ADDAM and CSA-ERM Modelling Approach and Results for the Short-Range Scenario

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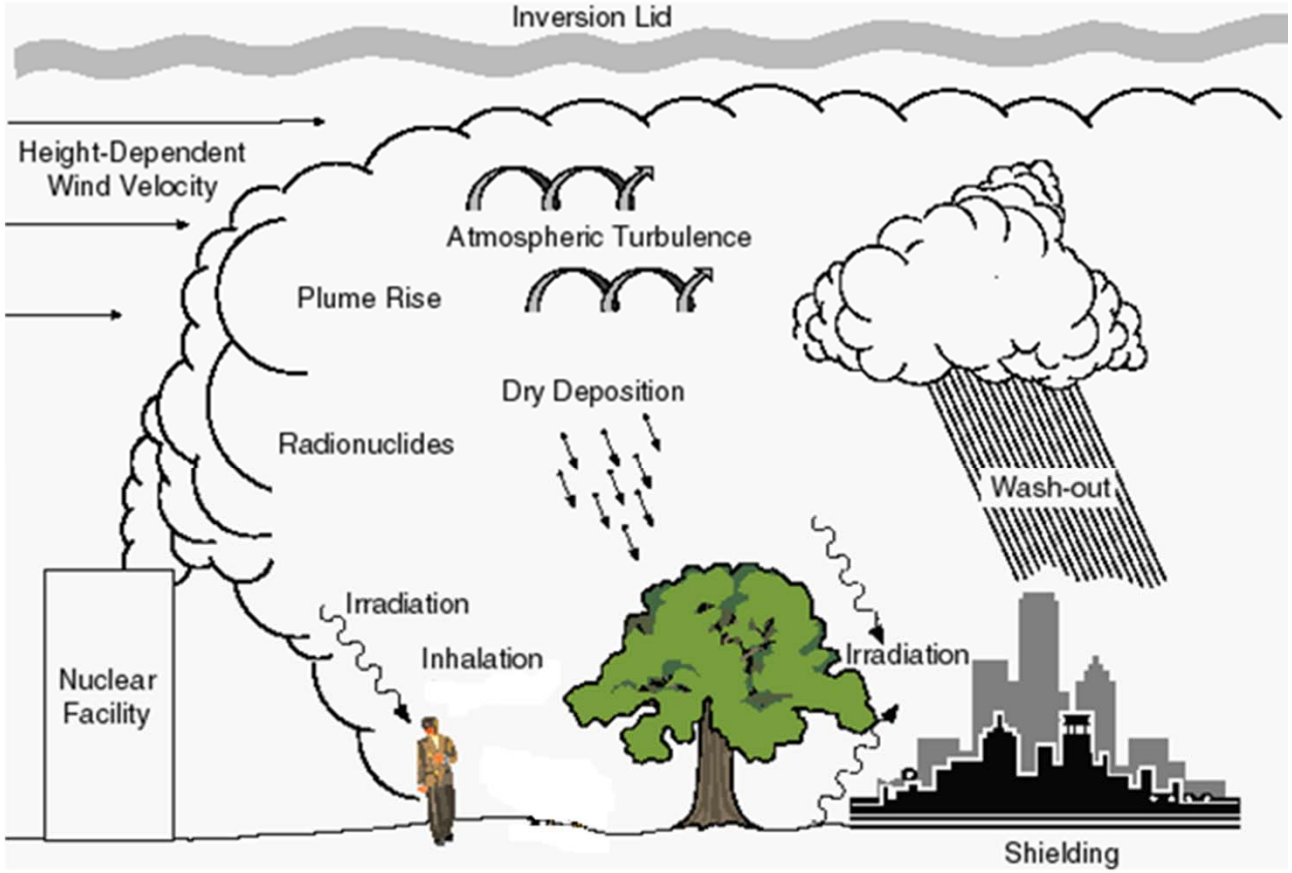
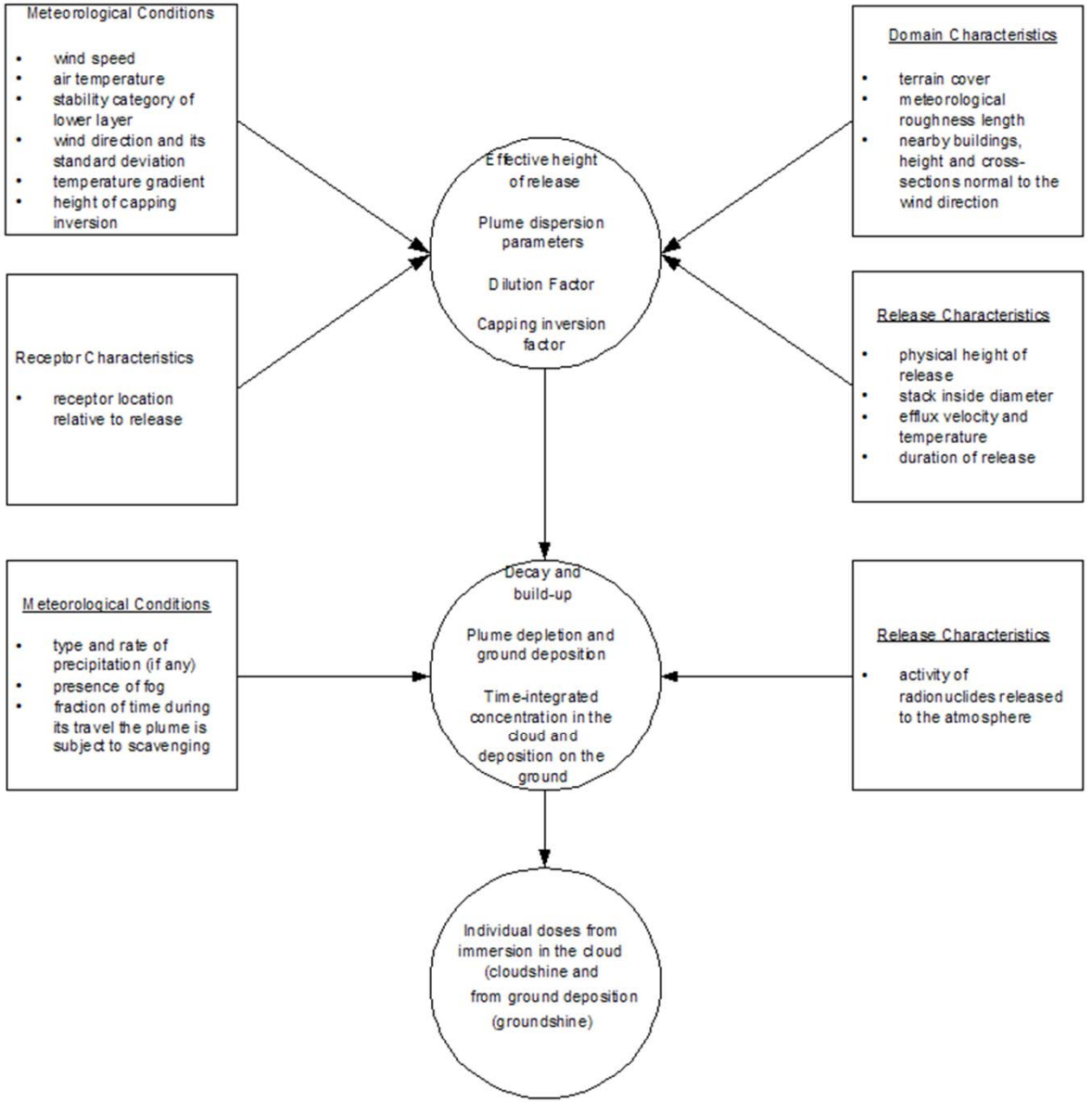
Processes Modelled in ADDAM

The features and capabilities of ADDAM and CSA-ERM codes were introduced to this Working Group (WG) in January 2010.

The illustrative picture below is from GENII, 2004.



Data requirements and calculations in ADDAM



Comparison of ADDAM & CSA-ERM codes

- Both codes based on CSA Standard N288.2 (1991)
- ADDAM documented; CSA-ERM not documented
- S. Chouhan is the developer and the user of both codes, so documentation is not an issue
- Both validated extensively
- ADDAM only predicts on the plume centerline for each met record, only at 15 downwind distance starting at 100 m; CSA-ERM predicts on a fine grid
- ADDAM tightly controlled, CSA-ERM easily modifiable research tool
- Thus results were produced by CSA-ERM, some verified with ADDAM

Application of the model to the short-range scenario

- CSA-ERM is not designed for modelling very short-term releases of explosive materials
- Participation in this scenario is to learn how its predictions will compare with other kinds of models and with the experimental data
- CSA-ERM has options for making either conservative or realistic predictions; realistic options and parameter values were used except for the deposition velocity, for which a semi-conservative approach was used (CSA-ERM can use a high value of deposition velocity for calculating deposition on the ground, and a low value for calculating plume depletion, in this case high values were used for both)
- Dry deposition velocity of 0.1 m/s used (highest estimated value for forest surface) after calibrating our model using data from Test # 1 and 2, which showed most of the contamination stayed within a 2 km range

Adapting the data in the scenario description to the model

- Tc-99m, halflife ~ 6 hours
- Activity released: 1.22e+9 Bq for Test 3
- Activity released: 8.95e+8 Bq for Test 4, after accounting for the 1 hour and 42 minute delay between when the activity was measured and the explosion took place

Assumptions made to match the model to the scenario

- Actual release was an instantaneous explosion, but 10 minutes release duration used in ADDAM
- Explosion time was noon (May 5 and Jul 14), Air temperature: Test3, 10.8 Degree; Test 4, 26.9 degree
- No rain
- Wind speed 2.7 m/s for Test 3 and 0.726 m/s for Test 4

Assumptions made to match the model to the scenario (continued)

- Stability class C for Test 3, using information provided with the scenario and also by looking at the 8 minutes (2009 May 5, 12:42-12:49) of the meteorological data

- Stability class A for Test 4, using information provided with the scenario and also by using the meteorological data from the 12th minute (when the wind speed became 0.9 m/s) to 59th minute (2009 July 14, 12:52-13:39)

Specific parameter values used for the scenario

- Effective release height 6.45 m to account for the plume top height of 12.9 m right after the explosion
- Right after the explosion, the plume cloud was 7 m wide and 7 m long. This spread was accounted for to some degree by applying the wake effect of a building 12.9 m high and 7 m wide to Σ_y and Σ_z
- Building constant C_b 0.5 at all distances for both Tests

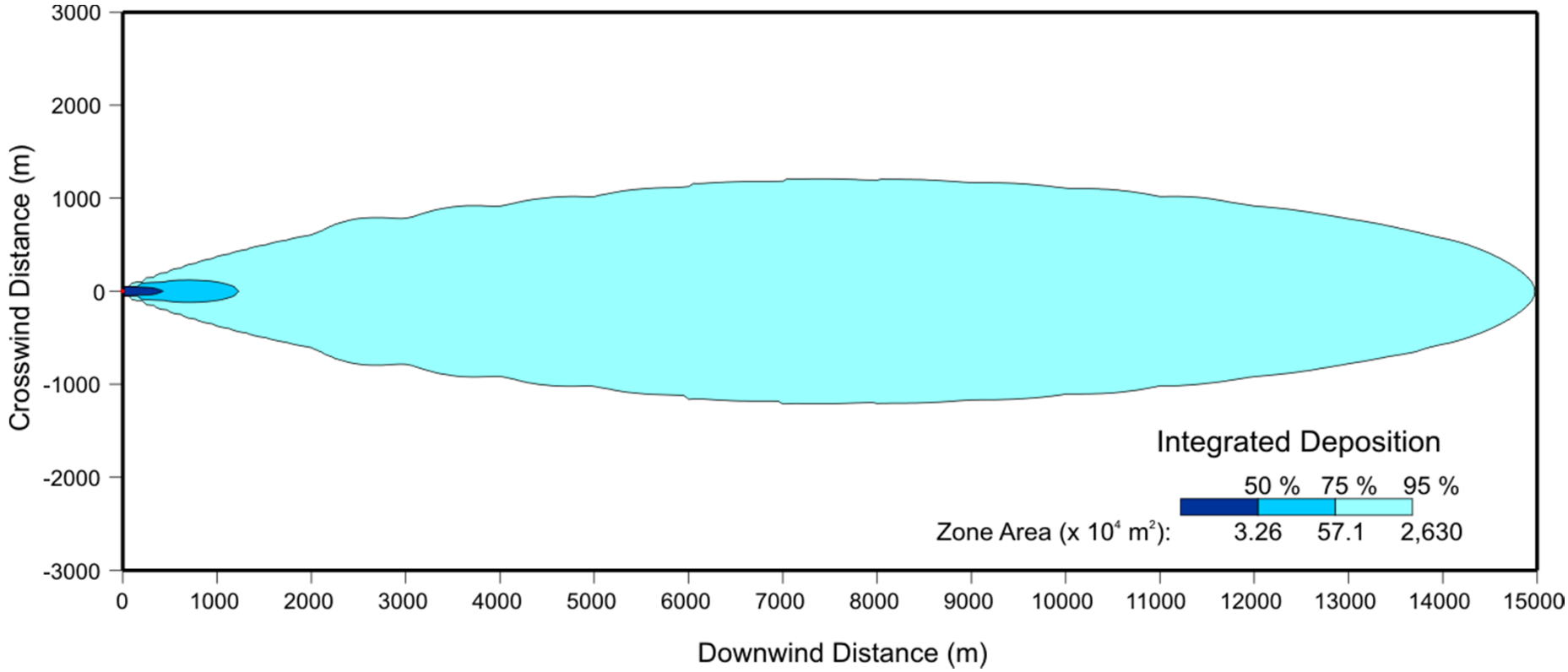
Specific parameter values used for the scenario (continued)

- Inversion layer height 5000 m
- σ_y calculated from σ_θ, and short-term dilution factor model used
- Terrain cover grass, and roughness length 0.4 m.
- Receptor height 0 m, and dose expected to be same at 1 m height because high energy gamma from Tc-99m.

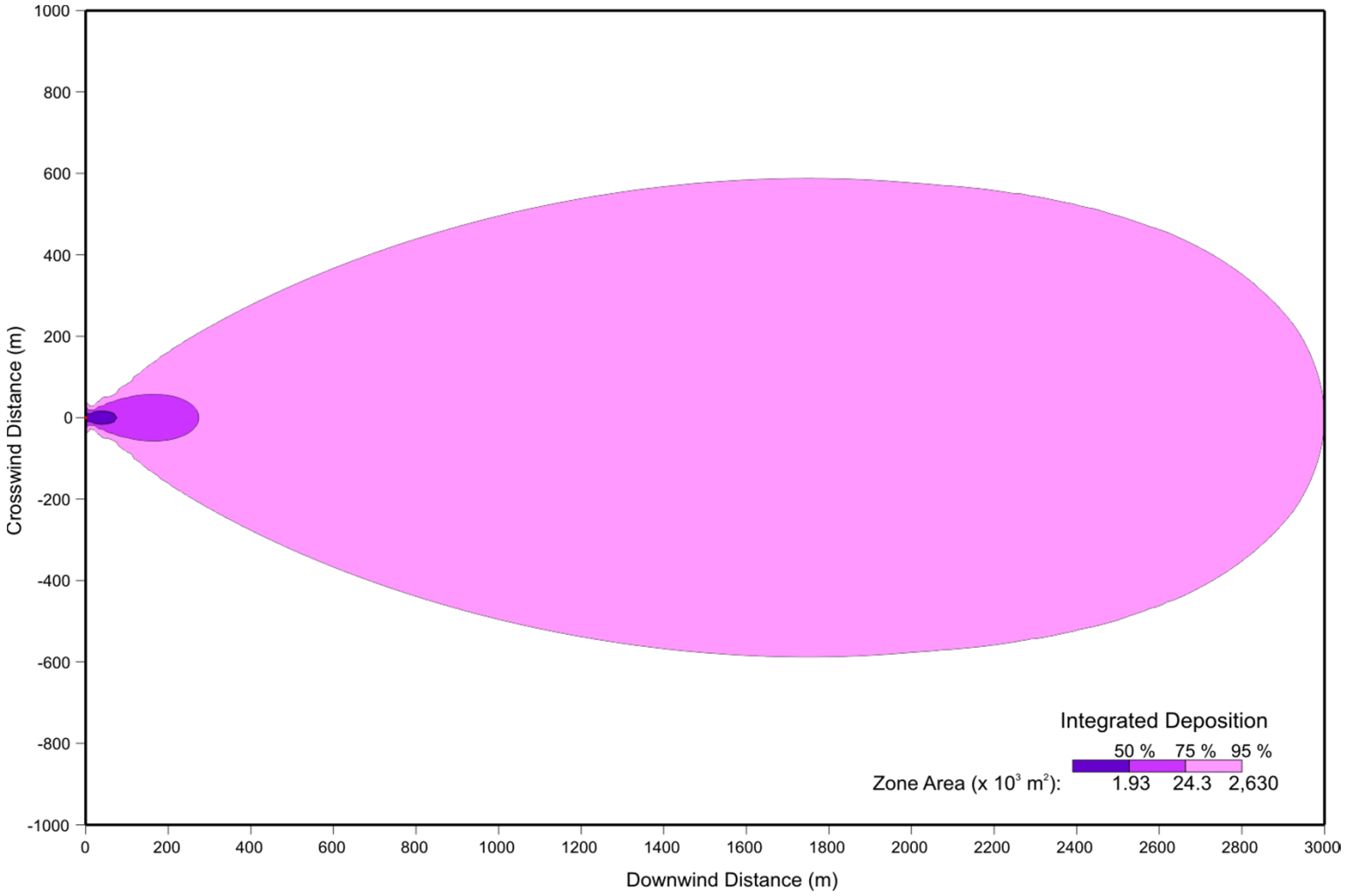
Specific parameter values used for the scenario (continued) and method used for producing results

- No finite cloud correction factor
- Immersion effective DCF for adult 5.3e-15 Sv/(Bq.s.m-3), and groundshine effective DCF for adult 1.1e-16 Sv/(Bq.s.m-2)
- Immersion dose calculated for the plume duration added to groundhshine dose for one hour to give the dose rates in Sv/hr.
- The contamination zones (integrated deposition percentiles of the total activity released: 50%, 75%, and 95%) were estimated by monitoring the cut-off value of multiplication of the depletion factor and the decay factor.

Results: Contamination zones (integrated deposition percentiles of the total activity released) for Test 3.



Results (continued): Contamination zones (integrated deposition percentiles of the total activity released) for Test 4



Results (continued)

- The CSA-ERM's predictions of air concentrations at the plume centerline do not change much with the height of the receptor (0 m to 5 m)

- More detailed results were provided to the WG leader for comparison

Acknowledgments to current ADDAM development and meteorological data collection team:

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