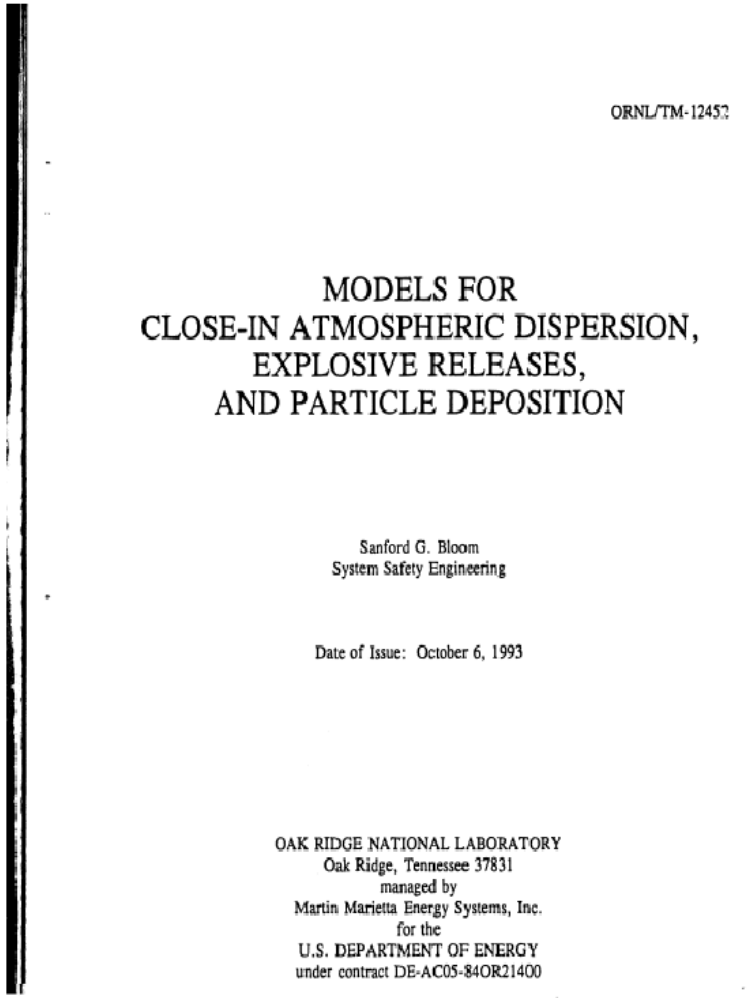
Simple ORNL model

- Provided in Quick Basic, re-implemented as visual basic in Excel
- Simple gas dispersion
- Deposition not explicitly output
- No gravitational settling



ORNL/TM-12457

MODELS FOR
CLOSE-IN ATMOSPHERIC DISPERSION,
EXPLOSIVE RELEASES,
AND PARTICLE DEPOSITION

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System Safety Engineering

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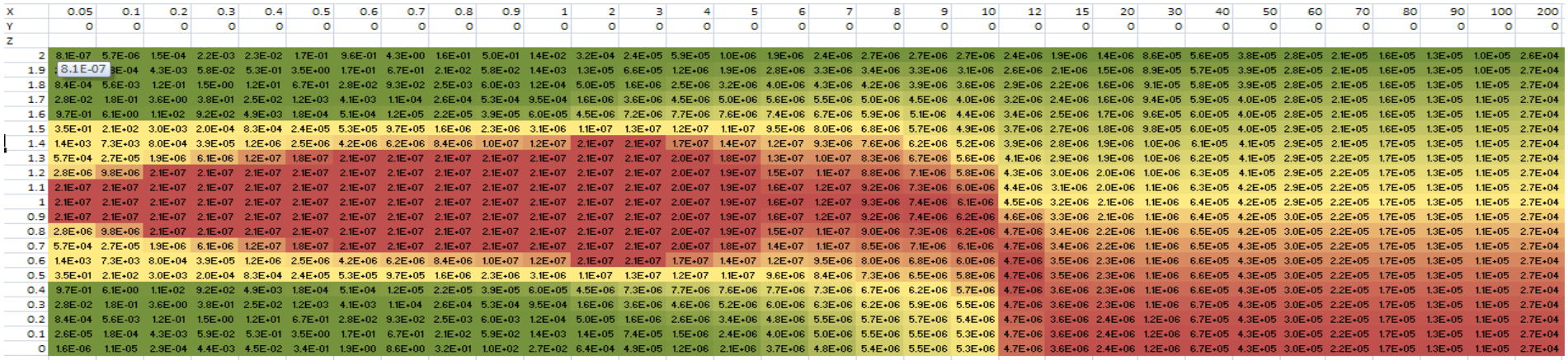
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37831
managed by
Martin Marietta Energy Systems, Inc.
for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-84OR21400

Inputs

- Stability category
- Wind speed
- Particle size ranges
- Deposition velocity by particle size range
- Height/radius of source

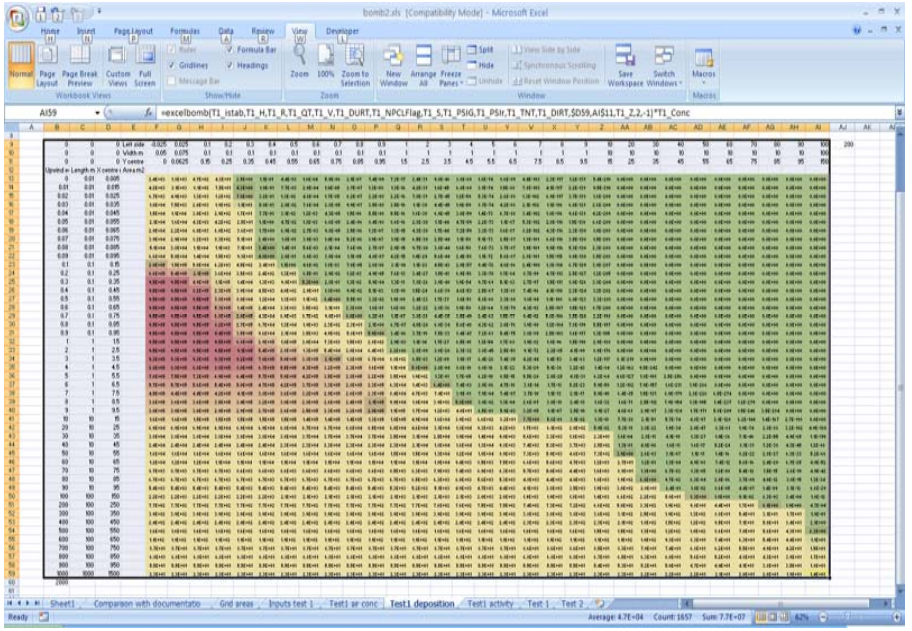
- Particle size fractions (optional)
- Mean particle size (optional)
- TNT equivalent
- Mass of material (including entrained material)



X	0.05	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1	2	3	4	5	6	7	8	9	10	12	15	20	30	40	50	60	70	80	90	100	200
Y	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z																																
2	8.1E-07	5.7E-06	1.5E-04	2.2E-03	2.3E-02	1.7E-01	9.6E-01	4.3E+00	1.6E+01	5.0E+01	1.4E+02	3.2E+04	2.4E+05	5.9E+05	1.0E+06	1.9E+06	2.4E+06	2.7E+06	2.7E+06	2.7E+06	2.4E+06	1.9E+06	1.4E+06	8.6E+05	5.6E+05	3.8E+05	2.8E+05	2.1E+05	1.6E+05	1.3E+05	1.0E+05	2.6E+04
1.9	8.1E-07	3E-04	4.3E-03	5.8E-02	5.3E-01	3.5E+00	1.7E+01	6.7E+01	2.1E+02	5.8E+02	1.4E+03	1.3E+05	6.6E+05	1.2E+06	1.9E+06	2.8E+06	3.3E+06	3.4E+06	3.3E+06	3.1E+06	2.6E+06	2.1E+06	1.5E+06	8.9E+05	5.7E+05	3.9E+05	2.8E+05	2.1E+05	1.6E+05	1.3E+05	1.0E+05	2.7E+04
1.8	8.4E-04	5.6E-03	1.2E-01	1.5E+00	1.2E+01	6.7E+01	2.8E+02	9.3E+02	2.5E+03	6.0E+03	1.2E+04	5.0E+05	1.6E+06	2.5E+06	3.2E+06	4.0E+06	4.3E+06	4.2E+06	3.9E+06	3.6E+06	2.9E+06	2.2E+06	1.6E+06	9.1E+05	5.8E+05	3.9E+05	2.8E+05	2.1E+05	1.6E+05	1.3E+05	1.1E+05	2.7E+04
1.7	2.8E-02	1.8E-01	3.6E+00	3.8E+01	2.5E+02	1.2E+03	4.1E+03	1.1E+04	2.6E+04	5.3E+04	9.5E+04	1.6E+06	3.6E+06	4.5E+06	5.0E+06	5.6E+06	5.5E+06	5.0E+06	4.5E+06	4.0E+06	3.2E+06	2.4E+06	1.6E+06	9.4E+05	5.9E+05	4.0E+05	2.8E+05	2.1E+05	1.6E+05	1.3E+05	1.1E+05	2.7E+04
1.6	9.7E-01	6.1E+00	1.1E+02	9.2E+02	4.9E+03	1.8E+04	5.1E+04	1.2E+05	2.2E+05	3.9E+05	6.0E+05	4.5E+06	7.2E+06	7.7E+06	7.6E+06	7.4E+06	6.7E+06	5.9E+06	5.1E+06	4.4E+06	3.4E+06	2.5E+06	1.7E+06	9.6E+05	6.0E+05	4.0E+05	2.8E+05	2.1E+05	1.6E+05	1.3E+05	1.1E+05	2.7E+04
1.5	3.5E+01	2.1E+02	3.0E+03	2.0E+04	8.3E+04	2.4E+05	5.3E+05	9.7E+05	1.6E+06	2.3E+06	3.1E+06	1.1E+07	1.3E+07	1.2E+07	1.1E+07	9.5E+06	8.0E+06	6.8E+06	5.7E+06	4.9E+06	3.7E+06	2.7E+06	1.8E+06	9.8E+05	6.0E+05	4.0E+05	2.9E+05	2.1E+05	1.6E+05	1.3E+05	1.1E+05	2.7E+04
1.4	1.4E+03	7.3E+03	8.0E+04	3.9E+05	1.2E+06	2.5E+06	4.2E+06	6.2E+06	8.4E+06	1.0E+07	1.2E+07	2.1E+07	2.1E+07	1.7E+07	1.4E+07	1.2E+07	9.3E+06	7.6E+06	6.2E+06	5.2E+06	3.9E+06	2.8E+06	1.9E+06	1.0E+06	6.1E+05	4.1E+05	2.9E+05	2.1E+05	1.7E+05	1.3E+05	1.1E+05	2.7E+04
1.3	5.7E+04	2.7E+05	1.9E+06	6.1E+06	1.2E+07	1.8E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.0E+07	1.8E+07	1.3E+07	1.0E+07	8.3E+06	6.7E+06	5.6E+06	4.1E+06	2.9E+06	1.9E+06	1.0E+06	6.2E+05	4.1E+05	2.9E+05	2.2E+05	1.7E+05	1.3E+05	1.1E+05	2.7E+04
1.2	2.8E+06	9.8E+06	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.0E+07	1.9E+07	1.5E+07	1.1E+07	8.8E+06	7.1E+06	5.8E+06	4.3E+06	3.0E+06	2.0E+06	1.0E+06	6.3E+05	4.1E+05	2.9E+05	2.2E+05	1.7E+05	1.3E+05	1.1E+05	2.7E+04
1.1	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.0E+07	1.9E+07	1.6E+07	1.2E+07	9.2E+06	7.3E+06	6.0E+06	4.4E+06	3.1E+06	2.0E+06	1.1E+06	6.3E+05	4.2E+05	2.9E+05	2.2E+05	1.7E+05	1.3E+05	1.1E+05	2.7E+04
1	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.0E+07	1.9E+07	1.6E+07	1.2E+07	9.3E+06	7.4E+06	6.1E+06	4.5E+06	3.2E+06	2.1E+06	1.1E+06	6.4E+05	4.2E+05	2.9E+05	2.2E+05	1.7E+05	1.3E+05	1.1E+05	2.7E+04
0.9	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.0E+07	1.9E+07	1.6E+07	1.2E+07	9.2E+06	7.4E+06	6.2E+06	4.6E+06	3.3E+06	2.1E+06	1.1E+06	6.4E+05	4.2E+05	3.0E+05	2.2E+05	1.7E+05	1.3E+05	1.1E+05	2.7E+04
0.8	2.8E+06	9.8E+06	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.0E+07	1.9E+07	1.5E+07	1.1E+07	9.0E+06	7.3E+06	6.2E+06	4.7E+06	3.4E+06	2.2E+06	1.1E+06	6.5E+05	4.2E+05	3.0E+05	2.2E+05	1.7E+05	1.3E+05	1.1E+05	2.7E+04
0.7	5.7E+04	2.7E+05	1.9E+06	6.1E+06	1.2E+07	1.8E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.0E+07	1.8E+07	1.4E+07	1.1E+07	8.5E+06	7.1E+06	6.1E+06	4.7E+06	3.4E+06	2.2E+06	1.1E+06	6.5E+05	4.3E+05	3.0E+05	2.2E+05	1.7E+05	1.3E+05	1.1E+05	2.7E+04
0.6	1.4E+03	7.3E+03	8.0E+04	3.9E+05	1.2E+06	2.5E+06	4.2E+06	6.2E+06	8.4E+06	1.0E+07	1.2E+07	2.1E+07	2.1E+07	1.7E+07	1.4E+07	1.2E+07	9.5E+06	8.0E+06	6.8E+06	6.0E+06	4.7E+06	3.5E+06	2.3E+06	1.1E+06	6.6E+05	4.3E+05	3.0E+05	2.2E+05	1.7E+05	1.3E+05	1.1E+05	2.7E+04
0.5	3.5E+01	2.1E+02	3.0E+03	2.0E+04	8.3E+04	2.4E+05	5.3E+05	9.7E+05	1.6E+06	2.3E+06	3.1E+06	1.1E+07	1.3E+07	1.2E+07	1.1E+07	9.6E+06	8.4E+06	7.3E+06	6.5E+06	5.8E+06	4.7E+06	3.5E+06	2.3E+06	1.1E+06	6.6E+05	4.3E+05	3.0E+05	2.2E+05	1.7E+05	1.3E+05	1.1E+05	2.7E+04
0.4	9.7E-01	6.1E+00	1.1E+02	9.2E+02	4.9E+03	1.8E+04	5.1E+04	1.2E+05	2.2E+05	3.9E+05	6.0E+05	4.5E+06	7.3E+06	7.7E+06	7.6E+06	7.7E+06	7.3E+06	6.7E+06	6.2E+06	5.7E+06	4.7E+06	3.6E+06	2.3E+06	1.1E+06	6.6E+05	4.3E+05	3.0E+05	2.2E+05	1.7E+05	1.3E+05	1.1E+05	2.7E+04
0.3	2.8E-02	1.8E-01	3.6E+00	3.8E+01	2.5E+02	1.2E+03	4.1E+03	1.1E+04	2.6E+04	5.3E+04	9.5E+04	1.6E+06	3.6E+06	4.6E+06	5.2E+06	6.0E+06	6.3E+06	6.2E+06	5.9E+06	5.5E+06	4.7E+06	3.6E+06	2.3E+06	1.1E+06	6.7E+05	4.3E+05	3.0E+05	2.2E+05	1.7E+05	1.3E+05	1.1E+05	2.7E+04
0.2	8.4E-04	5.6E-03	1.2E-01	1.5E+00	1.2E+01	6.7E+01	2.8E+02	9.3E+02	2.5E+03	6.0E+03	1.2E+04	5.0E+05	1.6E+06	2.6E+06	3.4E+06	4.8E+06	5.5E+06	5.7E+06	5.7E+06	5.4E+06	4.7E+06	3.6E+06	2.4E+06	1.2E+06	6.7E+05	4.3E+05	3.0E+05	2.2E+05	1.7E+05	1.3E+05	1.1E+05	2.7E+04
0.1	2.6E-05	1.8E-04	4.3E-03	5.9E-02	5.3E-01	3.5E+00	1.7E+01	6.7E+01	2.1E+02	5.9E+02	1.4E+03	1.4E+05	7.4E+05	1.5E+06	2.4E+06	4.0E+06	5.0E+06	5.5E+06	5.5E+06	5.3E+06	4.7E+06	3.6E+06	2.4E+06	1.2E+06	6.7E+05	4.3E+05	3.0E+05	2.2E+05	1.7E+05	1.3E+05	1.1E+05	2.7E+04
0	1.6E-06	1.1E-05	2.9E-04	4.4E-03	4.5E-02	3.4E-01	1.9E+00	8.6E+00	3.2E+01	1.0E+02	2.7E+02	6.4E+04	4.9E+05	1.2E+06	2.1E+06	3.7E+06	4.8E+06	5.4E+06	5.5E+06	5.3E+06	4.7E+06	3.6E+06	2.4E+06	1.2E+06	6.7E+05	4.3E+05	3.0E+05	2.2E+05	1.7E+05	1.3E+05	1.1E+05	2.7E+04

Outputs

- Fraction of material airborne
- Estimate of mean particle size
- Fractions of material in particle size ranges (assuming log normal distribution)
- Integrated air concentration
- Time weighted average air concentration
- No deposition (estimated using deposition velocity)
- No upwind spread



Preliminary findings

- Estimated/guessed inputs
- Test 1

  Material carries too far (95% within 500m)

  No gravitation settlement

  Small fraction
  air borne (16%)

	A	B	C	D
1	X	Y	Bq/m2	
2			measured	predicted
3	-15	5	292.49	1.3E-72
4	-15	10	618.28	5.1E-24
5	-15	15	1201.81	2.9E-10
6	-10	-2	18788.91	0.0E+00
7	-10	2	97906.06	4.9E-111
8	-10	5	1494.06	4.2E-39
9	-10	7	0	1.5E-21
10	-10	10	534.19	6.9E-10
11	-10	12	410.87	5.9E-06
12	-10	15	1878.89	1.6E-02
13	-10	20	7130.73	1.0E+01
14	-10	25	121264.89	2.0E+02
15	-10	30	119977.36	9.6E+02
16	-10	35	24787.78	2.3E+03
17	-10	40	8092.81	3.8E+03
18	-10	45	0	5.0E+03
19	-10	50	9054.9	6.0E+03
20	-9	2	18109.79	4.4E-97
21	-9	5	43.15	1.1E-32
22	-9	10	1216.75	2.2E-07
23	-9	15	2337.29	3.3E-01
24	-8	-2	701.75	0.0E+00
25	-8	2	5942.28	3.4E-83
26	-8	5	32.26	1.9E-26
27	-8	7	1019.57	2.3E-13
28	-8	10	727.51	5.1E-05
29	-8	12	297.83	2.6E-02