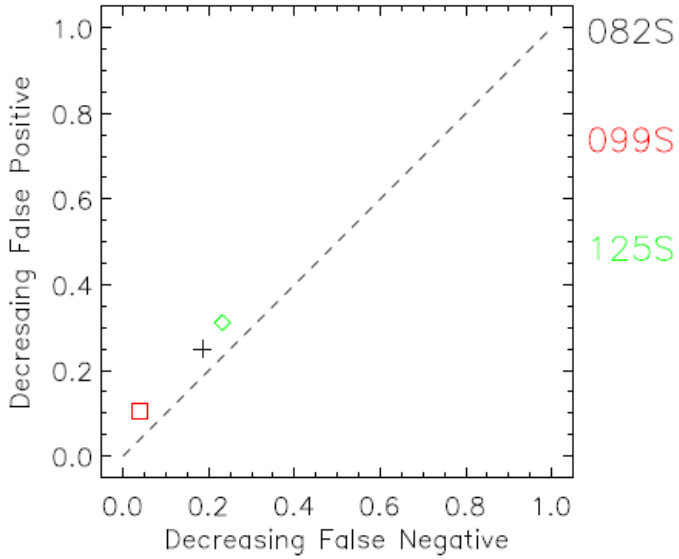
180-min Averaged Concentration

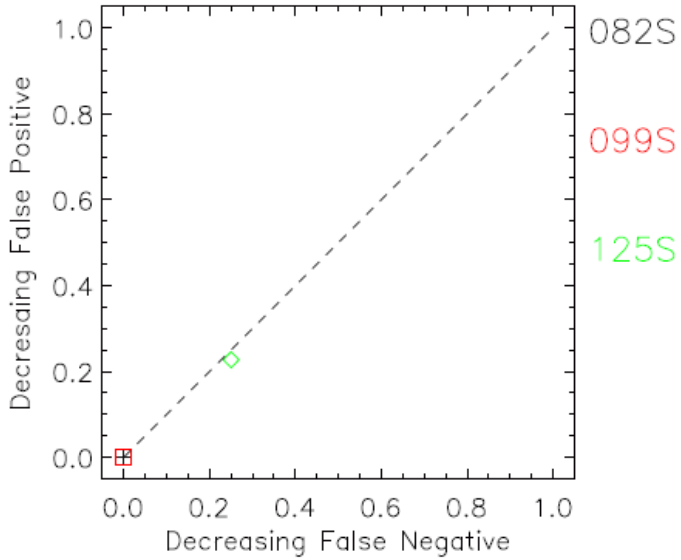
Truck Releases





Aircraft Releases



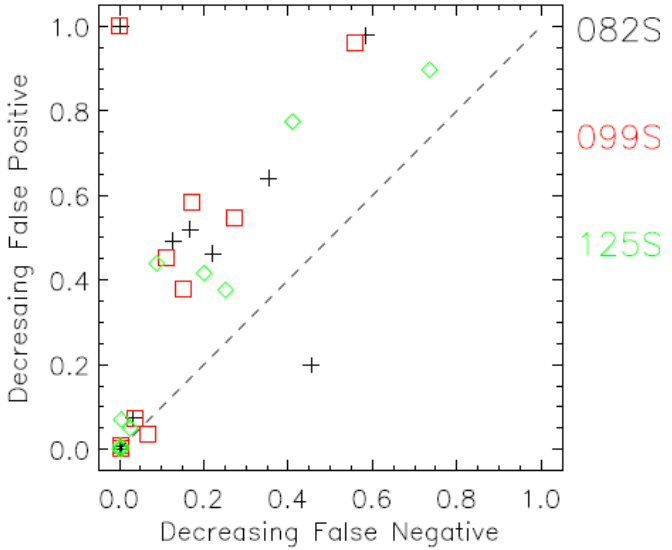


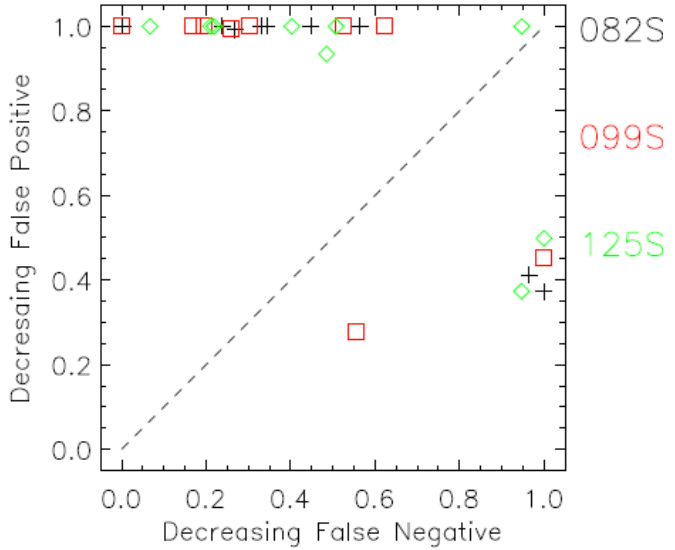
IDA | OLAD Average Concentration MOEs

15-min Averaged Concentration

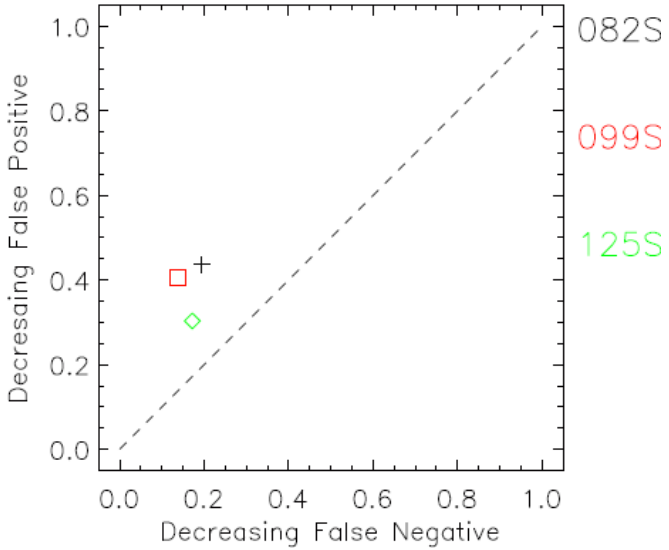
180-min Averaged Concentration

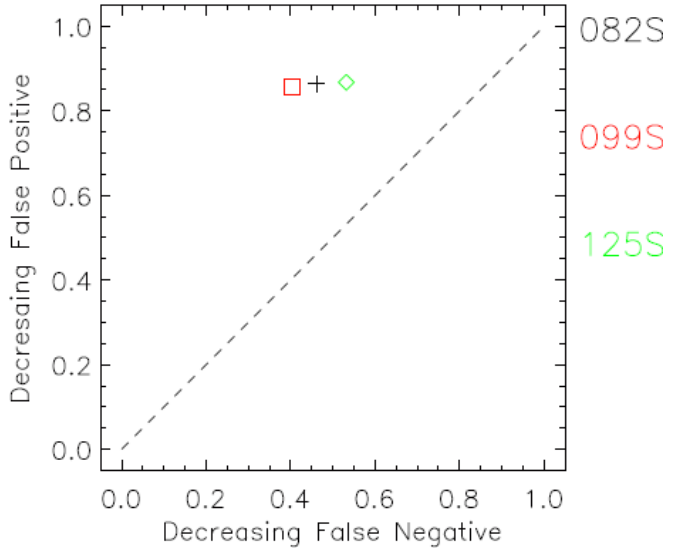
Individual MOEs





Averaged MOEs



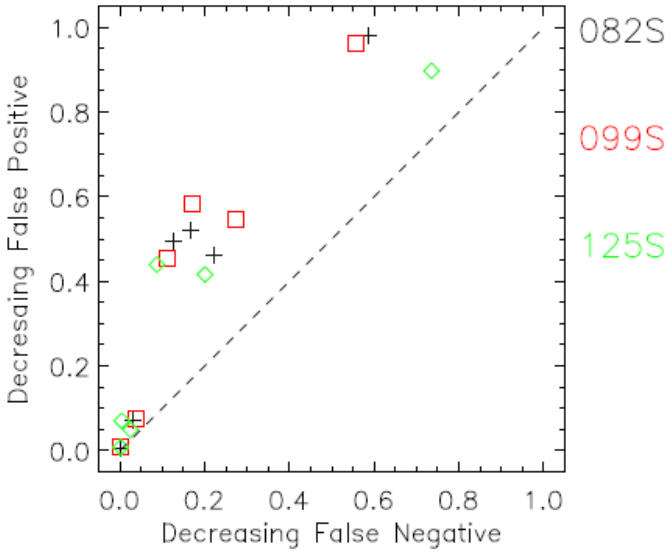


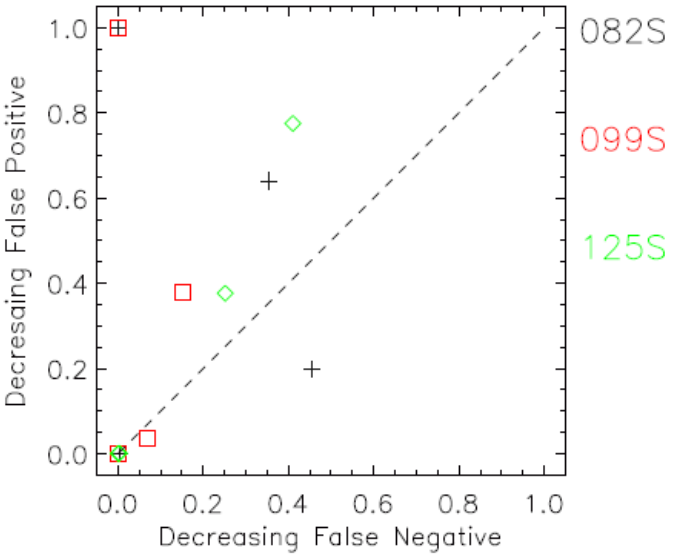
IDA | OLAD Individual Average Concentration MOEs

Truck Releases

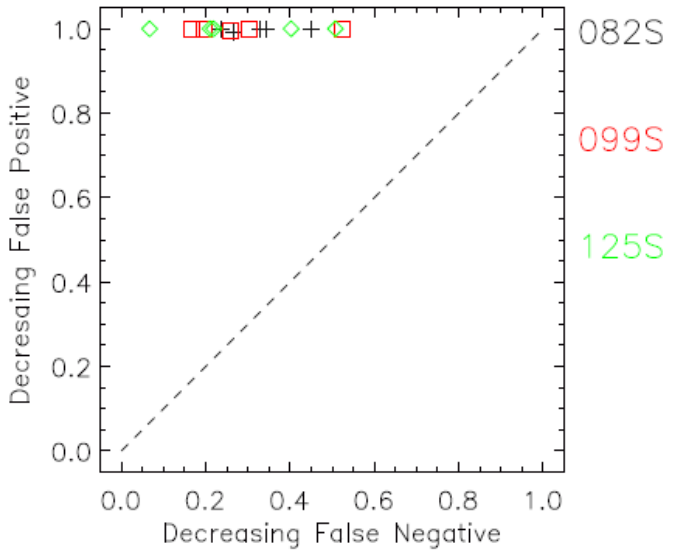
Aircraft Releases

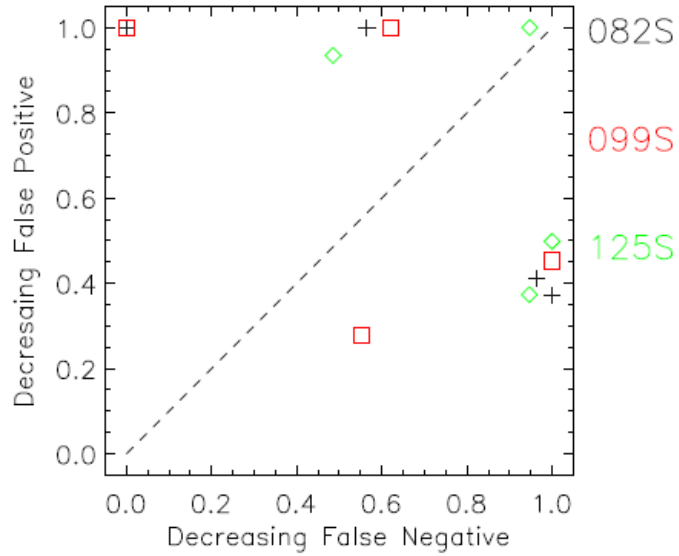
15-min Averaged Concentration





180-min Averaged Concentration



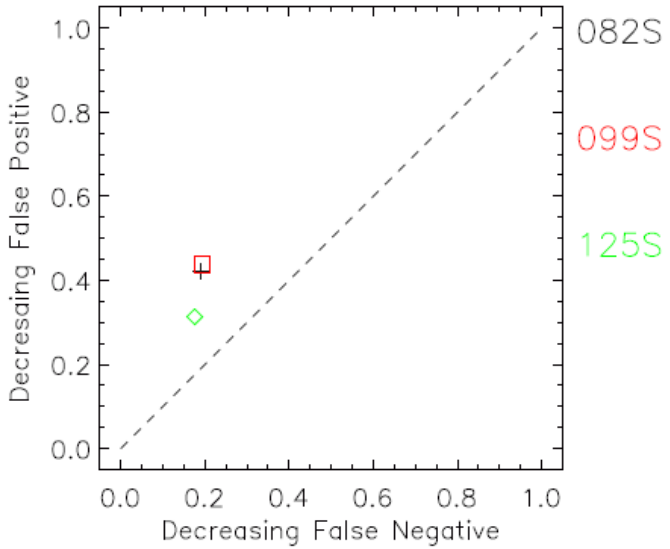


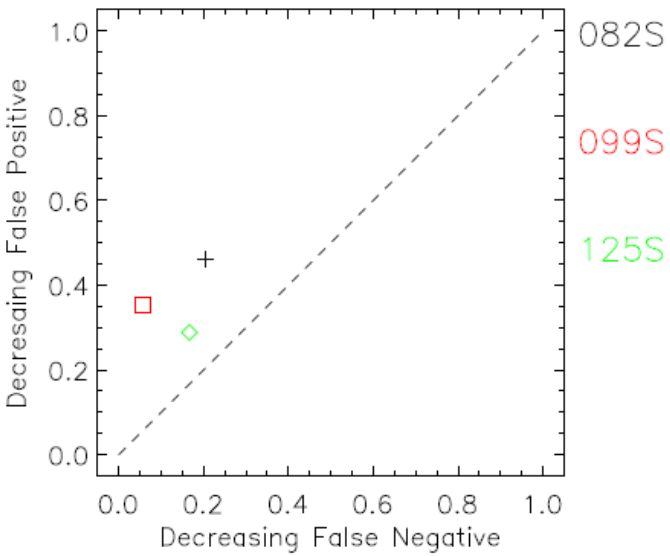
IDA | OLAD Averaged Average Concentration MOEs

Truck Releases

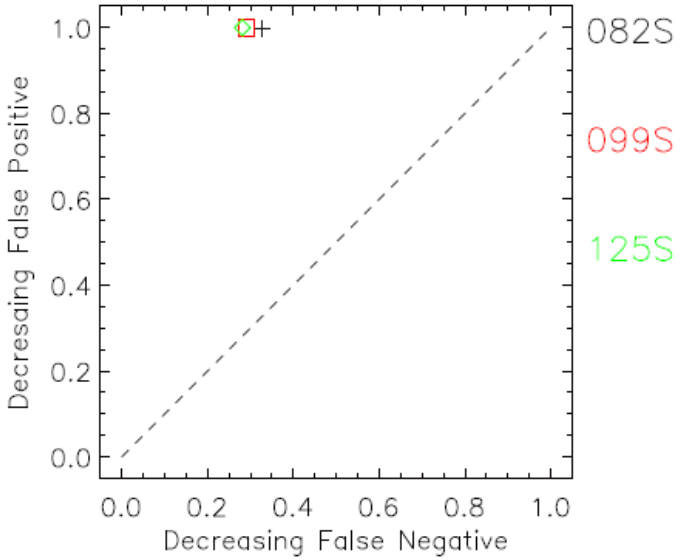
Aircraft Releases

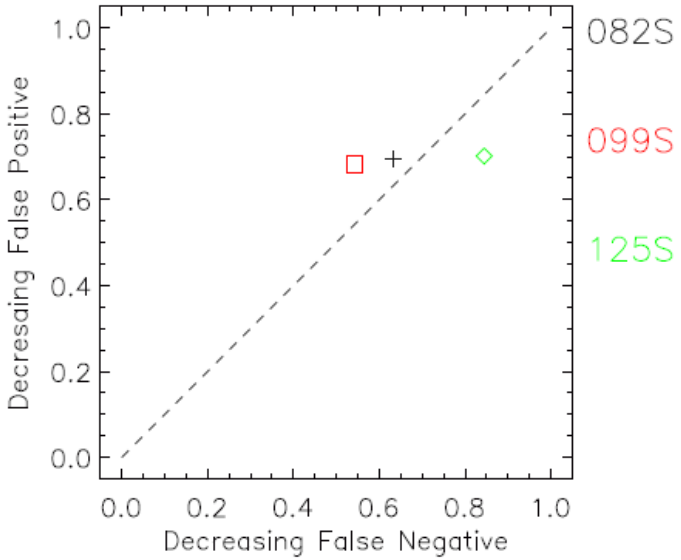
15-min Averaged Concentration





180-min Averaged Concentration





IDA | Comparison of line-maxes

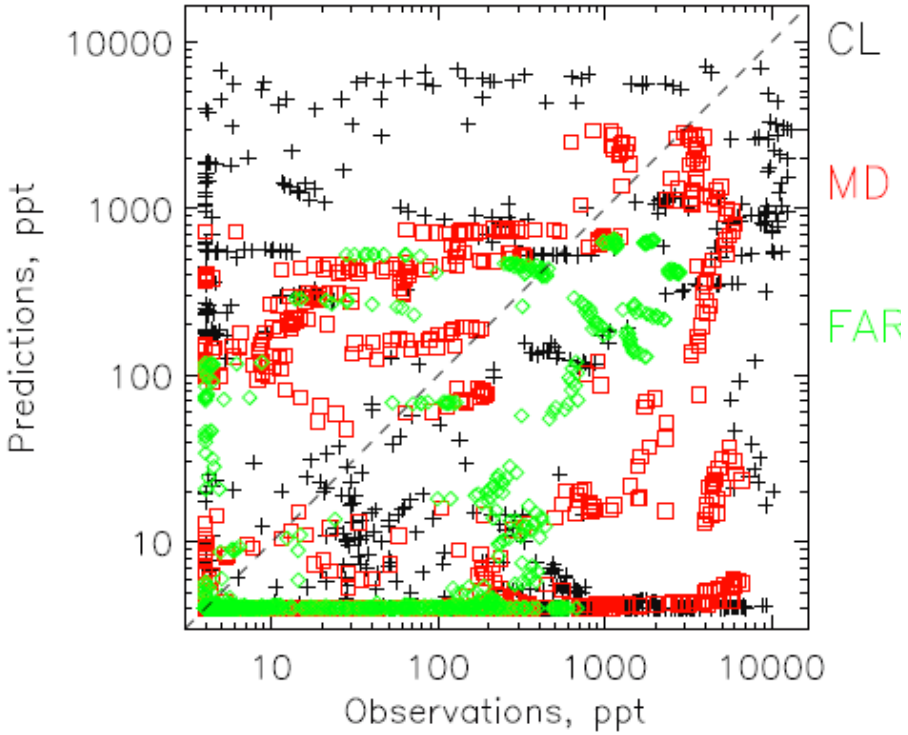
	FB	NMSE	NAD
JEM, 2009	1.232	8.880	0.638
B82	1.159	6.106	0.615
B99	1.237	7.332	0.661
B125	1.323	10.510	0.698

- Fractional Bias (FB) – Minor variations across model releases, B125 slightly worse
- Normalized Absolute Differences (NAD) – Minor variations across model releases, B125 slightly worse
- Normalized Mean Square Error (NMSE) – Some indication that B125 is worse than previous model releases

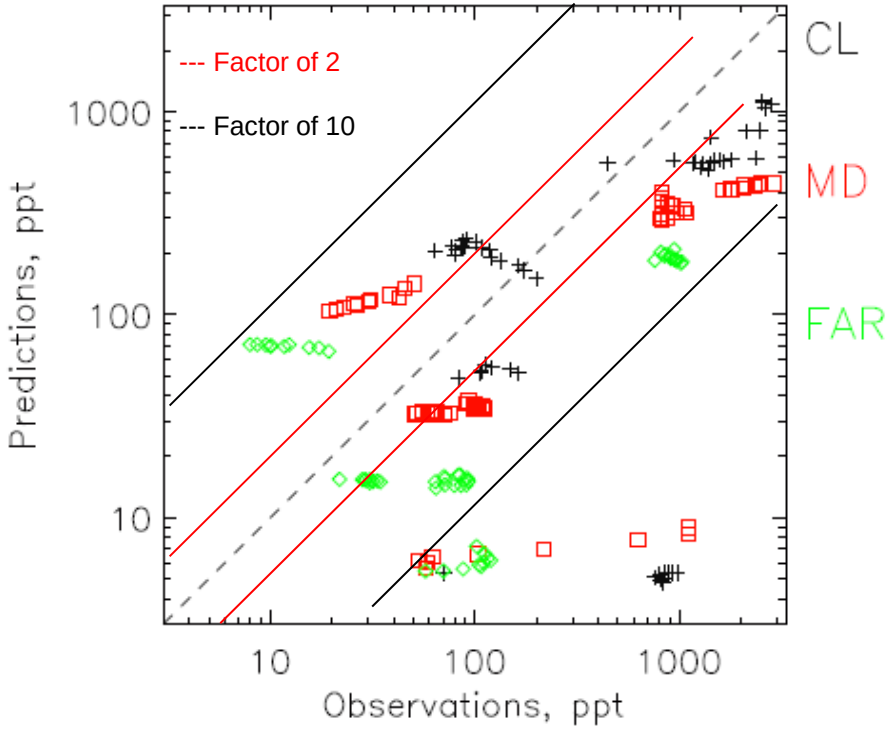
- We later realized that SWIFT (which ran successfully for all OLAD projects in Builds 82 and 99) ended in error for 10/12 Build 125 OLAD projects. In these cases, HPAC defaulted to MC-SCIPUFF.

IDA | OLAD Predictions vs. Observations Build 82

15-min Averaged Concentration

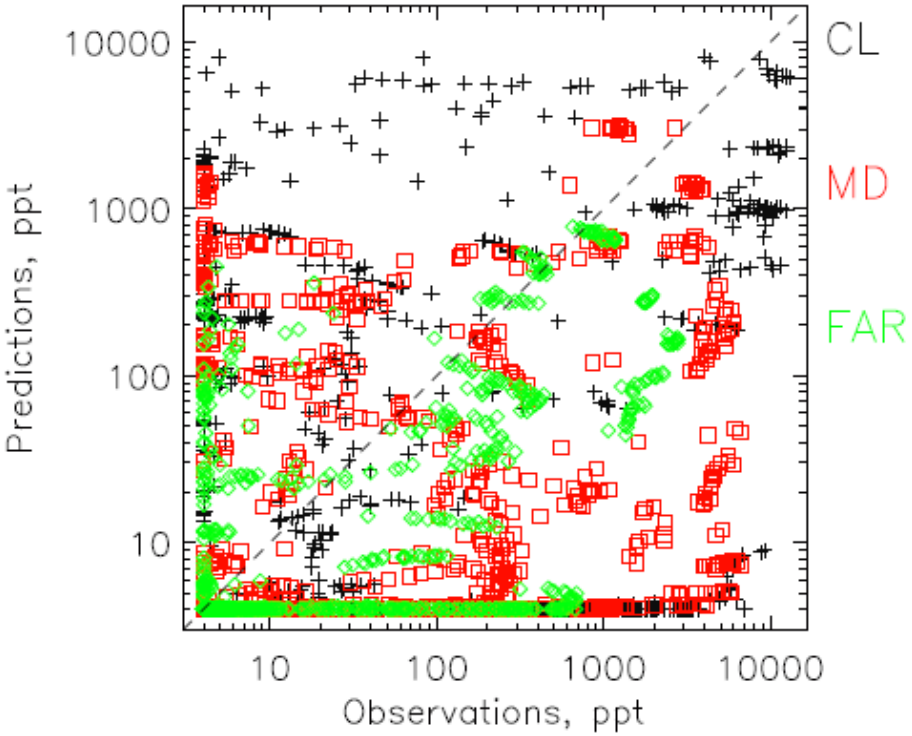


180-min Averaged Concentration

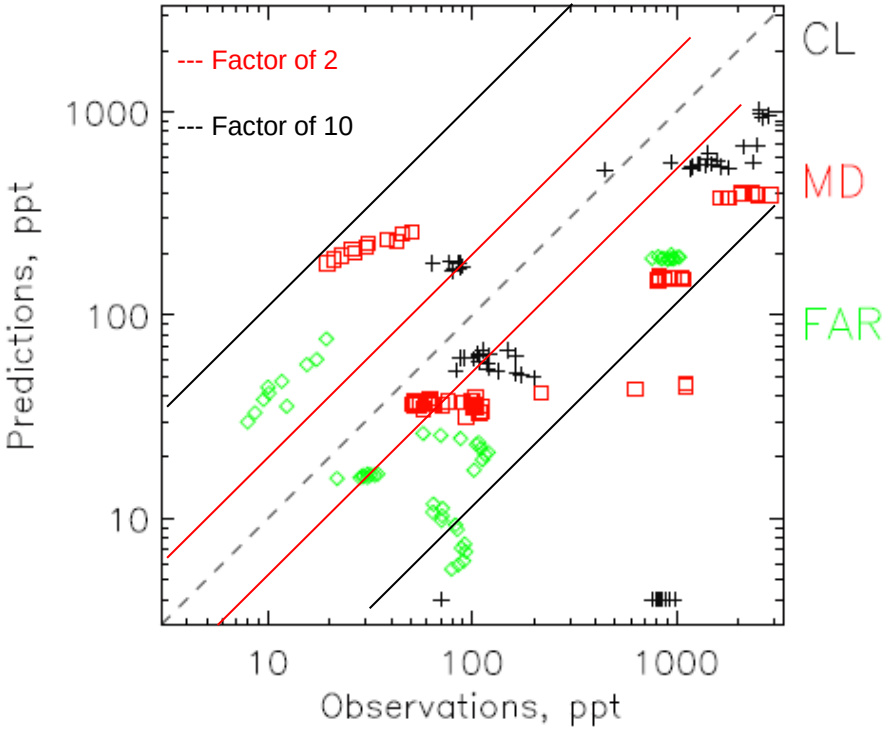


IDA | OLAD Predictions vs. Observations Build 99

15-min Averaged Concentration

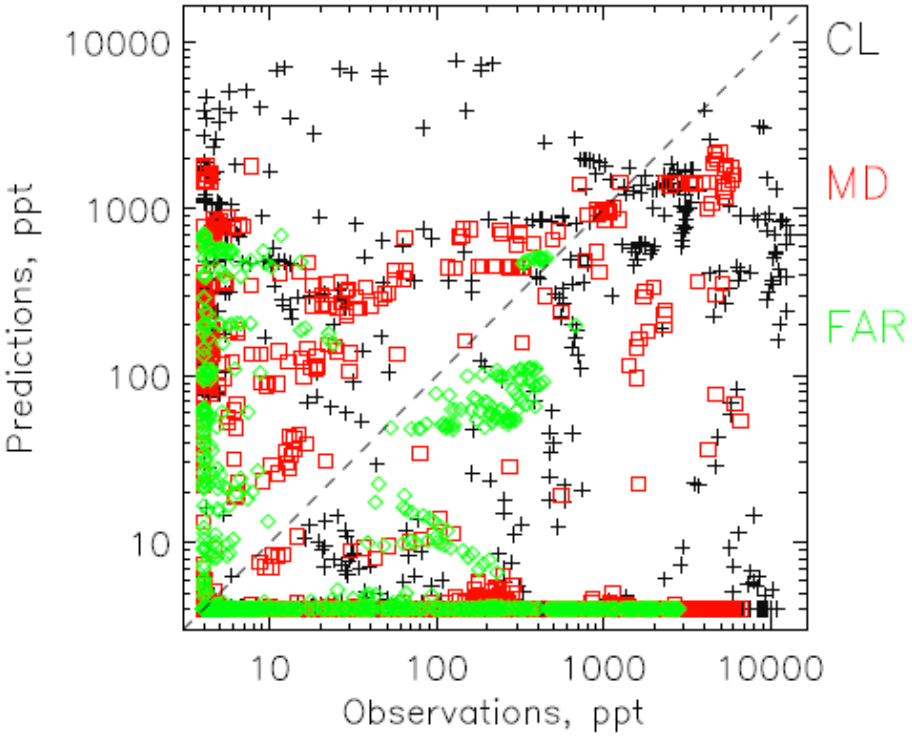


180-min Averaged Concentration

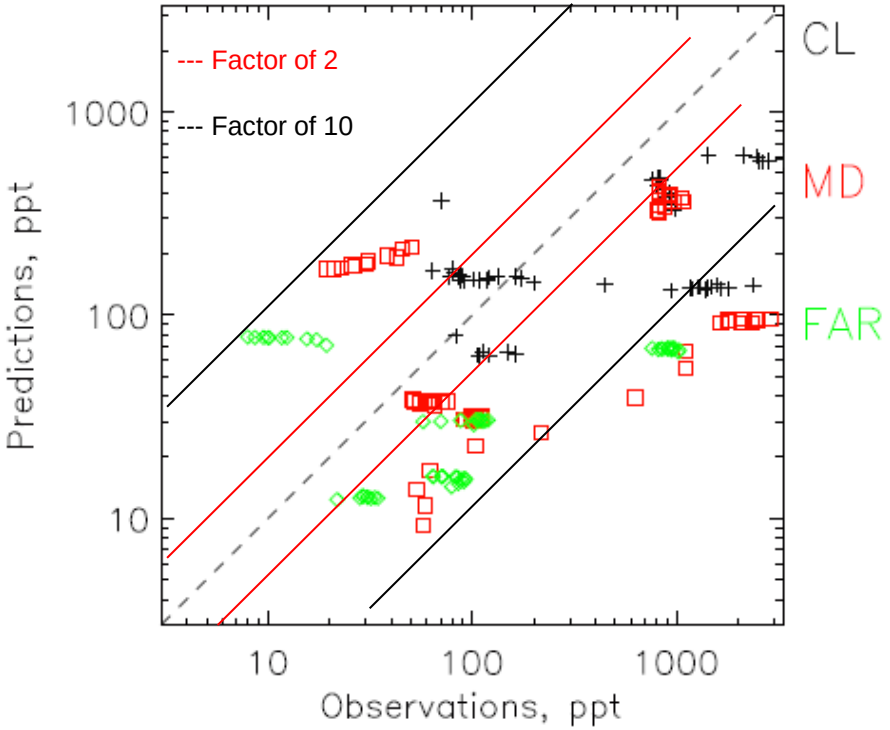


IDA | OLAD Predictions vs. Observations Build 125

15-min Averaged Concentration



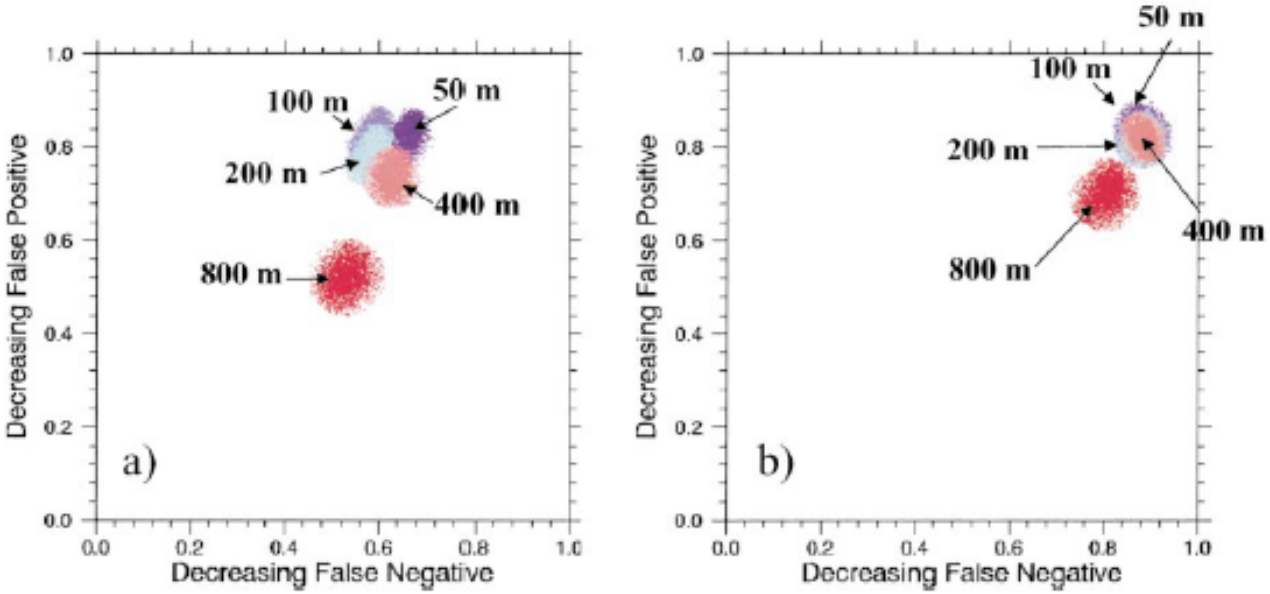
180-min Averaged Concentration



IDA | MOEs in Context (1)

- IDA has observed the possibility of MOE scores from hazard prediction models decreasing with increasing range to samplers and with added modeling complexity (e.g., terrain or urban environment).
- The OLAD experiment was done in the presence of complex terrain, and sampling distances were a minimum of 2 km, (maximum of 20 km).

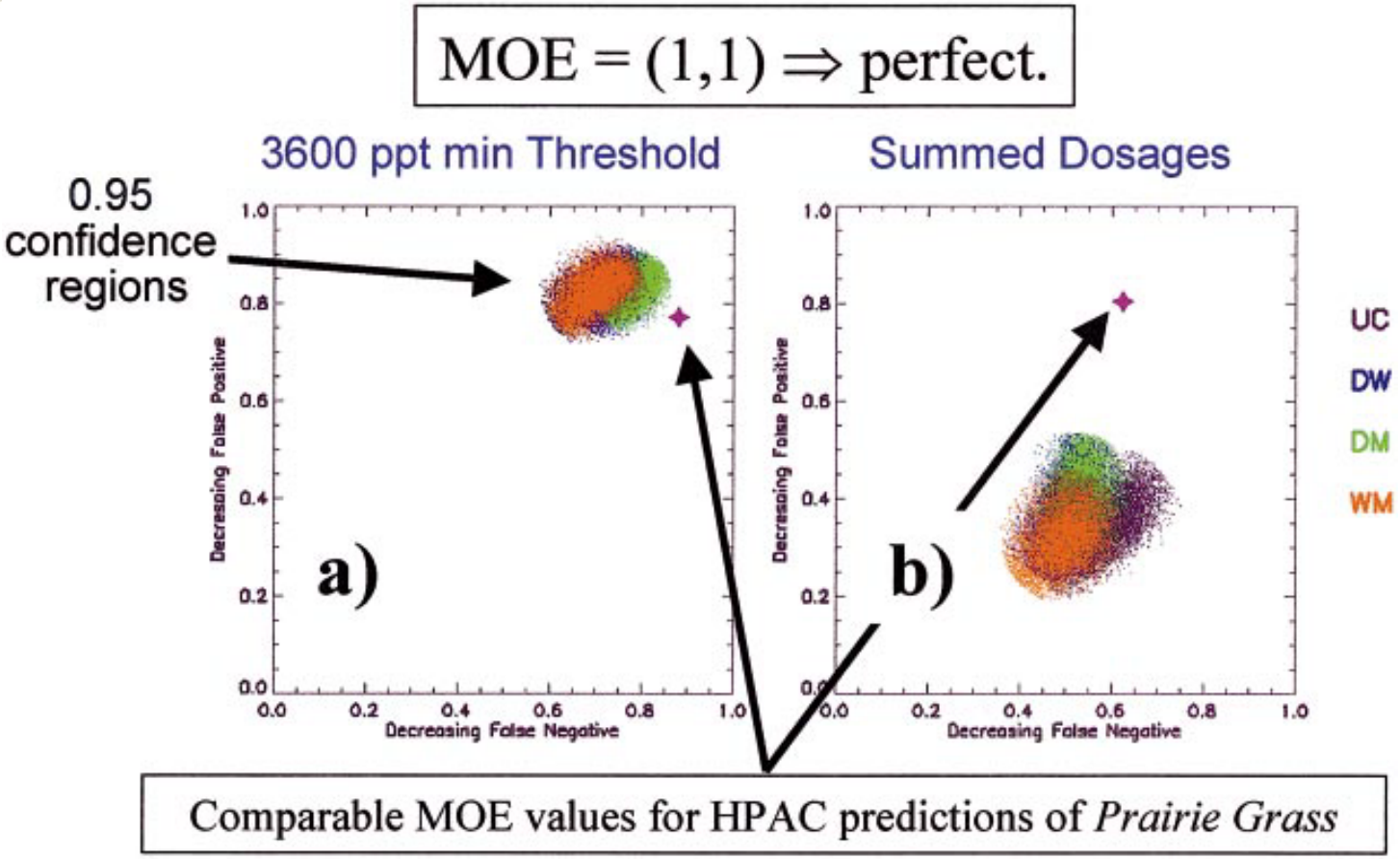
MOEs from Project Prairie Grass Evaluation



Dosage-based MOE **Threshold-based MOE**

MOEs in Context (2)

MOEs from Urban 2000 Evaluation (Raging Waters Met)



Downtown samplers were within 1 km of the source

IDA | Conclusions

- IDA is assisting with the IV&V efforts for the maintenance build of HPAC 5 (Build 125).
- Questions were raised about differences in OLAD predictions between earlier builds of HPAC.
- We have completed OLAD runs in Build 82, 99, and 125.
  - Compared predictions between builds
    - Significant differences between builds appear to be limited to a few releases.
  - Compared predictions to observations.
- There are no significant changes in model predictions when compared with earlier versions of the model
  - Both point-to-point 2D MOE comparisons and “line-max” comparisons
- OLAD predictions for all three builds of HPAC based on point-to-point comparisons currently show
  - Predictions for truck releases are somewhat better than for aircraft by the threshold-based MOE.
  - By the threshold-based MOE Build 125 may be best for aircraft releases, but the worst for truck releases.
  - By the average concentration based MOE predictions for truck releases may not be better than for aircraft releases.
- SWIFT does not run for 10/12 OLAD projects in Build 125.
- We are trying to put the observed OLAD performance in context and considering the potential consequences for the intended use of the model
  - Does a deterministic answer make sense, or do we need a probabilistic answer?
  - Is the validation methodology/metric appropriate for all intended uses of the models?
    - For example, is validation and accreditation of HPAC/JEM based on “line maximum concentration/dosage” predictions also appropriate for real-time “hazard area” predictions?