

Complex Terrain Modeling Still Woefully Short of Goals

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The Issue

- Air quality models used in regulatory settings, such as AERMOD, calculate design values at individual receptors on complex terrain (terrain above stack top).
- The current version of AERMOD uses the algorithms of CTDM which was developed in 1986 based on limited field studies.
- Comparisons to real world measurement data continue to show substantial over predictions of the CTDM method and advances in modeling or field studies of greater precision and accuracy are needed.

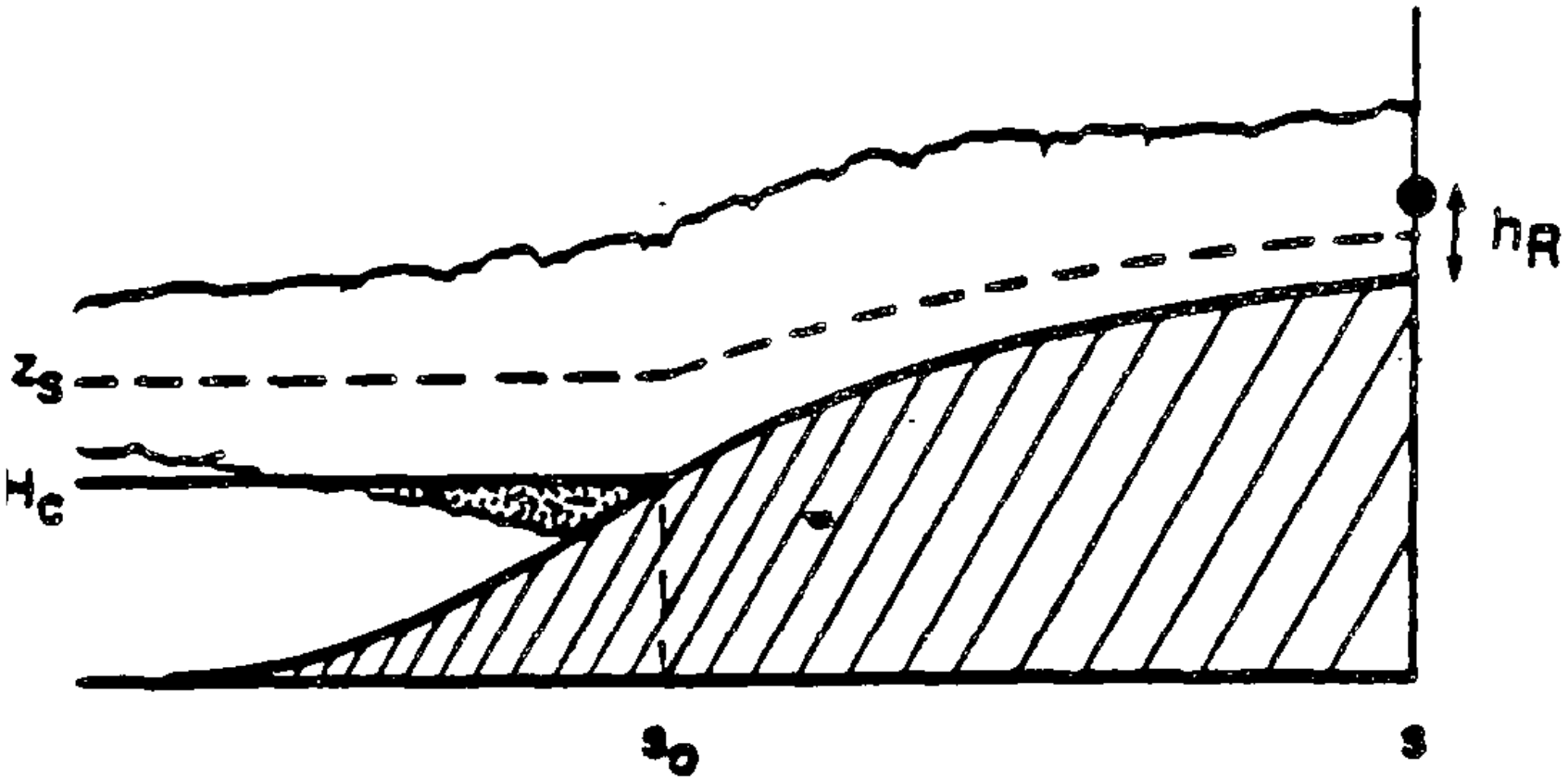
Origin of CTDM

- EPA Report From ERT/Sigma developing a model from field studies.
- Cinder Cone Butte: Stable downslope flows in the Snake River valley east of Boise toward isolated volcanic 100 meter high cinder cone.
- Hogback Ridge: A 90 meter ridge west od San Juan in New Mexico
- Tracey Power Plant: Truckee River valley east of Reno.
- Wind tunnel modeling by EPA was added to the evaluations

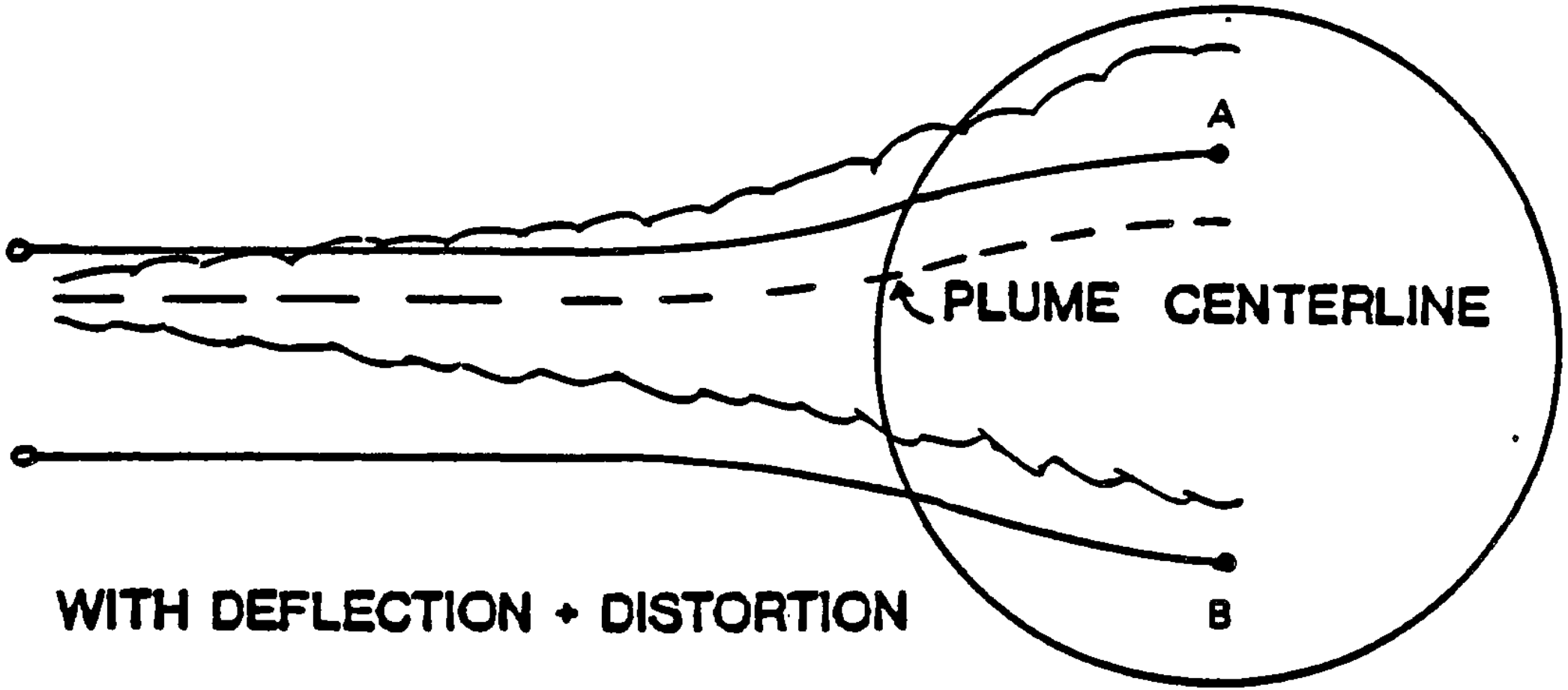
Model Basis

- Deflection of the air flow over an obstacle using Boussinesq flow
- Describes the distortion of the plume centerline and plume shape over the obstacle in order to obtain a centerline to ground distance for Gaussian dispersion.

Figure of Vertical Distortion Concept



Horizontal Distortion Concept



Model Results

- CTDM was within a factor of three if one tower met data was used for Cinder Cone Butte or Hogback Ridge,. If more met data was used performance improved
- CTDM was within 25% at Tracy even with only one met tower data base.
- CTDM was tested at two other sites with one tower data an was within a factor of three for both.

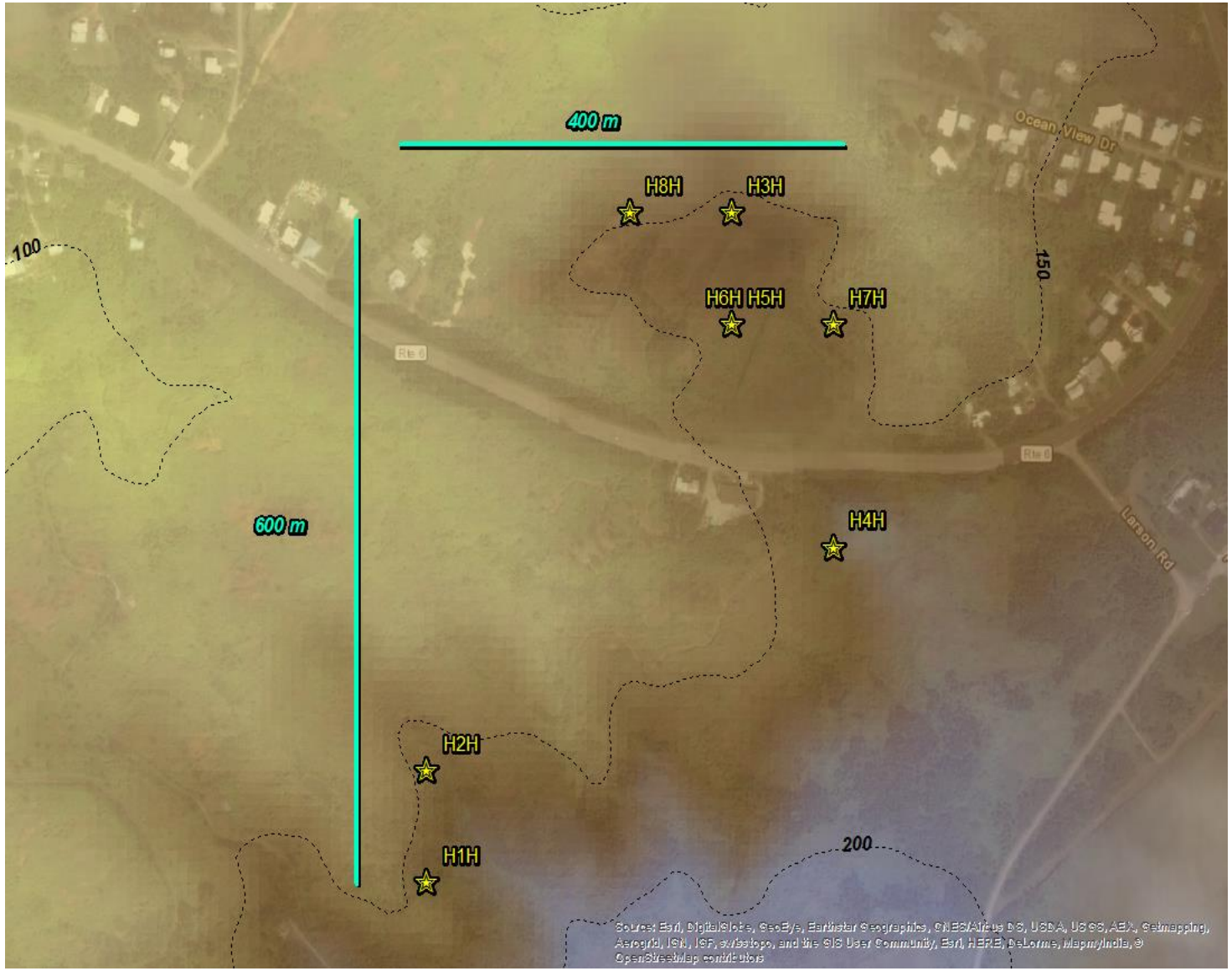
CTDM Report Warning

- CTDM is better than prior approaches
- CTDM performance degrades when only one meteorological tower is used and when diffusion measures are not available.
- Special warning about degraded performance for ridges.
- That is, it shouldn't be used with airport data or one met tower (my interpretation).

AERMOD/CTDM Method

- For both the SO_2 and NO_2 NAAQS, AERMOD/CTDM evaluates the 4th highest or 8th highest one hour concentration respectively at each receptor, in other words a statistically based assessment.
- When any terrain or meteorological condition indicates the need for closer spaced receptors, or when it is necessary to focus on the maximum receptor area to insure that the maximum concentrations are obtained, modelers add more receptors at shorter distances to obtain the maximum.
- The example I will use is a ridge line for a relatively rare wind toward the ridge (almost always the problem in complex terrain). In this example a 100 meter receptor grid was placed along the ridge.

Receptor Locations (Brown Shading is Ridge Line)



Meteorologically Rare Events

Year	Frequency WNW
2006	0.61%
2007	0.86%
2008	0.60%
2009	1.56%
2010	0.29%
Average	0.78%

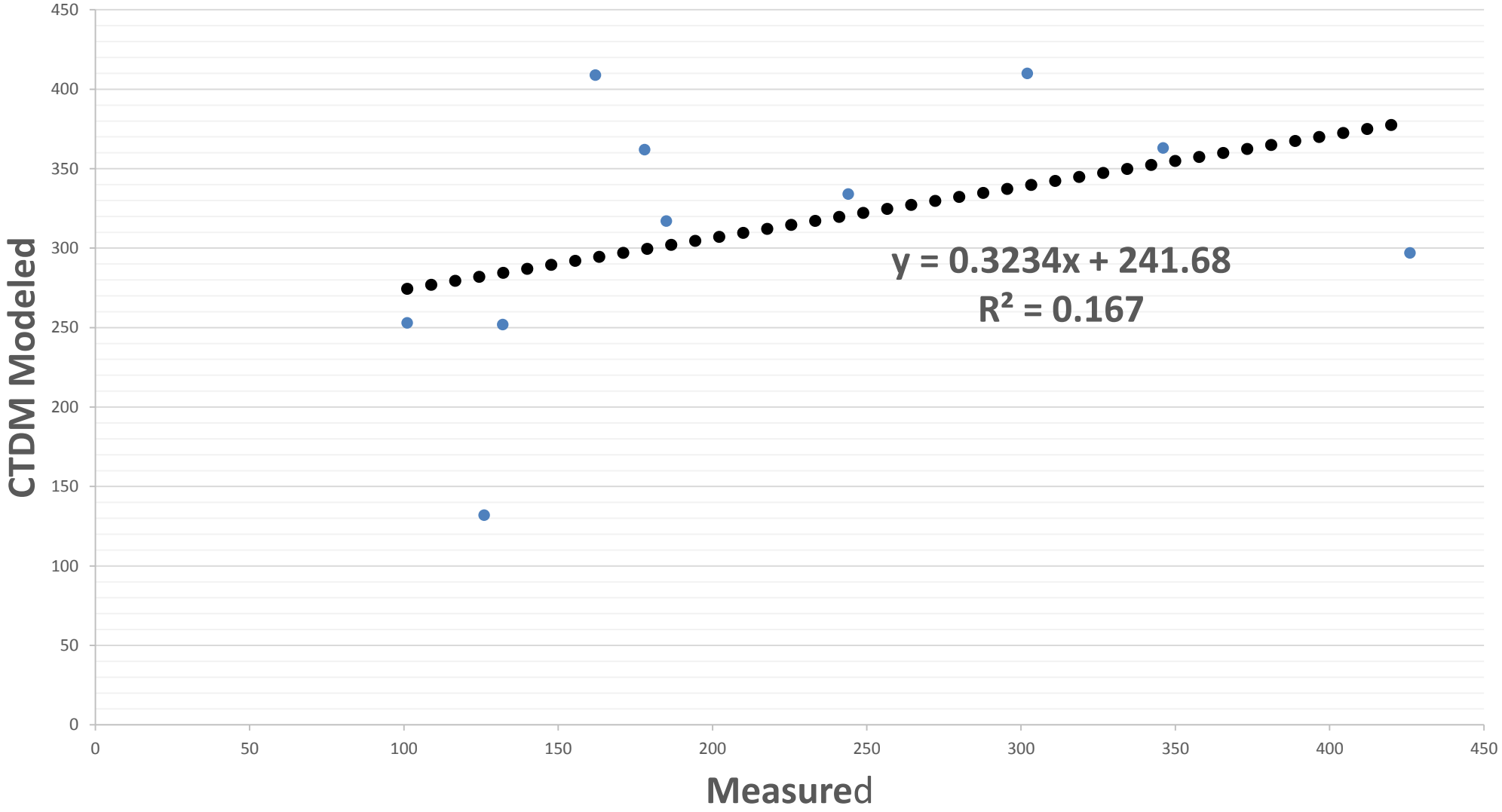
Model Results

Model Results One Hour Average			
	PTE	Actual	Measured
Highest	12295	3667	50
4th High	2280	619	36

Another Example

- In 1990-1991, 10 SO2 samplers were placed on elevated terrain within 3 miles of a copper smelter in Montana.
- The results were disappointing because the model over predicted at many locations and the maximum modeled without regard to location was twice any measured concentration.

Modeled Vs. Measured



Conclusion

- Regulatory Modeling still lacks any useful skill in modeling for location on high terrain near a source (complex terrain).
- The regulatory community has lived with this for three decades because no better field data set or model methodology has been developed.
- Given the obvious (continued regulatory reliance on the Gaussian plume), is there any opportunity to advance the state-of-the art?

Thank you

Questions?

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