

AERSURFACE

**8th Modeling
Conference**

RTP, NC

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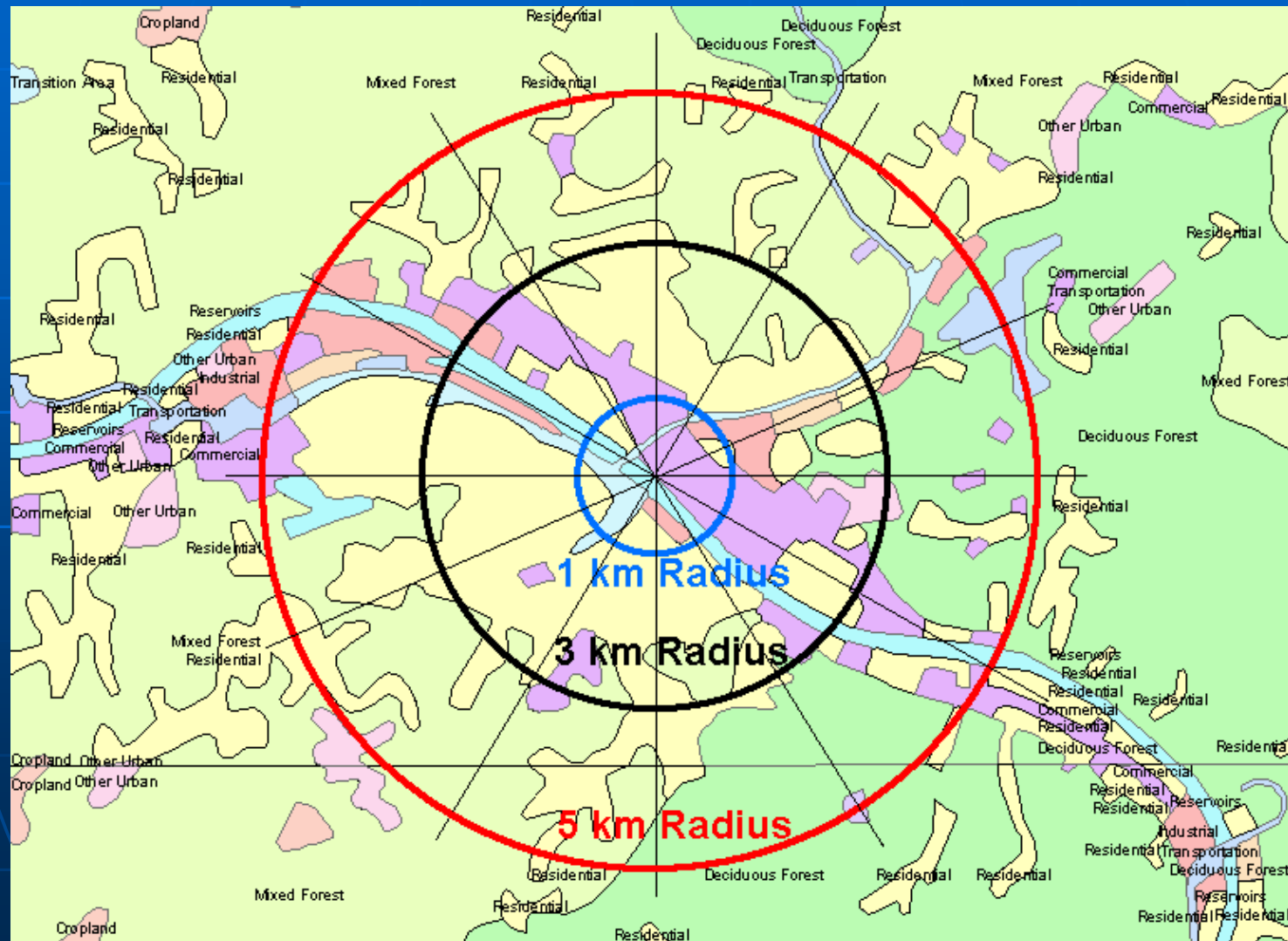
What is AERSURFACE?

- *AERSURFACE* is a tool that produces surface characteristics data (albedo, Bowen ratio & surface roughness) for use in *AERMET/AERMOD*
- Originally developed by Chris Arrington (WV DEP) and Larry Simmons (Energy & Environmental Management, Inc.)

Applying AERSURFACE

- *AERSURFACE* is a Fortran program that reads USGS land use data and returns average values of surface roughness, albedo, and Bowen ratio for 12 sectors
- Specify center location and radius for study area
- Circle parsed into 12 - 30 degree sectors

Applying AERSURFACE



AERSURFACE Output

Mean Albedo = 0.10
Mean Bowen ratio = 0.92
Mean Roughness (m) = 0.8308

	Albedo	Bowen	Rough
sector 01 = 000 to 030 =	0.11	0.89	0.7122
sector 02 = 030 to 060 =	0.10	0.97	0.9448
sector 03 = 060 to 090 =	0.10	0.94	0.9267
sector 04 = 090 to 120 =	0.11	0.89	0.7482
sector 05 = 120 to 150 =	0.11	0.94	0.7436
sector 06 = 150 to 180 =	0.10	0.99	0.9336
sector 07 = 180 to 210 =	0.10	0.99	0.9313
sector 08 = 210 to 240 =	0.10	0.97	0.8699
sector 09 = 240 to 270 =	0.10	0.97	0.8888
sector 10 = 270 to 300 =	0.10	0.94	0.8399
sector 11 = 300 to 330 =	0.10	0.97	0.9241
sector 12 = 330 to 360 =	0.11	0.58	0.5064

AERMET Input from AERSURFACE

FREQ_SECT ANNUAL 12

SECTOR 01 000 030

SECTOR 02 030 060

SECTOR 03 060 090

SECTOR 04 090 120

SECTOR 05 120 150

SECTOR 06 150 180

SECTOR 07 180 210

SECTOR 08 210 240

SECTOR 09 240 270

SECTOR 10 270 300

SECTOR 11 300 330

SECTOR 12 330 360

SITE_CHAR 1 01	0.11	0.89	0.7122
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SITE_CHAR 1 02	0.10	0.97	0.9448
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SITE_CHAR 1 03	0.10	0.94	0.9267
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SITE_CHAR 1 04	0.11	0.89	0.7482
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SITE_CHAR 1 05	0.11	0.94	0.7436
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SITE_CHAR 1 06	0.10	0.99	0.9336
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SITE_CHAR 1 07	0.10	0.99	0.9313
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SITE_CHAR 1 08	0.10	0.97	0.8699
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SITE_CHAR 1 09	0.10	0.97	0.8888
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SITE_CHAR 1 10	0.10	0.94	0.8399
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SITE_CHAR 1 11	0.10	0.97	0.9241
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SITE_CHAR 1 12	0.11	0.58	0.5064
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Sensitivity Study

- Wanted to better understand the sensitivity of AERMOD to changes in surface characteristics
- Part 1: Varied albedo (α), Bowen ratio (β), surface roughness (z_o) systematically for two sets of met data
- Part 2: Applied set of seasonal surface characteristics for 8 surface types

Sensitivity Study: Part 1

- Used two sets of met data:
 - Oklahoma City
 - Pittsburgh
- Varied surface characteristics:
 - $\alpha=0.1-0.6$ ($\beta=1.0$, $z_0=0.1$)
 - $\beta=0.1-10$ ($\alpha=0.2$, $z_0=0.1$)
 - $z_0=0.0001-1.3$ ($\alpha=0.2$, $\beta=1.0$)

Sensitivity Study: Part 1

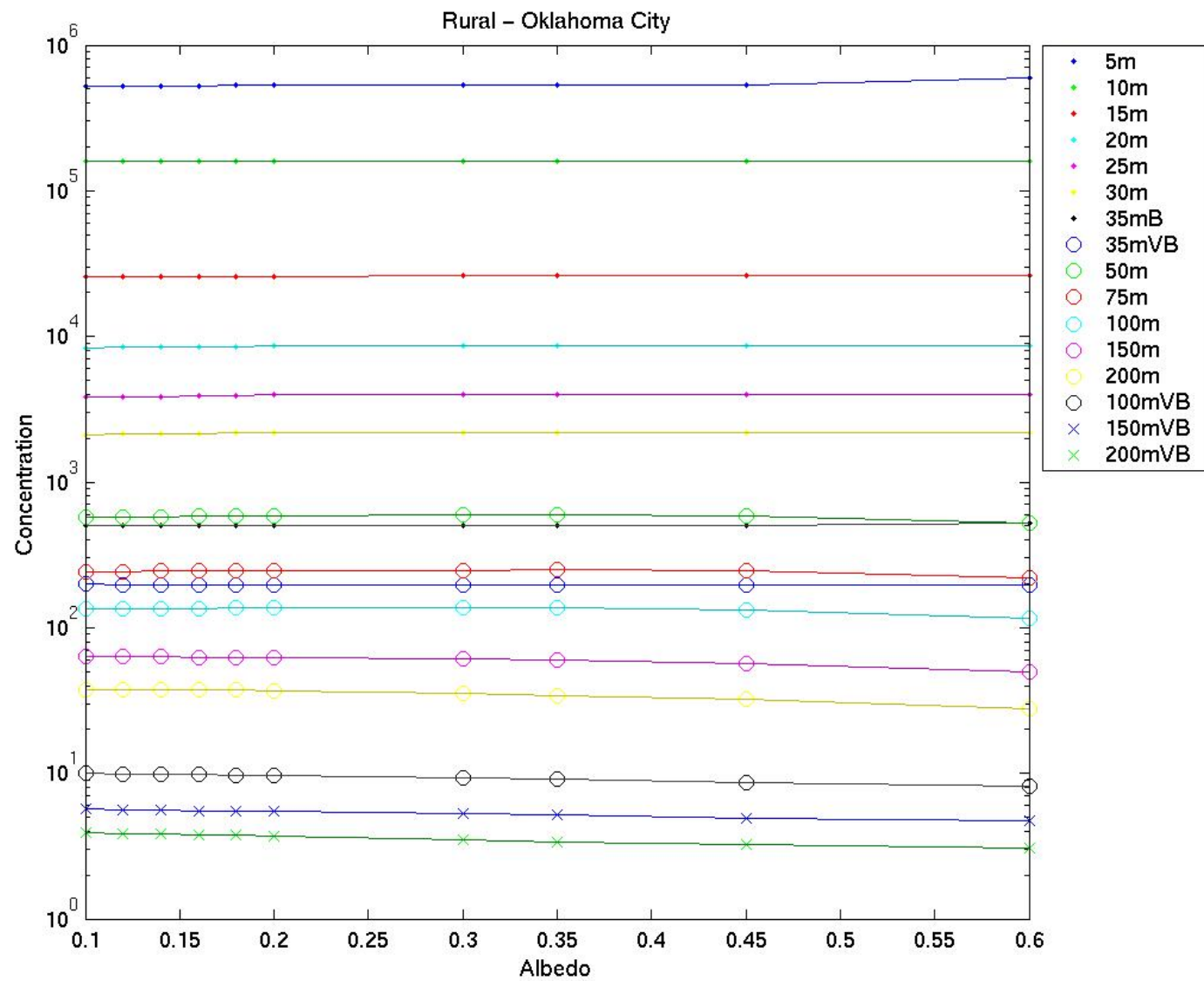
- Varied Stack Heights and Buoyancy
 - 5,10,15,20,25,30,50,75,100,150,200m
 - 100,150,200m very buoyant (VB)
 - 35m buoyant (B) and 35m VB for Oklahoma City

Sensitivity Results: Part 1

Albedo

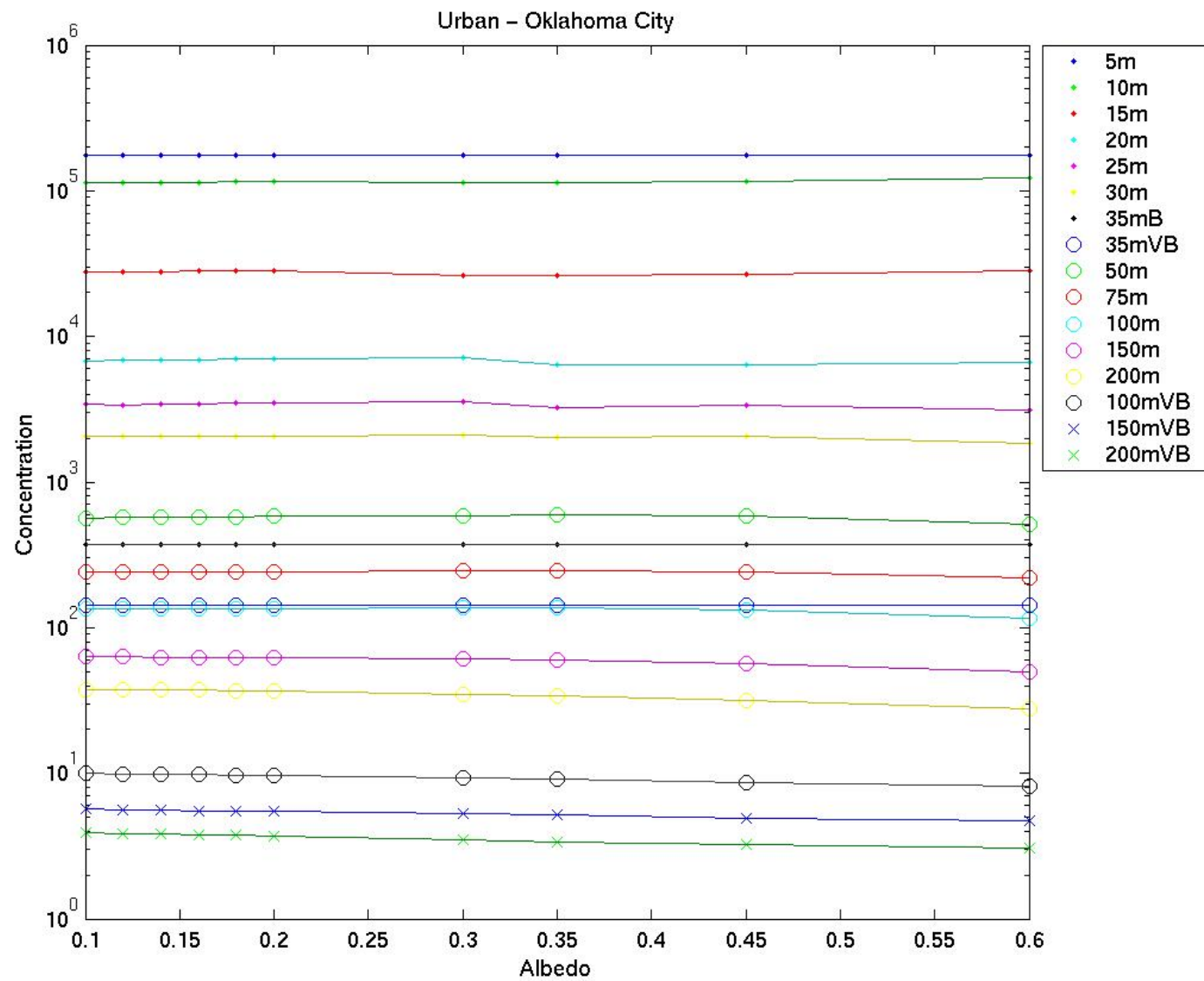
$$\alpha = 0.1 - 0.6 \quad (\beta = 1.0, z_o = 0.1)$$

24-hr average
1st High Concentration



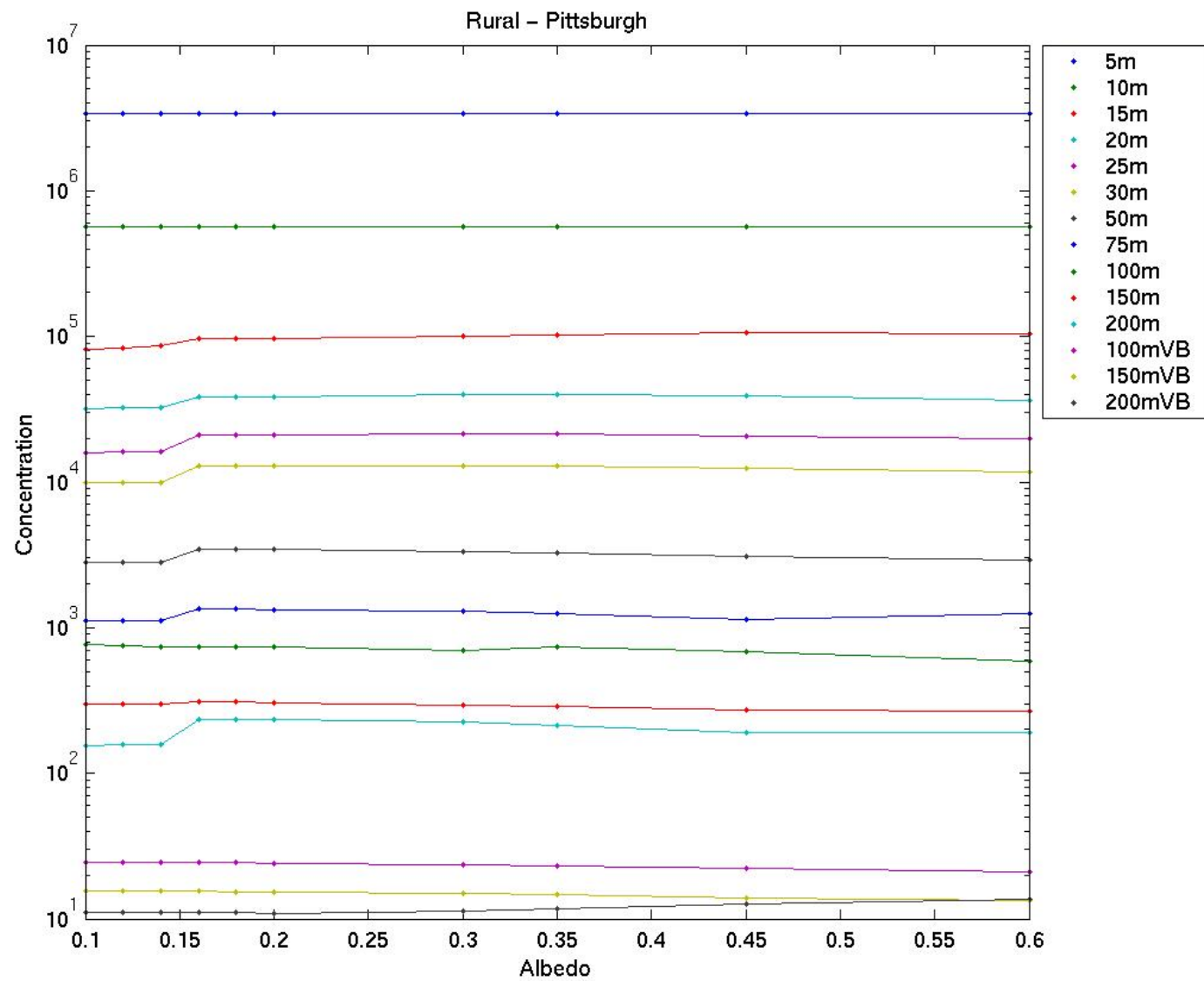
Conclusions: Albedo - % Diff.

Rural	Stack Height (<i>Oklahoma City</i>)			
$\alpha=0.1$	5m	30m	100m	200m VB
x2(0.2)	0.60	3.89	0.95	-4.95
x3(0.3)	1.17	4.21	0.98	-11.0
x4.5 (0.45)	1.99	4.51	-3.23	-17.4
x6(0.6)	13.4	4.54	-12.8	-21.6



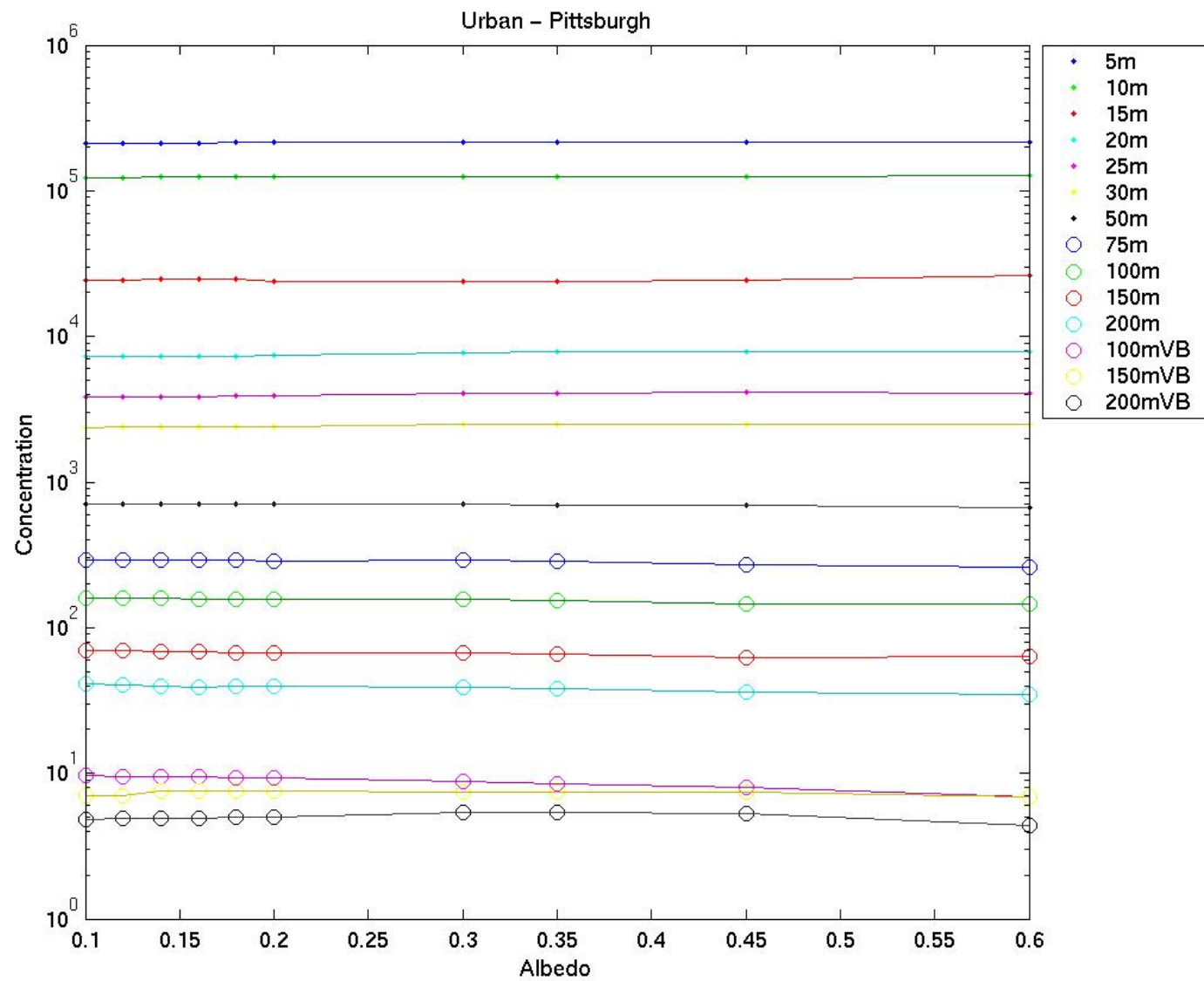
Conclusions: Albedo - % Diff.

Urban	Stack Height (<i>Oklahoma City</i>)			
$\alpha=0.1$	5m	30m	100m	200m VB
x2(0.2)	0.09	0.50	1.00	-4.95
x3(0.3)	0.18	0.95	0.93	-11.0
x4.5 (0.45)	0.31	-0.35	-3.26	-17.4
x6(0.6)	0.43	-11.3	-12.9	-21.6



Conclusions: Albedo - % Diff.

Rural	Stack Height (<i>Pittsburgh</i>)			
$\alpha=0.1$	5m	30m	100m	200m VB
x2(0.2)	<0.01	31.2	-2.81	-1.96
x3(0.3)	<0.01	31.4	-5.51	0.75
x4.5 (0.45)	<0.01	24.4	-1.73	12.6
x6(0.6)	<0.01	19.3	-13.0	21.7



Conclusions: Albedo - % Diff.

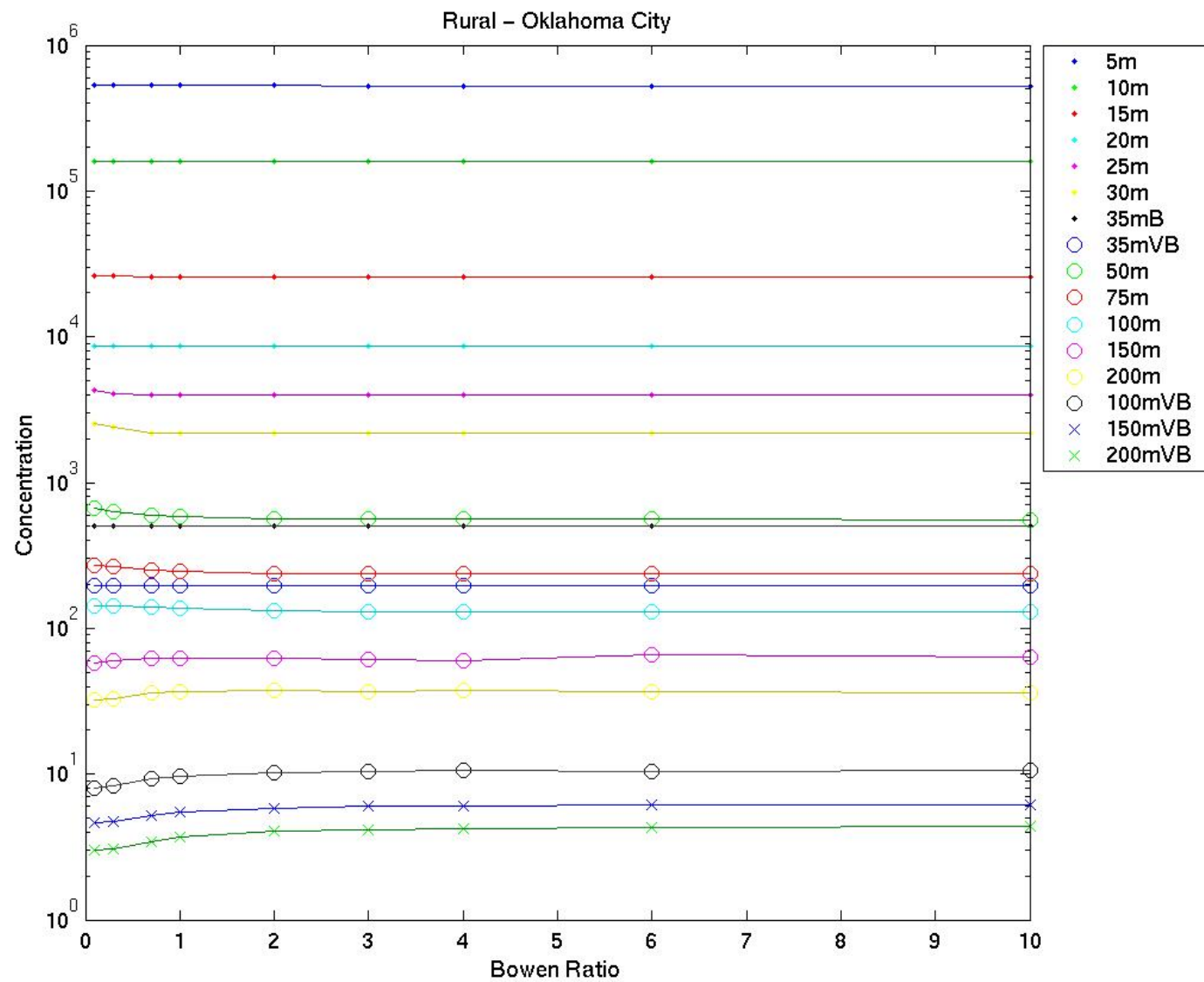
Urban	Stack Height (<i>Pittsburgh</i>)			
$\alpha=0.1$	5m	30m	100m	200m VB
x2(0.2)	0.32	1.77	-2.74	2.84
x3(0.3)	0.75	5.74	0.17	11.8
x4.5 (0.45)	1.25	5.88	-7.12	8.06
x6(0.6)	2.05	4.85	-0.59	9.05

Sensitivity Results: Part 1

Bowen Ratio

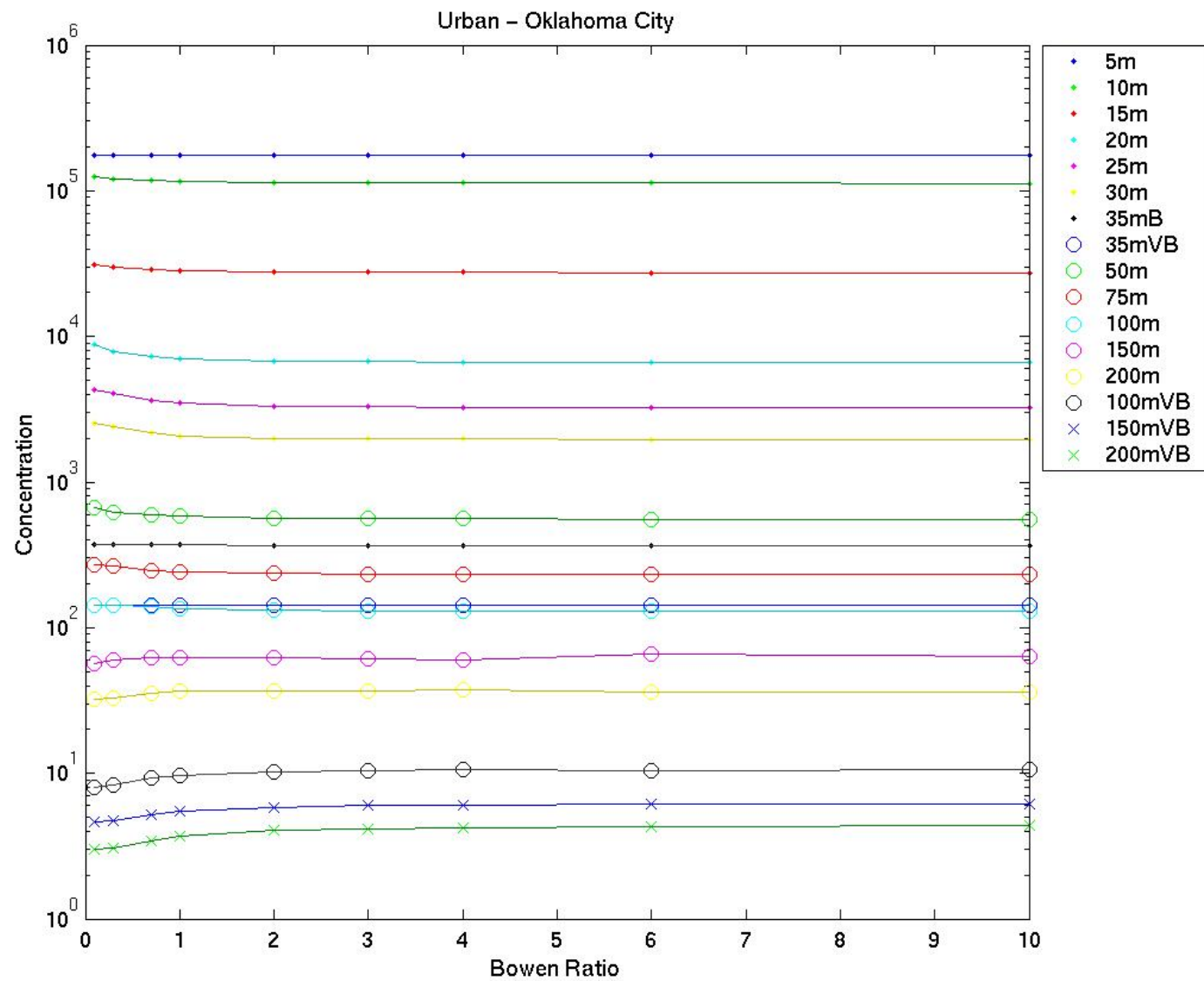
$$\beta=0.1-10 \text{ } (\alpha=0.2, z_o=0.1)$$

24-hr average
1st High Concentration



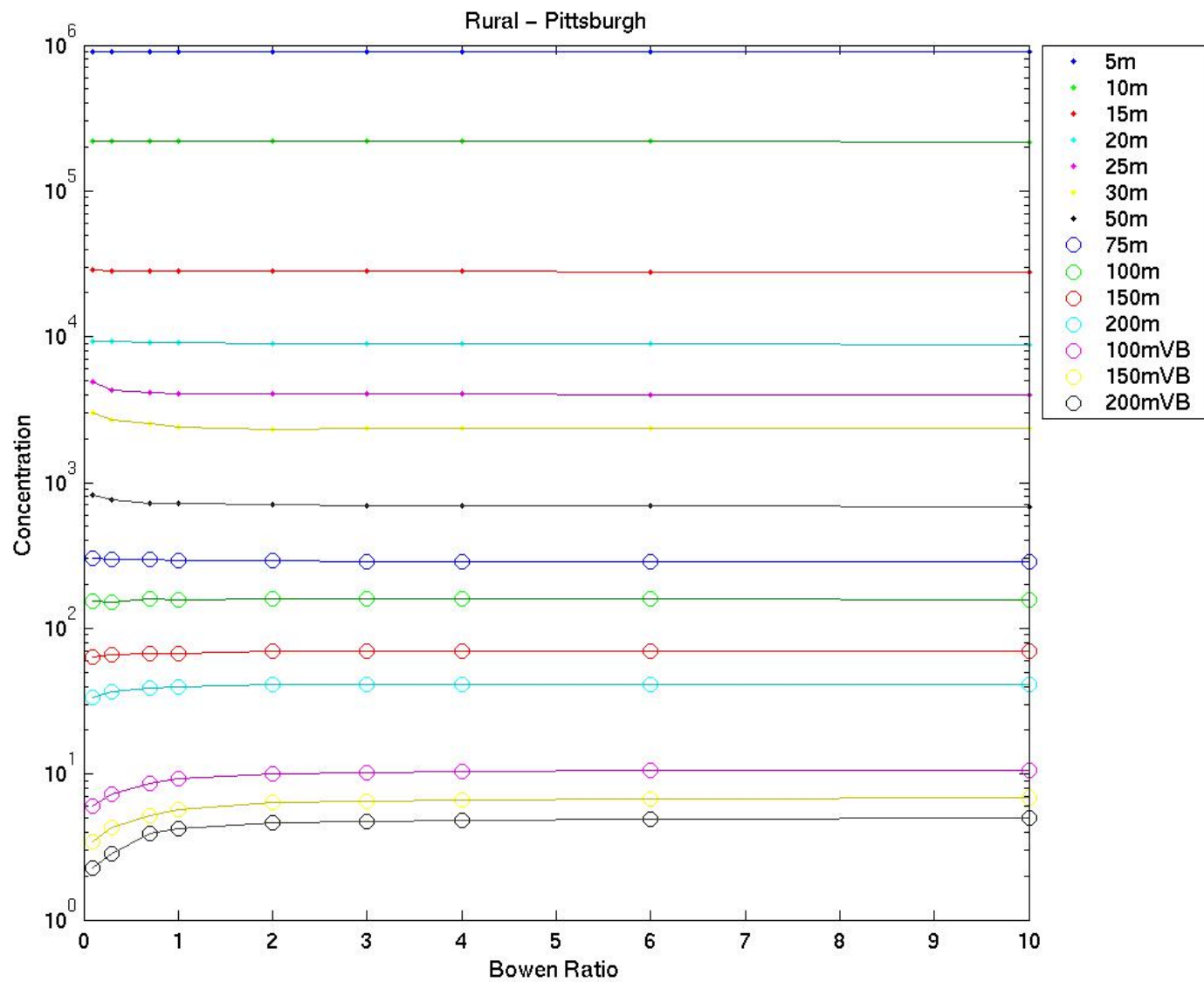
Conclusions: Bowen Ratio - % Diff.

Rural	Stack Height (<i>Oklahoma City</i>)			
$\beta=0.1$	5m	30m	100m	200m VB
x3(0.3)	-0.28	-4.12	0.62	2.46
x10(1)	-0.60	-13.3	-4.25	23.2
x40(4)	-0.83	-13.6	-8.09	40.7
x100(10)	-0.85	-13.6	-8.86	44.6



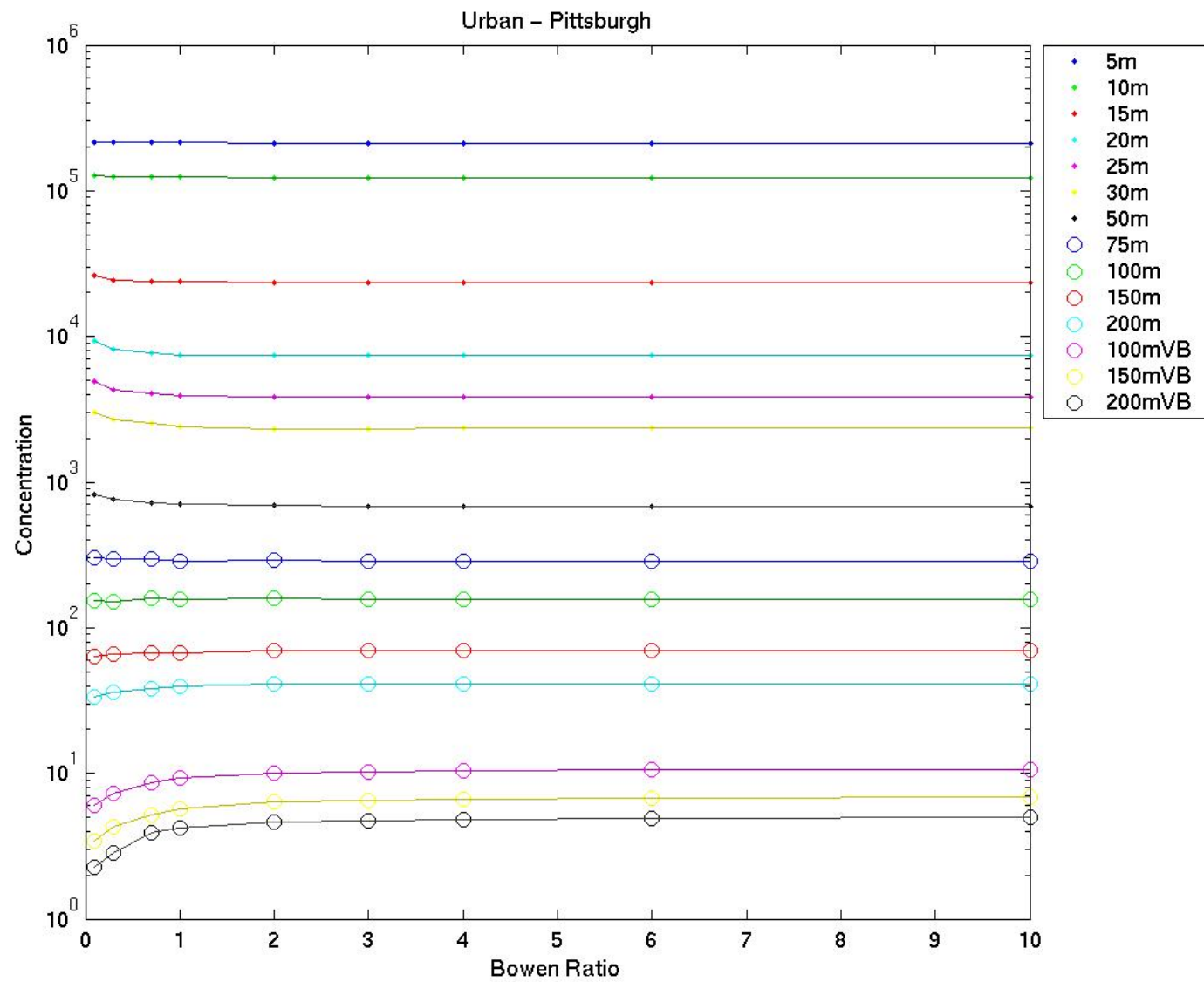
Conclusions: Bowen Ratio - % Diff.

Urban	Stack Height (<i>Oklahoma City</i>)			
$\beta=0.1$	5m	30m	100m	200m VB
x3(0.3)	-0.07	-4.12	0.66	2.46
x10(1)	-0.18	-17.6	-4.15	23.2
x40(4)	-0.29	-21.8	-8.01	40.7
x100(10)	-0.33	-22.7	-8.76	44.6



Conclusions: Bowen Ratio - % Diff.

Rural	Stack Height (<i>Pittsburgh</i>)			
$\beta=0.1$	5m	30m	100m	200m VB
x3(0.3)	-0.22	-10.6	-2.32	24.9
x10(1)	-0.38	-19.3	1.78	82.9
x40(4)	-0.46	-21.7	2.74	111.9
x100(10)	-0.47	-21.4	2.22	118.7



Conclusions: Bowen Ratio - % Diff.

Urban	Stack Height (<i>Pittsburgh</i>)			
$\beta=0.1$	5m	30m	100m	200m VB
x3(0.3)	-0.93	-10.6	-2.32	24.9
x10(1)	-1.58	-19.3	1.76	82.9
x40(4)	-1.89	-21.8	2.82	111.9
x100(10)	-1.93	-21.4	2.32	118.7

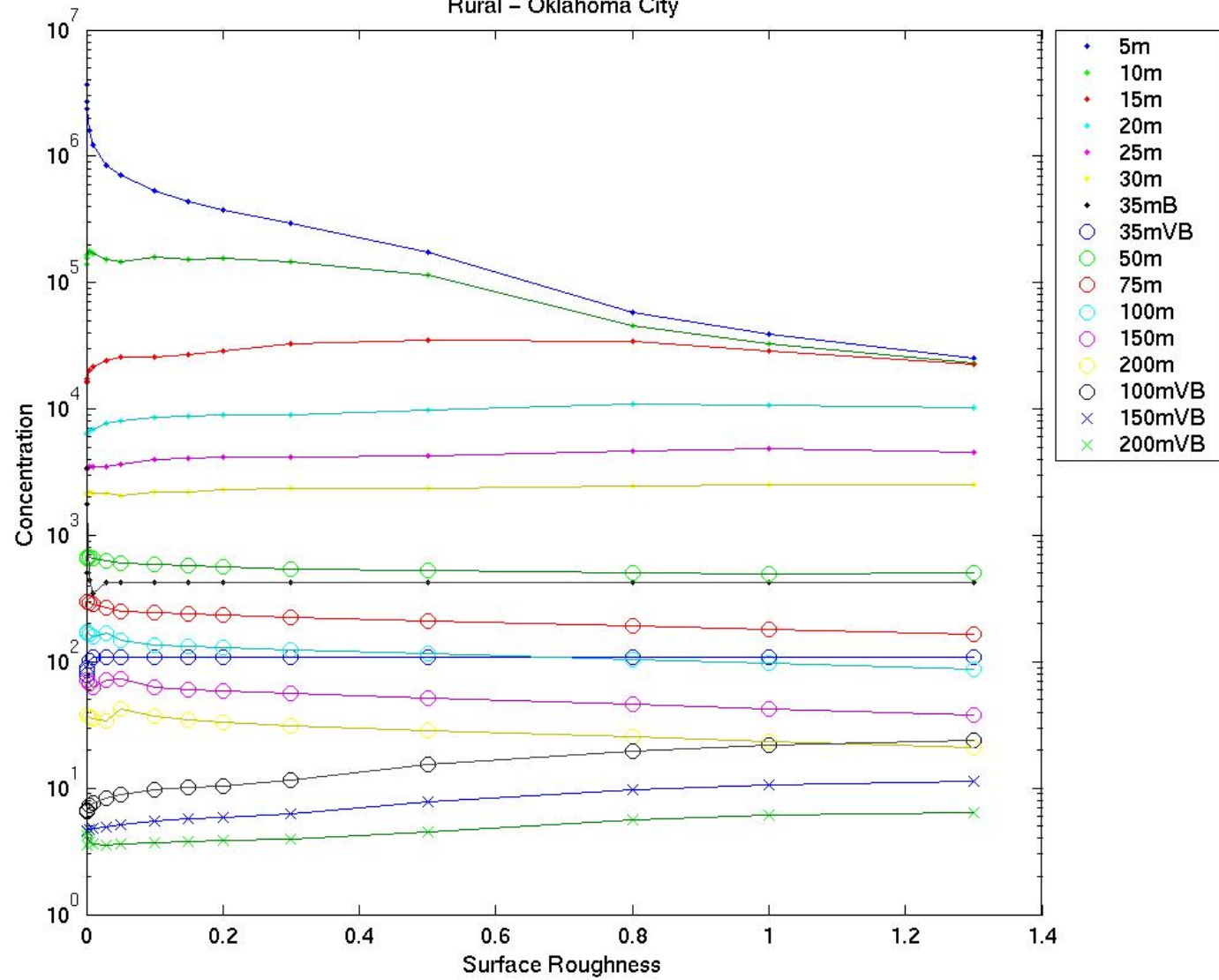
Sensitivity Results: Part 1

Surface Roughness

$$z_o = 0.0001 - 1.3 \quad (\alpha = 0.2, \beta = 1.0)$$

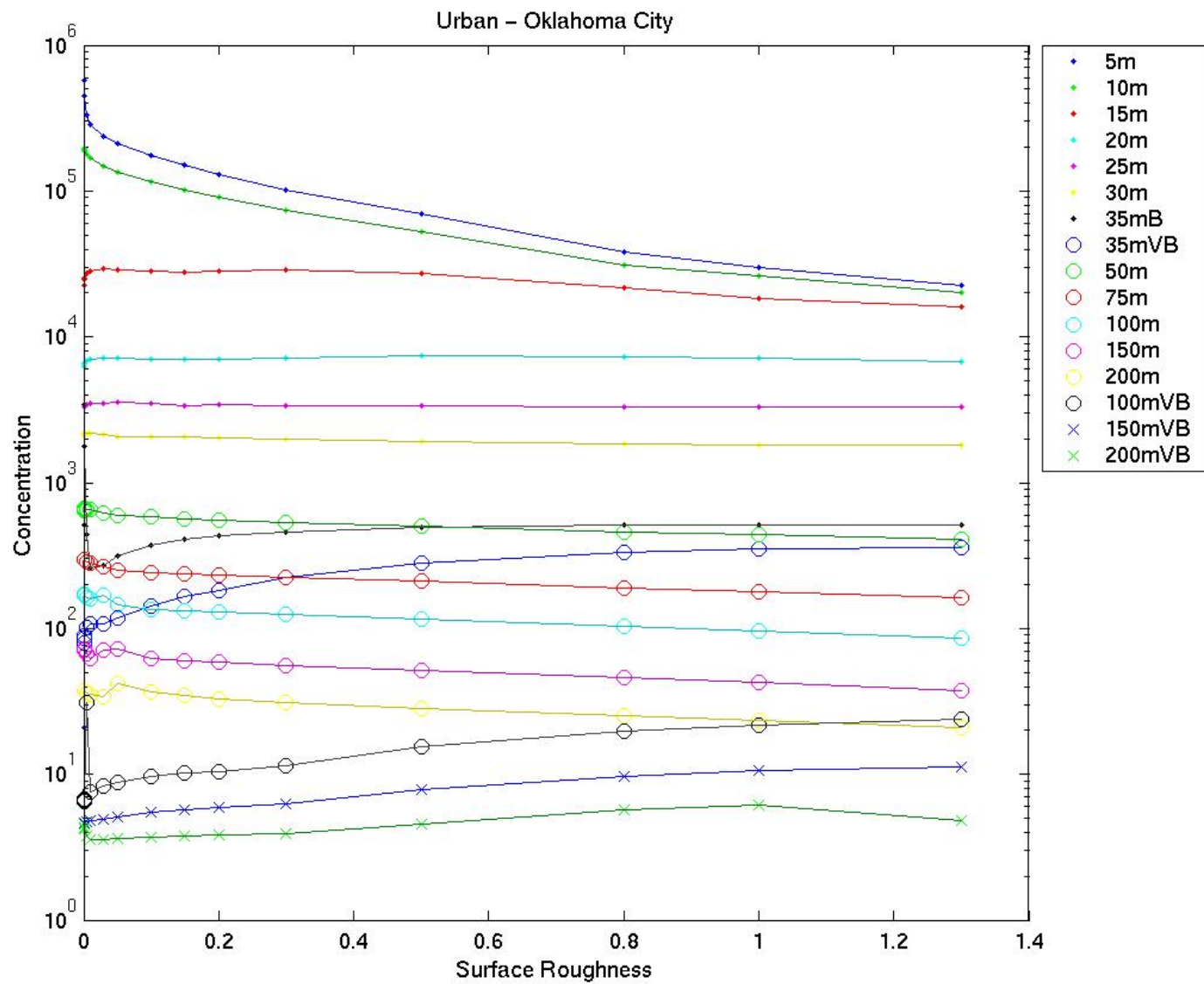
24-hr average
1st High Concentration

Rural – Oklahoma City



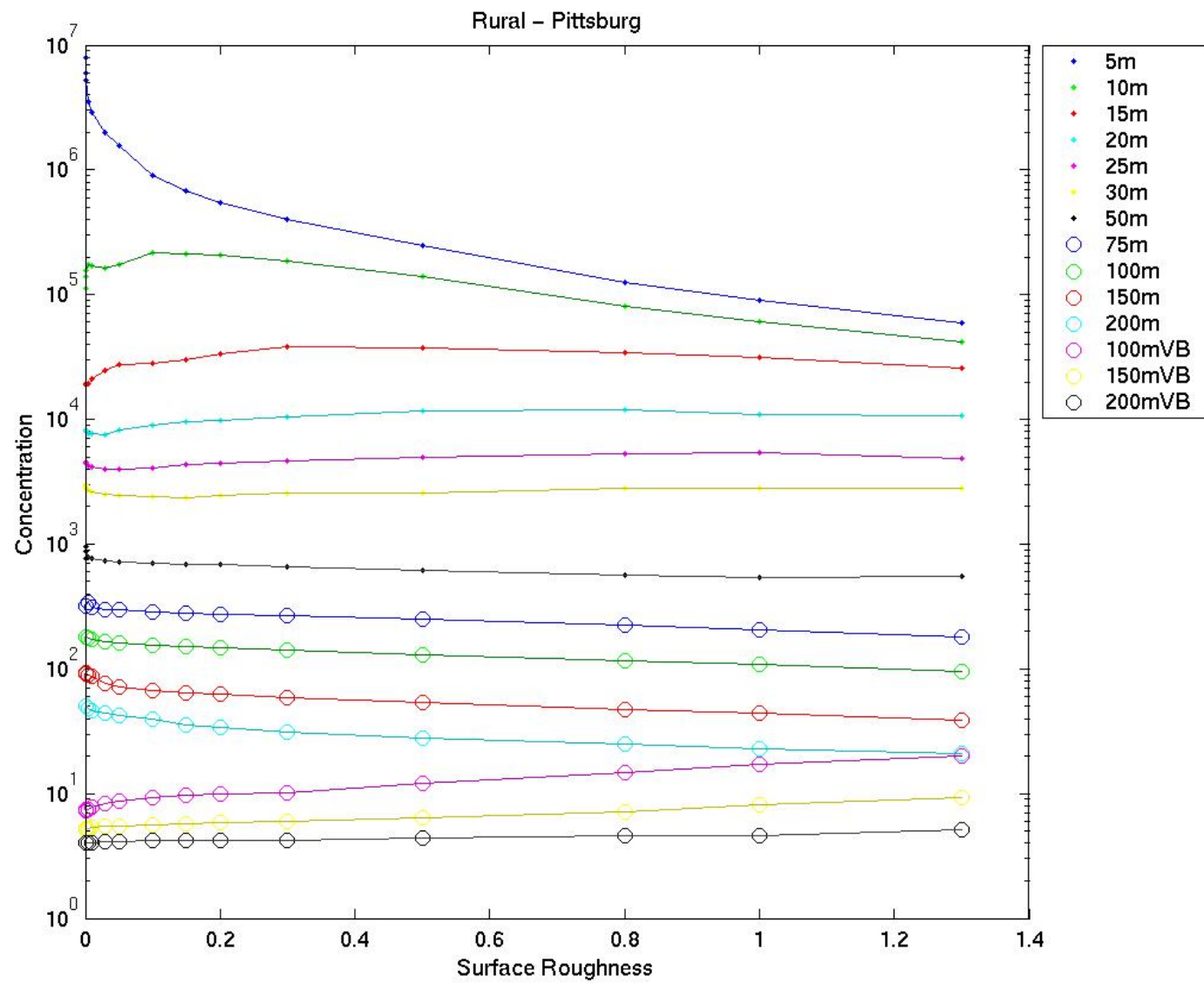
Conclusions: Surface Roughness - % Diff.

Rural	Stack Height (<i>Oklahoma City</i>)			
z_o =0.0001	5m	30m	100m	200m VB
x5 (.0005)	-25.8	2.18	-0.91	-22.1
x50 (.005)	-56.0	4.32	-5.16	-16.7
x500 (.05)	-80.7	-0.87	-15.1	-20.8
x5000 (0.5)	-95.2	11.0	-32.6	-0.29
x13000 (1.3)	-99.3	20.6	-49.6	41.1



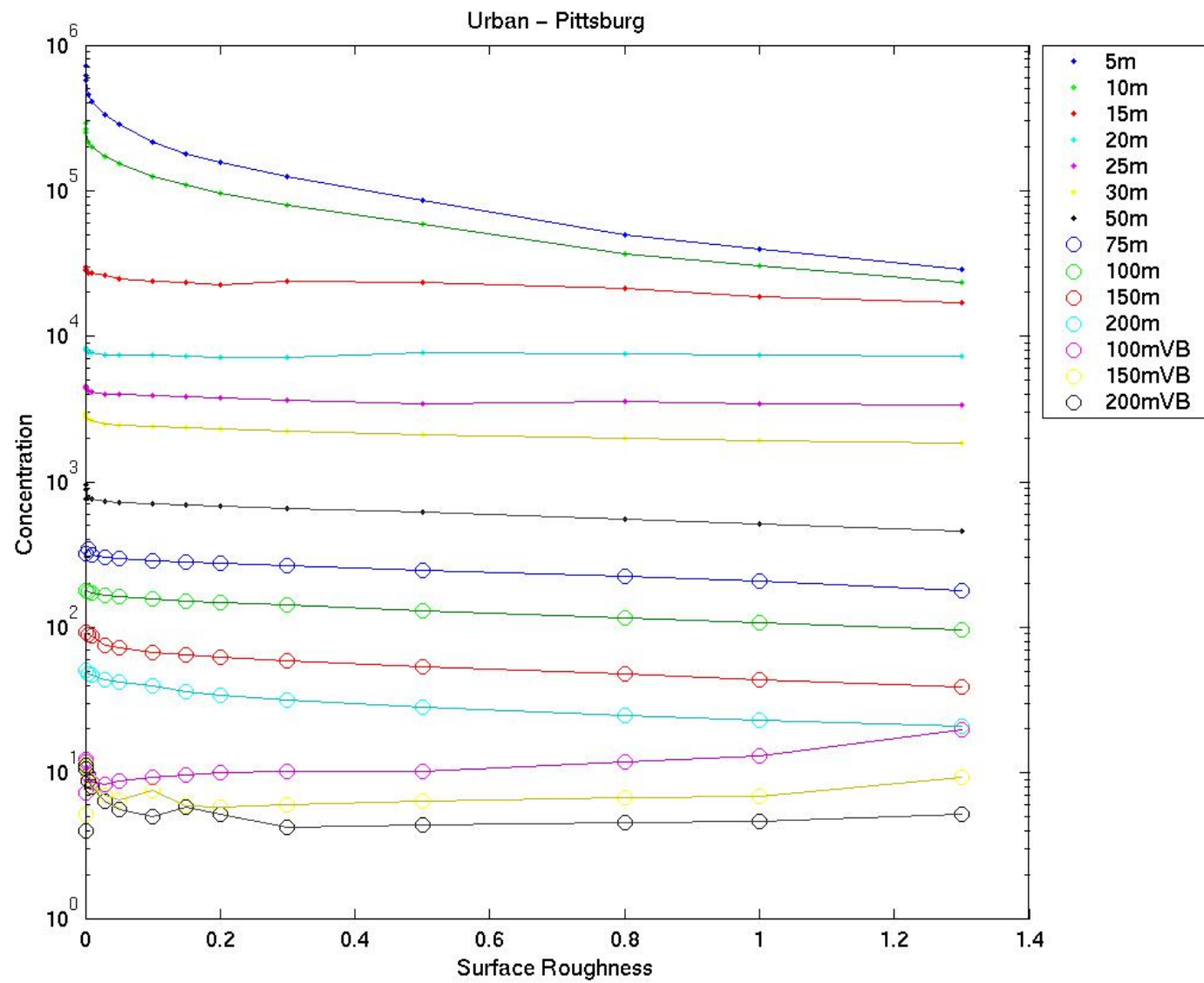
Conclusions: Surface Roughness - % Diff.

Urban	Stack Height (<i>Oklahoma City</i>)			
z_o =0.0001	5m	30m	100m	200m VB
x5 (.0005)	-100.0	2.18	-1.03	-5.2
x50 (.005)	-41.4	4.32	-5.23	-16.7
x500 (.05)	-62.8	-1.05	-15.1	-20.8
x5000 (0.5)	-87.9	-8.79	-32.7	-0.29
x13000 (1.3)	-96.0	-14.1	-49.8	5.54



Conclusions: Surface Roughness - % Diff.

Rural	Stack Height (<i>Pittsburgh</i>)			
z_0 =0.0001	5m	30m	100m	200m VB
x5 (.0005)	-24.2	2.06	<0.01	0.33
x50 (.005)	-55.2	-7.91	-2.45	0.60
x500 (.05)	-80.4	-15.3	-9.19	3.13
x5000 (0.5)	-96.9	-11.2	-27.0	9.88
x13000 (1.3)	-99.2	-4.03	-46.8	29.8



Conclusions: Surface Roughness - % Diff.

Urban	Stack Height (<i>Pittsburgh</i>)			
z_o =0.0001	5m	30m	100m	200m VB
x5 (.0005)	-13.9	2.06	<0.01	183.0
x50 (.005)	-35.7	-7.91	-2.45	120.4
x500 (.05)	-60.1	-15.3	-9.19	38.8
x5000 (0.5)	-88.0	-27.8	-27.0	9.88
x13000 (1.3)	-96.0	-36.3	-46.8	29.8

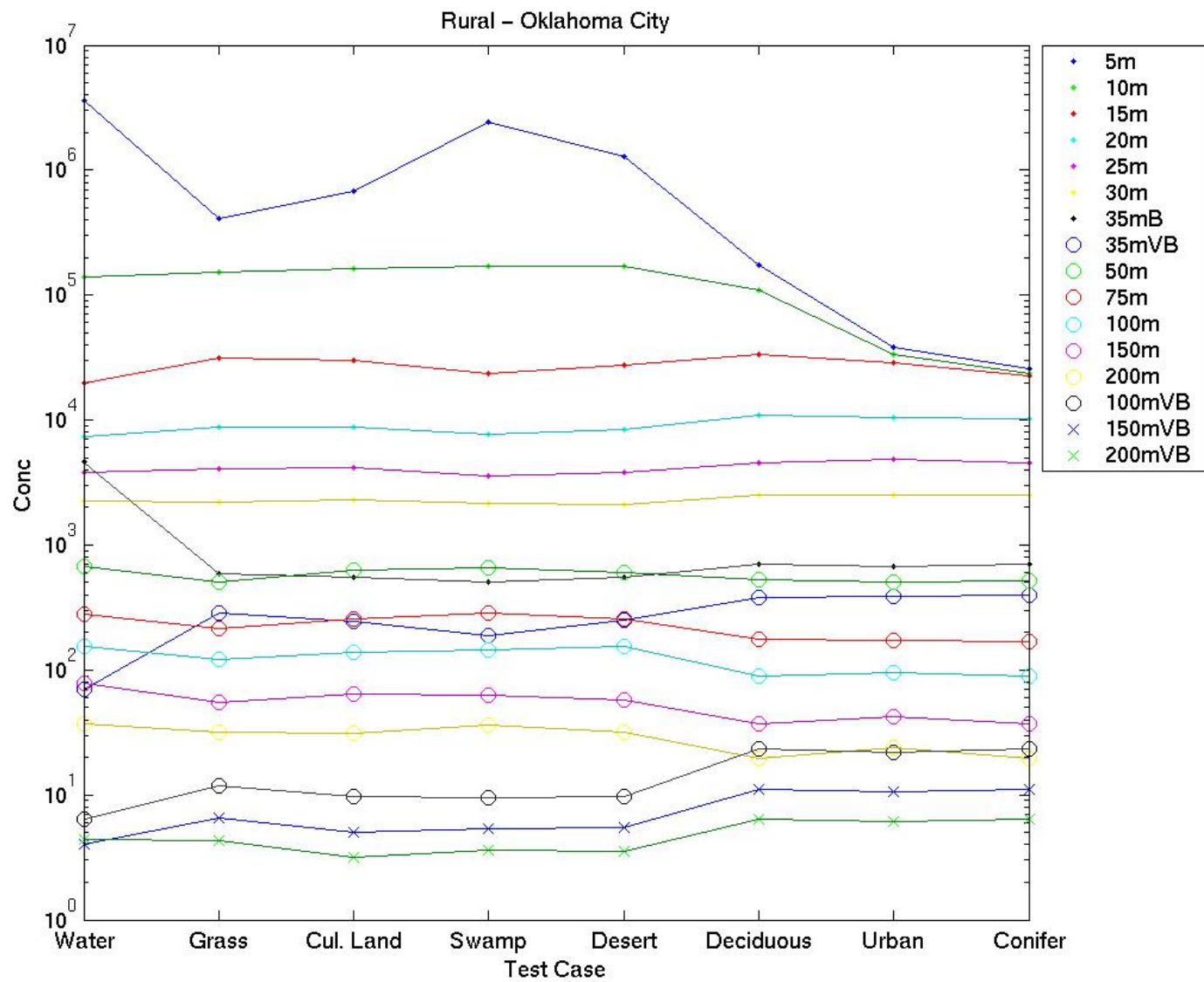
Conclusions: Part 1

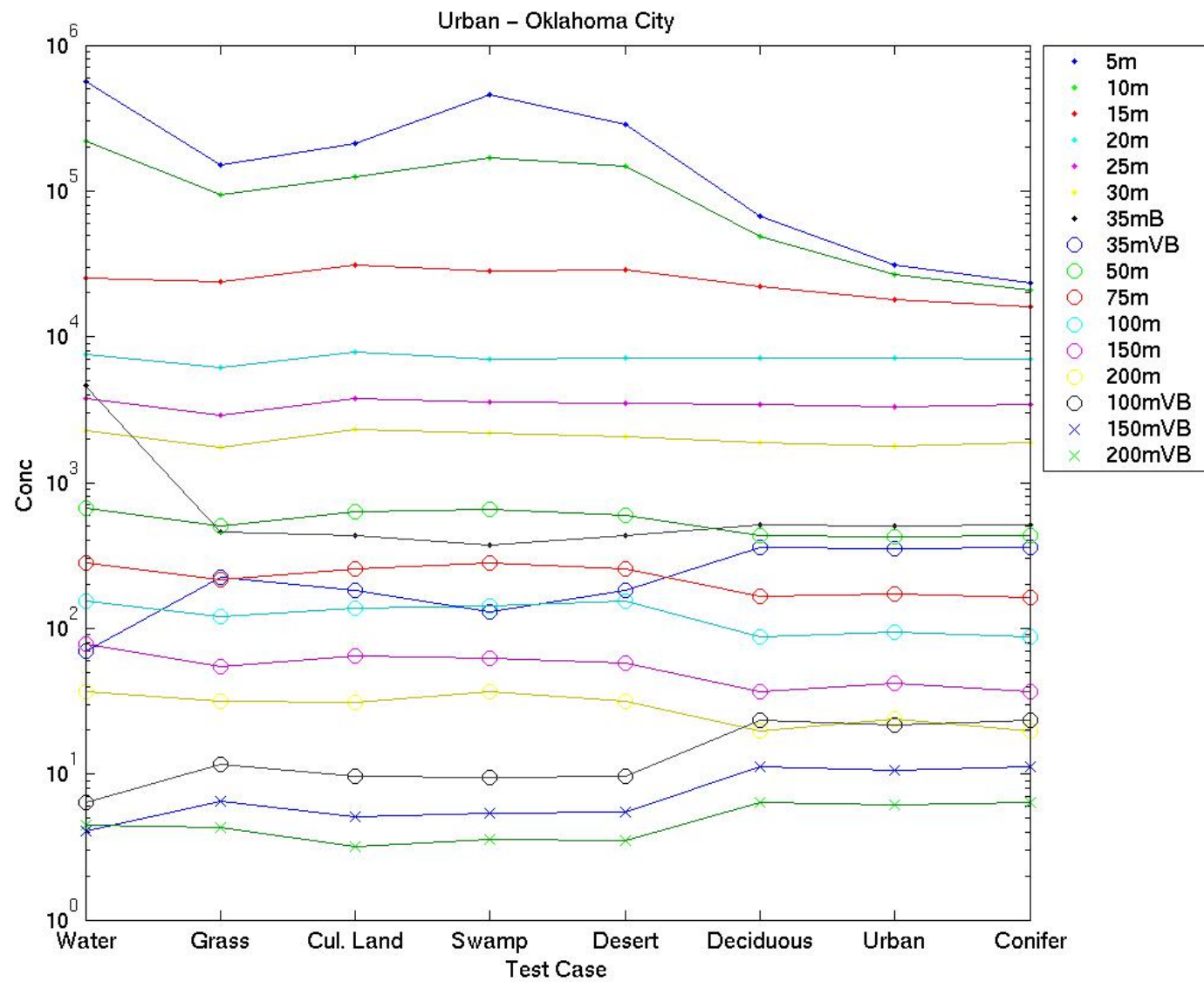
- Most sensitive to surface roughness
- Some sensitivity to albedo and Bowen ratio
- Definite source height dependency
 - Shorter stacks most sensitive to surface roughness
 - Taller stacks more sensitive to albedo and Bowen ratio

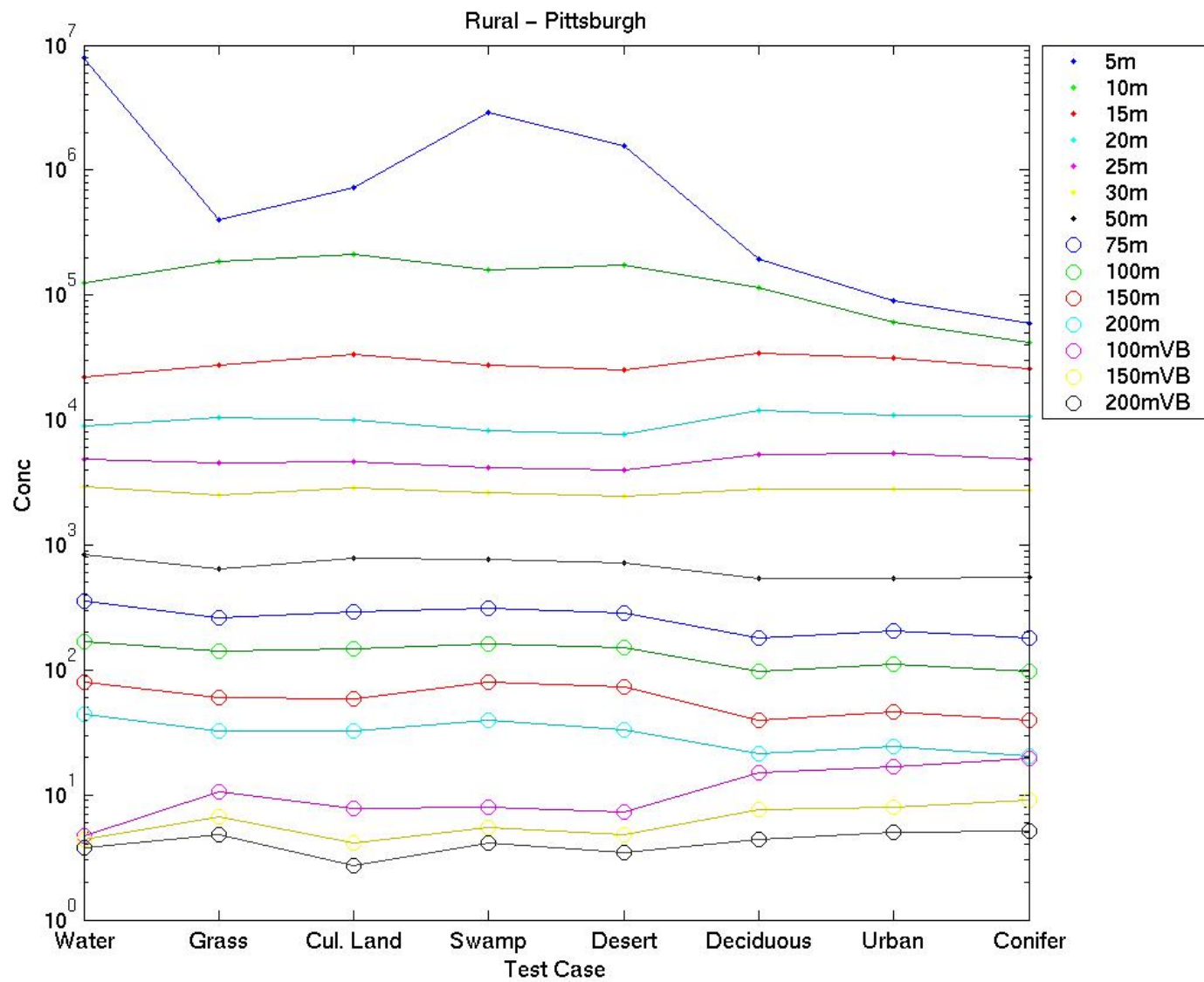
Sensitivity Study: Part 2

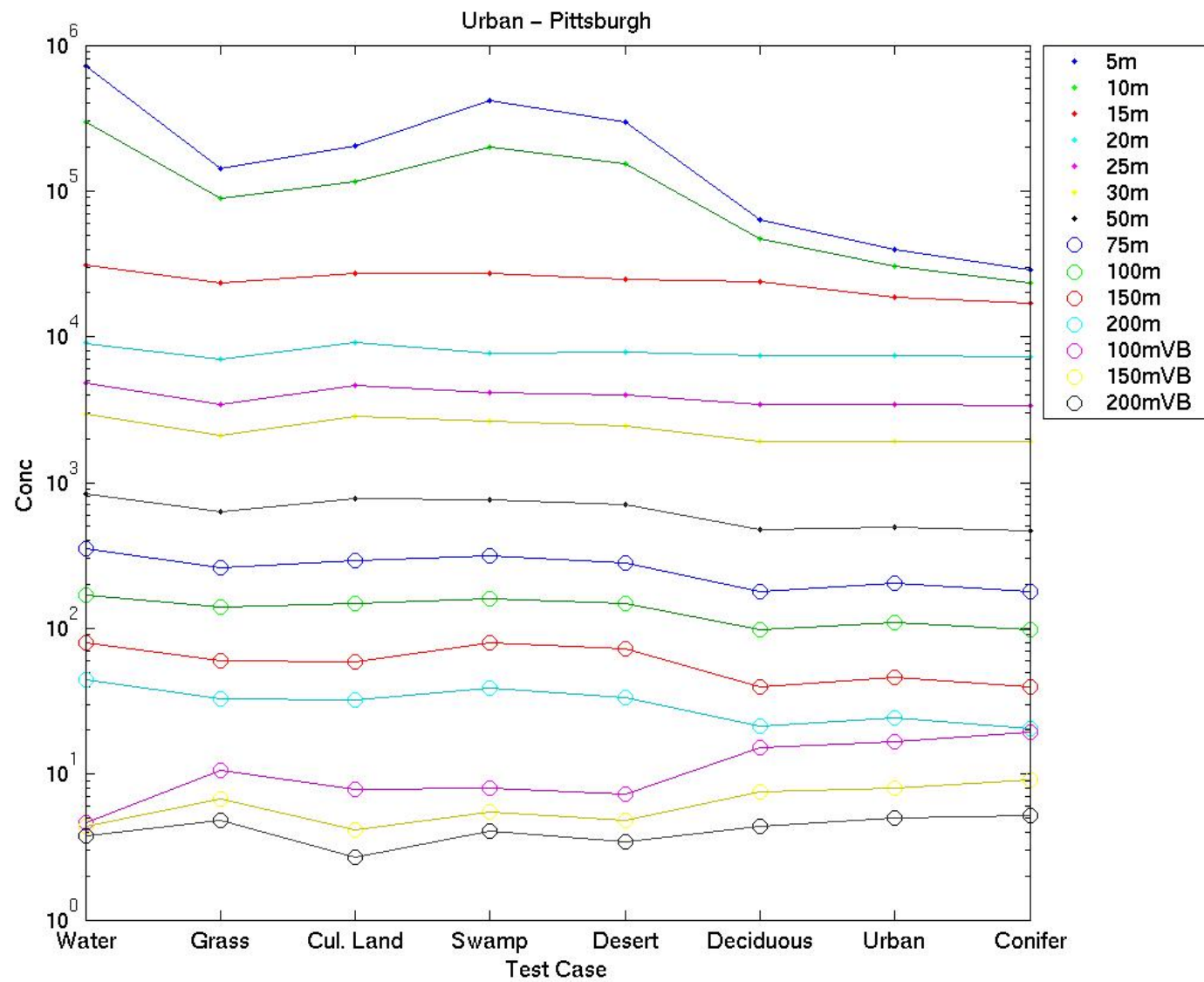
Applied seasonal values from
AERMET User's Guide for 8 land types
(Bowen Ratio for normal conditions)

- Water
- Grass
- Cultivated Land
- Swamp
- Desert
- Deciduous Forest
- Urban
- Conifer Forest









Conclusions: Part 2

- Surface roughness dominates the influence on the concentration, though the influence of the albedo and Bowen ratio are not negligible
- Will need to take into account these findings for further AERSURFACE development

Future Plans

- AERSURFACE will be modified to use USGS NLCD 92 data
 - 21-category land cover classification scheme
 - 30 m spatial resolution
- AERSURFACE to have seasonal variations for surface characteristics data

Future Plans

- There will be default values/functions but users will be given choices:
 - Number of sectors
 - Radius used to evaluate land use data
 - Output monthly, seasonal, annual data
 - Wet/dry/normal conditions for Bowen ratio
- We welcome input into other possible user options