

Comparison of CALPUFF and SCIPUFF with Tracer Gas Observations at Two Mesoscale Field Experiments

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Reference: Chang et al., 2003, JAM, 42, 453-466

Two Field Experiments with 30 km Distance Scale (Mesoscale)

- Two mesoscale SF₆ tracer experiments sponsored by DOD – Dipole Pride 26 (1996 at Nevada Test Site) and OLAD (1997 at Dugway Proving Ground, UT)
- Instantaneous puff releases from a point source near ground level at DP26 (14 trials total); instantaneous line releases (from airplane at 100 m or truck at ground level) at OLAD (11 trials total)

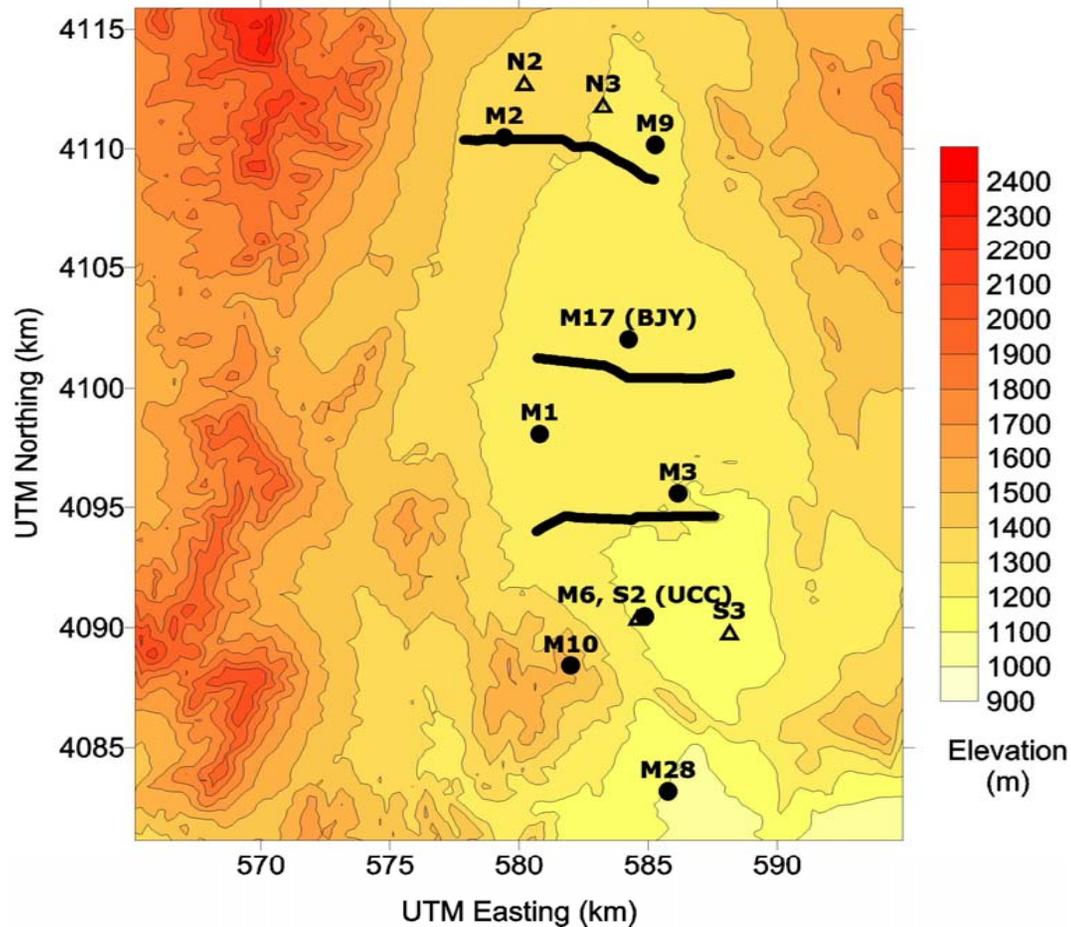
Model Evaluation Methods

- Use dosage (ppt-hr) arc max for each trial and distance (of interest to DOD)
- BOOT software (Chang and Hanna, 2004) – In wide use, such as part of EU Model Validation Kit and ASTM Guidelines
- Performance measures (e.g., MG, VG, FAC2, compare Avg, St Dev, and Hi)
- Analysis of false positives and false negatives if there is an emergency response issue.

Significance Tests and Model Acceptance Criteria

- Bootstrap resampling to calculate whether there are significant differences between performance measures for two models, or whether mean bias for one model is significantly different from 0.0
- Model acceptance criteria (Chang and Hanna 2004, Hanna and Chang 2013) (e.g., $FB < 0.3$ in rural areas)

Dipole Pride 26 Field Trials
Yucca Flat
Nevada Test Site, Nevada



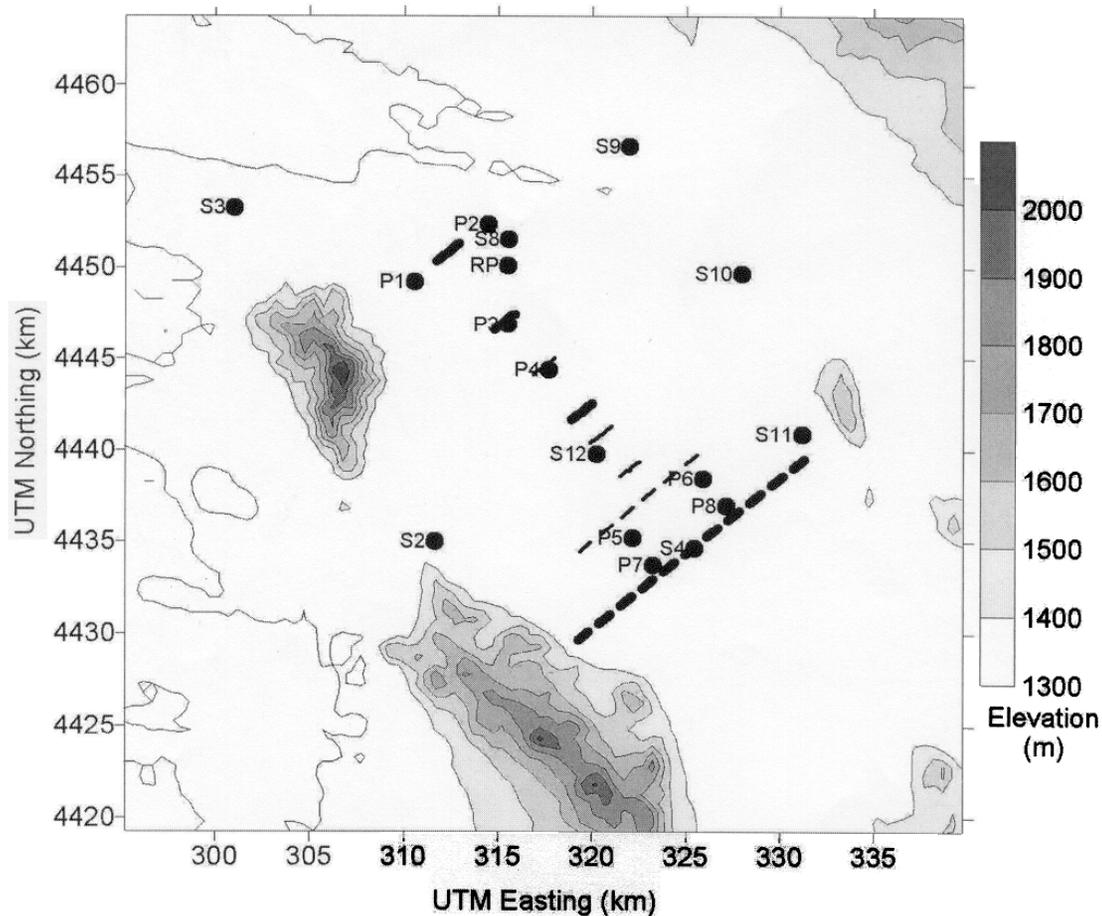
DP 26

Triangles –
source
locations

Large dots –
met stations

Three lines of
30 small dots
– SF₆
sampling
stations

Fig. 1. The Dipole Pride 26 test site at Yucca Flat, Nevada Test Site. Also shown are the three SF₆ sampler lines (thick lines, 30 samplers per line), eight MEDA surface meteorological stations (dark circles), and four possible release locations (open triangles). There are also two pibal stations (BJY, near M17; and UCC, near M6), and one radiosonde station (UCC, near M6). Terrain resolution is 250 m. The map covers an area of 30 × 35 km. The release in each trial is from one of the four release locations N2, N3, S2, and S3. (From Chang et al., 2002).



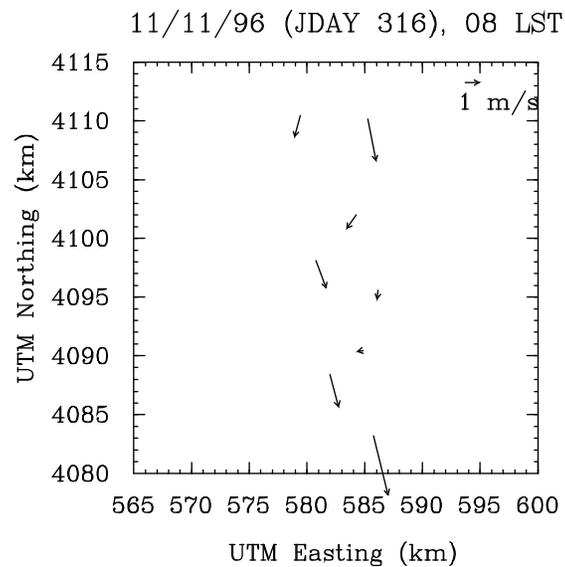
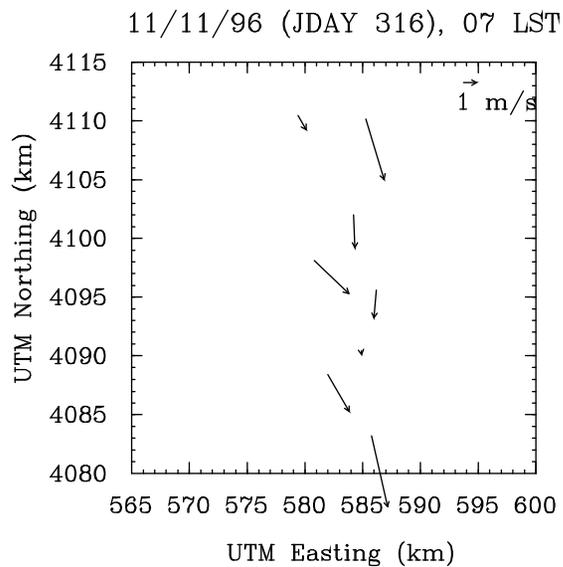
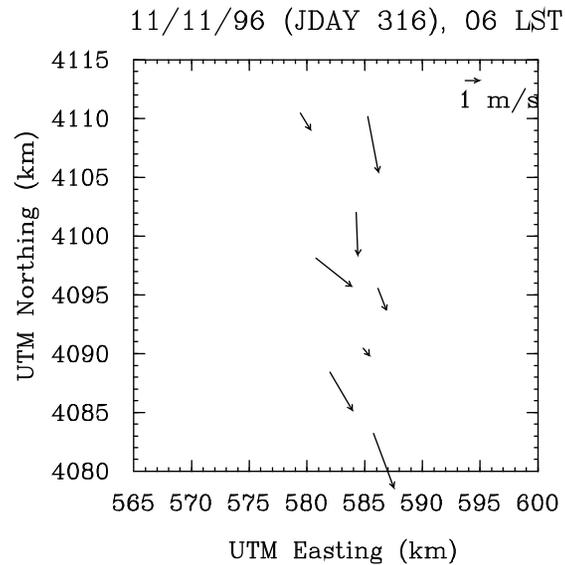
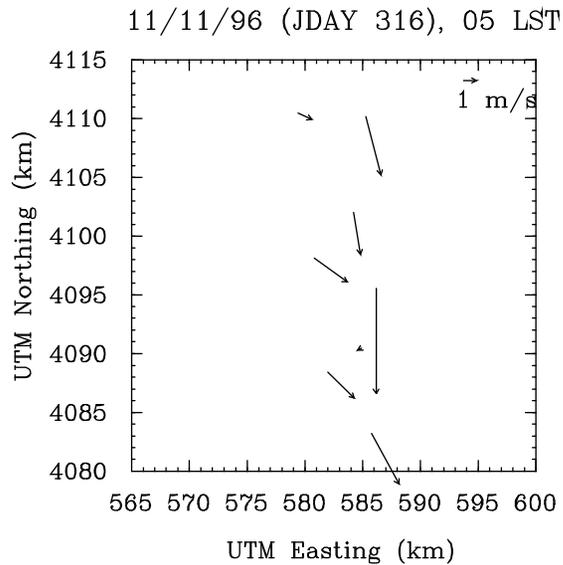
OLAD

Large dots – met stations

Short solid lines – series of 30 SF₆ samplers

Long dashed lines: line source (from truck–thin line, or from plane-thick line)

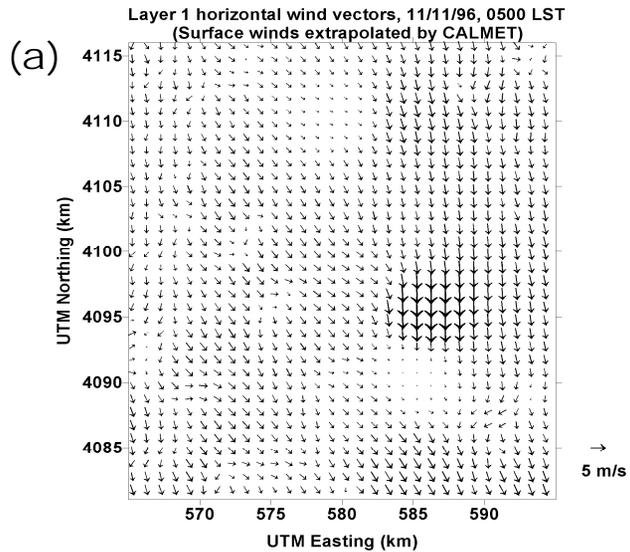
Fig. 2. Terrain elevation at the Over-Land Alongwind Dispersion (OLAD) test site at West Desert Test Center, U.S. Army Dugway Proving Ground, Utah. Two-meter Portable Weather Information and Display System (PWIDS) instrument masts are listed as P1, P2, etc. Ten-meter Surface Atmospheric Measurement Systems (SAMS) instrument towers are listed as S2, S3, etc. The radiosonde and pibal measuring site is listed as RP. The thin dashed line is the line source from truck, and the thin solid lines are the corresponding sampling lines. The thick dashed line is the line source from aircraft, and the thick solid lines are the corresponding sampling lines. The map covers an area of 45 × 45 km. The southwest corner of the map roughly corresponds to (39.9°N, 113.4°W).



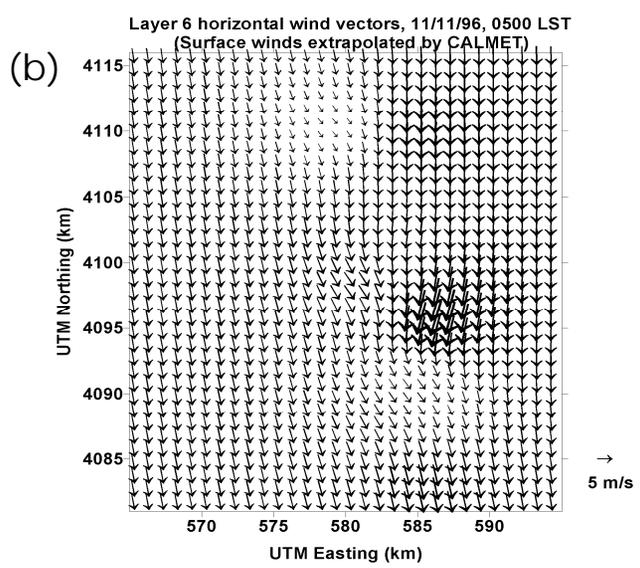
DP26

Observed winds during Trial 5. The release was at 0440 at N 2

For the 8 wind sites over all 14 trials, RMS wind speed is 1 to 2 m/s and RMS wind dir is 60 deg



DP26

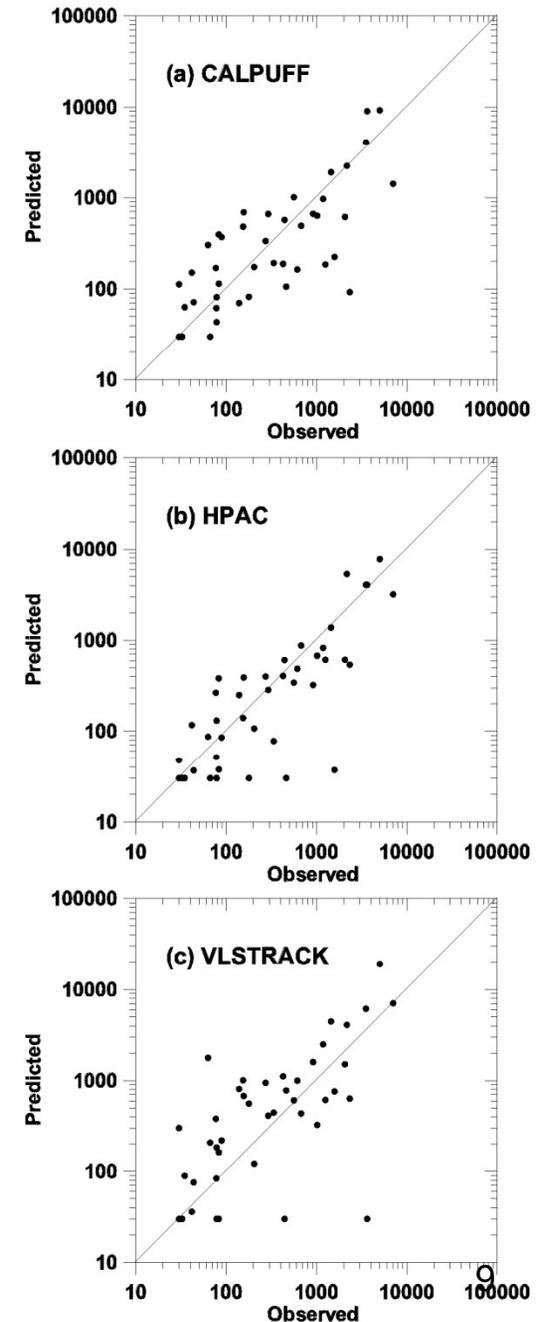


**CALMET
interpolated
wind fields**

Fig. 4.12 (Continued). Horizontal wind fields simulated by CALMET for 0500 LST, Nov 11, 1996, where surface wind observations were vertically extrapolated. (a) Layer 1 (0 to 20 m above the ground). (b) Layer 6 (2000 to 3300 m above the ground).

DP26

Evaluation of three puff models (CALPUFF - top, HPAC/SCIPUFF - mid, and VLSTRACK - bottom)



OLAD

Evaluation of three puff models (CALPUFF - top, HPAC/SCIPUFF - mid, and VLSTRACK - bottom)

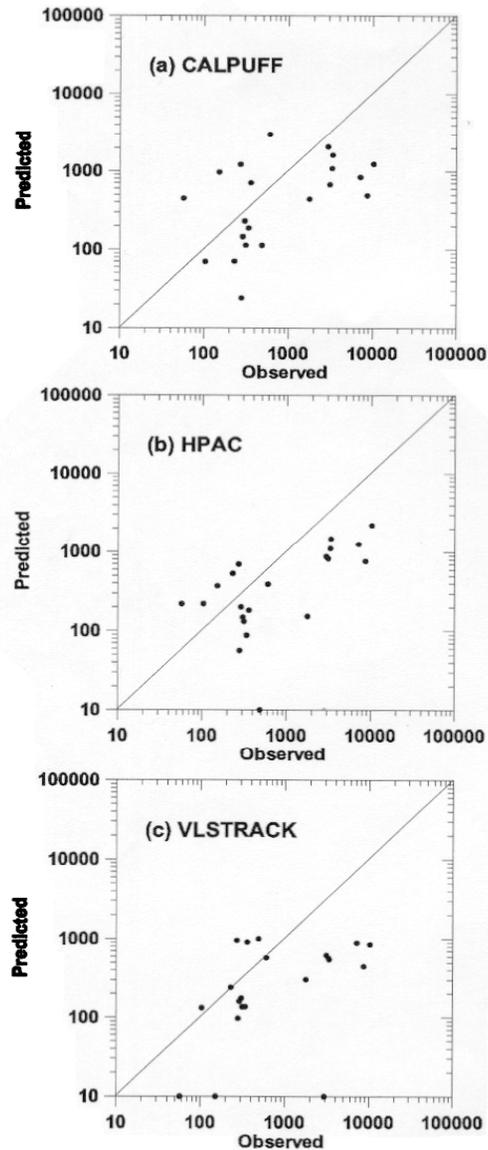


Fig. 4. Scatter plots of the maximum dosage (ppt-hr) at each sampling line predicted by CALPUFF, HPAC, and VLSTRACK versus observations from the whole-air samplers at the OLAD site. Note that a lower dosage threshold of 10 ppt-hr, based on the level of detection, was imposed.

Quantitative Evaluation Results based on dosage in ppt-hr

	DP26 Obs	DP26 CAL	DP26 SCI	OLAD Obs	OLAD CAL	OLAD SCI
MG	-	1.07	1.32	-	1.82	2.06
VG	-	3.06	2.87	-	9.82	3.61
FAC2	-	0.52	0.60	-	0.29	0.48
Avg	927	917	838	2100	748	854
St Dev	1463	1979	1610	2935	743	1044
Hi	7036	9233	7761	10210	2988	3993

Conclusions

- Good performance at DP26; FAC 2 underpredictions at OLAD (not sure why) for CALPUFF and SCIPUFF
- The two models' performance is about the same for the two mesoscale tracer experiments (DP26 and OLAD)
- No significant difference (at 95 % level) between most performance measures for CALPUFF and SCIPUFF
- Similar performance even when both use the CALMET diagnostic wind models
- Caveat – both models have changed somewhat since this study was done in 2002

References

Chang J, Franzese P, Chayantrakom K, Hanna S, 2003: Evaluations of CALPUFF, HPAC, and VLSTRACK with two mesoscale field data sets. *J Appl Meteorol.* 42, 453-466.

Chang J and Hanna S, 2004: Air quality model performance. *Meteorol and Atmos Physics.* 87, 167-196.

Hanna S, Chang J, 2012: Acceptance criteria for urban dispersion model evaluation. *Meteorol and Atmos Physics.* 94 doi 10.1007/s00703-011-0177.