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Supplement of

A comparison of plume rise algorithms to stack plume measurements in the Athabasca oil sands

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Supplementary Material for:

A Comparison of Plume Rise Algorithms to Stack Plume Measurements in the Athabasca Oil Sands

The following 22 figures compare the predicted plume rise from the Briggs parameterization used in GEM-MACH (h_B) with the measured plume rise as determined by tower measurements at AMS03 (h_M) as described in the text.

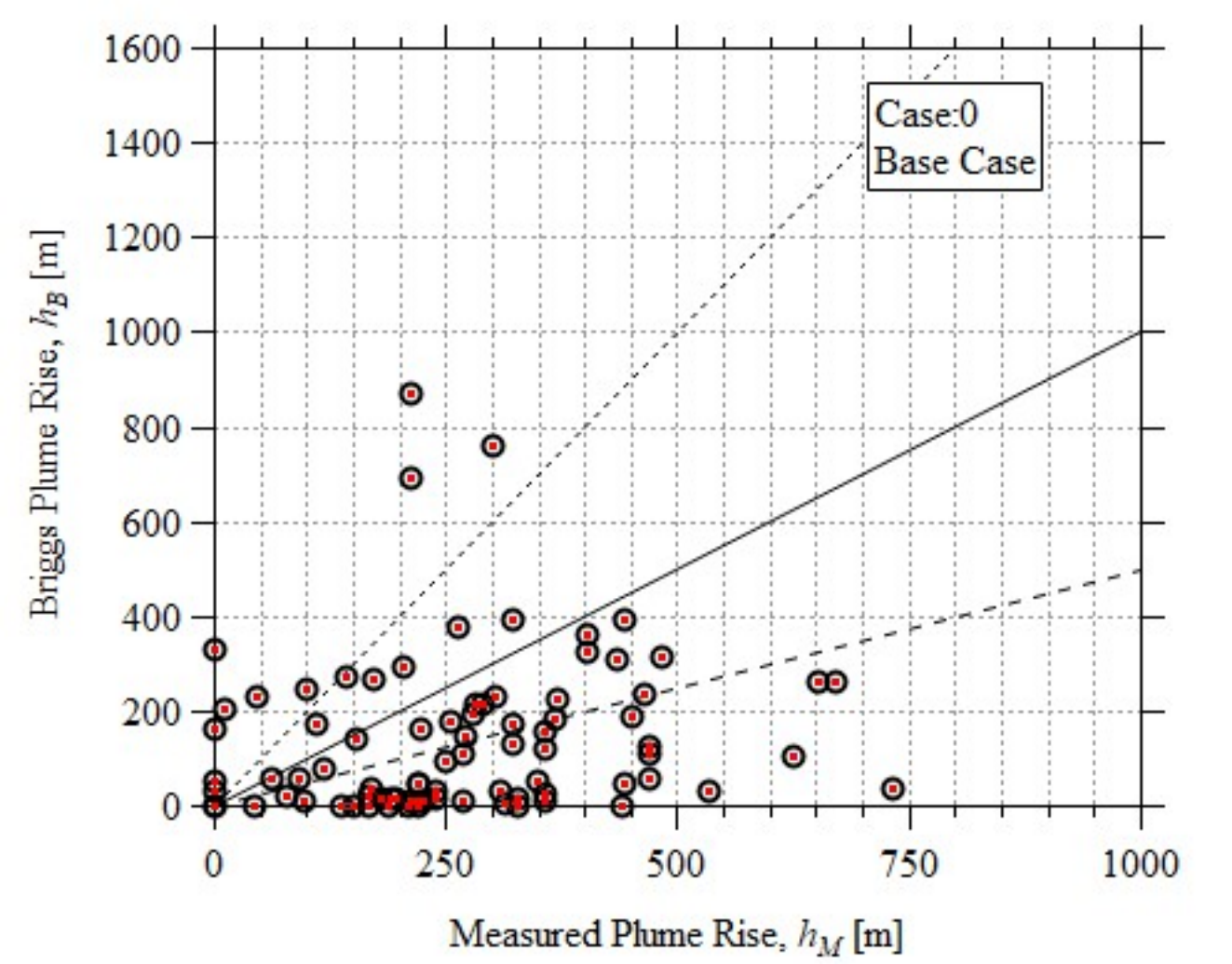
Each figure corresponds to a "case" listed in Table 6. The red dots repeat the base case (case 0) in each figure for comparison. The black circles are the comparison results for each case.

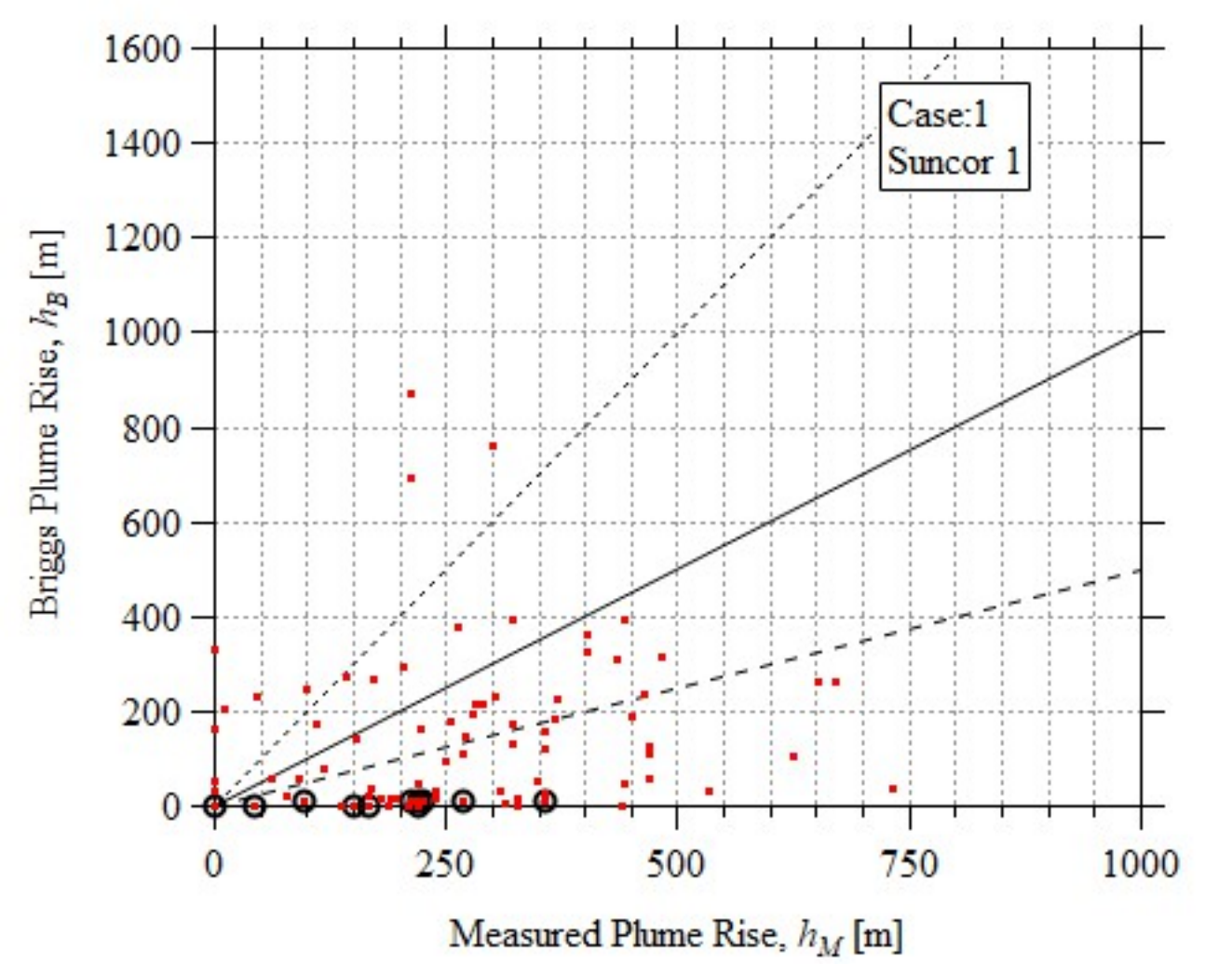
For ease of comparison, the h_B axis scale is not modified in cases where values of $h_B > 1600$ m occur. Instead the number of values greater than 1600 m are given as well as the maximum h_B value.

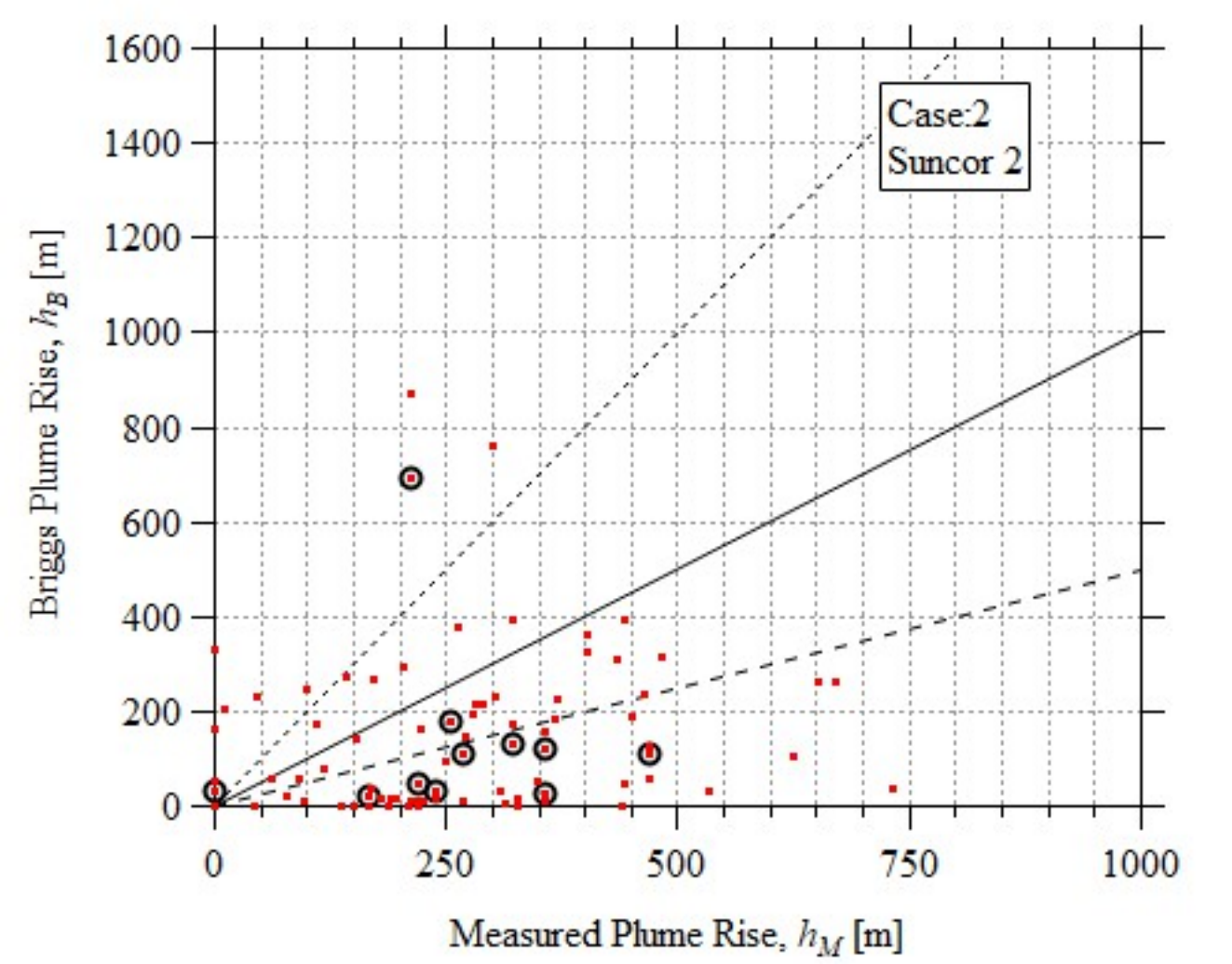
Lines demonstrate 2:1 (dotted), 1:1 (solid), and 1:2 (dashed) ratios for comparison.

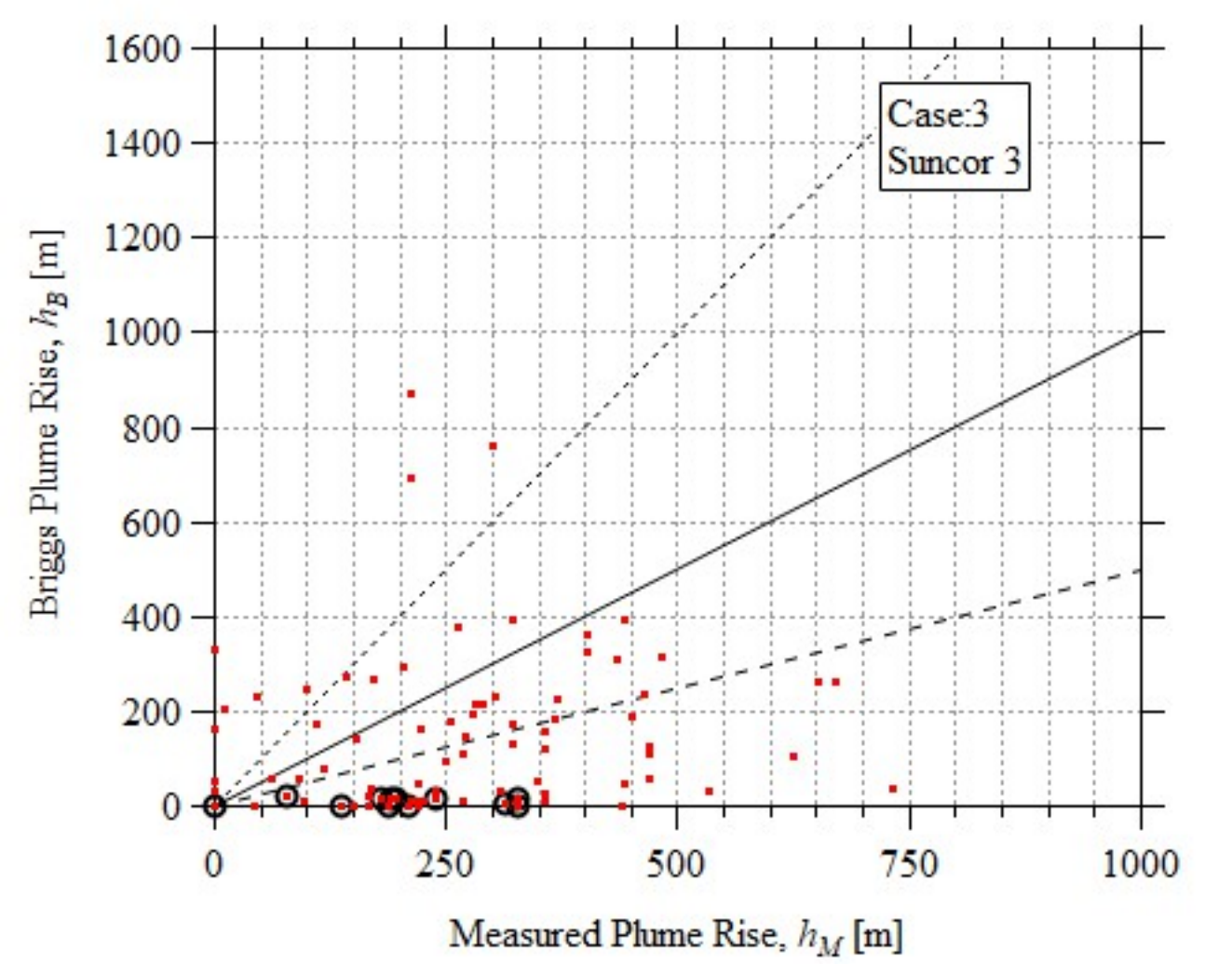
Table 6 is reproduced here for comparison. See text for explanation of cases and variables.

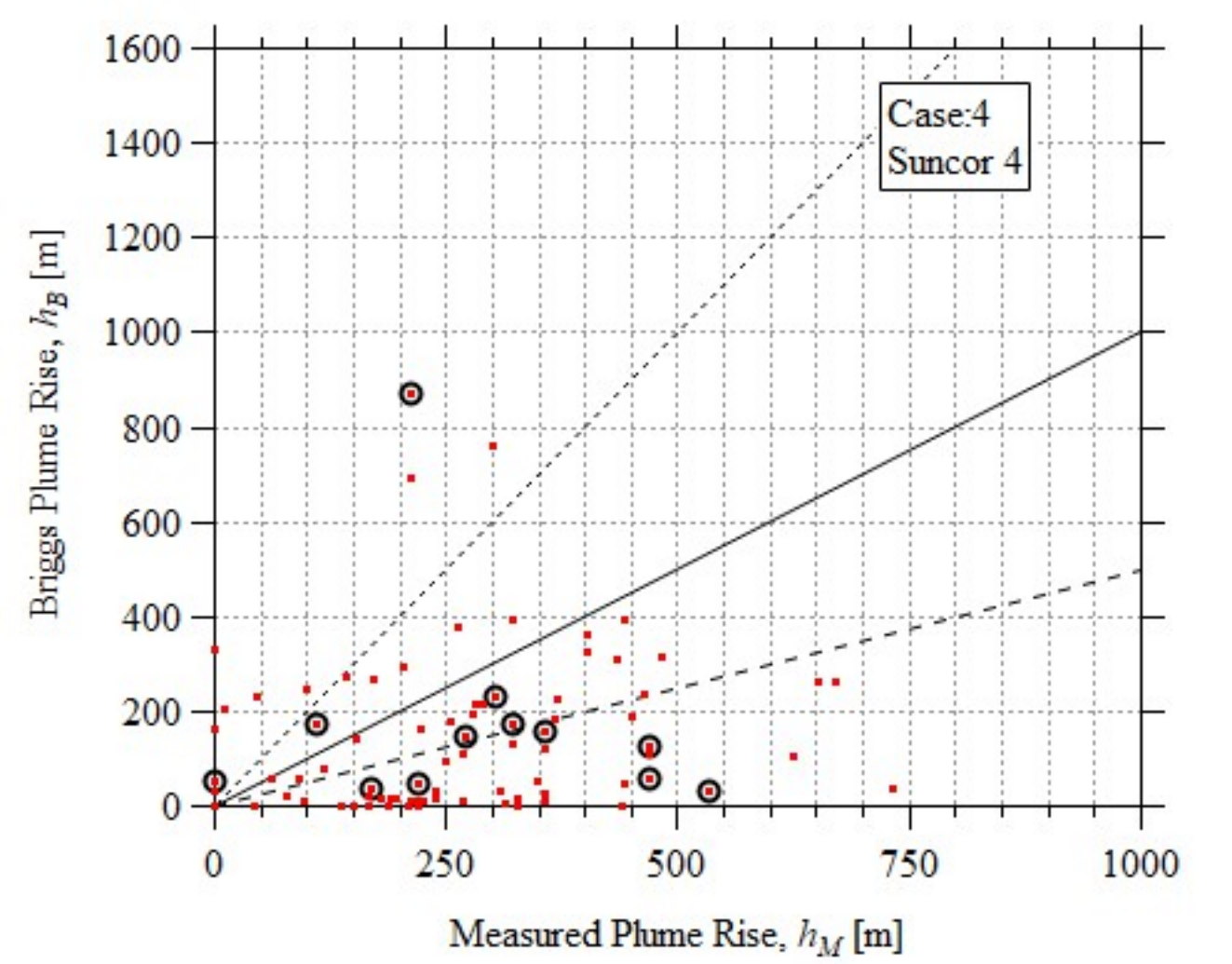
Case	#	a [m]	b	r^2	$\overline{h_B}$ [m]	$\overline{h_M}$ [m]	$\overline{h_B}/\overline{h_M}$	Ratio < 0.5	>0.5 & <2	Ratio > 2	n
Base Case	0	105	0.14	0.02	143	265	0.54	55%	30%	14%	83
Suncor 1	1	1	0.03	0.32	6	178	0.04	91%	0%	9%	11
Suncor 2	2	140	-0.01	0.00	137	260	0.52	73%	9%	18%	11
Suncor 3	3	8	0.00	0.00	9	199	0.04	92%	0%	8%	12
Suncor 4	4	235	-0.21	0.02	175	286	0.61	50%	33%	17%	12
Syncrude 1	5	289	0.02	0.00	294	296	1.00	18%	53%	29%	17
Syncrude 2	6	149	0.12	0.04	185	298	0.62	25%	69%	6%	16
CNRL 1	7	66	-0.04	N/A	49	395	0.13	100%	0%	0%	2
CNRL 2 (NPRI)	8	100	-0.23	N/A	15	374	0.04	100%	0%	0%	2
Neutral Cases Only	9	101	0.13	0.01	134	244	0.55	56%	26%	18%	50
Stable Cases Only	10	116	0.14	0.04	157	296	0.53	55%	36%	9%	33
Expanded Neutral Limits	11	105	0.14	0.02	143	265	0.54	55%	30%	14%	83
Reduced Neutral Limits	12	94	0.16	0.03	136	265	0.51	55%	30%	14%	83
Stability by Lapse Rate	13	93	0.14	0.05	129	265	0.49	55%	33%	12%	83
Stability by P-G. Class.	14	140	0.24	0.02	203	265	0.77	48%	33%	19%	83
Incl. $x_e > 50$km	15	126	-0.01	0.00	123	306	0.40	63%	24%	13%	121
Scaled to Max. Dist.	16	107	0.14	0.02	145	265	0.55	55%	30%	14%	83
No limit of −5K/km	17	109	0.16	0.02	151	265	0.57	53%	31%	16%	83
Eqns 4b and 5b (no min)	18	1416	-1.25	0.00	1085	265	4.10	54%	23%	23%	83
Alternate Neutral Eq. 16	19	4422	-4.26	0.00	3293	265	12.44	51%	23%	27%	83
Momentum (Eq 17 & 18)	20	114	0.17	0.02	159	265	0.60	54%	30%	16%	83
Momentum (Eq 20)	21	227	0.40	0.02	333	265	1.26	48%	17%	35%	83

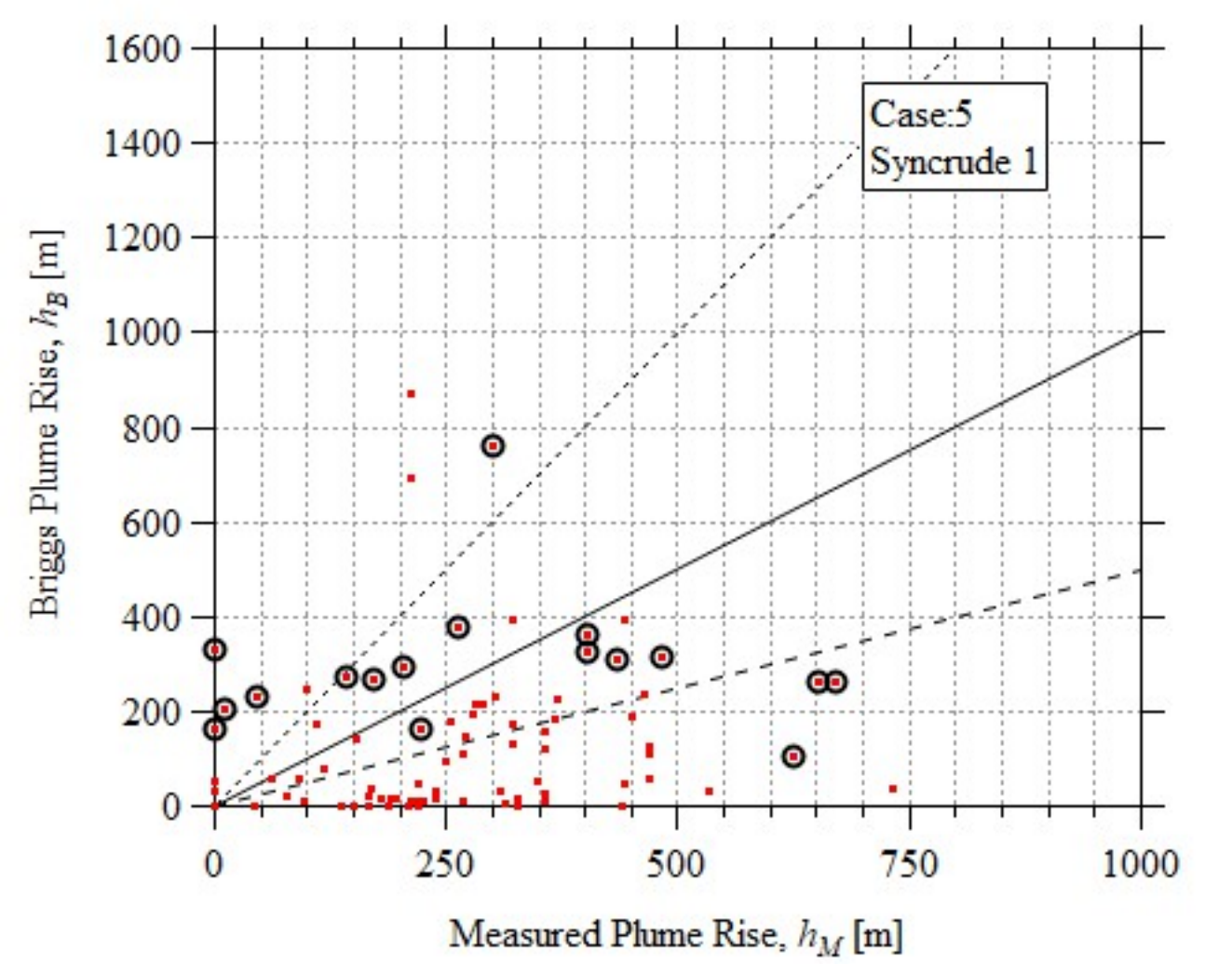

Case:0
Base Case
Briggs Plume Rise, h_B [m]
Measured Plume Rise, h_M [m]
0
200
400
600
800
1000
1200
1400
1600
0
250
500
750
1000

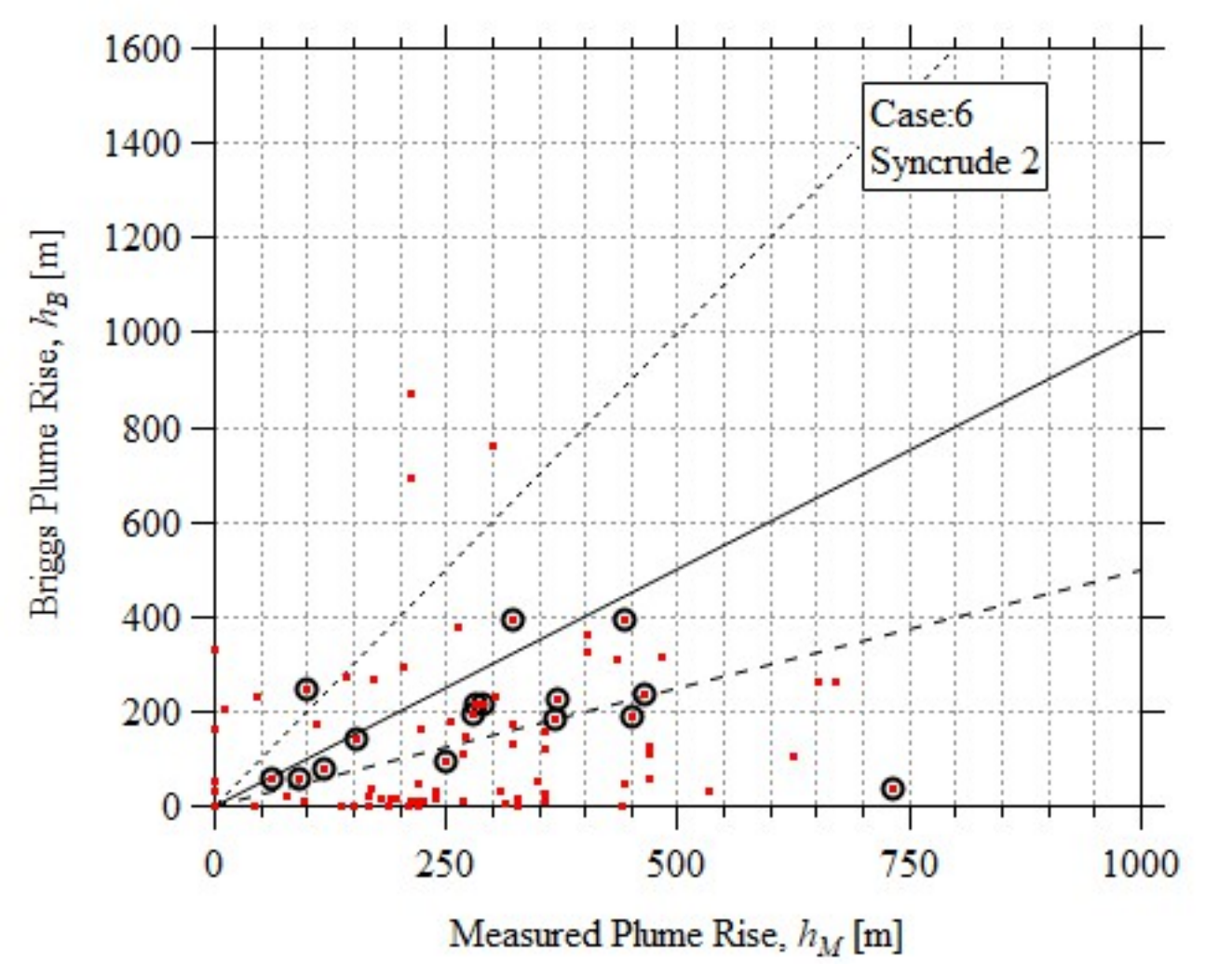

Case:1
Suncor 1
Briggs Plume Rise, h_B [m]
Measured Plume Rise, h_M [m]
0
200
400
600
800
1000
1200
1400
1600
0
250
500
750
1000

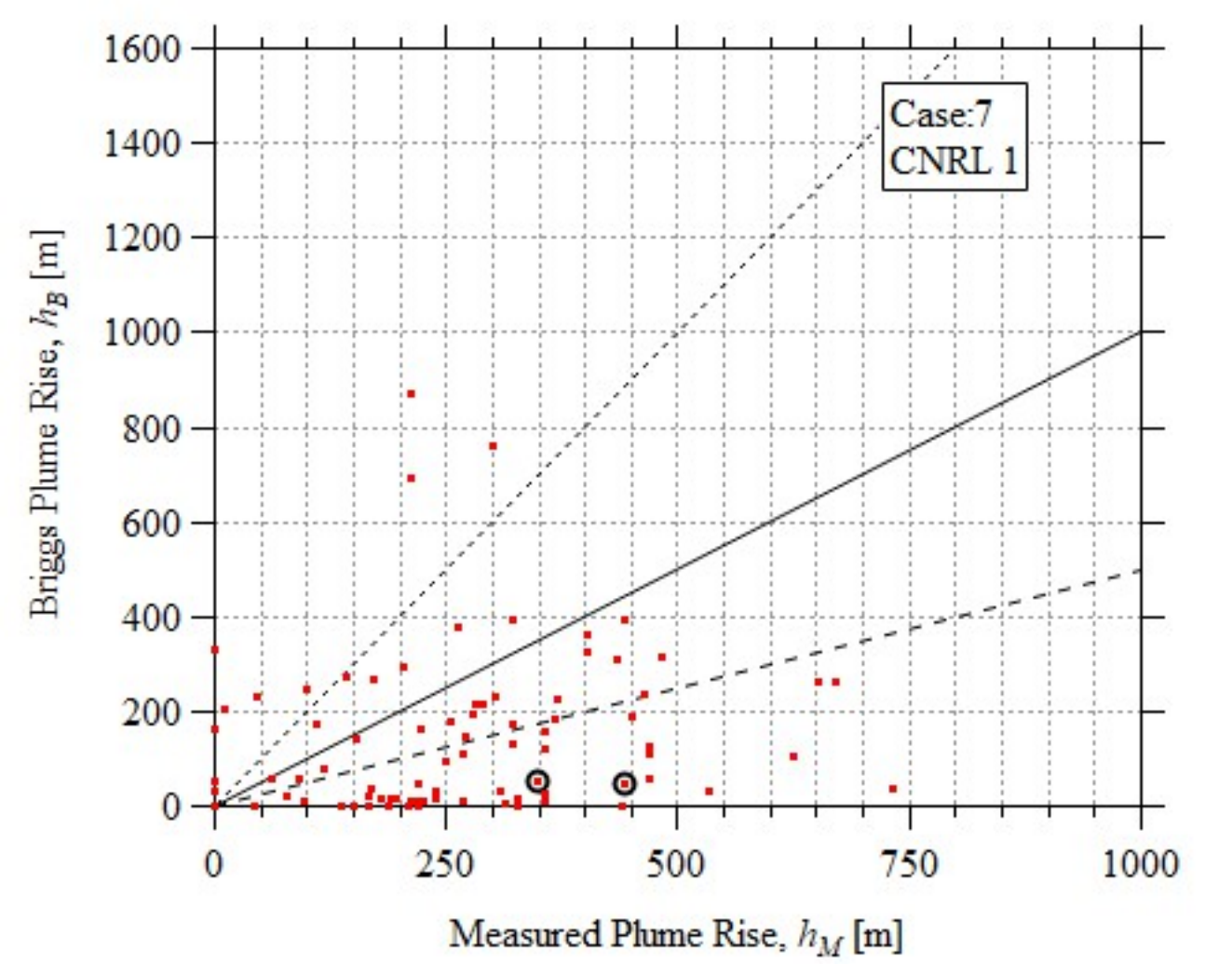

Case:2
Suncor 2
Briggs Plume Rise, h_B [m]
Measured Plume Rise, h_M [m]
0
200
400
600
800
1000
1200
1400
1600
0
250
500
750
1000

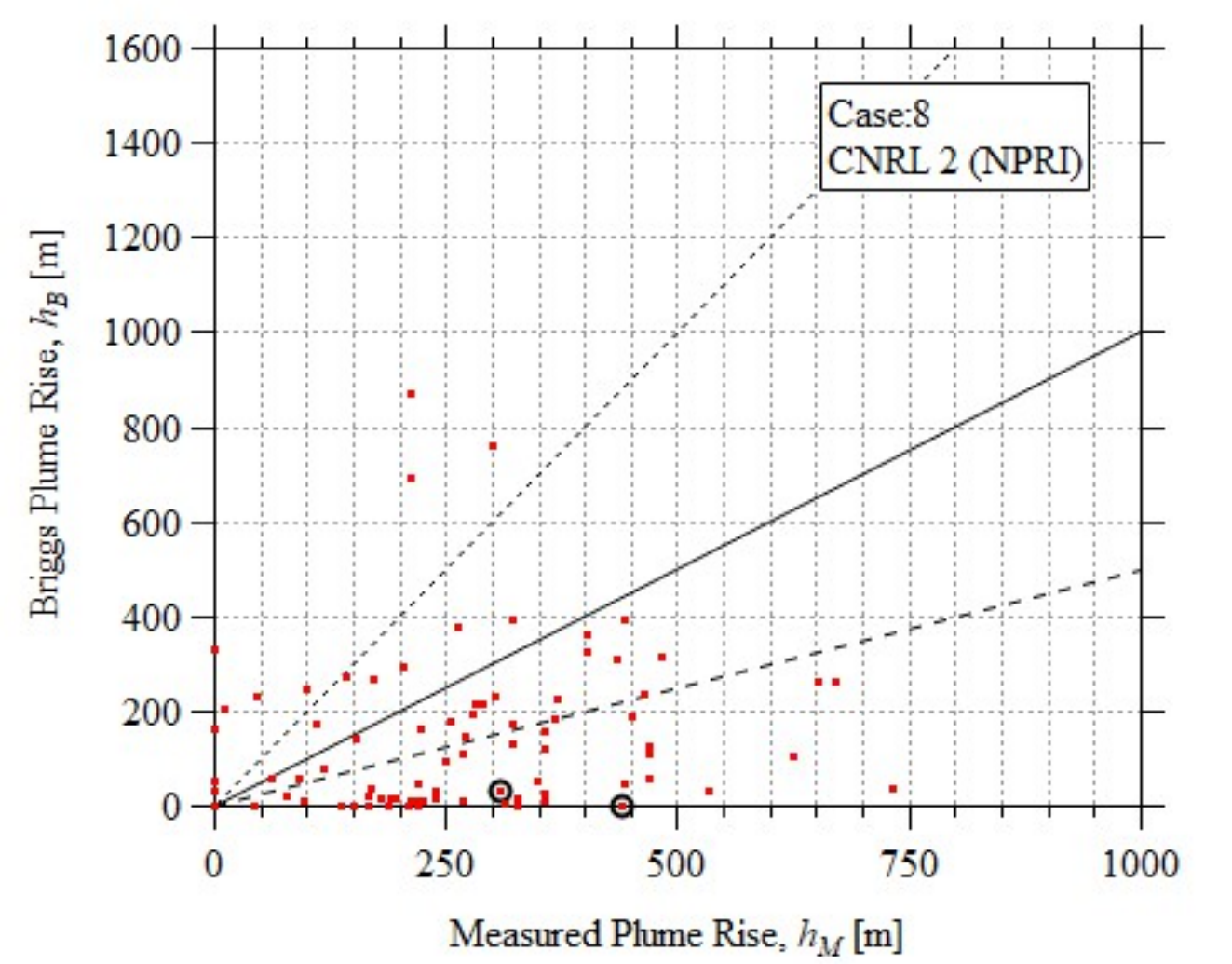

Case:3
Suncor 3
Briggs Plume Rise, h_B [m]
Measured Plume Rise, h_M [m]
0
200
400
600
800
1000
1200
1400
1600
0
250
500
750
1000

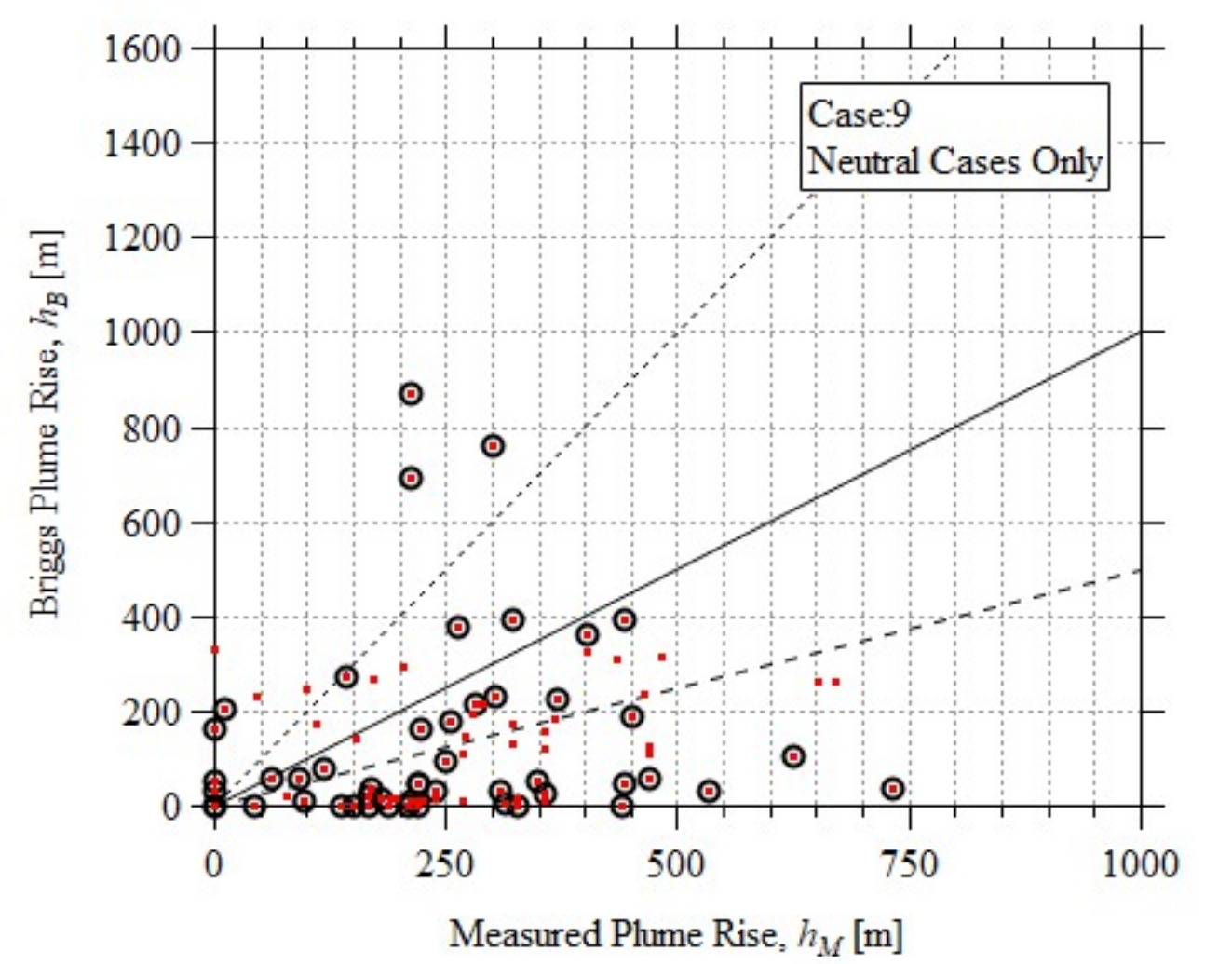

Case:4
Suncor 4
Briggs Plume Rise, h_B [m]
Measured Plume Rise, h_M [m]
0
200
400
600
800
1000
1200
1400
1600
0
250
500
750
1000

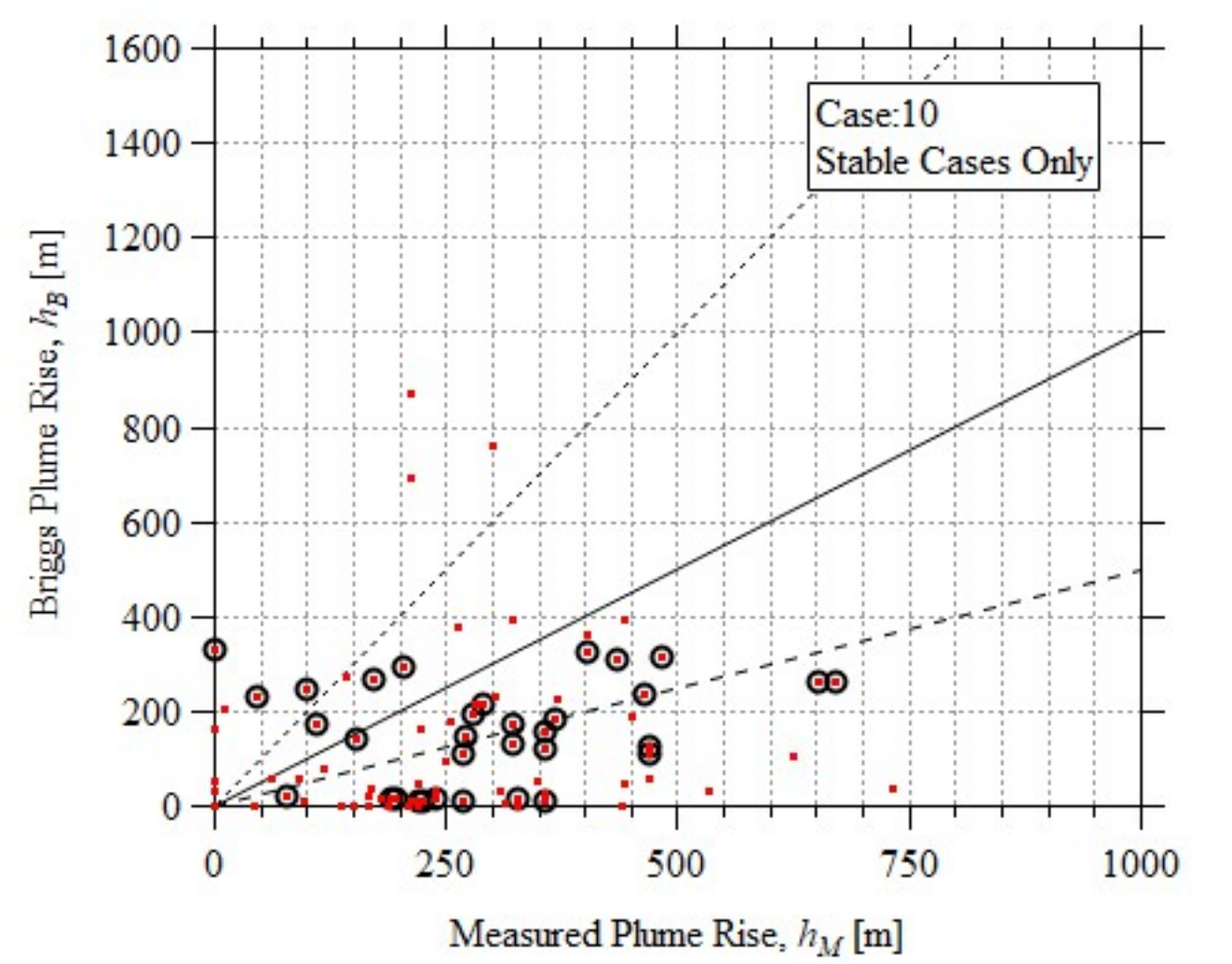

Case:5
Syncrude 1
Briggs Plume Rise, h_B [m]
Measured Plume Rise, h_M [m]
0
200
400
600
800
1000
1200
1400
1600
0
250
500
750
1000

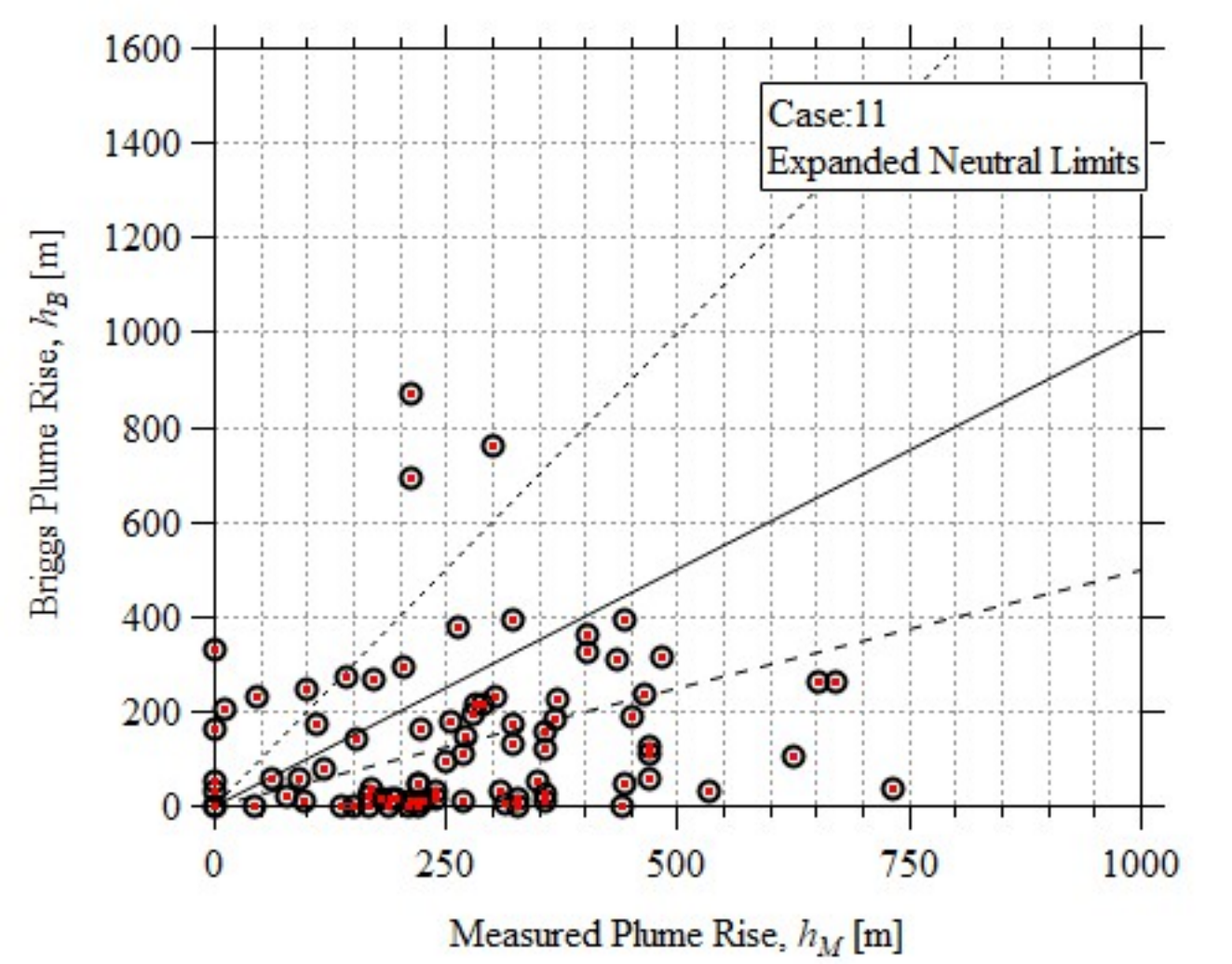

Case:6
Syncrude 2
Briggs Plume Rise, h_B [m]
Measured Plume Rise, h_M [m]
0
200
400
600
800
1000
1200
1400
1600
0
250
500
750
1000

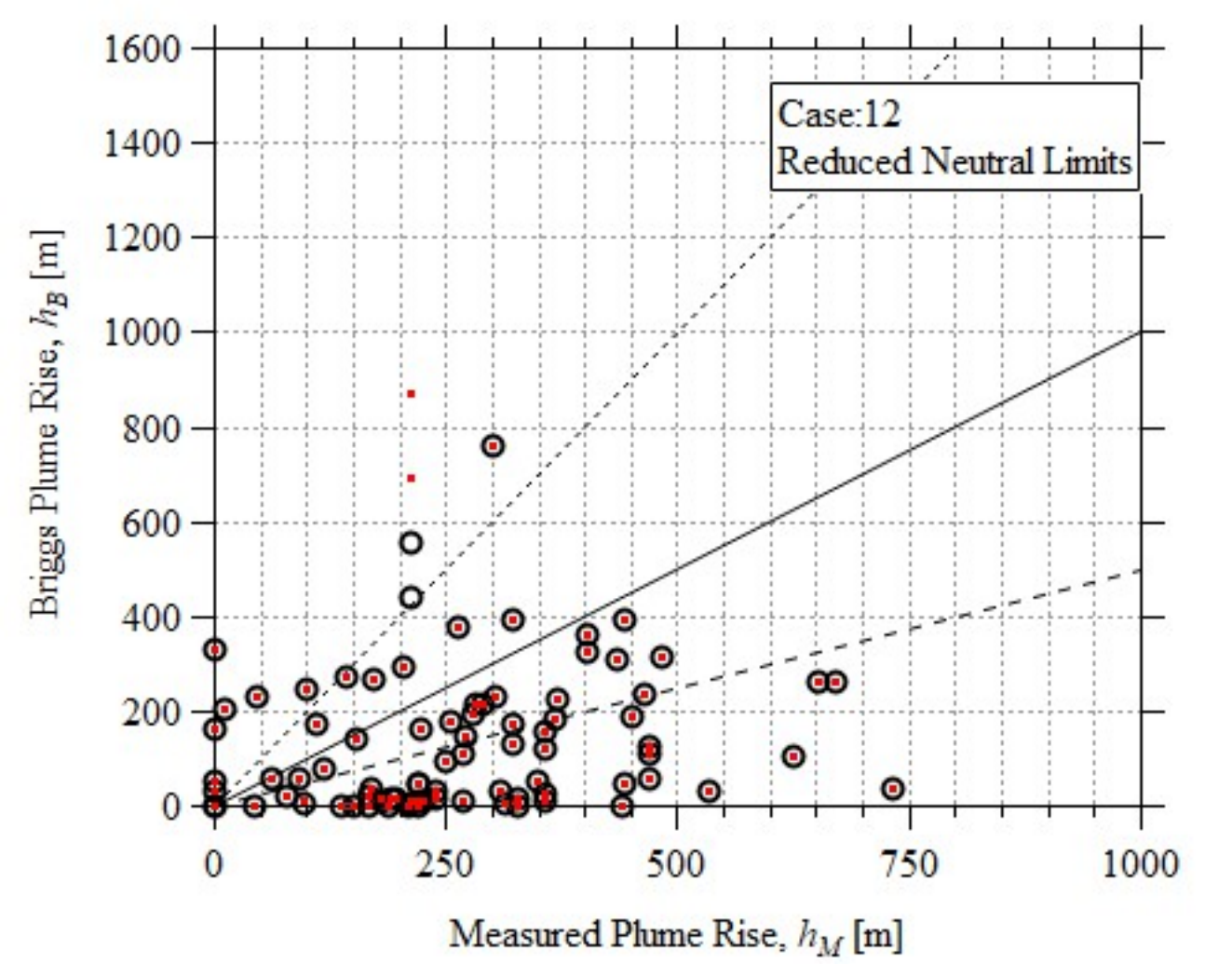

Case:7
CNRL 1
Briggs Plume Rise, h_B [m]
Measured Plume Rise, h_M [m]
0
200
400
600
800
1000
1200
1400
1600
0
250
500
750
1000

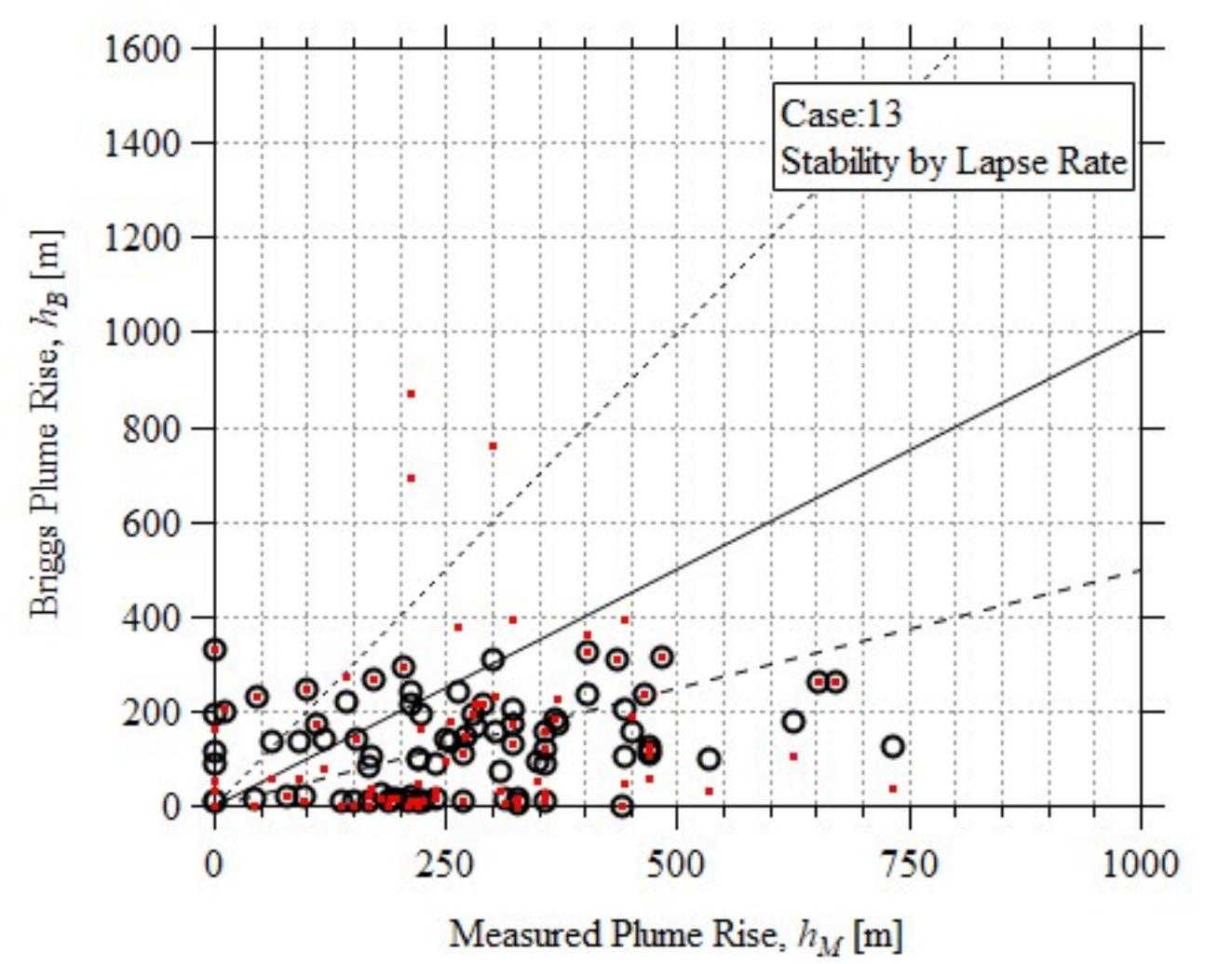

Case:8
CNRL 2 (NPRI)
Briggs Plume Rise, h_B [m]
Measured Plume Rise, h_M [m]
0
200
400
600
800
1000
1200
1400
1600
0
250
500
750
1000

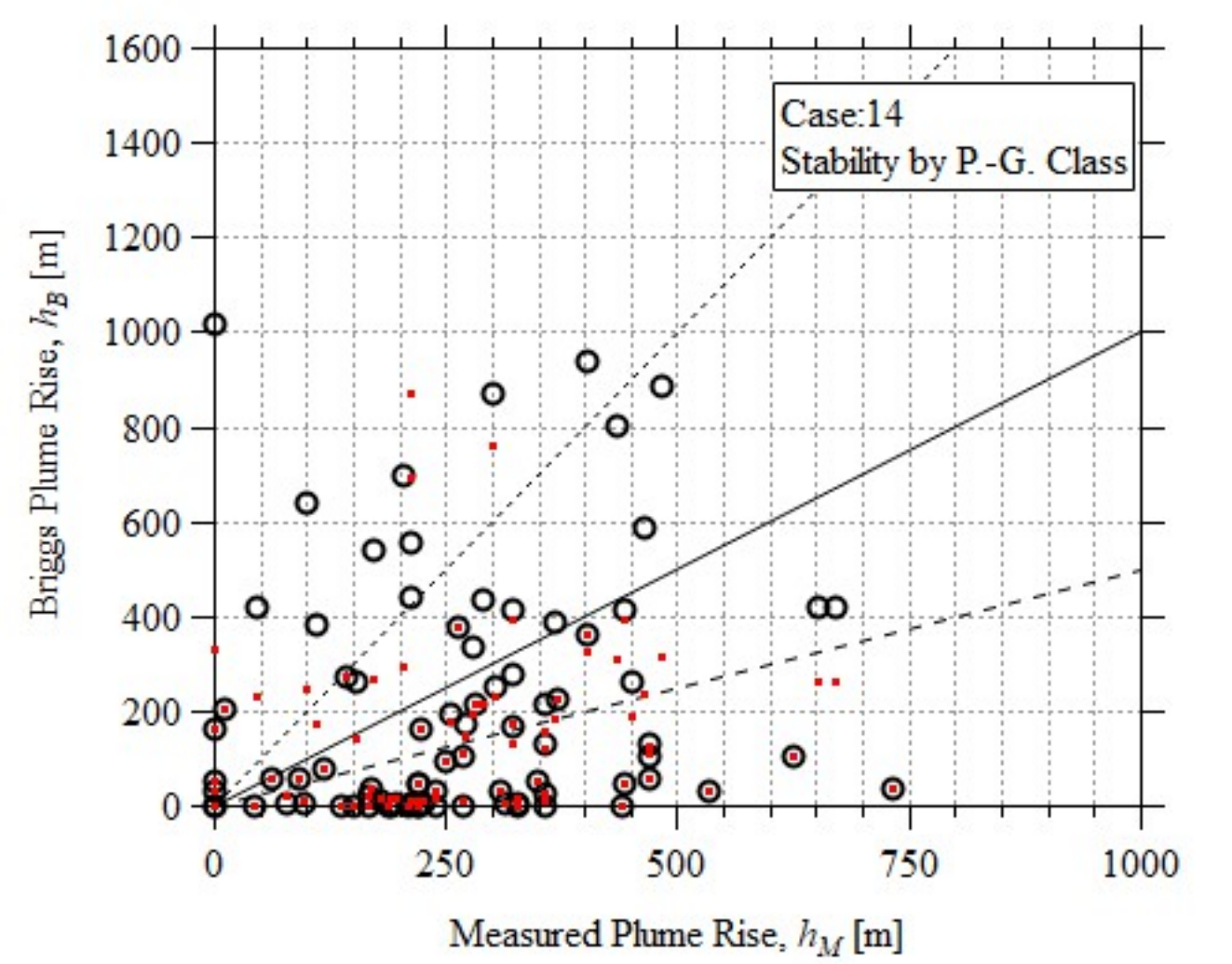

Case:9
Neutral Cases Only
Briggs Plume Rise, h_B [m]
Measured Plume Rise, h_M [m]
0
200
400
600
800
1000
1200
1400
1600
0
250
500
750
1000

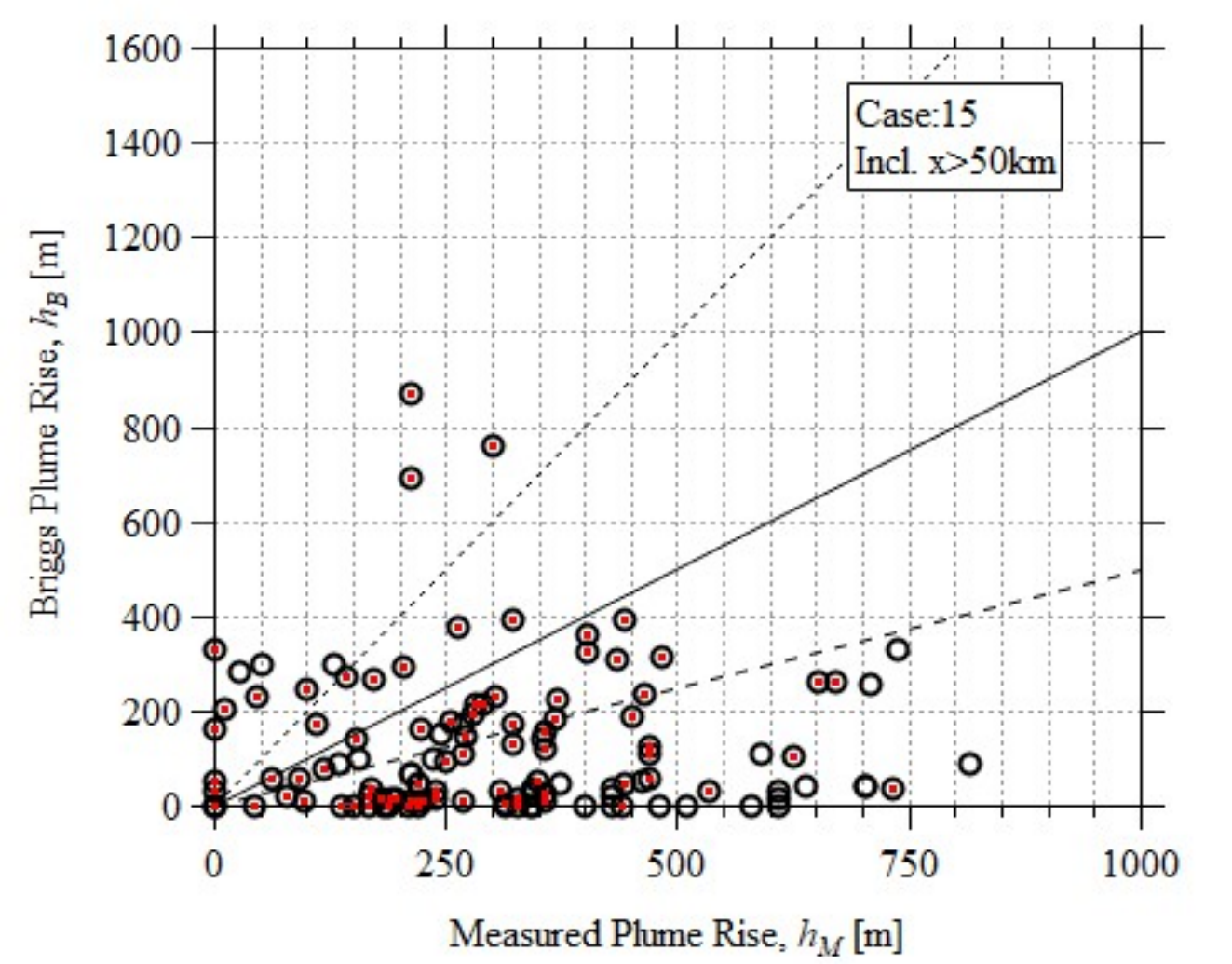

Case:10
Stable Cases Only
Briggs Plume Rise, h_B [m]
Measured Plume Rise, h_M [m]
0
200
400
600
800
1000
1200
1400
1600
0
250
500
750
1000

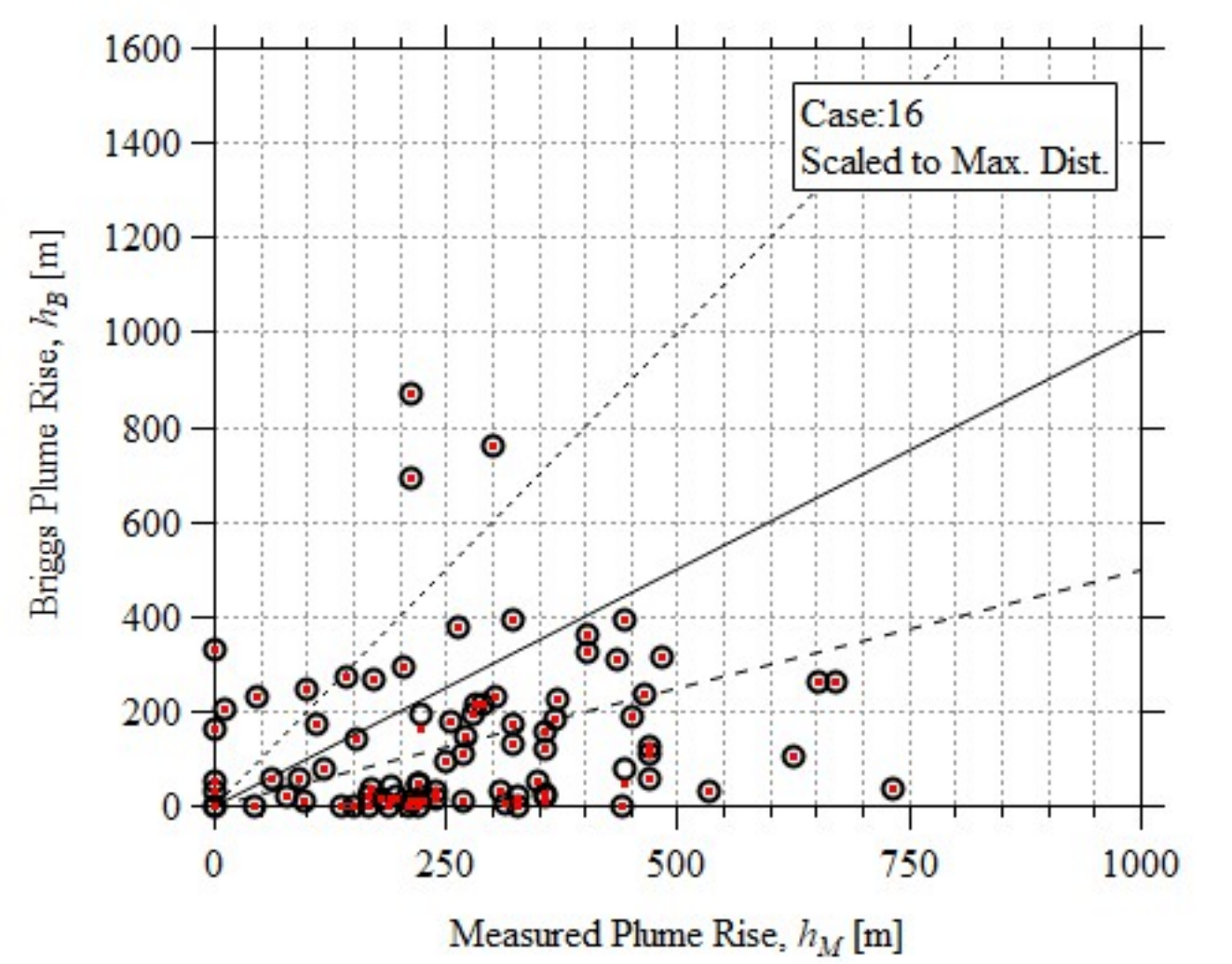

Case:11
Expanded Neutral Limits
Briggs Plume Rise, h_B [m]
Measured Plume Rise, h_M [m]
1600
1400
1200
1000
800
600
400
200
0
0
250
500
750
1000

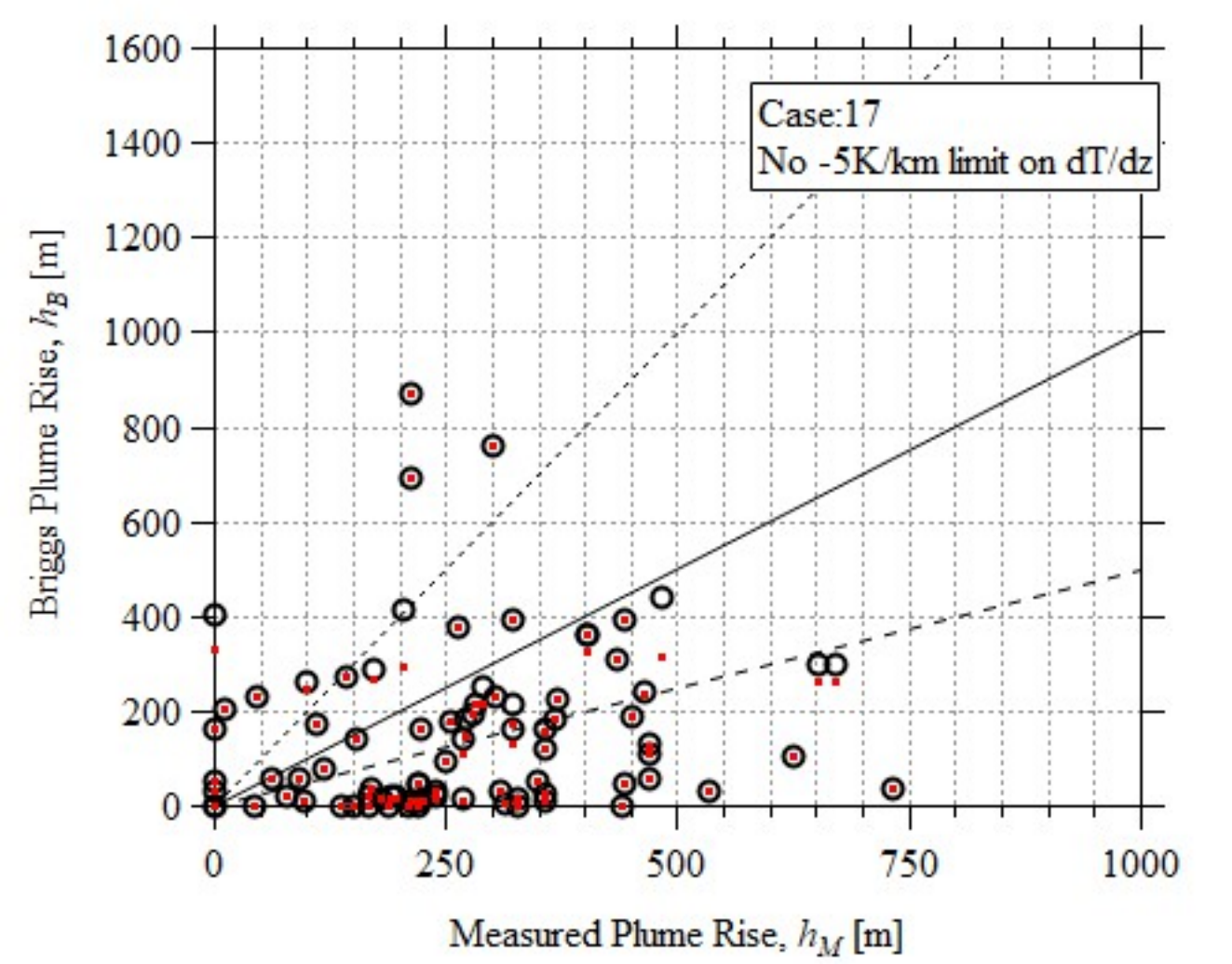

Case:12
Reduced Neutral Limits
Briggs Plume Rise, h_B [m]
Measured Plume Rise, h_M [m]
0
200
400
600
800
1000
1200
1400
1600
0
250
500
750
1000

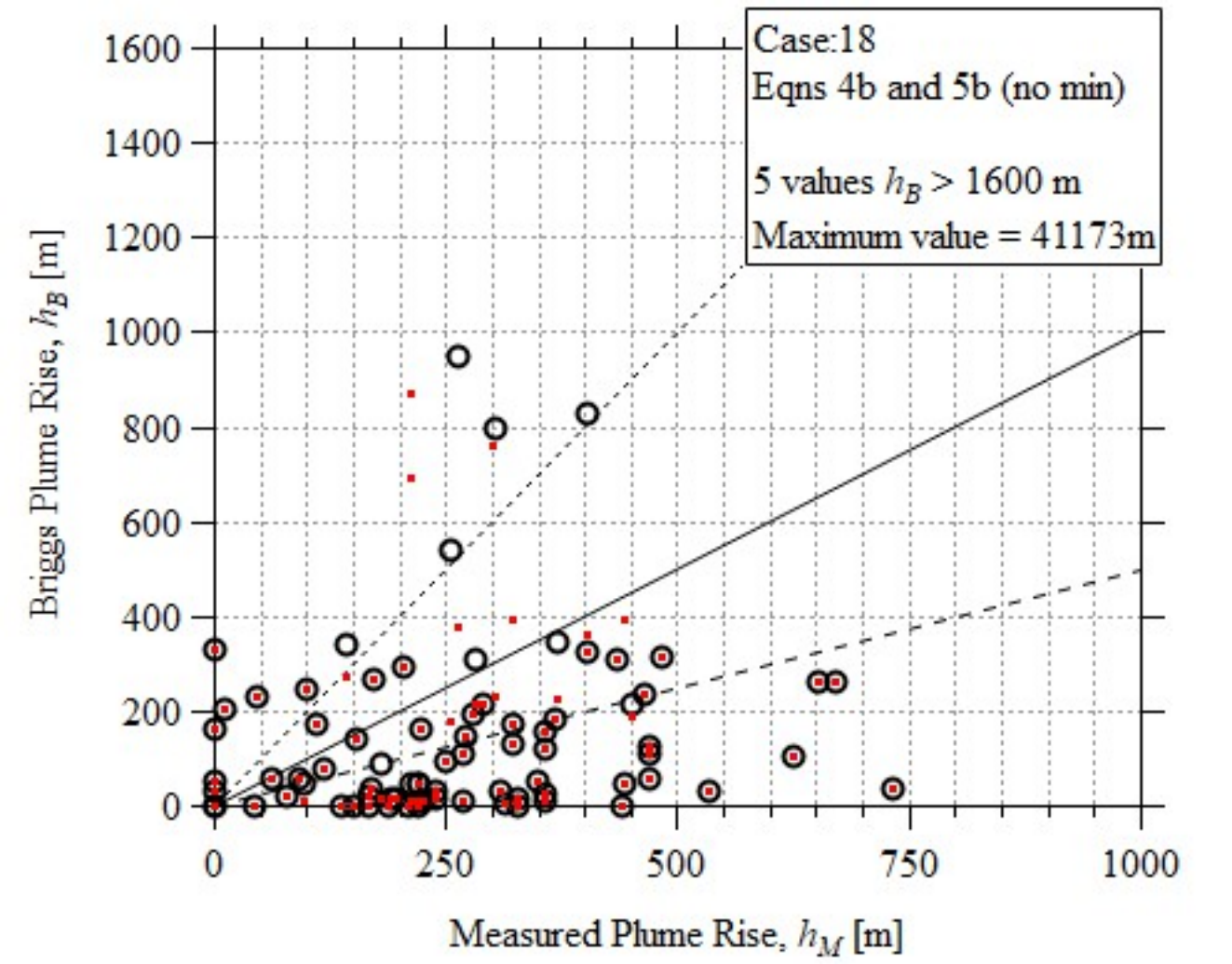

Case:13
Stability by Lapse Rate
Briggs Plume Rise, h_B [m]
Measured Plume Rise, h_M [m]
0
200
400
600
800
1000
1200
1400
1600
0
250
500
750
1000

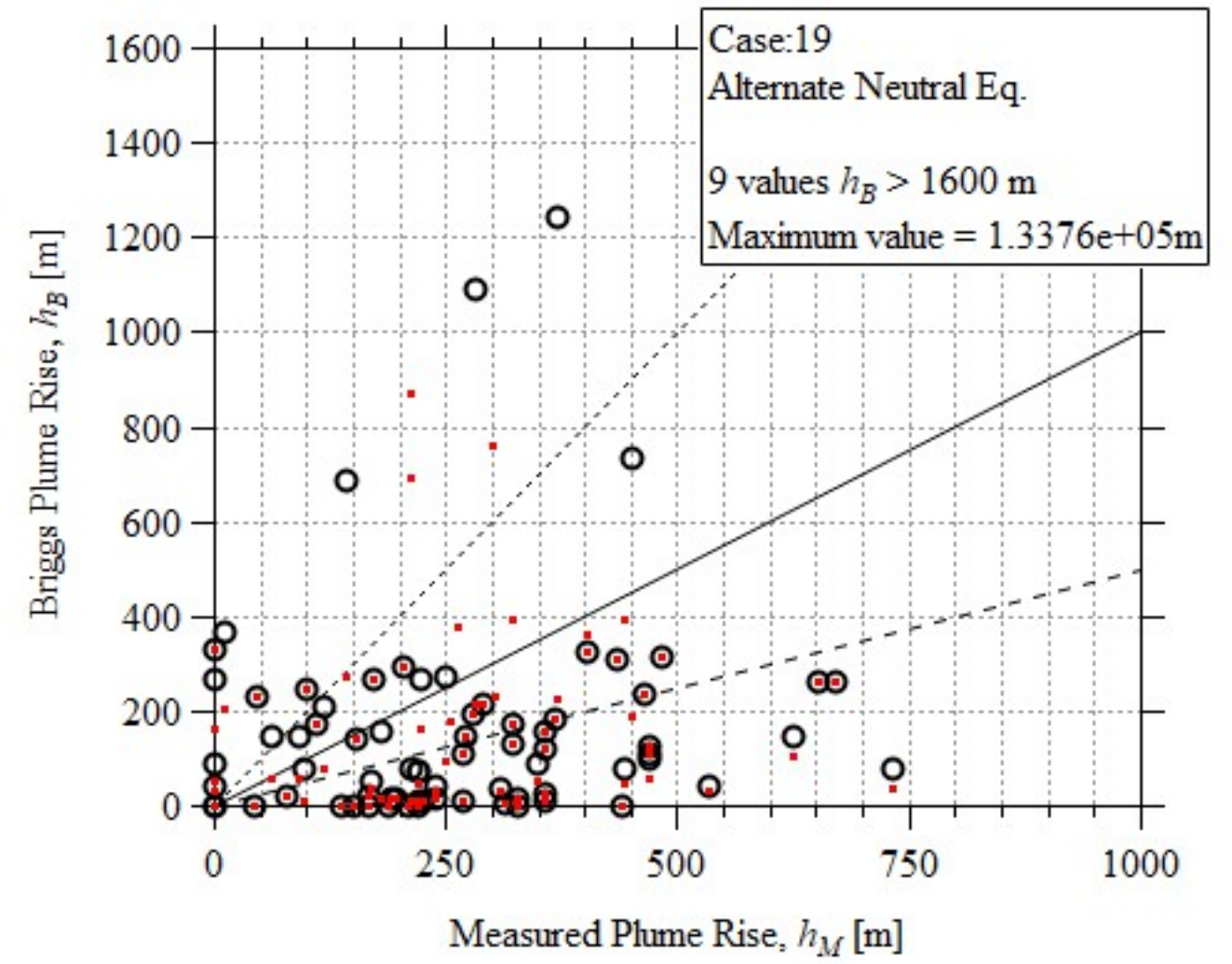

Case:14
Stability by P.-G. Class
Briggs Plume Rise, h_B [m]
Measured Plume Rise, h_M [m]
0
200
400
600
800
1000
1200
1400
1600
0
250
500
750
1000

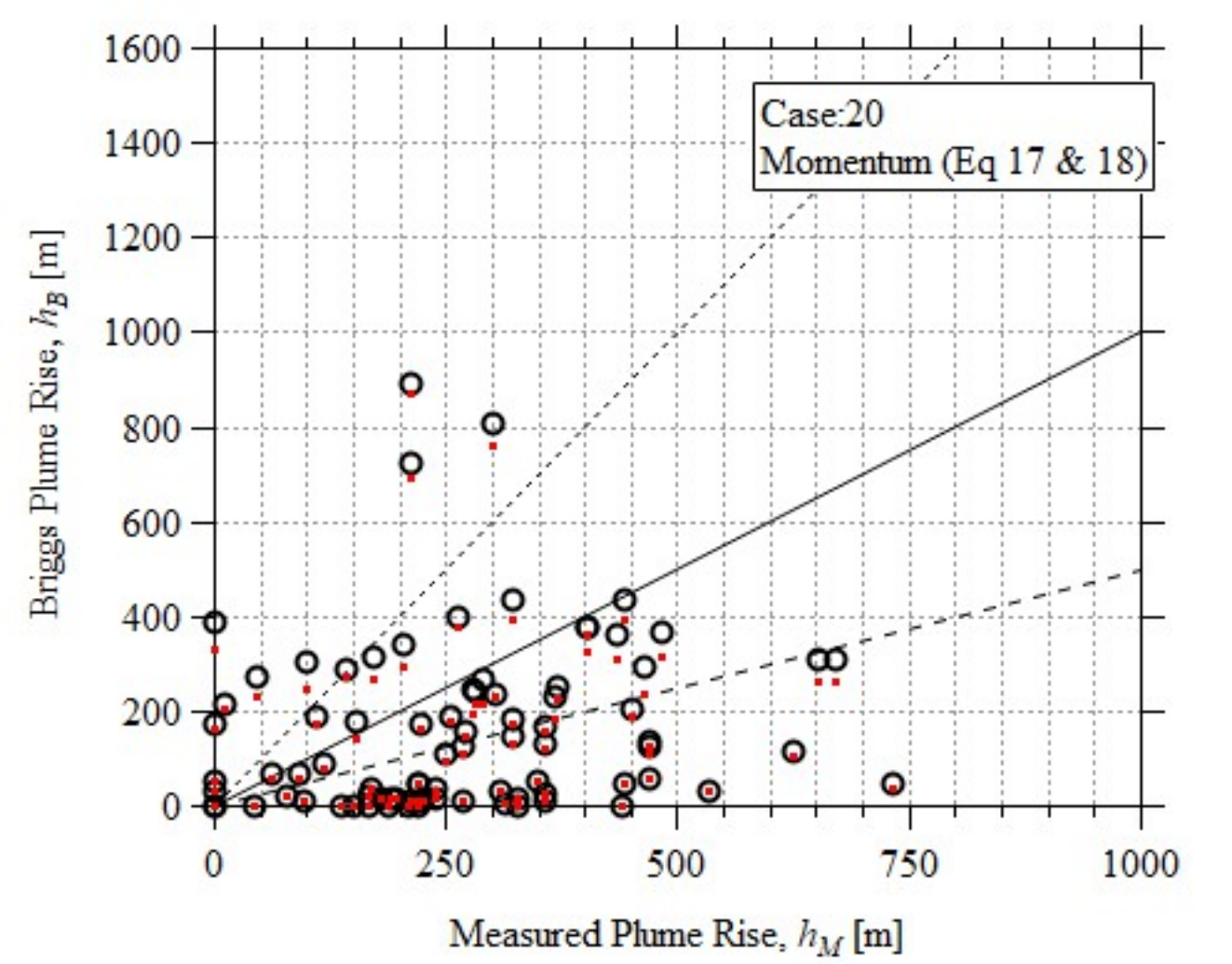

Case:15
Incl. x>50km
Briggs Plume Rise, h_B [m]
Measured Plume Rise, h_M [m]
0
200
400
600
800
1000
1200
1400
1600
0
250
500
750
1000

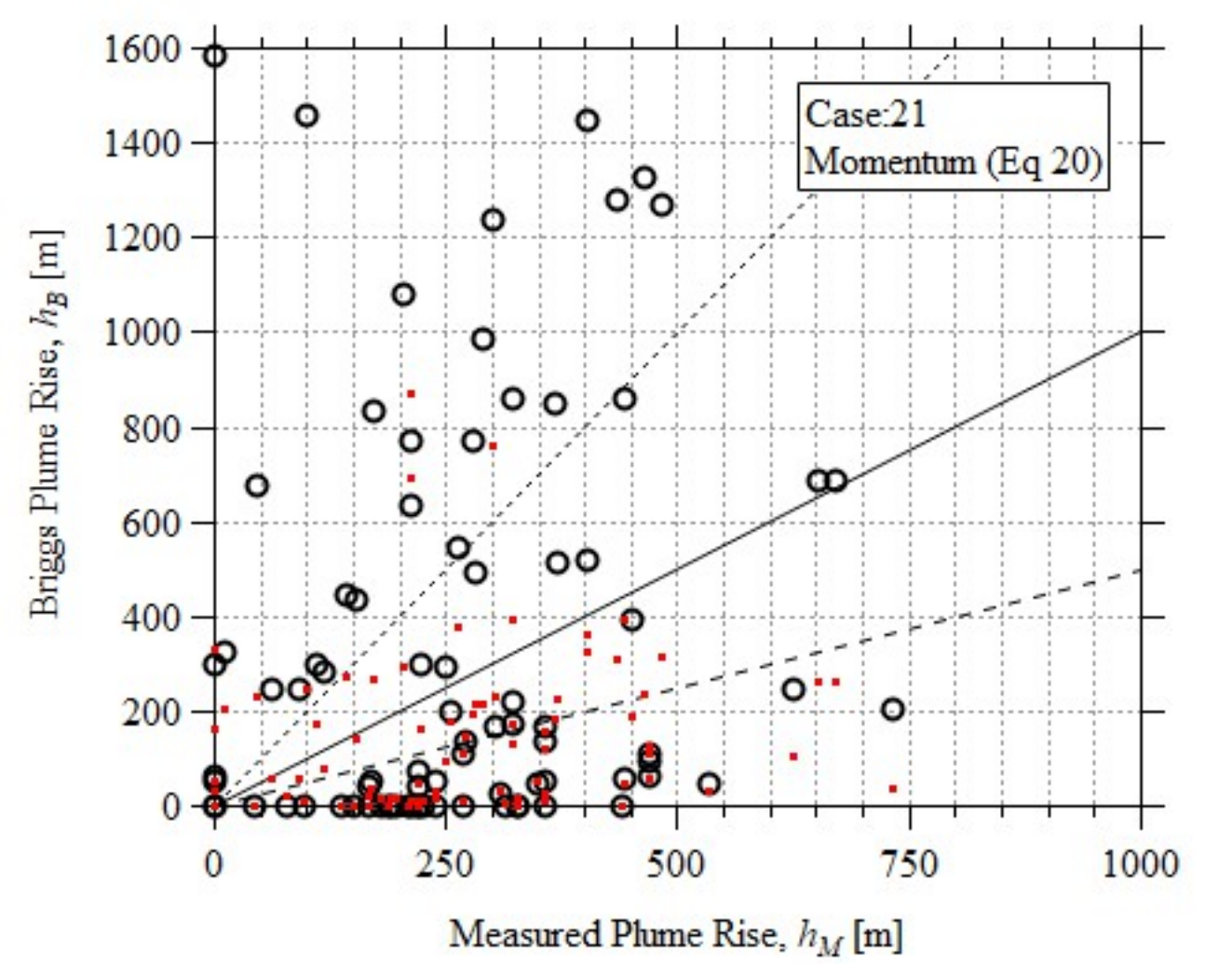

Case:16
Scaled to Max. Dist.
Briggs Plume Rise, h_B [m]
Measured Plume Rise, h_M [m]
0
200
400
600
800
1000
1200
1400
1600
0
250
500
750
1000


Case:17
No -5K/km limit on dT/dz
Briggs Plume Rise, h_B [m]
Measured Plume Rise, h_M [m]
0
200
400
600
800
1000
1200
1400
1600
0
250
500
750
1000


Case:18
Eqns 4b and 5b (no min)
5 values h_B > 1600 m
Maximum value = 41173m
Briggs Plume Rise, h_B [m]
Measured Plume Rise, h_M [m]
0
200
400
600
800
1000
1200
1400
1600
0
250
500
750
1000


Case:19
Alternate Neutral Eq.
9 values h_B > 1600 m
Maximum value = 1.3376e+05m
Briggs Plume Rise, h_B [m]
Measured Plume Rise, h_M [m]
0
200
400
600
800
1000
1200
1400
1600
0
250
500
750
1000


Case:20
Momentum (Eq 17 & 18)
Briggs Plume Rise, h_B [m]
Measured Plume Rise, h_M [m]
0
200
400
600
800
1000
1200
1400
1600
0
250
500
750
1000


Case:21
Momentum (Eq 20)
Briggs Plume Rise, h_B [m]
Measured Plume Rise, h_M [m]
0
200
400
600
800
1000
1200
1400
1600
0
250
500
750
1000