



Comparison DRIFT Version 3 Predictions with DRIFT Version 2 and Experimental Data

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1.0 Introduction

In this report we present some comparisons between DRIFT Version 3 and DRIFT Version 2 predictions and selected field trial results. The aim here is not to undertake a comprehensive validation study of DRIFT against all available datasets, rather to compare how DRIFT Version 3.6.1 predictions compare with those of DRIFT Version 2.31 measured against the same datasets. Comparison is useful from the point of view of

- Verification testing – checking whether the models broadly agree where expected
- Highlighting areas where DRIFT Version 3 produces significantly different predictions from DRIFT Version 2.

Validation of DRIFT Version 3's URAHFREP modelling aspects such as buoyant lift-off and rise are not considered here.

The comparisons reported are for field trials selected from the following gas dispersion datasets:

- Thorney Island: Freon 12/Nitrogen mixture
- Burro: Liquefied Natural Gas (LNG) spill and dispersion
- Desert Tortoise: Two-phase ammonia dispersion
- Goldfish: Two-phase hydrogen fluoride dispersion
- Prairie Grass: Passive tracer dispersion

These datasets cover releases involving dense and passive gas dispersion behaviour in a range of atmospheric conditions. Most of the conditions for the trials have been obtained from the Modeller's Data Archive (MDA) [1], or from DRIFT validation reports [2], [3] and [4].

2.0 Results

2.1 Thorney Island – Freon 12

Comparisons have been made with two continuous release trials in the absence of obstacles. These are low momentum releases of a mixture of Freon 12 and nitrogen with an initial density of approximately twice that of air [5], [6]. DRIFT was originally tuned against Trial 45. Trials 45 and 47 are both in a low wind speed. A neutral stability has been assumed following [3]. Results of the comparisons are given in Figure 2-1 and Figure 2-2.

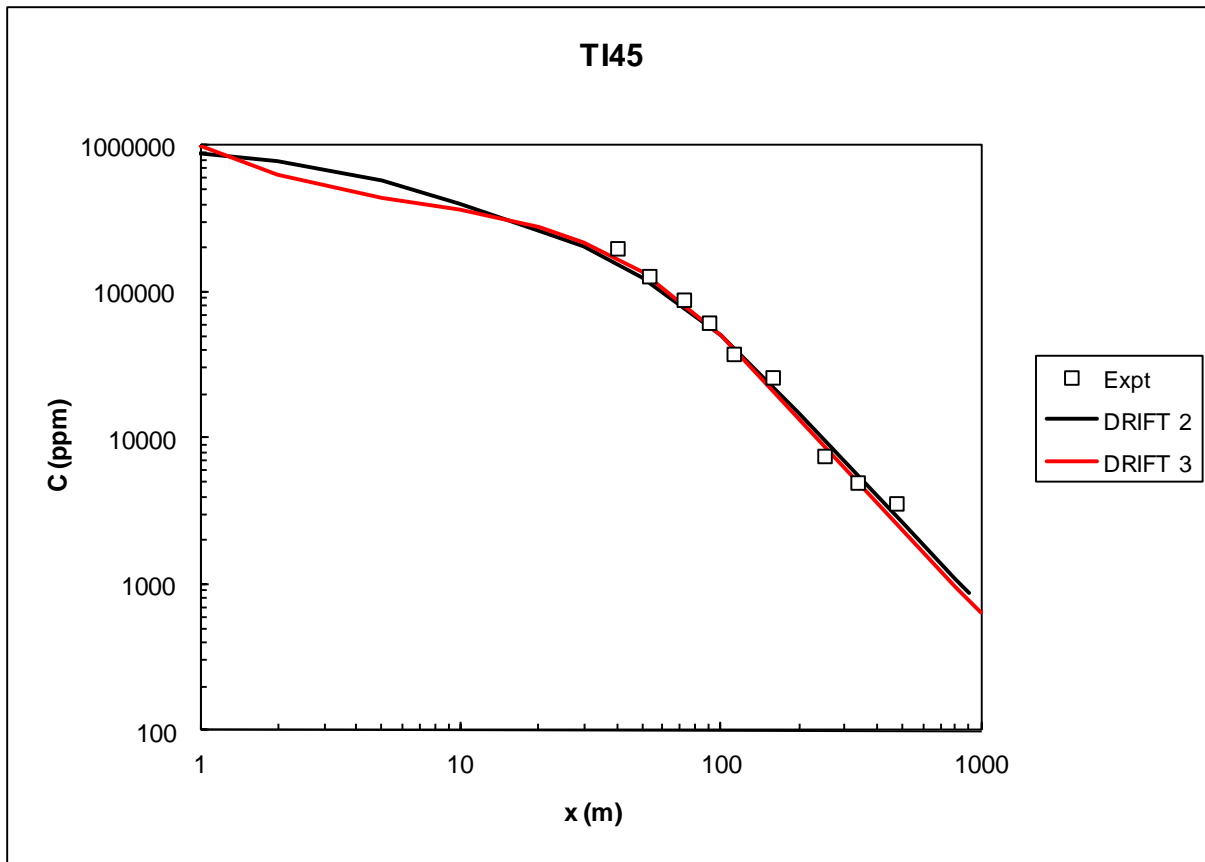


Figure 2-1 Centreline concentration predictions for Thorney Island Trial 45. Note DRIFT was originally tuned against this data.

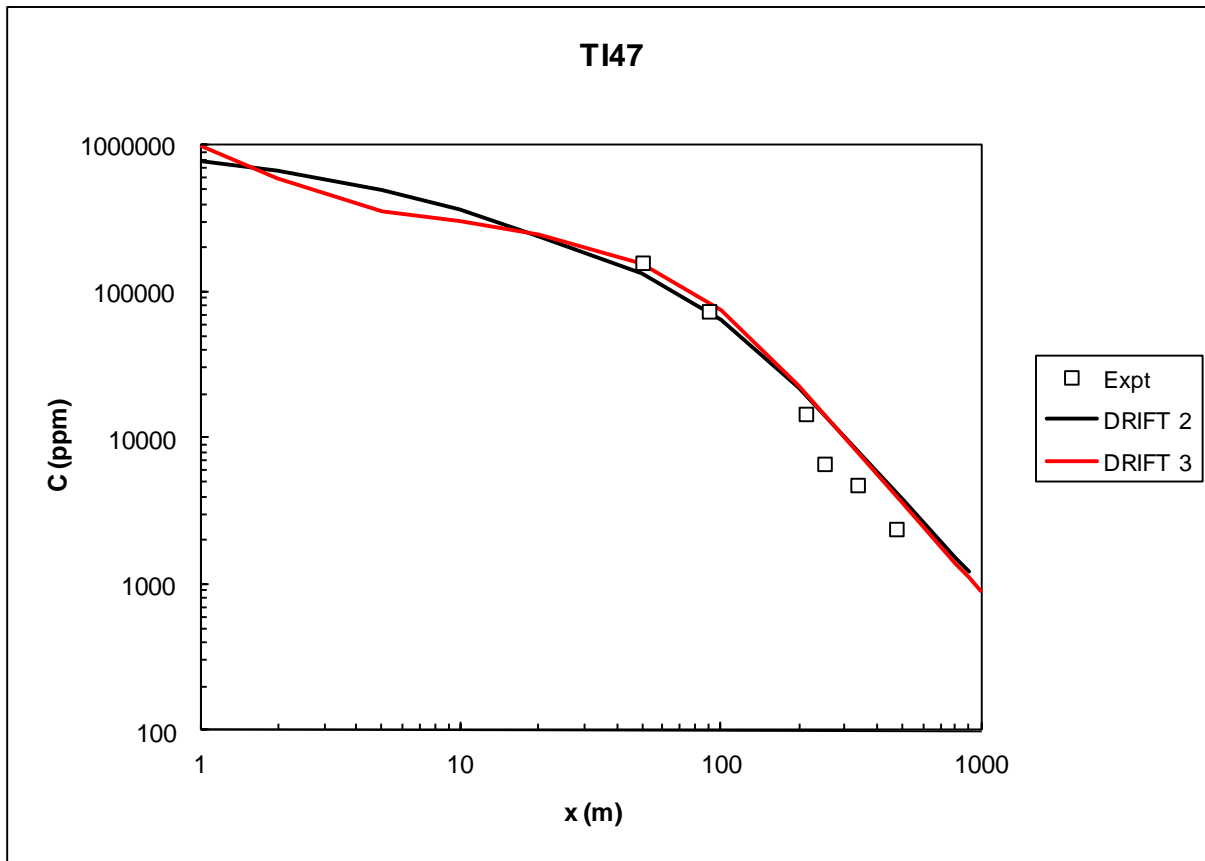


Figure 2-2 Centreline concentration predictions for Thorney Island Trial 47.

2.2 Burro Series – LNG

The Burro series of trials involved continuous release of LNG onto the surface of a 1m deep pool of water. Data for eight trials are available [7], [8]. The same release conditions as in [3] have been used for the model runs. All the trials were in slightly unstable or neutral conditions, apart from BU8 which was in stable conditions.

The DRIFT Version 3 runs have been undertaken using the finite duration model with a “low momentum source” including dilution over the source. The DRIFT Version 2 runs neglect dilution over the source and are for steady continuous conditions. The results for all 8 trials are given in Figure 2-3 to Figure 2-11 below and show the peak concentrations achieved over the duration of the dispersion. Two sets of experimental data are shown on each graph, each set using a different averaging time. Four curves are shown for DRIFT Version 3, which takes account of two different averaging times (t_{av}) and two different receptor heights ($h=0m$ and $h=1m$). We show curves for the two different receptor heights in order to demonstrate the sensitivity of the results to a change in height, especially for low height clouds.

Trial 8 (Figure 2-9) was in stable low wind conditions. Compared with the measured values at distances of 400m and 800m DRIFT overpredicts concentrations at 1m height for this trial. Closer to the source the DRIFT predictions at 1m height are relatively flat giving underprediction near the source. As expected for low clouds, the concentrations are very sensitive to the assumed receiver height – in this case ground level concentrations give a better match in the region near the source and at 2m height a better match further away. Overall, the predictions for this trial are within a factor of three of the experimental data.

Some of the DRIFT Version 3 curves (e.g. BU9) display a change of gradient near to the edge of the source. This is because DRIFT adopts a concentration profile over the entire source (typically ~40m wide for the Burro trials) which differs from that used for the subsequent downwind evolution.

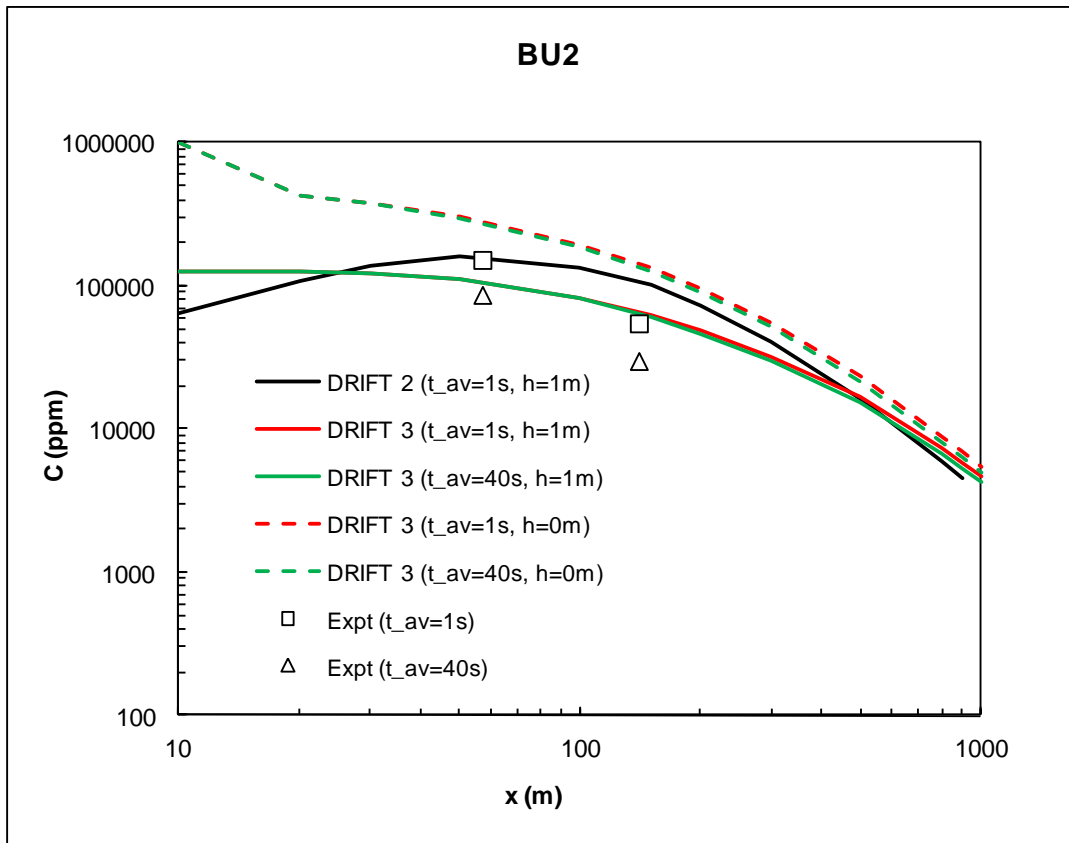


Figure 2-3 Centreline concentration predictions for Burro Trial BU2

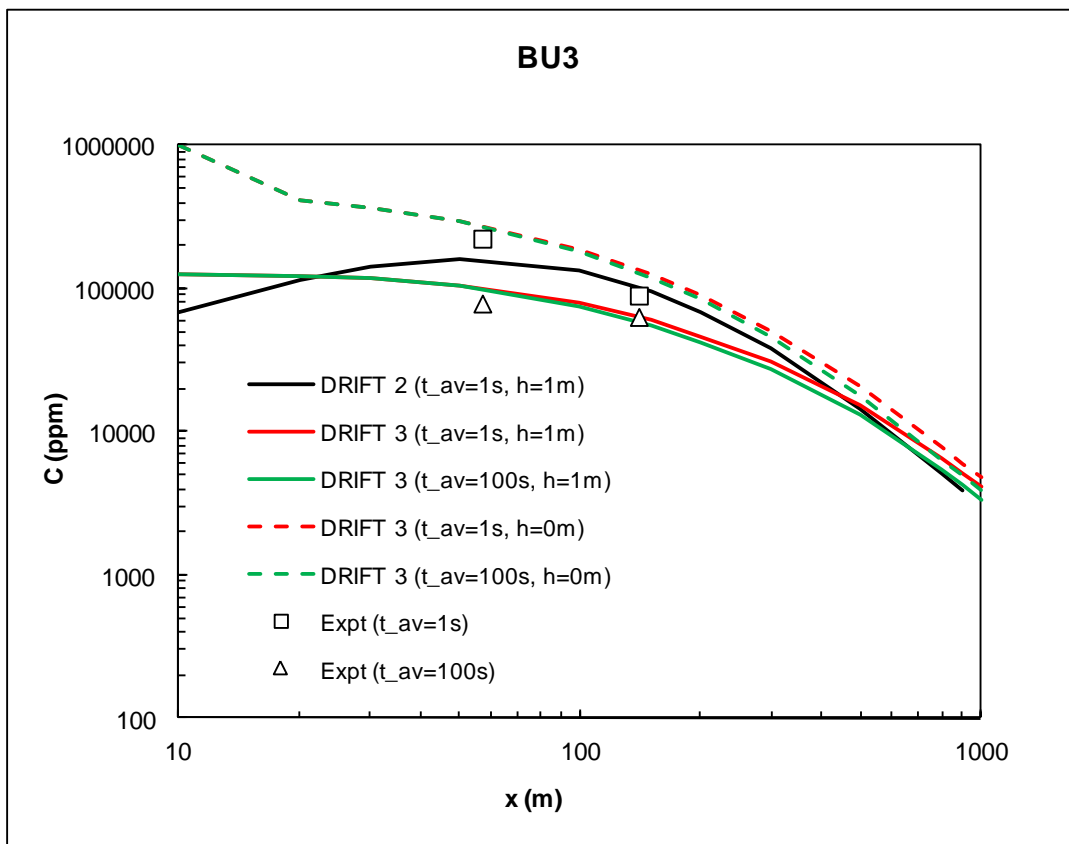


Figure 2-4 Centreline concentration predictions for Burro Trial BU3

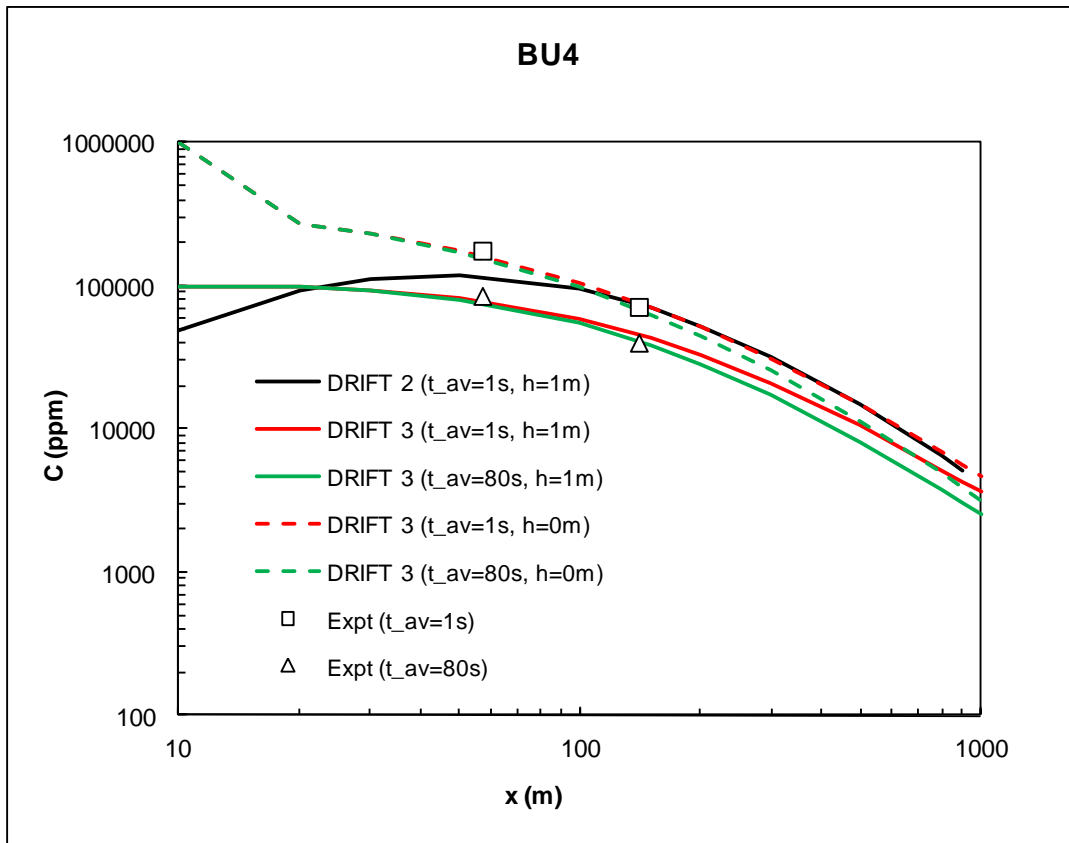


Figure 2-5 Centreline concentration predictions for Burro Trial BU4

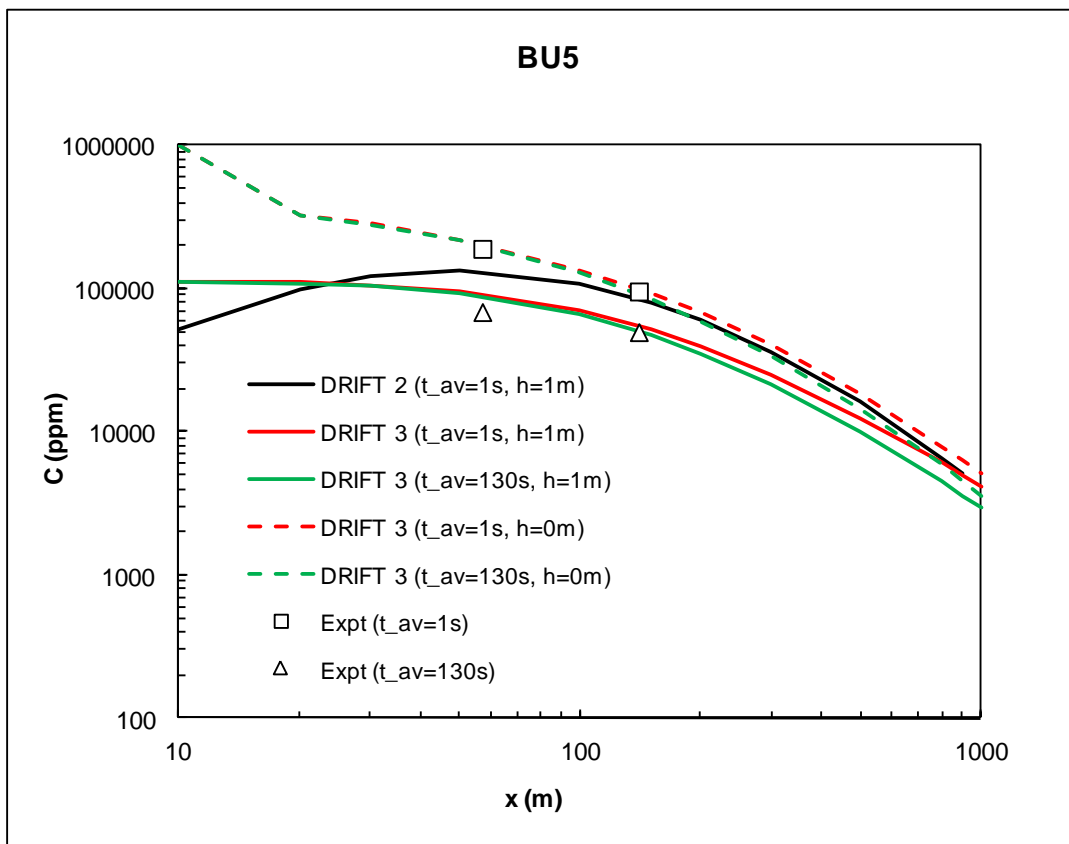


Figure 2-6 Centreline concentration predictions for Burro Trial BU5

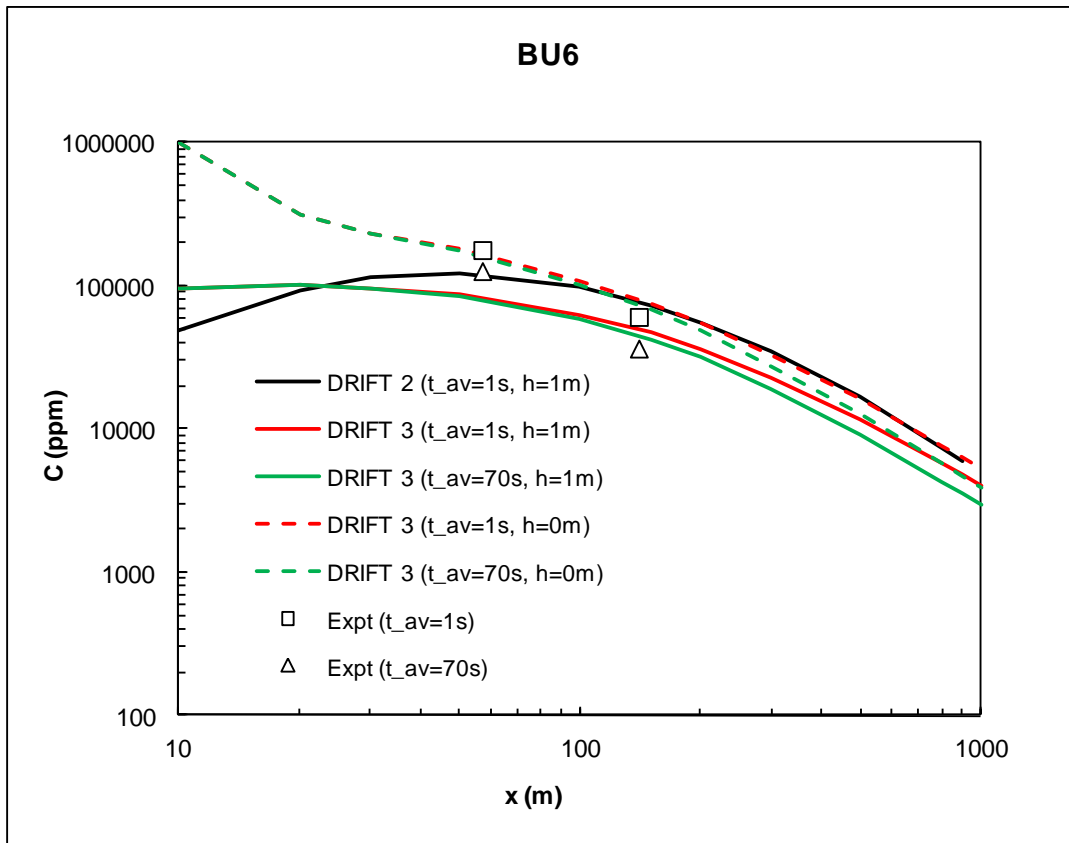


Figure 2-7 Centreline concentration predictions for Burro Trial BU6

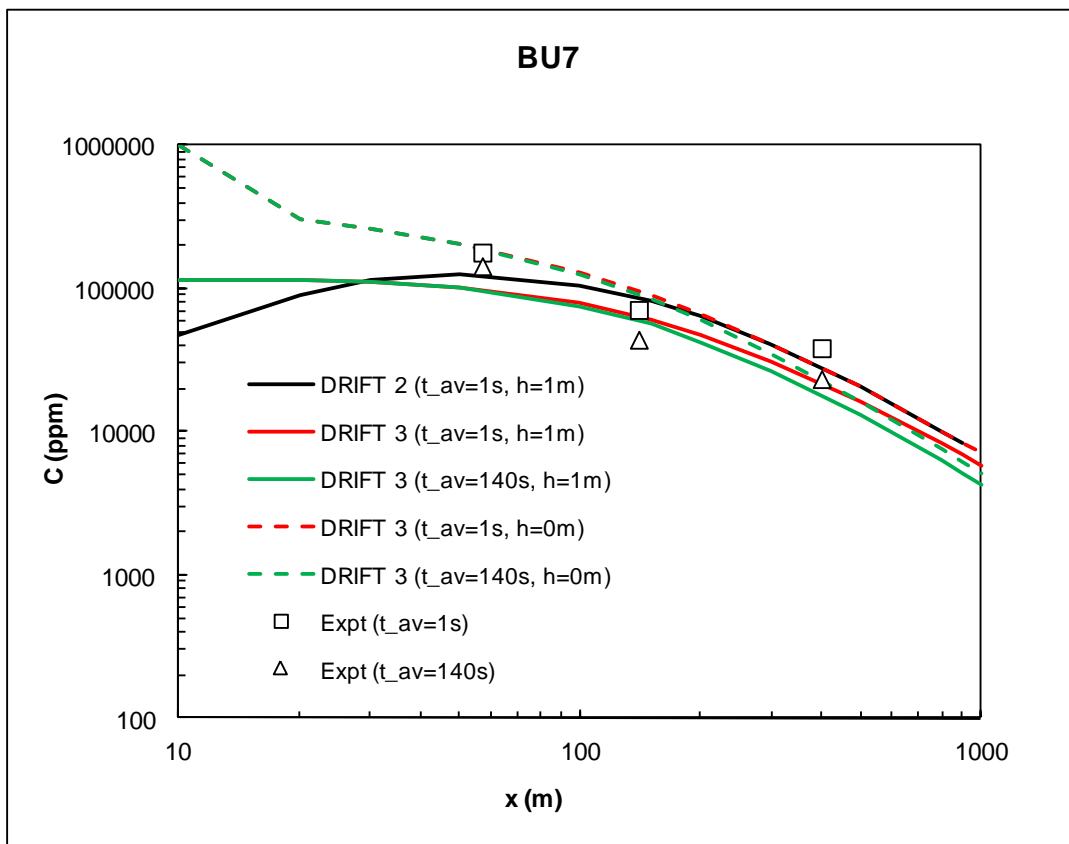


Figure 2-8 Centreline concentration predictions for Burro Trial BU7

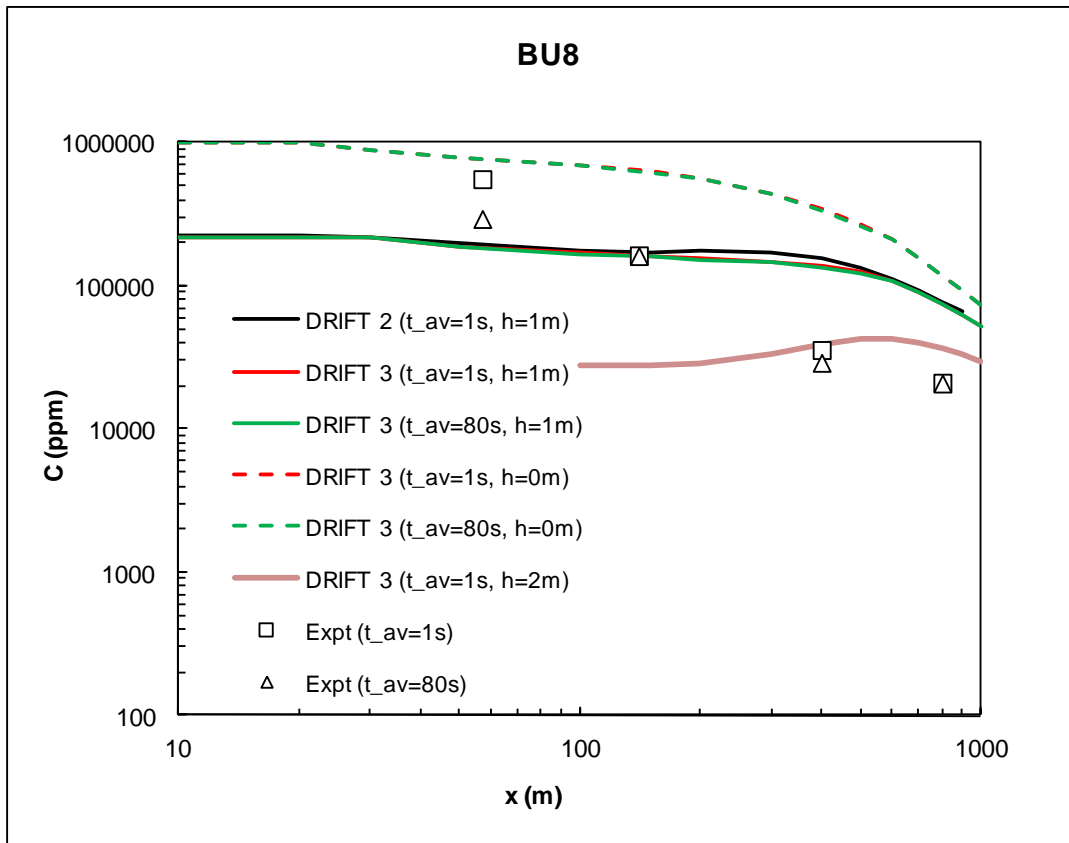


Figure 2-9 Centreline concentration predictions for Burro Trial BU8

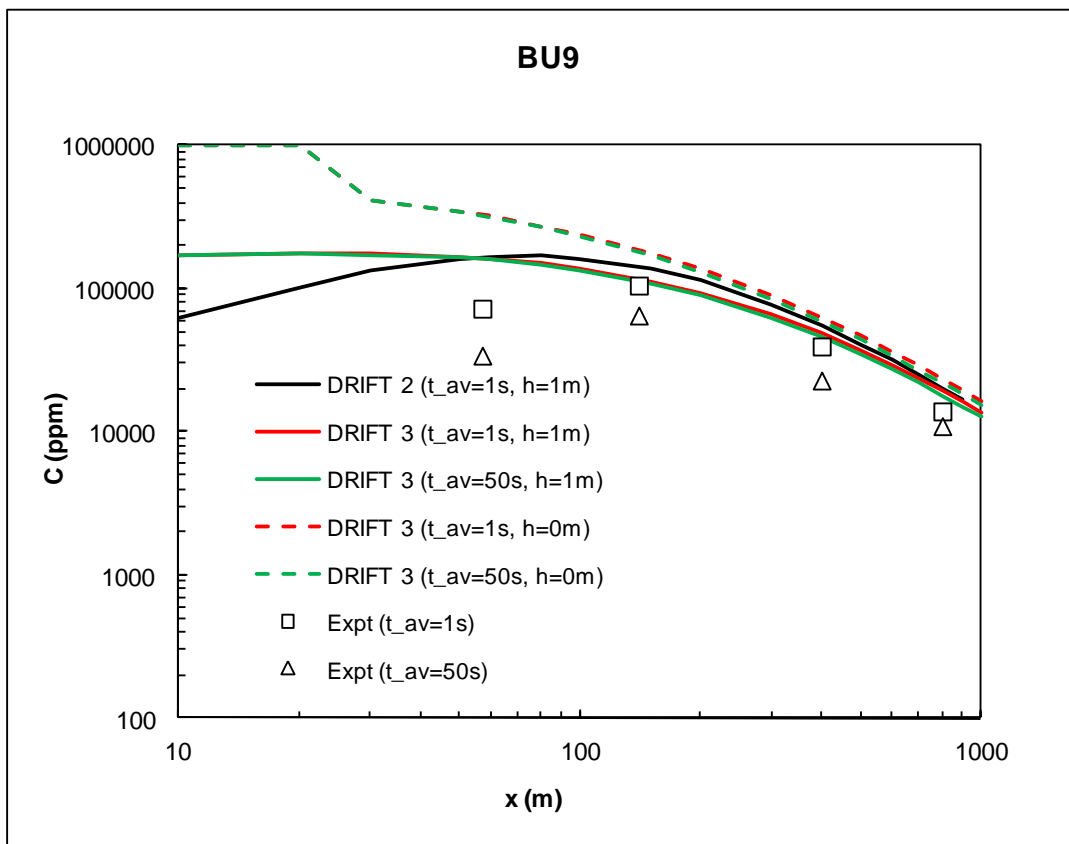


Figure 2-10 Centreline concentration predictions for Burro Trial BU9

2.3 Desert Tortoise – Ammonia

The Desert Tortoise series of experiments were carried out by Lawrence Livermore National Laboratory at their Nevada desert facility. There were trials involving release of pressure liquefied (anhydrous) ammonia from a horizontal pipe approximately 1m above the ground. The DRIFT Version 2 runs for these trials use the same input files as for the runs given in [3] – these DRIFT runs are based on a source term determined using the TRAUMA two-phase jet model. The DRIFT Version 3 runs use DRIFT’s new integrated jet dispersion model. Figure 2-11 to Figure 2-15 show comparison of these runs. Two sets of experimental data are shown on each graph, each set using a different averaging time. DRIFT Versions 2 and 3 give similar results over the 100m-1000m range and sometimes further. DT1 appears to show a different asymptotic decay between the two models for distances greater than 1000m – the reason for this is due to the finite duration effects that are modelled by DRIFT Version 3, which are not present in DRIFT Version 2 results. When the release duration is increased in DRIFT Version 3 there is much closer agreement with the predictions of Version 2 in the far field – however, given the duration of the DT1 release use of the finite duration model is warranted at distances in excess of 1000m.

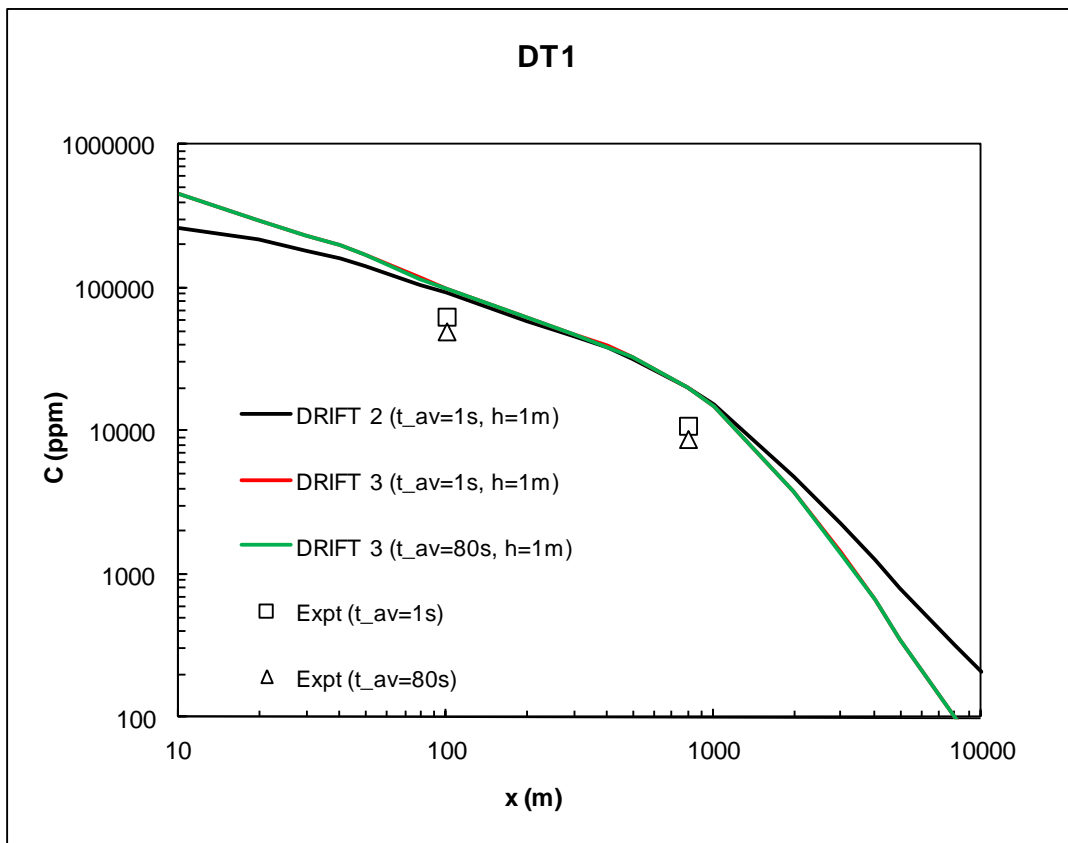


Figure 2-11 Centreline concentration predictions for Desert Tortoise Trial DT1

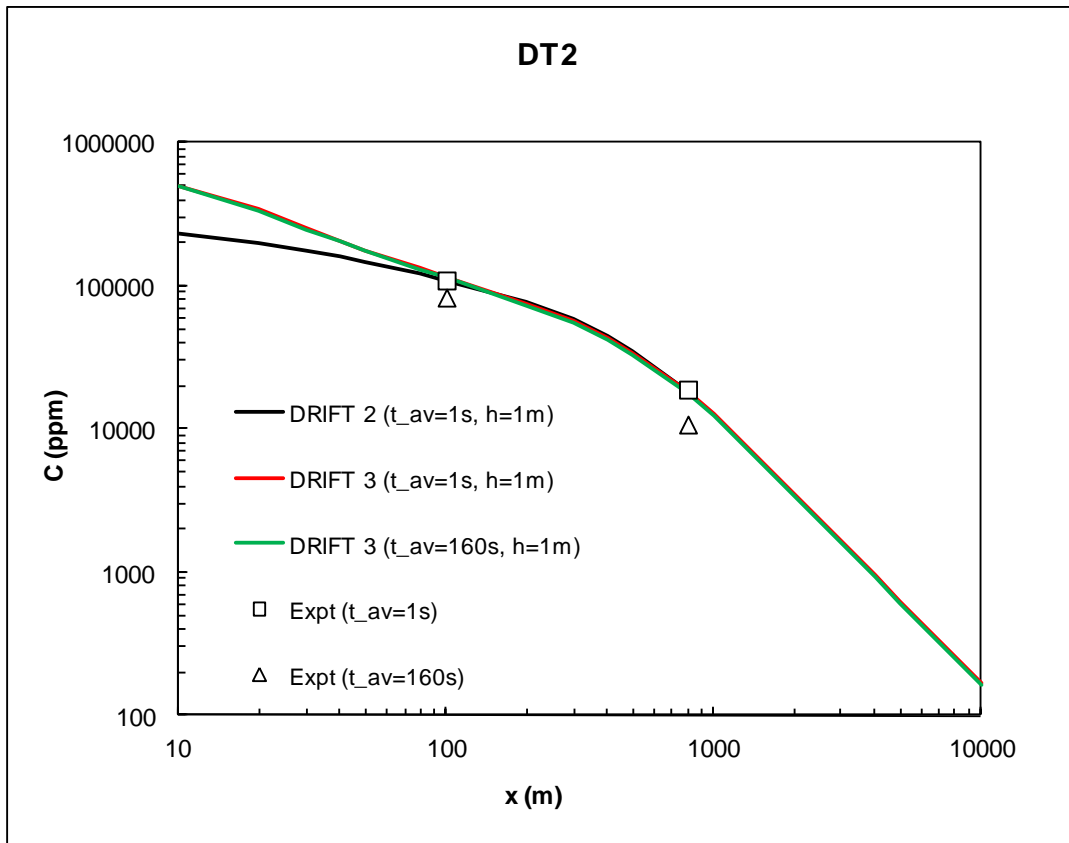


Figure 2-12 Centreline concentration predictions for Desert Tortoise Trial DT2

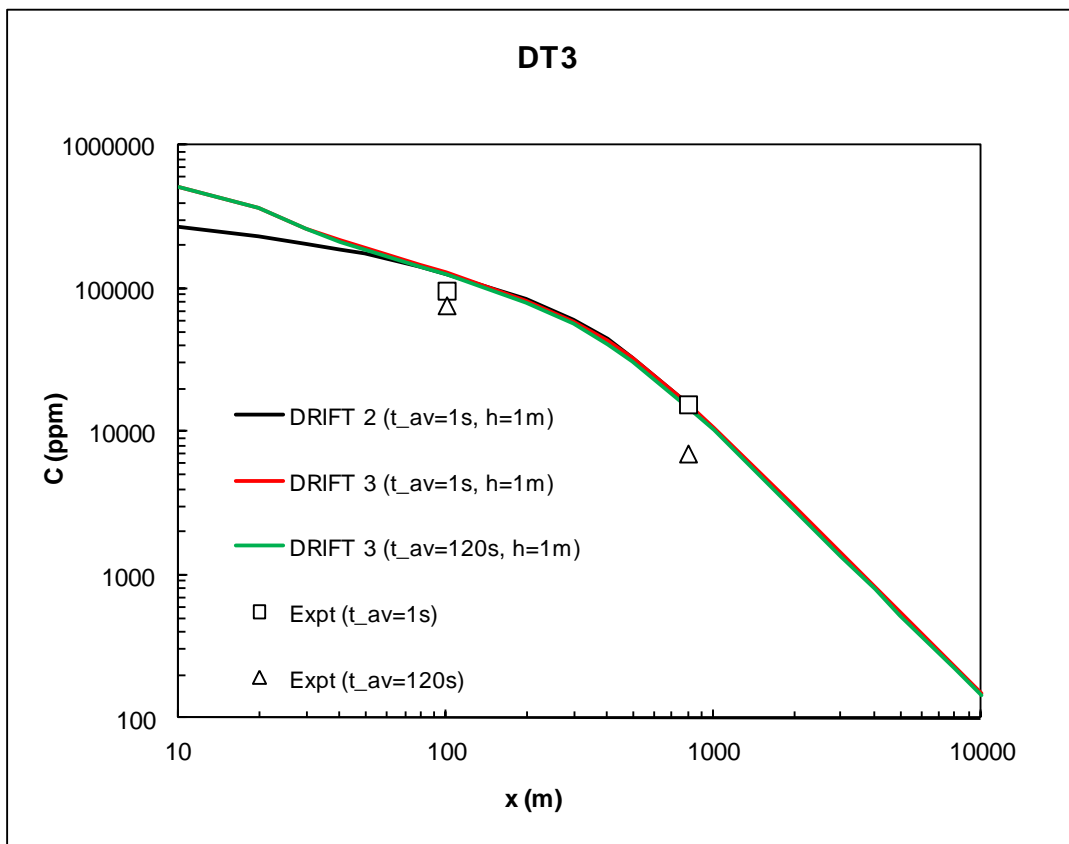


Figure 2-13 Centreline concentration predictions for Desert Tortoise Trial DT3

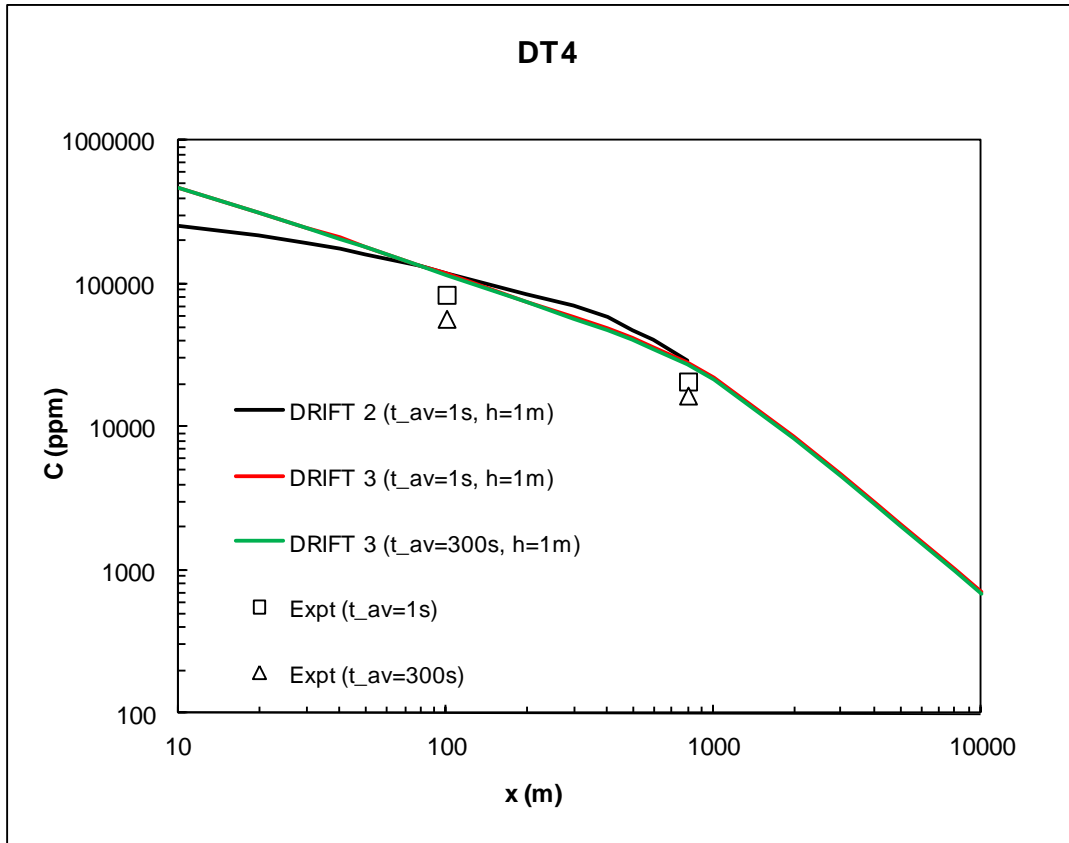


Figure 2-14 Centreline concentration predictions for Desert Tortoise Trial DT4

2.4 GOLDFISH – Hydrogen Fluoride

The Goldfish series [9] involved a series of 6 trials involving the release of superheated (anhydrous) hydrogen fluoride were performed at the Frenchman Flat spill test facility in Nevada. The release conditions for the modelling have been taken to match those given in [3]. As in [3], the DRIFT Version 2 runs are without using a jet dispersion model and assume steady state dispersion. The DRIFT Version 3 runs use the new inbuilt jet dispersion model together with the finite duration dispersion model. Generally the results are very similar between the two versions of DRIFT.

The DRIFT Version 3 runs are with the finite duration option, which is not included in DRIFT Version 2. This leads to the DRIFT Version 3 predictions being slightly smaller than the DRIFT Version 2 predictions at 10,000m due to the effect of the finite duration of the release – the difference is greatest for GF1 is the shortest release duration release (125s compared with 360s for the other trials).

The sharp change in the gradient of DRIFT Version 3's concentration curves at approximately 20m distance is due to the release height and the receiver height being the same, so that near to the source the receiver is directly in the centre of the jet. As the jet moves downstream its centreline will move away from the receiver height and the concentration will drop sharply before levelling out again once the vertical length scale increases sufficiently that the centreline height becomes unimportant. This effect is not present in the DRIFT 2 data which exclude the TRAUMA jet results.

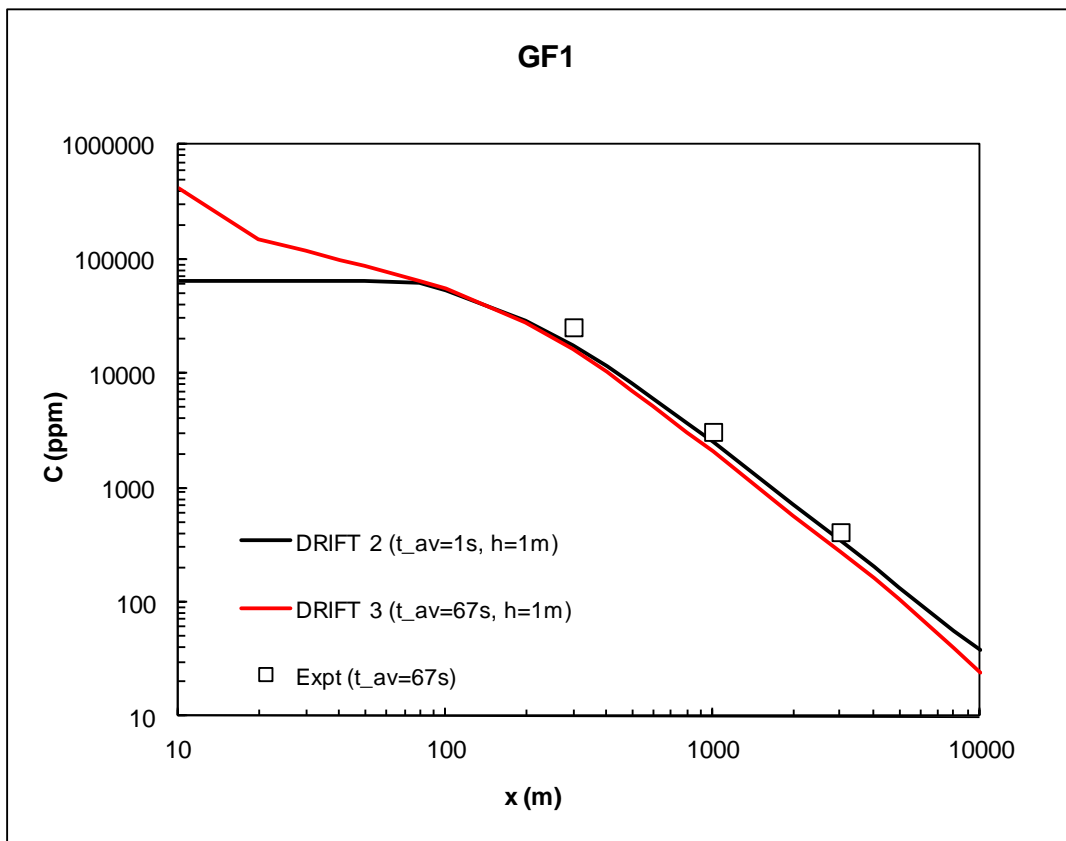


Figure 2-15 Centreline concentration predictions for Goldfish Trial GF1

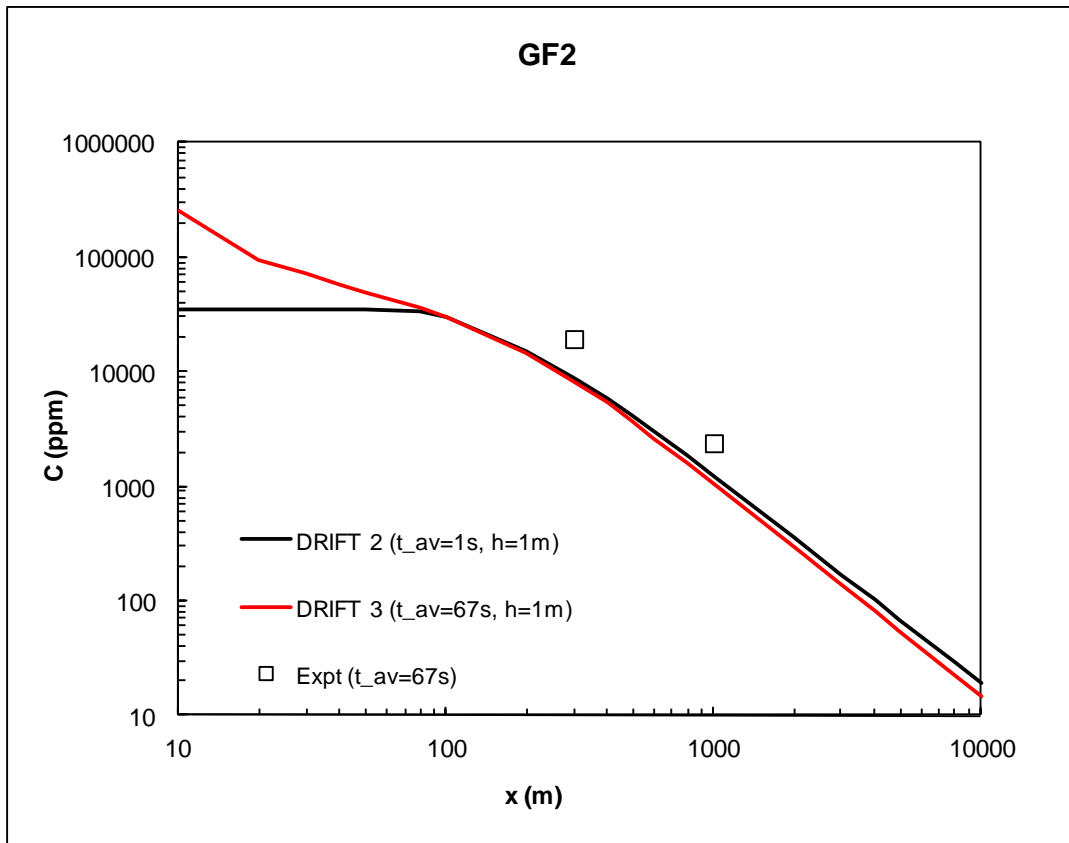


Figure 2-16 Centreline concentration predictions for Goldfish Trial GF2

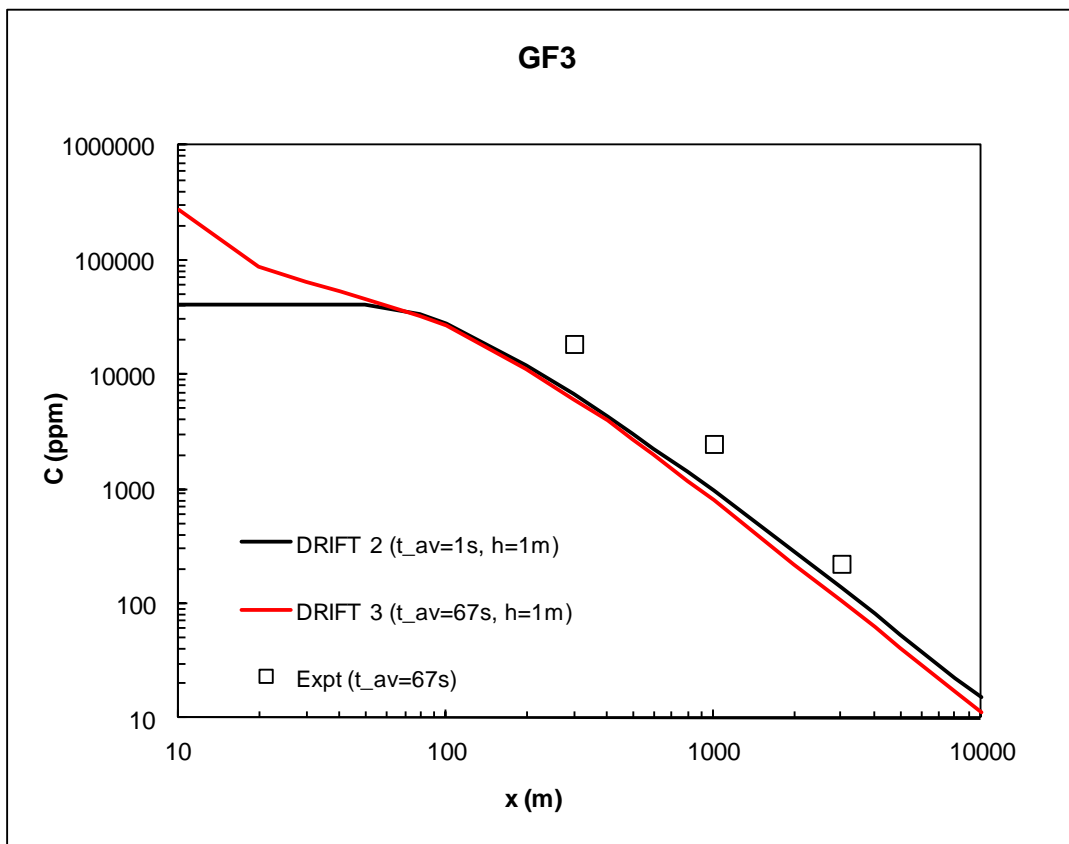


Figure 2-17 Centreline concentration predictions for Goldfish Trial GF3

2.5 Prairie Grass – Passive Tracer

The Prairie Grass experiments were conducted using a point source of SO₂ tracer released near ground level. Release conditions and concentration measurements for the Prairie Grass experiments are given in [1].

Figure 2-18 to Figure 2-22 show model comparisons for the trials PG9, PG10, PG32, PG33 and PG36. These trials have been selected to match the validation runs in [4]. PG9 and PG10 are in unstable conditions, PG33 is in neutral conditions, PG32 and PG36 are in stable conditions. The results are time averaged over 600s. DRIFT Version 3 differs from DRIFT Version 2 in its approach to time averaging. However, generally the results are found to be very similar.

DRIFT shows a tendency to overpredict concentrations in unstable conditions (PG9 and PG10). In stable conditions, PG36 shows close agreement, whereas PG32 shows consistent underprediction compared with experiment – both versions of DRIFT show this behaviour. However, switching off time-averaging makes the results of DRIFT Version 3 much closer to the experimental data in the PG32 case.

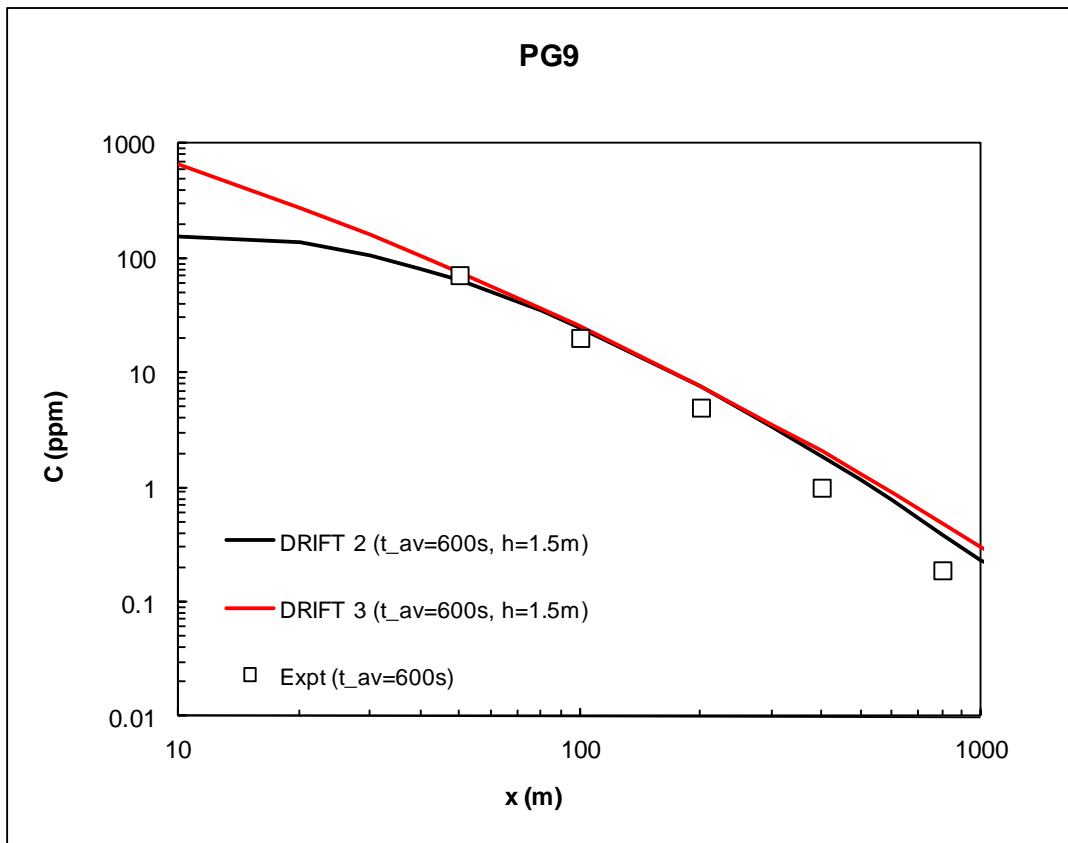


Figure 2-18 Centreline concentration predictions for Prairie Grass Trial PG9

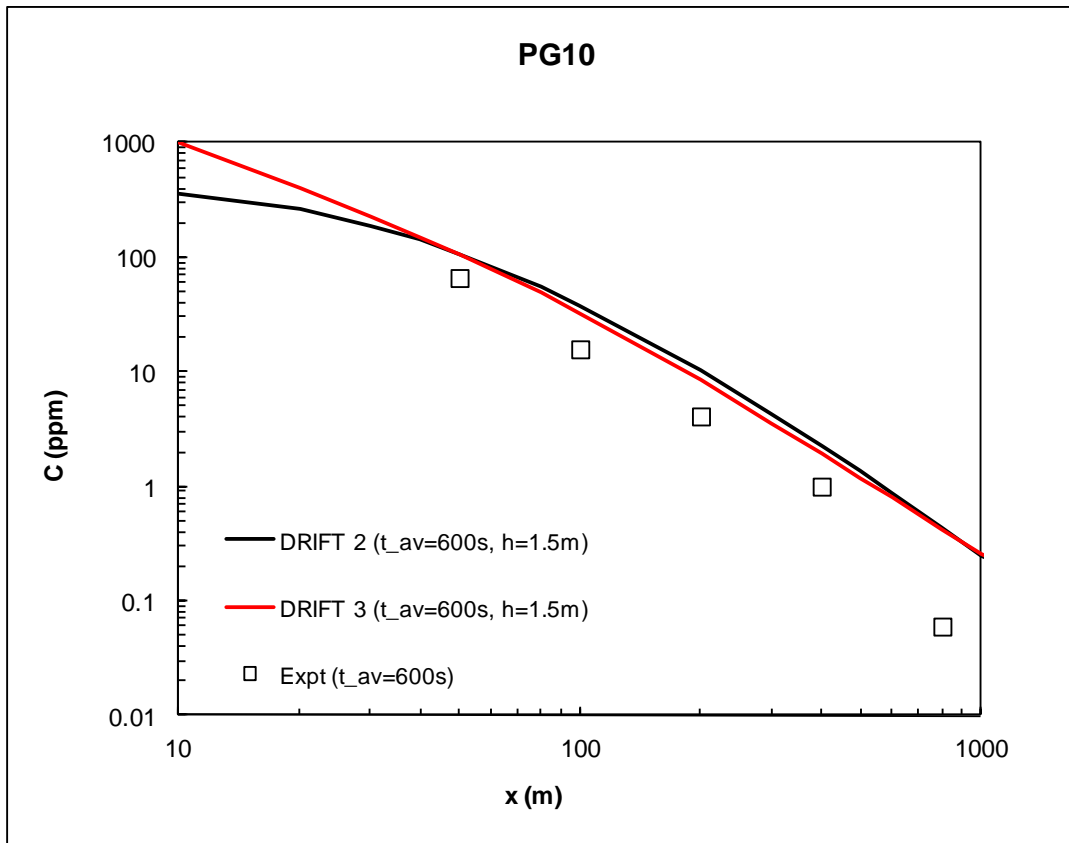


Figure 2-19 Centreline concentration predictions for Prairie Grass Trial PG10

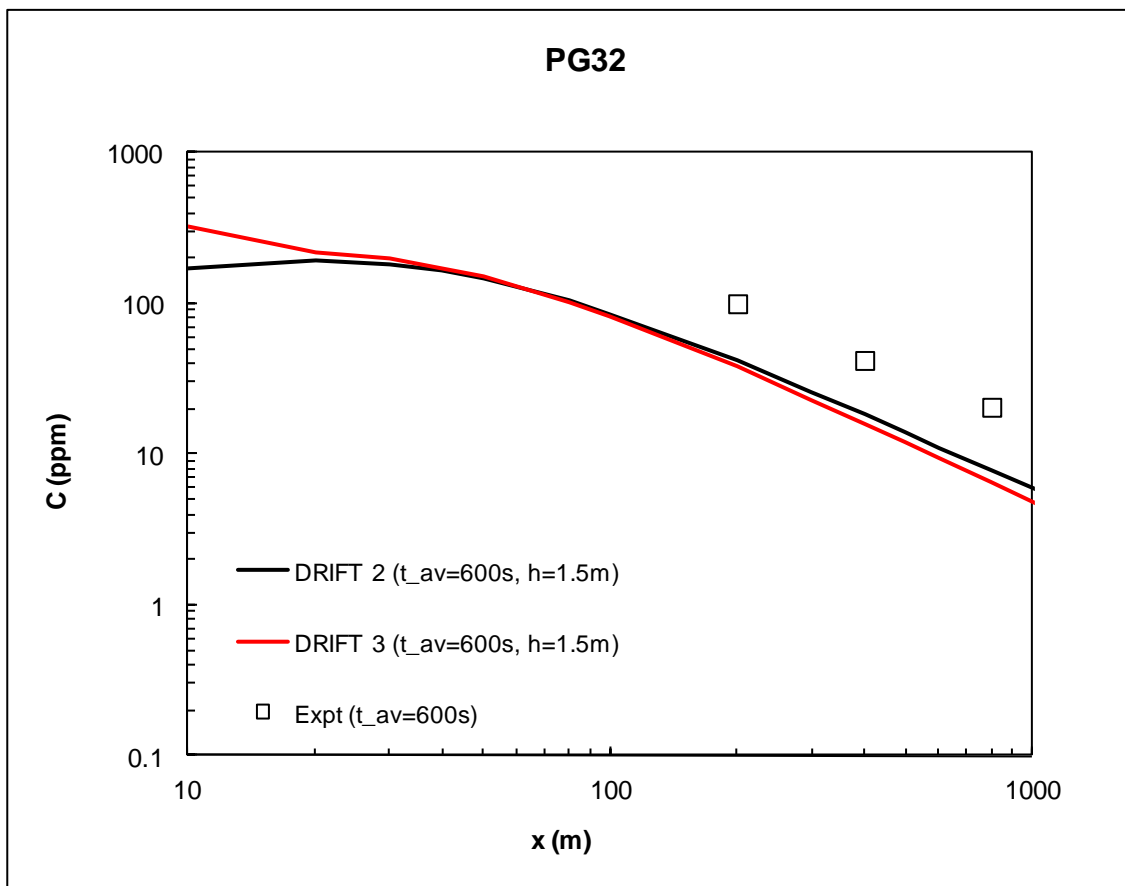


Figure 2-20 Centreline concentration predictions for Prairie Grass Trial PG32

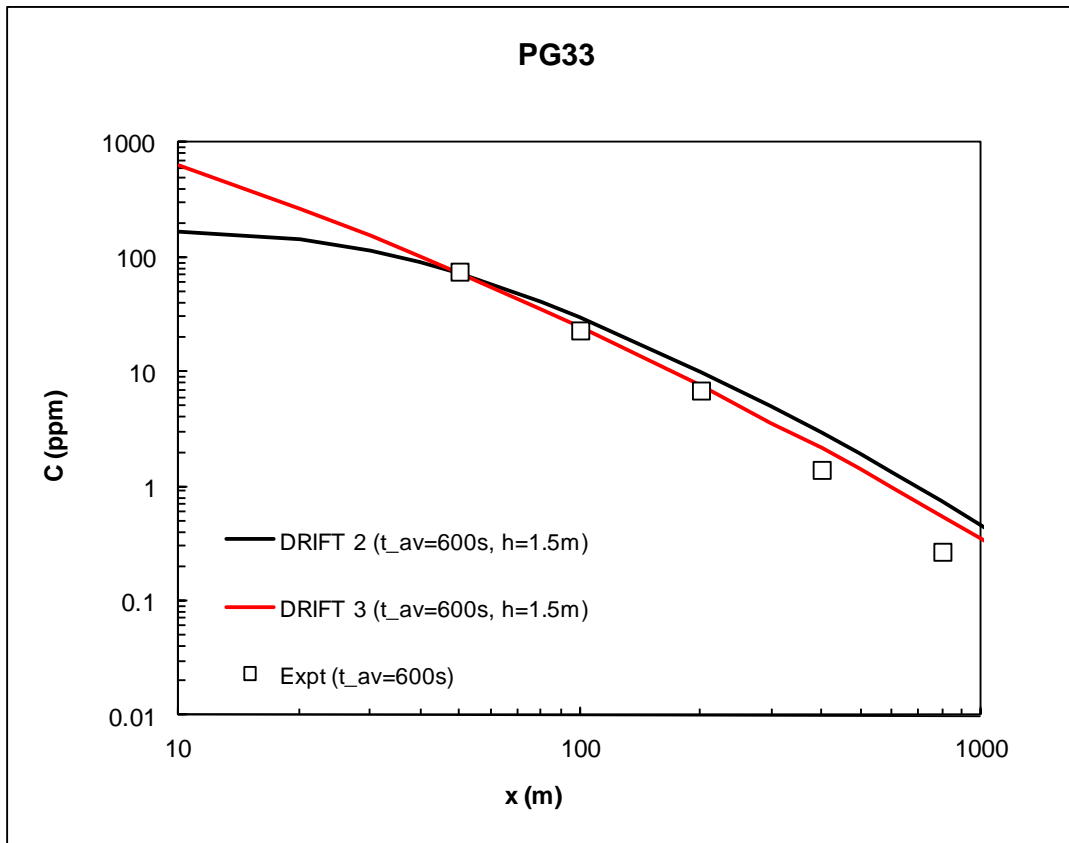


Figure 2-21 Centreline concentration predictions for Prairie Grass Trial PG33

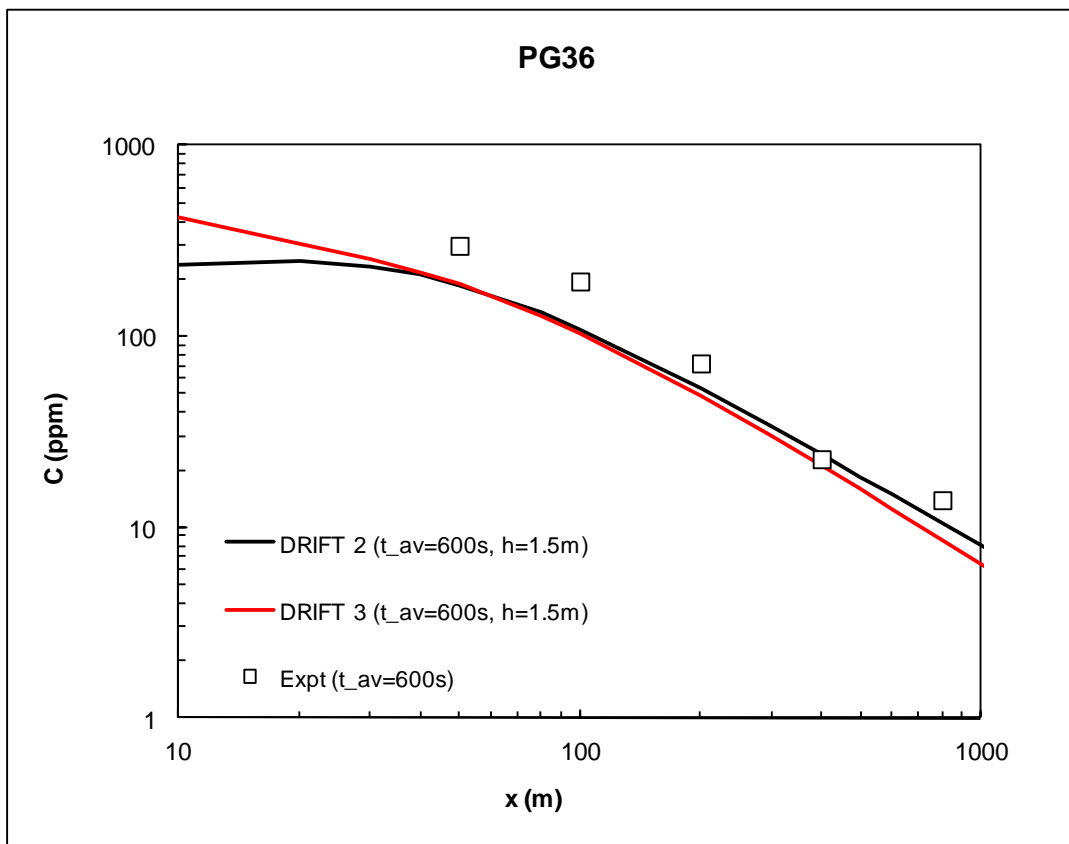


Figure 2-22 Centreline concentration predictions for Prairie Grass Trial PG36

3.0 Conclusions

The comparisons of DRIFT Version 3 and 2 predictions with dense gas and passive gas dispersion datasets show that in many cases Version 3 gives similar results to Version 2.

There is a known bug in DRIFT Version 2 (and earlier) for unstable conditions – this results in equal vertical and lateral spread and an exponential vertical concentration profile ($s=1$ in the vertical profile). This may lead to some of the observed differences between DRIFT Version 3 and Version 2 for unstable conditions.

The comparisons highlight the sensitivity of model predictions to assumed receiver height, time averaging and finite release duration.

4.0 References

- [1] Hanna S R, Strimaitis D G and Chang J C, "Hazard response modelling uncertainty. Volume II. Evaluation of commonly used hazardous gas dispersion models", Sigma Research Corporation, 234 Littleton Road, Suite 2E, Westford, Massachusetts MA 01886, USA, 1991.
- [2] Jones S J, Mercer A, Tickle G A, Webber D M and Wren T, "Initial Verification and Validation of DRIFT", SRD/HSE R580, October 1993.
- [3] Webber D M, Jones S J, Martin D, Tickle G A and Wren T, "Complex Features in Dense gas Dispersion Modelling", AEA Technology Report AEA/CS/FLADIS/1994 Issue 1, 1994.
- [4] Tickle G A, "Model Predictions Compared with URAHFREP Campaign 2 Field Trial Data", AEA Technology Report AEAT/NOIL/27328006/003 (R) Issue 2, June 2001.
- [5] "Heavy Gas Dispersion Trials. Thorney Island 1982-3, Data for Trial 045", Published by HSE Research and Laboratory Services Division, Broad Lane, Sheffield.
- [6] "Heavy Gas Dispersion Trials. Thorney Island 1982-3, Data for Trial 047", Published by HSE Research and Laboratory Services Division, Broad Lane, Sheffield.
- [7] Koopman R P et al, "Burro Series Data Report. LLNL/NWC 1980 Spill Tests", UCID-19075, Lawrence Livermore National Laboratory, California, USA, 1982.
- [8] Koopman R P et al, "Analysis of Burro 40m³ LNG spill experiments", J Haz. Mat, Vol 6, Nos. 1+2, July 1982.
- [9] Goldwire H C, et al, "Desert Tortoise series data report: 1983 pressurised ammonia spills", UCID-20562, Lawrence Livermore National Laboratory, California, USA, 1985.



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