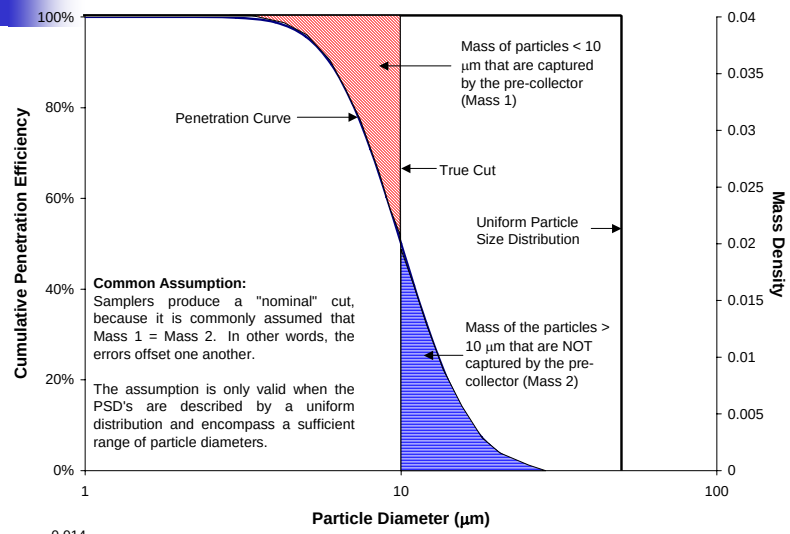
PM Sampler Placement and Sampler Errors! Why should Regulatory and Agricultural Industries Care?

Dr. Michael Buser
USDA Agricultural Research Service
Cotton Production and Processing Research Unit
Lubbock, TX
(806) 746-5353 x 104 – Office
(806) 543-1432 – Cell
mike.buser@ars.usda.gov

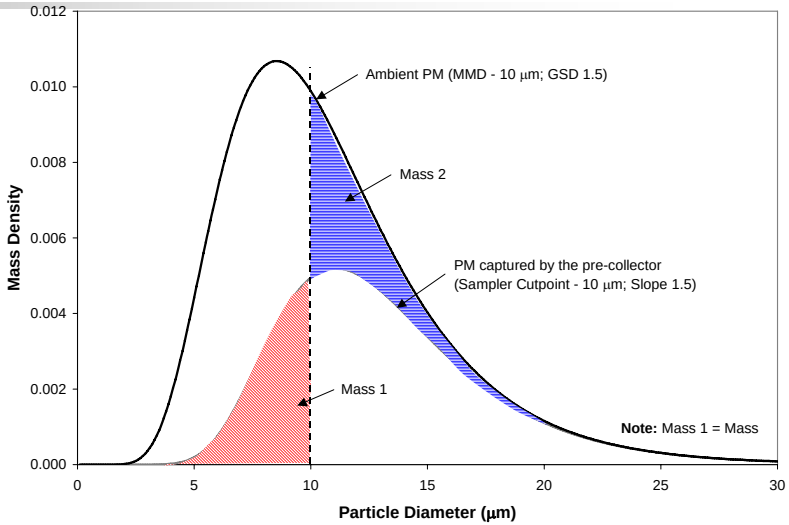
United States Department Of Agriculture
Agricultural Research Service

PM_{10} Samplers – Theoretical Errors

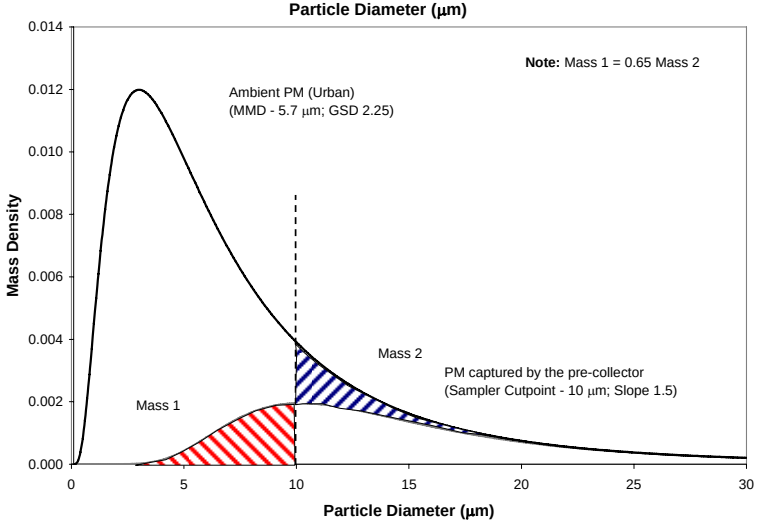
EPA Performance Criteria Guidelines



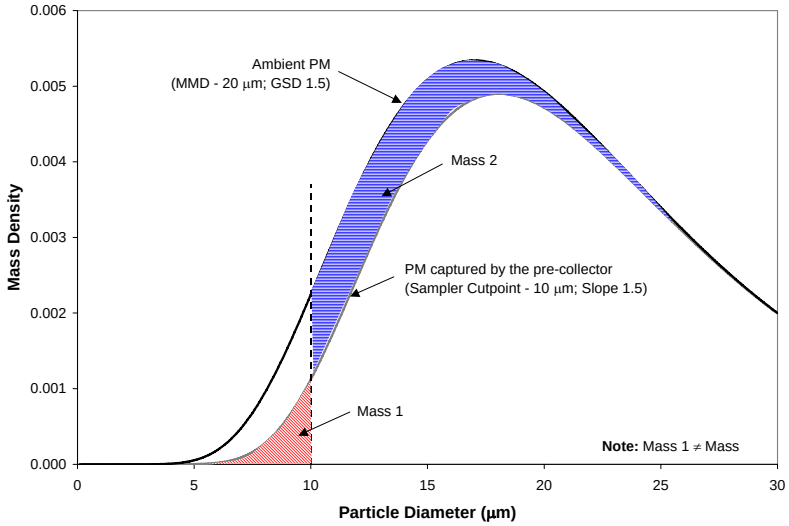
Ideal Environment



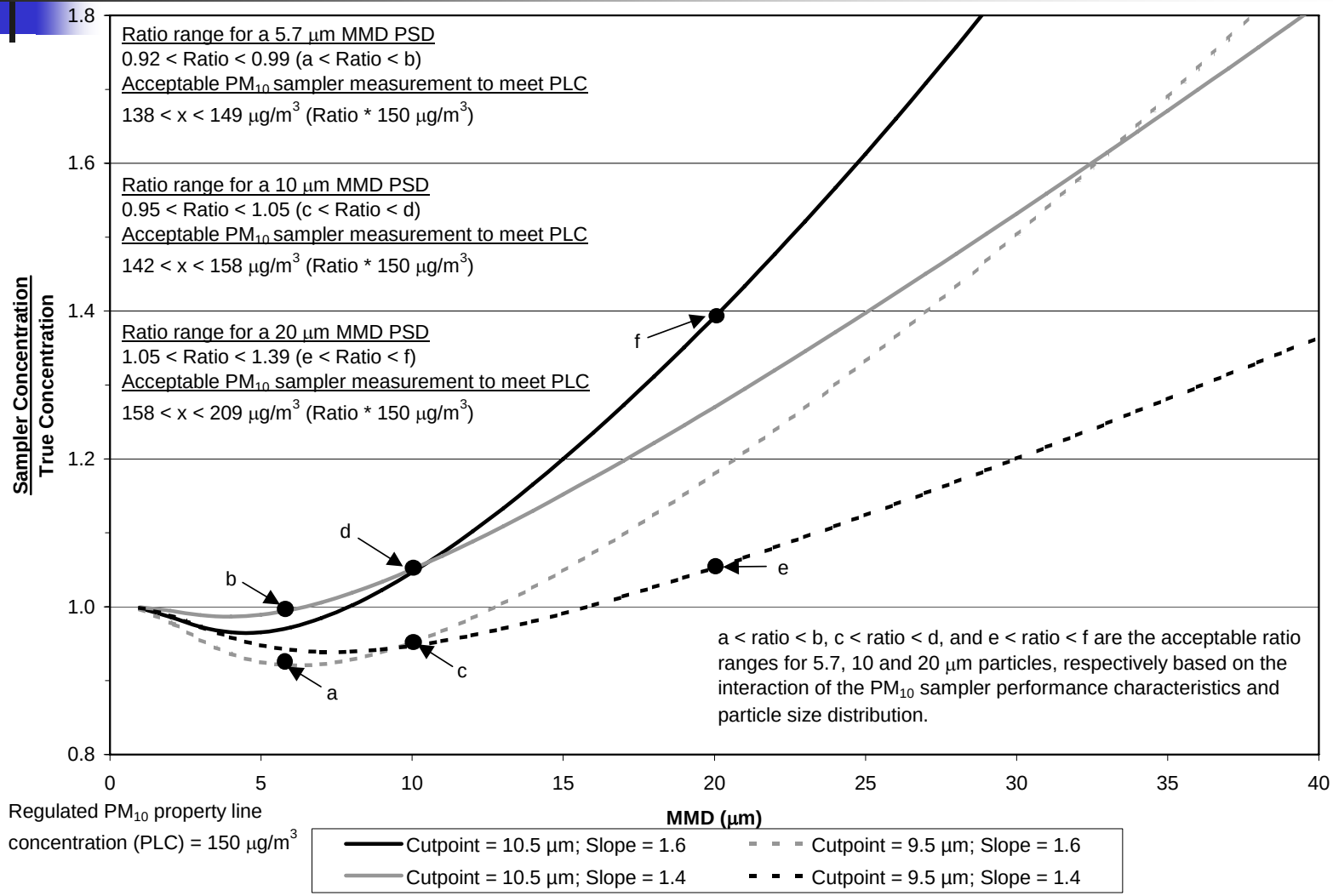
Urban Environment



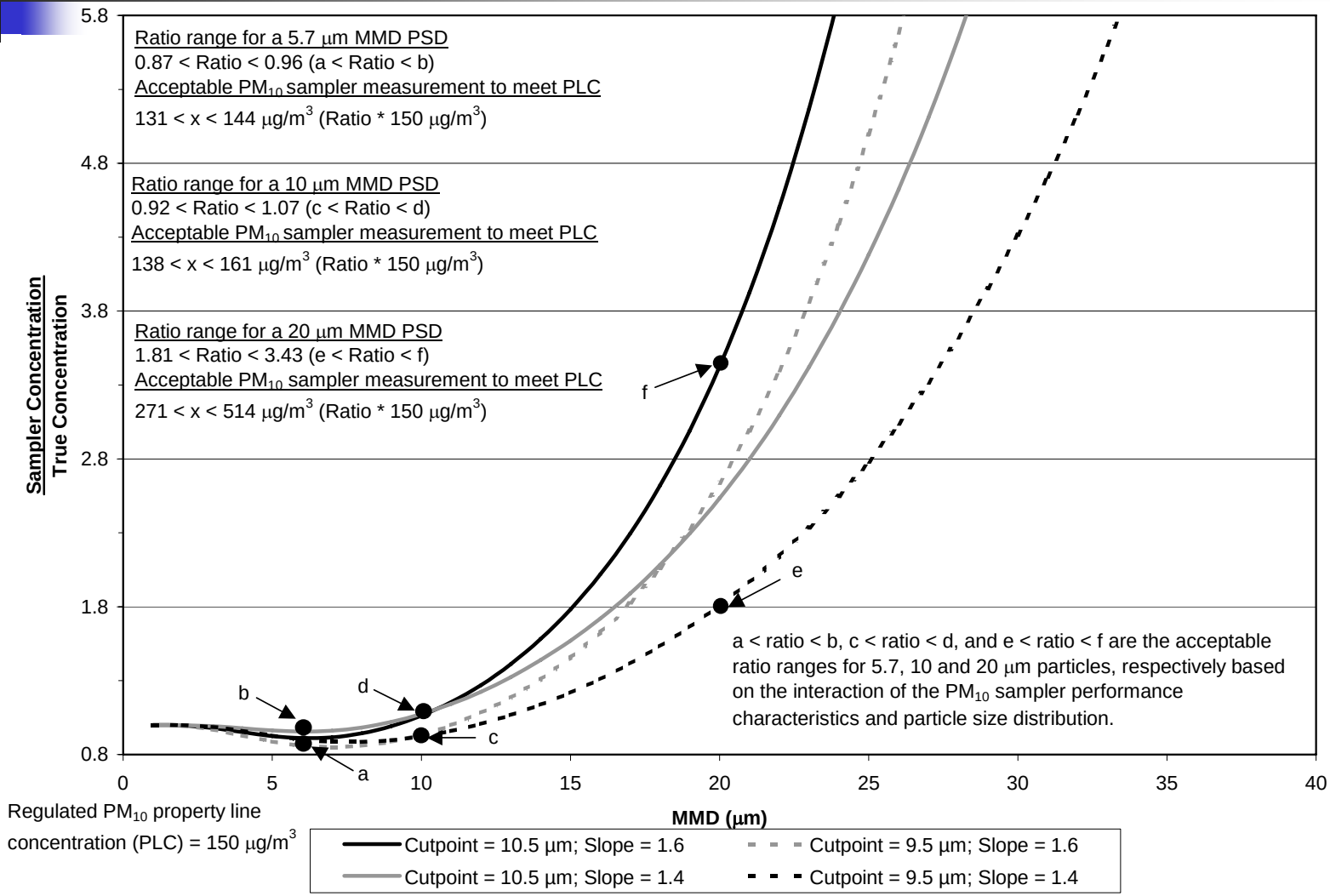
Rural Environment



Theoretical Ratios of PM_{10} Sampler to True Concentrations (PSD – GSD = 2.0)

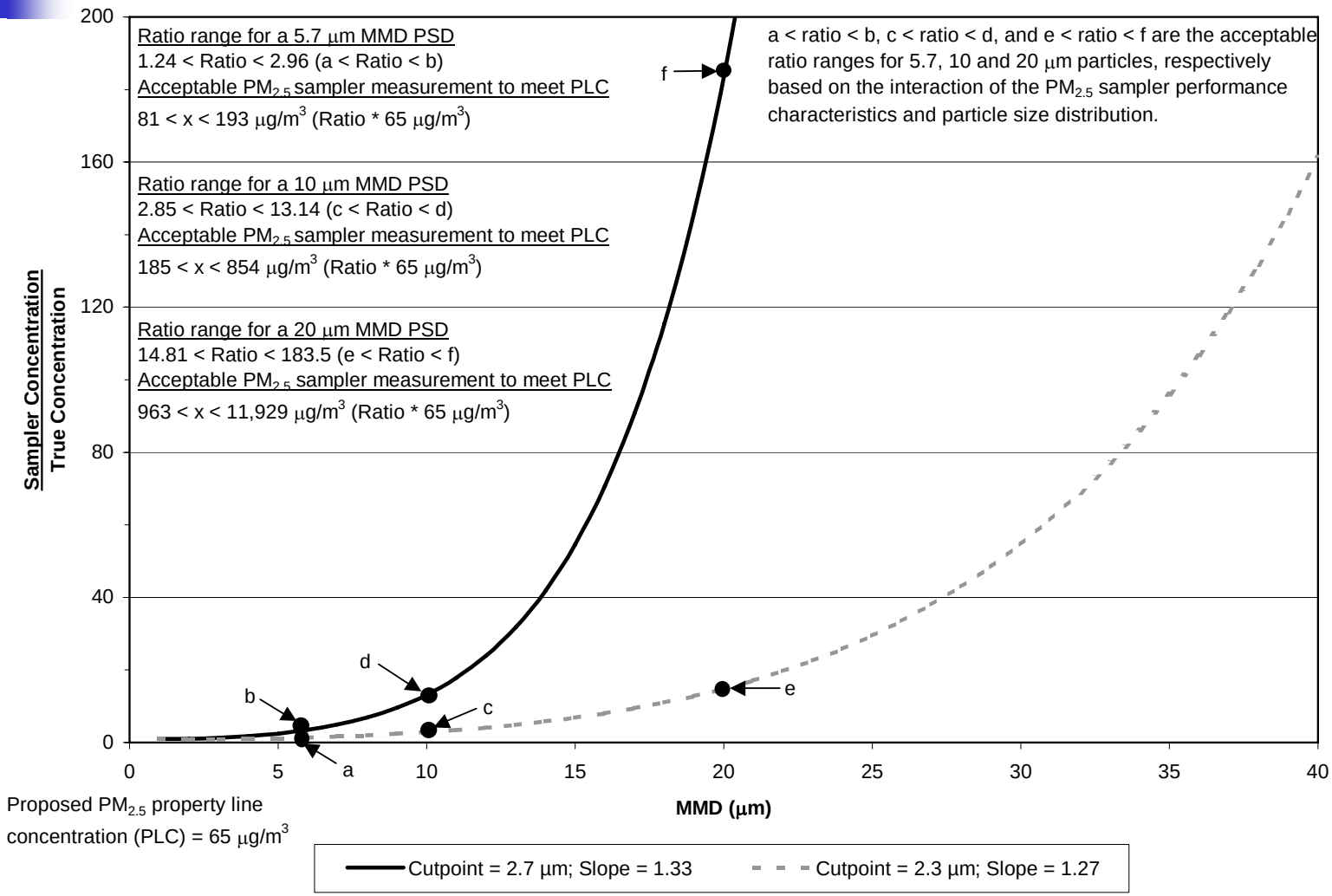


Theoretical Ratios of PM_{10} Sampler to True Concentrations (PSD – GSD = 1.5)



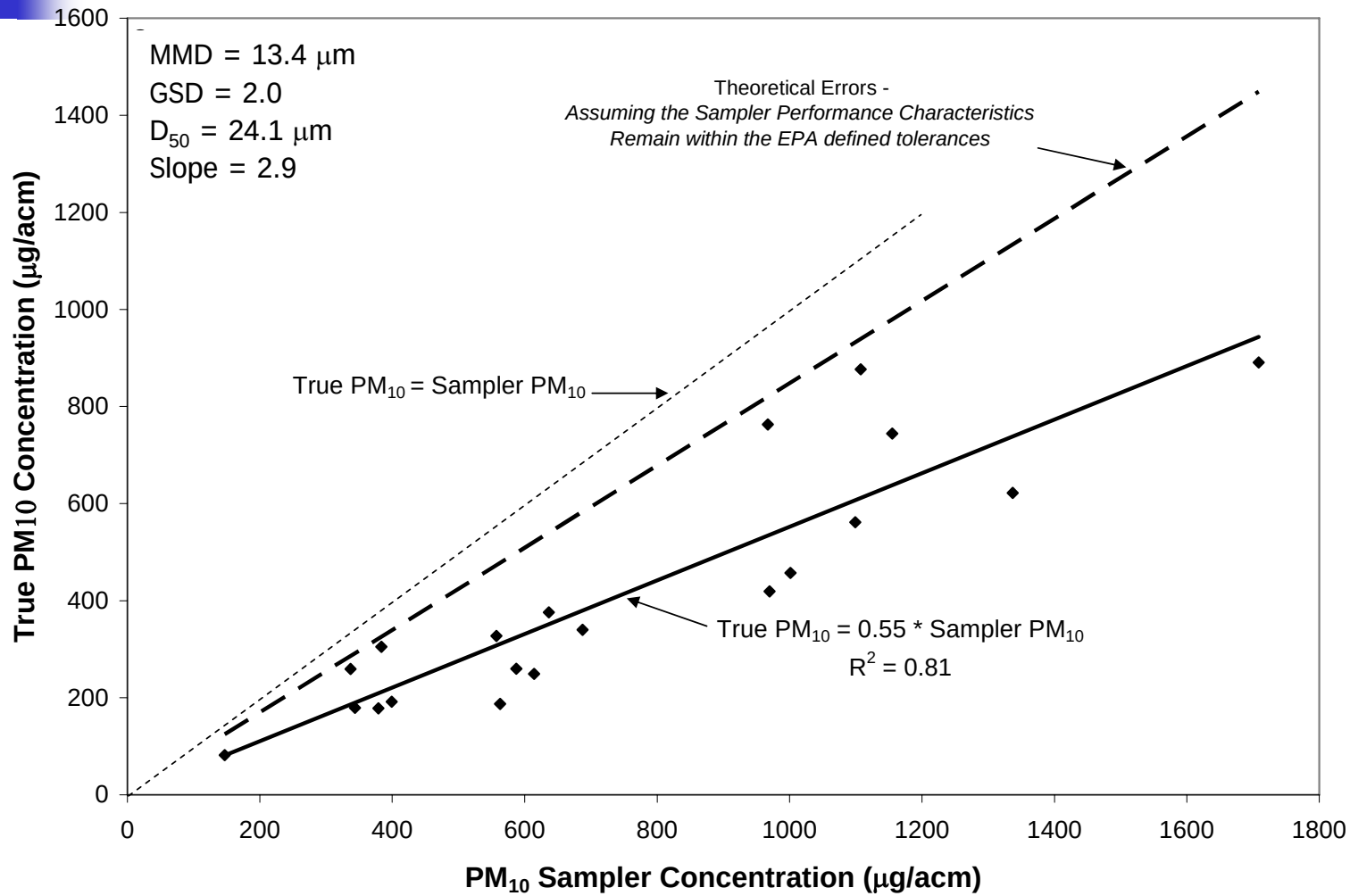
Regulated PM_{10} property line concentration (PLC) = 150 μg/m^3

Theoretical Ratios of $PM_{2.5}$ Sampler to True Concentrations (PSD – GSD = 1.5)



Proposed $PM_{2.5}$ property line concentration (PLC) = 65 $\mu g/m^3$

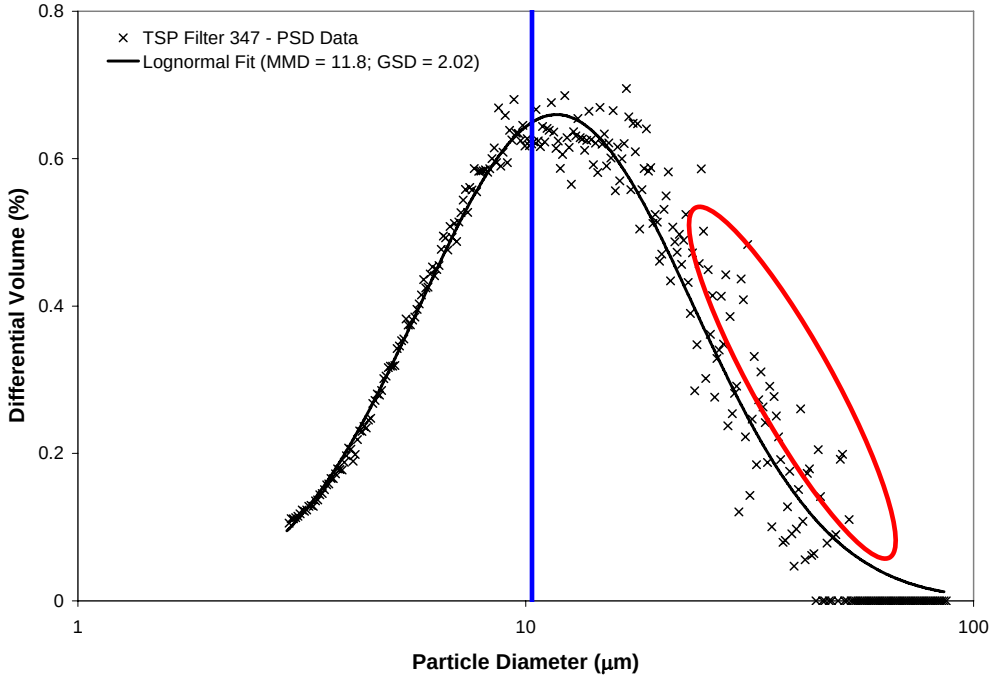
PM_{10} Sampler – Actual Errors



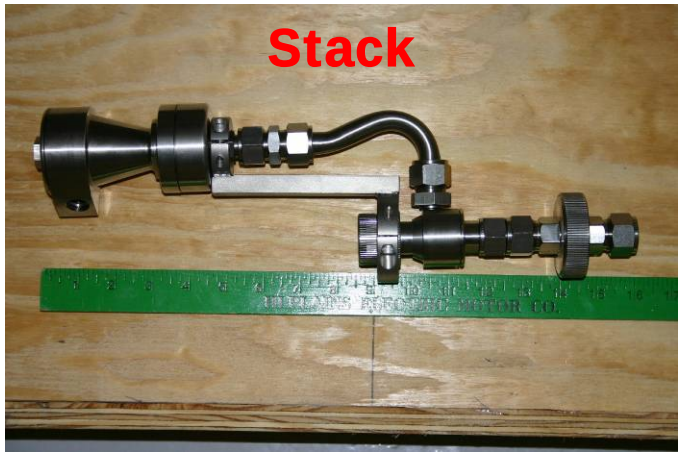
So What!

	Concentration ($\mu g/m^3$)	MMD (μm)	GSD
TSP	1,207	13.4	2
PM_{10}	812	11.3	1.8

- Bottom Line!
  - Cutpoint = 24.1 μm {compared to 10 μm}
  - Slope = 2.9 {compared to 1.5}



Errors Associated with PM Stack & Ambient Samplers



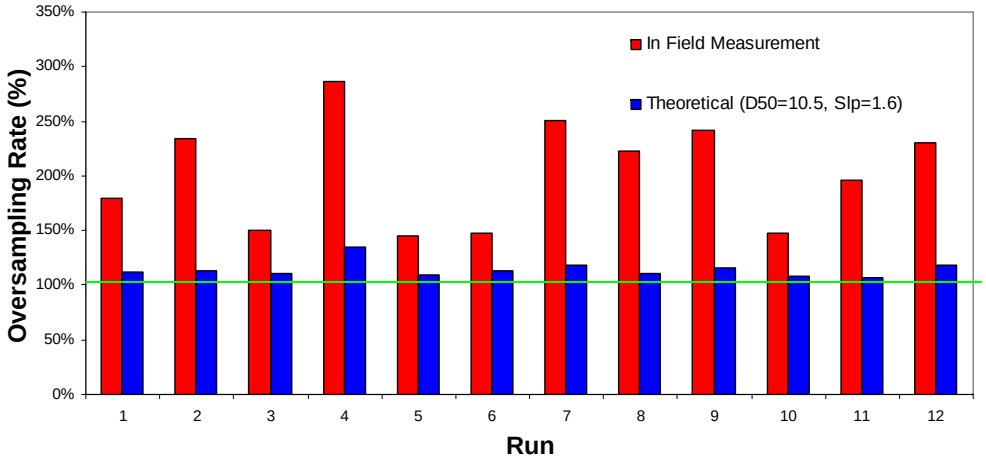
Source	PM_{10} Over-Sampling Rate
Cotton Gin	181 %
Cattle Feed Yard	185 %
Almond Harvesting	139 %

Study Results

Limestone	PM_{10} Over-Sampling	$PM_{2.5}$ Over-Sampling
Rate = 32 g/m^3	123%	700%
Rate = 148 g/m^3	133%	606%
Starch		
Rate = 32 g/m^3	477%	30000%
Rate = 148 g/m^3	444%	25316%

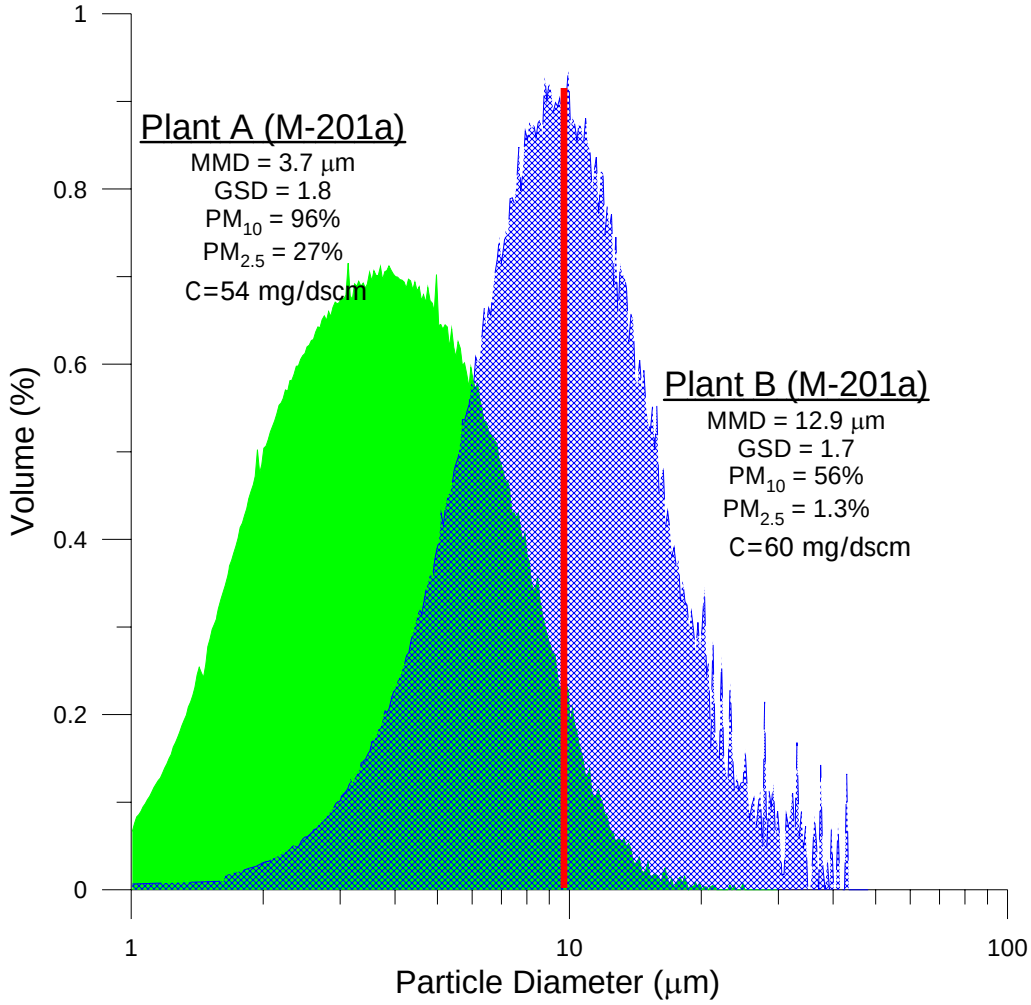
[a]Limestone - MMD = 7.0 μm ESD; GSD = 1.71; ρ = 2.62 g/cm^3

[b]Starch - MMD = 15.1 μm ESD; GSD = 1.33; ρ = 1.26 g/cm^3



Questions

1) Health based studies – are the PM data used in the studies comparable?
   A. Are we comparing apples to apples?
2) If I stand at the property line that separates Plant A and B will Plant B's (higher PM_{10} sampler based concentration) emissions more negatively impact my health?
3) If I'm evaluating regional PM air quality models using FRM PM sampler concentrations, how good are my modeling results?
   A. Garbage in – garbage out
4) Are these plants being equally regulated?
5) How will you answer the same questions for $PM_{2.5}$?
   1) The PSD differences are greater



Perspective

Characteristics of Various Types of Particulate Matter

Source	MMD (μm)	GSD	Particle Density (g/cm^3)	Reference
Urban				
Urban Dust	5.7	2.25	NR	USEPA (1996a)
Agricultural				
Rice	21.75	NR	NR	Plemons (1981)
Rice	12.10	2.24	1.46	Parnell et al. (1986)
Corn	19.57	NR	NR	Plemons (1981)
Corn	13.70	NR	NR	Wade (1979)
Corn	13.60	1.80	1.50	Parnell et al. (1986)
Soybeans	25.17	NR	NR	Plemons (1981)
Soybeans	30.00	NR	NR	Martin (1981)
Soybeans	15.50	NR	NR	Wade (1979)
Soybeans	14.80	1.87	1.69	Parnell et al. (1986)
Wheat	32.97	NR	NR	Plemons (1981)
Wheat	14.70	2.08	1.48	Parnell et al. (1986)
Sorghum	36.92	NR	NR	Plemons (1981)
Sorghum	15.70	2.16	1.43	Parnell et al. (1986)
Cotton Gin (Combined Streams)	20 - 23	1.82 – 2.00	1.8 - 2.0	Wang (2000)
Cotton Lint Fibers	12.94	2.25	NR	Parnell and Adams (1979)
Cattle Feedlot (Downwind)	14.2	2.25	1.71	Sweeten et al. (1989)
Swine Finishing House (Aerial)	14.3	2.02	NR	Barber et al. (1991)
Swine Finishing House (Settled)	18.4	1.99	NR	Barber et al. (1991)
Swine Production Facility	17.97	NR	NR	Barber et al. (1991)
Poultry Production Facility	24.0 – 26.7	1.6	NR	Redwine and Lacey (2001)
Typical Soil	25	2.0	2.5	Pargmann et al. (2000)

NR – Data not reported in the reference.