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A PERFORMANCE EVALUATION OF THE HPAC AND QUIC MODELS USING THE MUST TRIALS DATA

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INTRODUCTION

The Radiological Assessment Team at AWE uses a variety of dispersion models in support of its emergency response and planning work. It is desirable that the accuracy of these models is known. Previous performance evaluations of the models QUIC and HPAC have been conducted which have yielded mixed results (especially for QUIC), making it necessary to carry out further evaluation work. To this end a further evaluation of the models has been performed using data from the MUST (Mock Urban Setting Test) trials conducted in Utah in 2001 comparing it with the output from QUIC and HPAC.

MODELS

The QUIC (**Q**uick **U**rban and **I**ndustrial **C**omplex) dispersion modelling system developed by Los Alamos National Laboratory in the United States and the HPAC (**H**azard **P**rediction **A**ssessment **C**apability) dispersion modelling system produced by the Defense Threat Reduction Agency (DTRA) in the United States were used in this model evaluation study. QUIC comprises of several models including one for computing flow around buildings and another for calculating concentration and deposition fields around buildings. HPAC predicts the effects of hazardous radiological, biological and chemical material releases into the atmosphere and its effects on civilian and military populations. HPAC employs integrated source term models, high resolution weather data and particulate transport algorithms to model hazard areas and human collateral effects. HPAC includes the Second-order Closure Integrated PUFF (SCIPUFF) atmospheric transport model and HPAC employs the Urban Dispersion Model (UDM) to calculate the flow, concentration and deposition fields around buildings and in urban areas. Although DTRA produce HPAC, the UDM sub-model used in this study was developed by the Defense Science and Technical Laboratory (DSTL) in the UK.

MUST DATASET

The MUST (Mock Urban Setting Test) trials were conducted in the Great Basin desert of western Utah on 6-27 September 2001. Sixty eight trials in total were completed involving (mainly) continuous releases of propylene tracer gas into a 12 by 10 array of conex shipping containers. The tracer concentrations were measured at seventy two locations within the array by digiPID and UVIC detectors. Meteorological data was measured at several locations within and around the test site. Figure 1 shows the MUST trials setup showing the positioning of the conex shipping containers, release locations and detector and met towers positions**.** Out of the sixty-eight MUST trials fourteen were chosen for modelling in HPAC and QUIC, based on a combination of 'highest quality' data, time of day, release height and release position.

RESULTS AND CONCLUSIONS

To determine how well HPAC and QUIC performed against the MUST trials, factors of 2 and 10 for the HPAC/MUST or QUIC/MUST ratio were chosen as benchmarks. Table 1 shows the percentage of ratio values that match these target figures. Only non-zero concentration values were used in the calculation of the percentages. The average percentage over all fourteen HPAC and QUIC runs are given at the bottom of Table 1.

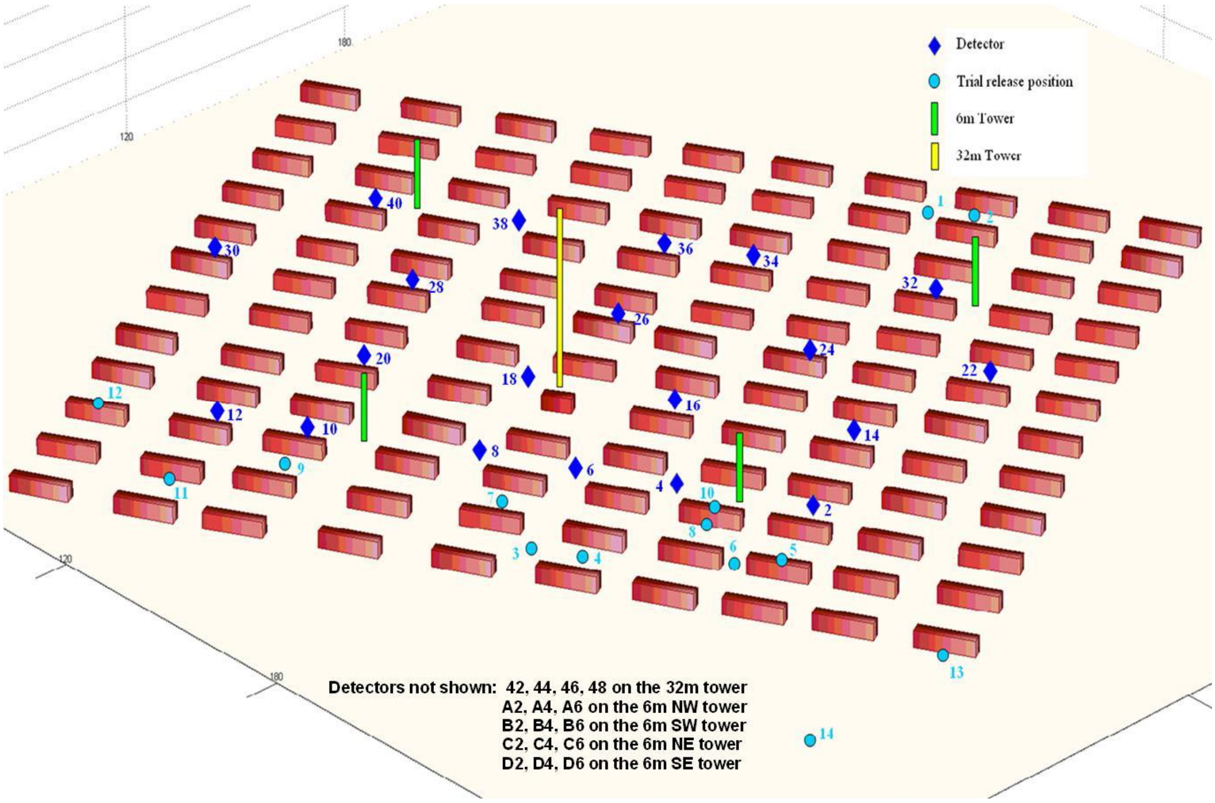

Figure 1. MUST Trials Setup Showing the Release Locations and Detector and Met Tower Positions

Table 1. The percentage of ratio values that match the factors of 2 and 10 for HPAC and QUIC.

HPAC& QUIC Run	MUST Trial	QUIC/ MUST Ratio ≥ 0.5 and ≤ 2.0 (%)	HPAC/ MUST Ratio ≥ 0.5 and ≤ 2.0 (%)	QUIC/ MUST Ratio ≥ 0.1 and ≤ 10 (%)	HPAC/ MUST Ratio ≥ 0.1 and ≤ 10 (%)
1	2562210	30	14	88	95
2	2562325	30	28	93	95
3	2610543	27	7	77	53
4	2610758	50	19	92	80
5	2620307	30	16	61	48
6	2620356	15	25	50	75
7	2640138	28	10	71	63
8	2640701	25	8	56	65
9	2672033	66	7	94	67
10	2672235	10	14	57	77
11	2682150	30	24	70	92
12	2682320	31	17	95	73
13	2692131	23	29	90	100
14	2692250	39	19	82	100
		Average 30%	Average 17%	Average 76%	Average 77%

Mean concentration values predicted by the models were compared against the experimentally observed values. For QUIC it was found that between 50% and 95% (average 76%) of values met the chosen benchmark of a factor of ten difference whereas for HPAC it was found that between 48% and 100% (average 77%) of values met this chosen benchmark value. For the more stringent target of a factor of two difference, percentages of between 10% and 66% (average 30%) were achieved by QUIC and percentages of between 7% and 29% (average 17%) were achieved by HPAC. In summary, HPAC and QUIC performed similarly for the factor of ten difference between model and experimental values but QUIC performed better than HPAC for the more stringent target of a factor of two difference.

In the previous evaluation study of HPAC and QUIC against the DAPPLE dataset HPAC performed better than QUIC but only the factor of ten difference between model and experimental values was calculated in this study. One explanation on these conflicting model performances for the two different datasets might be that QUIC performs better with a more uniform array of objects as in the MUST experimental set up of uniform shipping containers and HPAC performs better for a more irregular array of objects as in the case of the DAPPLE dataset which took place in London.

REFERENCES

Biltoft, C.A., 2001: Customer Report For Mock Urban Setting Test, DPG Document No. WDTC-FR-01-121.

Kosteniuk Consulting Ltd, 2002: MUST Trial Data and Results, Release 1.0. Made available by DSTL Porton Down.

Suden, P., 2012: Performance Evaluation of the QUIC (v5.8) Model using DAPPLE Experimental Data, AWE/SAG/124/B/1174.

Tull, B. and P. Suden, 2013: Performance Evaluation of the QUIC (v5.8) and HPAC (v5.0 SP1) Models using the DAPPLE Experimental Data, AWE/SAG/1305/B/2963.

Tull, B. and P. Suden, 2013: Further Performance Evaluation of the QUIC (v5.92) and HPAC (v5.0 SP1) Models using the DAPPLE Experimental Data, AWE/SAG/1310/B/3959.

Suden, P., 2014: A Performance Evaluation of the QUIC (v5.8) and HPAC (v5.0 SP1) Models using MUST Trials Data, AWE/NNSP/14/B/3342.

Suden, P. and P. Brent, 2014: A Performance Evaluation of the QUIC (v6.01) Using Obstacle Array Field Trials Data', AWE/NNSP/14/2948.

Suden, P., 2015: A Performance Evaluation of the HPAC & QUIC Models Using MUST Trials Data', AWE/NNSP/15/B/2357.

QUIC model and reports downloaded from http://www.lanl.gov/projects/quic/.

QUIC poster http://www.lanl.gov/projects/quic/.