1.2 MODELERS' DATA ARCHIVE – A COLLECTION OF ATMOSPHERIC TRANSPORT AND DISPERSION DATA SETS

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ABSTRACT

Atmospheric Transport and Dispersion (ATD) field and laboratory data play a critical role in understanding ATD processes, developing new algorithms, evaluating model performance, *etc*. Many experiments have been conducted since the 1950s. About two decades ago, we assembled an initial version of the Modelers' Data Archive (MDA) that included some major dense gas field data sets with funding from the American Petroleum Institute (API) and the U.S. Air Force. The archive has been steadily growing in time, despite a lack of any subsequent funding, to include about 50 data sets that cover a wide range of scenarios, *e.g*., different plume densities (dense, buoyant, and neutral), spatial scales ranging from 0.1 to 1,000 km, release rates ranging from 0.01 mg s^{-1} to 100 kg s^{-1}, flat vs. complex terrain, different times of the day, surface vs. elevated release, point vs. line source, rural vs. urban land use, and episodic vs. routine releases. These data sets have been freely distributed to the scientific community, and have contributed to a large body of research concerning ATD model development and evaluation. In some cases, the MDA has become the only known source for certain data sets. This paper discusses the history and attributes of the MDA, and common problems with a data set. It ends with a solicitation of ideas to sustain this "grass-roots" effort in maintaining and distributing ATD data sets.

1. INTRODUCTION

Atmospheric Transport and Dispersion (ATD) field and laboratory data are invaluable resources for understanding ATD processes, developing new algorithms, evaluating model performance, *etc.* For example, data collected from the Prairie Grass field experiment (Barad 1958; Haugen 1959) have been substantially used to develop the so-called Gaussian Plume Model and various boundary-layer similarity theories (*e.g.*, Pasquill 1961, Gifford 1961 and 1968, Briggs 1973, Hanna *et al*. 1982, van Ulden 1978, Nieuwstadt 1980, and Cimorelli *et al*. 2005). Chang and Hanna (2004) recommend the model acceptable criteria based on a compilation of the results from a variety of model evaluation studies (Table 1).

Many experiments have been conducted in the past few decades, since the 1950s in particular. However, systematic efforts in archiving these data are generally lacking. Hence, it is often challenging to locate appropriate data sets for research, and to leverage investment already made in these historical experiments. This paper describes the Modelers' Data Archive (MDA), a grass-roots effort in archiving, adding values to, and distributing many historical. The MDA preserves many of the valuable data sets that would have been lost otherwise, and facilitate a large body of research.

2. BACKGROUND

About two decades ago, Steven Hanna, David Strimaitis, and Joseph Chang conducted a dense-gas model evaluation project jointly sponsored by the American Petroleum Institute (API) and the U.S. Air Force (USAF) (Hanna *et al.* 1993 and 1991). The project used field data from six dense gas (Burro, Coyote, Desert Tortoise, Goldfish, Maplin Sands, and Thorney Island) and two tracer gas (Prairie Grass and Hanford Kr^{85}) experiments. Raw data of these experiments were condensed into a common MDA file format that contains enough information to run the 15 dense-gas dispersion models under consideration, including DEGADIS, HGSYSTEM, SLAB, CHARM, PHAST, and TRACE. Programs were developed to run these models in batch mode using the MDA files in a consistent and efficient manner.

At the end of the API/USAF project, despite a lack of any follow-on funding, the data archive continued to grow. We recognized the value of archiving not just condensed "MDA files" but also the original raw data, and began to call the entire collection of data sets MDA. At the same time, we began to add derived data (*e.g.,* quality-assurance indicators, time averages, tabulation, reformatting, model inputs, *etc*.) when appropriate, mostly when we happened to work on these data sets under the support of various projects. We strived to combine data and any documentation (*e.g.*, reports and papers) into a single package, which sometimes required scanning old reports. Word began to spread around, and we began distributing the data sets free of charge to any scientists who requested them. At the same time, scientists from organizations such as the Environmental Protection Agency, Dugway Proving Ground, Lawrence Livermore National Laboratory, and Risø National

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Laboratory in Denmark also collaborated and contributed data to the archive.

3. DATA SETS AND THEIR CHARACTERISTICS

Currently, MDA includes roughly 50 data sets as shown below:

- Dense Gas MDA (including Burro, Coyote, Desert Tortoise, Goldfish, Maplin Sands, and Thorney Island)
- Prairie Grass
- Hanford Kr^{85}
- Ocean Breeze
- Dry Gulch
- Green Glow
- Kit Fox
- DTRA Phase I
- DP26 (Dipole Pride 26)
- OLAD (Overland Alongwind Dispersion)
- MVP (Model Validation Program)
- Ventura
- Pismo Beach
- Cameron
- Carpinteria
- LROD (Long-Range Overwater Diffusion)
- MADONA (Meteorology And Diffusion Over Non-Uniform Areas)
- ACURATE (Atlantic Coast Unique Regional Atmospheric Tracer Experiment)
- ANATEX (Across North America Tracer Experiment)
- METREX (Metropolitan Tracer Experiment)
- CAPTEX (Cross Appalachian Tracer Experiment)
- ETEX (European Tracer Experiment)
- INEL74
- OKC80
- Birmingham
- Urban 2000 (Salt Lake City)
- Joint Urban 2003 (Oklahoma City)
- Madison Square Garden 2005
- Midtown Manhattan 2005
- MUST (Mock Urban Setting Test)
- EMU (Evaluation of Model Uncertainty)
- DPG (Dugway Proving Ground) Barrel
- LA (Los Angeles) 2001
- Barrio Logan (San Diego)
- Macdonald (water tunnel)
- SMEDIS (Scientific Model Evaluation of Dense Gas Dispersion Models)
- TRAPOS (Optimization of Modeling Methods for Traffic Pollution in Streets)
- REDIPHEM (Review and Dissemination of Physical Effects Models)
- FLADIS (Research on the Dispersion of Two-Phase Flashing Releases)
- Chesapeake Bay 2001
- Kincaid
- Bull Run
- Indianapolis
- Clifty Creek
- Tracy
- Martins Creek
- Westvaco
- SARMAP (San Joaquin Valley Air Quality Study, Regional Meteorological and Air Pollution)
- LMOS (Lake Michigan Ozone Study)
- OTAG (Ozone Transport Assessment Project)

Note that some of the more recent data sets such as Joint Urban 2003 (Allwine and Flaherty, 2006a), Madison Square Garden 2005 (Allwine and Flaherty, 2006b), and Midtown Manhattan 2005 (Allwine and Flaherty, 2007) are still maintained by their official source, the Dugway Proving Ground.

Figures 1-9 show maps or photos of the following nine field experiments included in the MDA:

- Prairie Grass (Barad 1958; Haugen 1959)—Short-range (~800 m) continuous point-source surface tracer releases over flat terrain.
- Dipole Pride 26 (Biltoft *et al*. 1998; Watson *et al.* 1998)—Mesoscale (~20 km) instantaneous point-source surface tracer releases in a lake bed surrounded by mountains.
- Over-Land Alongwind Dispersion (Biltoft *et al*. 1999; Watson *et al*. 2000)—Mesoscale (~20 km) instantaneous line-source surface and elevated tracer releases in a lake bed surrounded by mountains.
- Long-Range Overwater Diffusion (Bowers *et al*. 1994)—Mesoscale (~100 km) instantaneous line-source elevated tracer releases over water.
- European Tracer Experiment (Nodop *et al.* 1998)—Continental scale (~2,000 km) continuous point-source surface tracer releases over Europe.
- Kit Fox (WRI 1998, Hanna and Chang 2001)—1/10 field scale (~225 m) finite-duration area-source dense-gas (CO_2) releases over flat terrain in a nested roughness array.
- Desert Tortoise (Goldwire *et al.* 1985)—Short-range (~800 m) pressurized two-phase anhydrous ammonia releases over dry lake bed.
- Thorney Island (McQuaid and Roebuck 1985)—Short–range (~500 m) instantaneous volume-source dense-gas releases (mixture of Freon-12 and nitrogen) over flat terrain.
- Urban 2000 (Allwine *et al.* 2002)—Short-range (~6 km) continuous point- and line-source surface tracer release in an urban area (Salt Lake City).

The data sets included in the MDA encompass a wide range of scenarios. For example, they cover a time span of five decades, from 1956 to 2005; and length scales from ~100 to ~1,000 km, four orders

of magnitude. Many source types are included, including neutrally buoyant, buoyant, and dense; daytime, nighttime, and transition periods; continuous and instantaneous; stationary and moving; surface and elevated; and point, line and volume source. Release rates range from 0.01 mg s^{-1} to 100 kg s^{-1}, over ten orders of magnitude. Experiments were conducted over flat, complex, and urban terrain; and overland, overwater, and coastal. Data were collected from either special research-grade campaigns (*i.e.*, more samplers with shorter time periods) or regular observations (*i.e.*, fewer samplers but with longer time periods). Table 2 further summarizes the characteristics of the majority of the data sets included in the MDA.

The MDA is essentially just a collection of files and is not maintained by any Database Management System. This is partly due to the lack of funding for data archival, and partly due to the fact that most scientists would like to perform their own analyses and not subject to any existing database construct.

4. MDA FILE FORMAT

As mentioned before, the term "MDA" refers to both the complete collection of data sets and the common file format. The need to apply 15 dissimilar dispersion models to eight data sets for the API/USAF project required us to put the data in a common MDA format. It contains just enough information to satisfy the input requirements of all models, and facilitates efficient and consistent running of all models. However, we found that the advent of a "fancy" graphical user interface for more recent versions of some of the models often makes batch-processing more difficult. In other words, user-friendliness is sometimes achieved at the expense of efficiency. Table 3 shows Desert Tortoise's MDA file, which includes four major sections—physical and chemical properties, source term, meteorology, and concentration (both peak and time-averaged) and cloud width. Hanna *et al*. (1991 and 1993) describe in detail derivation of some of the parameters in the MDA file.

5. COMMON PROBLEMS WITH DATA SETS

Over the course of collecting, analyzing, and archiving data sets, we identify these problems:

- Lack of adequate metadata—We sometimes found information such as site description; and instrumentation accuracy, thresholds, and averaging time missing.
- Lack of or unknown data quality assurance and check—We had to perform quality checks and assign quality indicators for some of the data sets.
- Lack of adequate upper-air meteorological data—This is especially true for earlier experiments.
- Inconsistent, confusing units, time zones, coordinates, and missing data indicator—We found simultaneous use of m s^{-1}, knots, and mph for wind speeds; simultaneous use of LST, LDT, and UTC for time zone; lack of information on the datum for the Universal Transverse Mercator (UTM) coordinates; and inconsistent missing data indicators (*e.g.*, N/A, 9999, -999, and -9).
- Diverse media and formats—We found some old data sets have data in hard copy only (only very few of such data sets have been digitized, including Prairie Grass and Long-Range Overwater Diffusion), data stored in antiquated media (*e.g.*, 9-track tapes and 5.25" floppy disks), and data stored in uncommon binary formats (*e.g.*, 40-bit word). All data stored in antiquated media have been transferred to hard disks and other modern media. All data stored in uncommon binary formats have been converted to ASCII if those data sets happened to be within the scope of a funded project. We still consider ASCII the best format as it can be easily read by all types of applications and disk storage is really not an issue nowadays.

Future experiments should leverage these lessons-learned.

6. DATA SETS DISTRIBUTION

The data sets included in the MDA have been freely distributed to scientists who requested them by sending an email to the authors. We have so far distributed data to about 100 scientists, and these data have led to the publication of many journal articles, dissertations, and reports. It is interesting that in some cases the organizations who originally conducted the experiments have approached us for data. In other words, if not for the MDA, these data sets probably would have been lost forever.

Data sets that were most frequently requested include Prairie Grass, Dipole Pride 26, Over-Land Alongwind Dispersion, Kit Fox, Burro, Coyote, Desert Tortoise, Goldfish, and Thorney Island.

7. OTHER DATA SOURCES

The MDA is far from being comprehensive. Many other data sources also exist, including:

- National Oceanic and Atmospheric Administration's Air Resources Laboratory (including the Headquarters, the Atmospheric Turbulence and Diffusion Division, and the Field Research Division).
- Dugway Proving Ground.
- Lawrence Livermore National Laboratory.
- Environmental Protection Agency.
- Nuclear Regulatory Commission.
- Naval Surface Warfare Center, Dahlgren Division.

- European organizations such as the Risø National Laboratory in Denmark (*e.g*., Model Validation Kit) and the University of Hamburg in Germany.

8. SUMMARY

This paper describes a grass-roots effort in archiving and distributing about 50 historical ATD data sets. These data sets have been freely distributed by us and facilitated a large body of research. Due to a lack of any funding, very limited "technical" support can be provided, and the archive is essentially just a collection of files without any overarching database structure. Added-values have been provided to those data sets that have been personally worked on by us; other data sets are provided "as is" without additional derived information. We welcome contributions from colleagues of other data sets. We also welcome suggestions on the "business model" of how to sustain this effort, *e.g.*, turning over archival and distribution to a government agency vs. maintaining the status quo.

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Table 1 Compilation of some model performance evaluation studies from which the model acceptance criteria (Chang and Hanna 2004) were developed.

	Suggested Acceptance Criteria	Data Base or Study Name										
		Prairie Grass (GPM)	Prairie Grass (VLSTRACK)	Indianapolis (HPDM)	AERMOD study (3 models)	Dense gas MDA (10 models)	Kit Fox (3 HEGADAS versions)	DP26 (4 models)	OLAD (3 models)	Urban 2000 (20 HPAC configurations)	Urban 2000 (20 HPAC configurations)	ETEX (46 models)
No. of Trials	N/A	44	44	89 (hr)	100s (hr)	41	52	14	11	18	18	1 (90 hr)
Reference	Chang and Hanna (2004)	Chang (1998)	Chang (1998)	Hanna and Chang (1993)	Hanna *et al*. (2000)	Hanna *et al*. (1993)	Hanna and Chang (2001)	Bowers *et al*. (2004). Chang *et al*. (2003)	Chang *et al*. (2003)	Chang *et al*. (2005)	Chang *et al*. (2005)	Girardi *et al*. (1998)
Output Considered	Unpaired in space	Arc-max conc.	Arc-max conc.	Arc-max conc.	Arc-max conc.	Arc-max conc.	Arc-max conc.	Arc-max dosage	Arc-max dosage	Arc-max conc.	Paired in space and time	Paired in space and time
Systematic Bias	< 30%	10% under	60% over	5%	2% - factor of 3	30% - 50%	5% to 50%	< 35%	Factor of 2 - 3 under	0 to factor of 4 over (median: 50% over)	25% to factor of 4 over (median: 50% over)	0 to factor of 4 (median: 5%)
Random Scatter	Factor of 2 -3	Factor of 2	Factor of 4	Not reported	Factor of 2 - 7	Factor of 2	Factor of 2	Factor of 3 - 4	Factor of 4 - 7	Factor of 2 - 9 (median: factor of 3)	Factor of 9 - 25 (median: factor of 13)	Factor of 4 - 11 (median: factor of 5)
Fraction Within a Factor of 2	> 50%	80%	30%	65%	10% - 80%	50%	50% - 90%	40% - 60%	25% - 50%	5% - 60% (median: 40%)	20% - 30% (median: 25%)	10% - 40% (median: 30%)

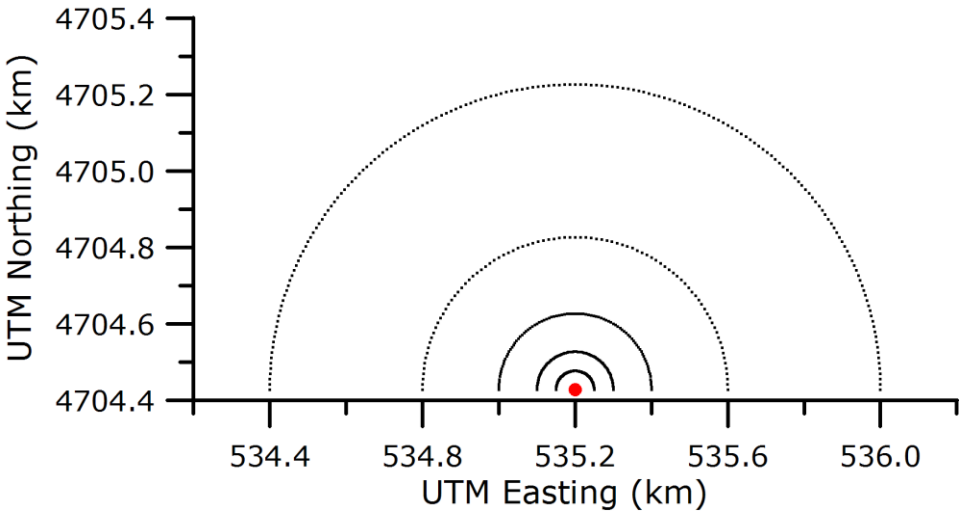

Figure 1 Sampler locations for the Prairie Grass field experiment at O'Neill, Nebraska. The red circle indicates the source location. The five sampling arcs are 50, 100, 200, 400, and 800 m away from the source. Samplers are separated by 2° in the first four arcs, and 1° in the farthest arc. The total number of samplers is 545.

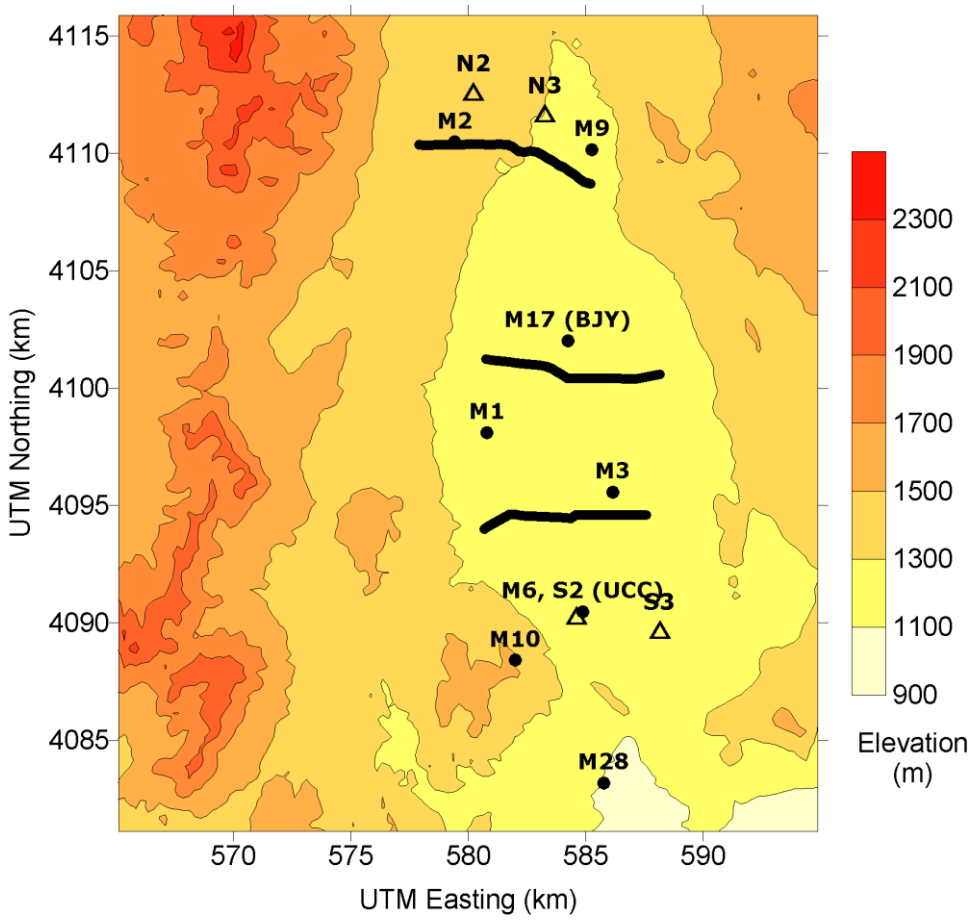

Figure 2 Terrain elevation at the Dipole Pride 26 (DP26) test site at Yucca Flat, the Nevada Test Site, Nevada. Also shown are the three SF_6 sampling lines (thick lines, 30 samplers per line), eight surface meteorological stations (solid circles), and four possible release locations (open triangles). The actual release location for a trial was chosen based on the observed wind direction. There were also two pibal stations (BJY, near M17; and UCC, near M6), and one radiosonde station (UCC).

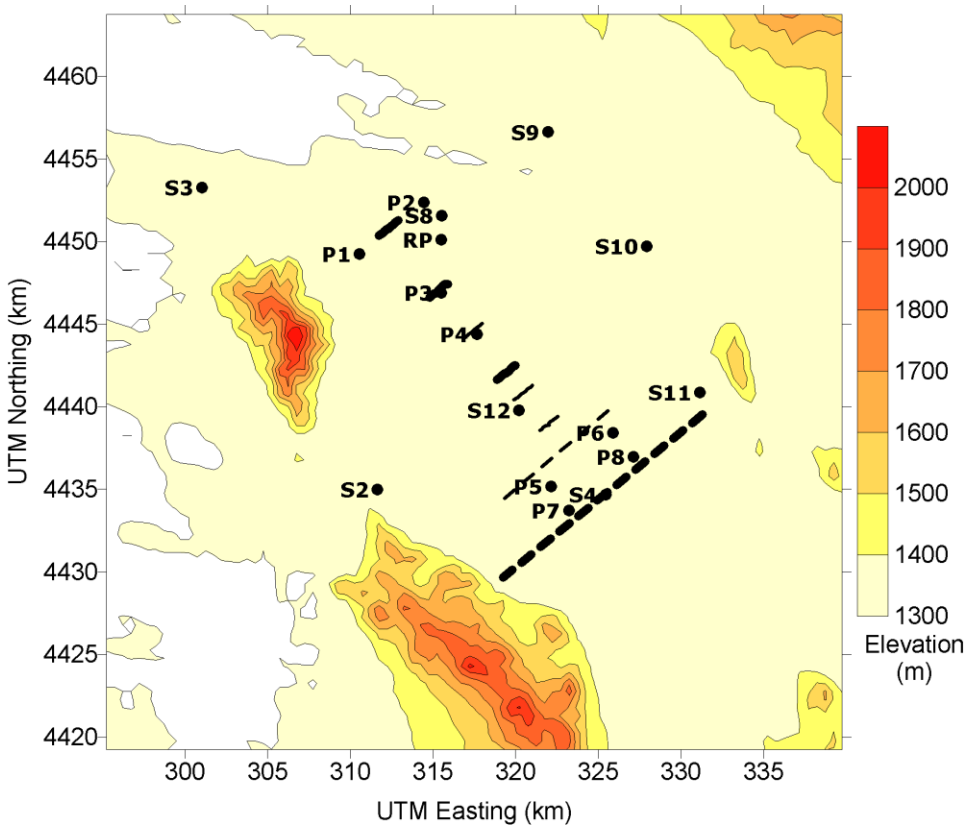

Figure 3 Terrain elevation at the Over-Land Alongwind Dispersion (OLAD) test site at the West Desert Test Center, U.S. Army Dugway Proving Ground, Utah. Two-meter Portable Weather Information and Display System (PWIDS) instrument masts are listed as P1, P2, *etc*. Ten-meter Surface Atmospheric Measurement 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 mobile truck SF_6 release line, and the thin solid lines are the corresponding sampling lines (15 samplers on each line). The thick dashed line is the aircraft SF_6 release line, and the thick solid lines are the corresponding sampling lines (also 15 samplers on each line).

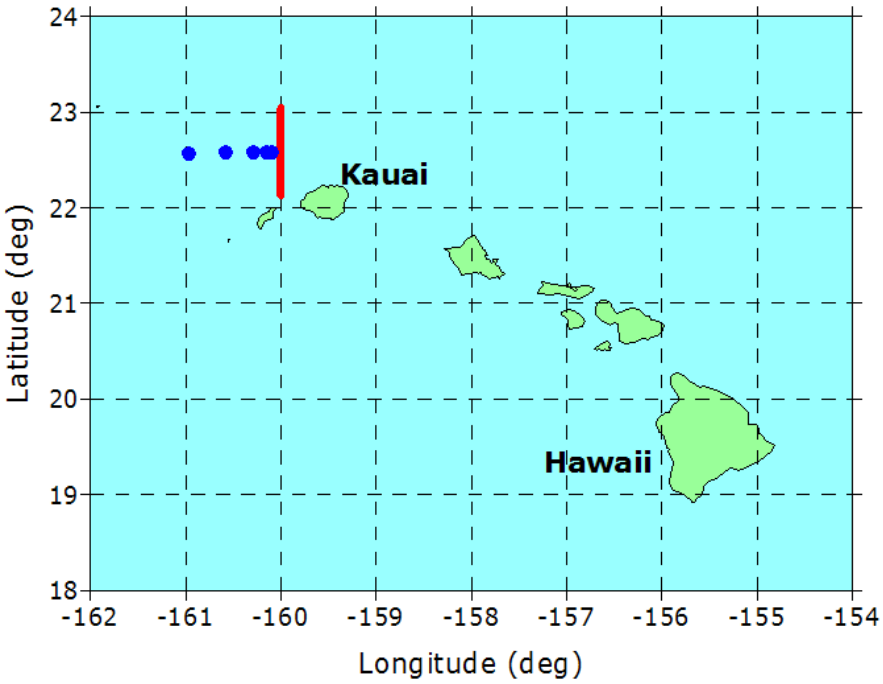

Figure 4 The Long-Range Overwater Diffusion (LROD) field experiment site near the Island of Kauai, Hawaii. The red line indicates the aircraft dissemination line (~100 km in length) for prevailing winds from the east. Blue circles indicate the locations of five sampling boats, which were roughly 10, 15, 30, 60, and 100 km downwind of the line source.

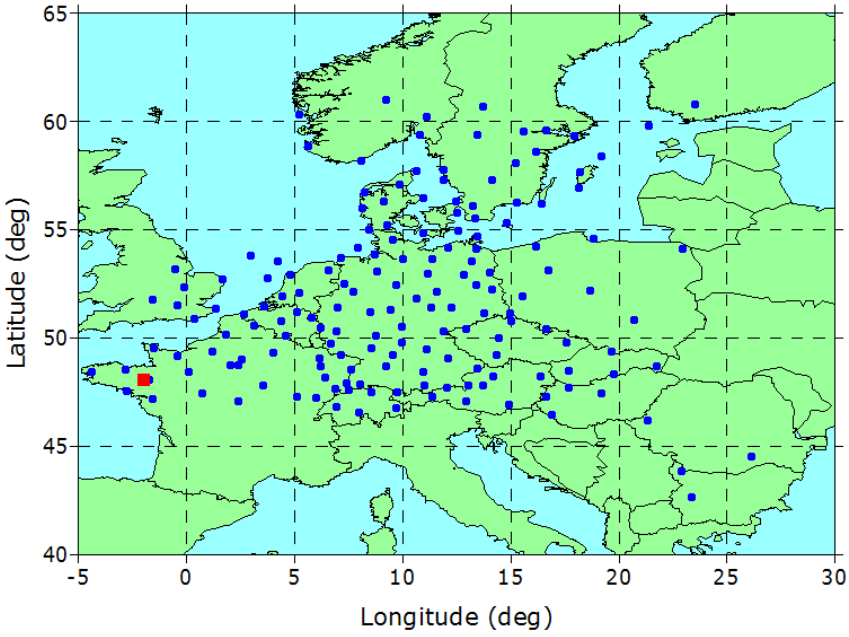

Figure 5 Network of the 168 samplers for the European Tracer Experiment (ETEX). The red square indicates the release location.

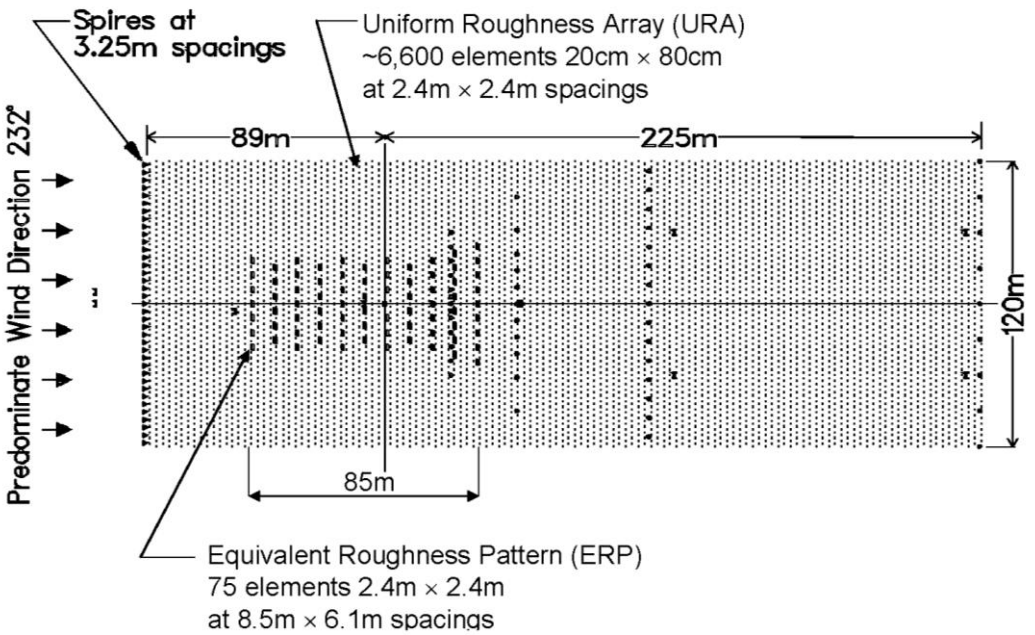

Figure 6 Plot plan of the Kit Fox site, the Nevada Test Site, Nevada, showing the locations of the Uniform Roughness Array (URA), the Equivalent Roughness Pattern (ERP), and the four sampling arcs located at 25, 50, 100, and 225 m downwind. Figure adapted from WRI (1998).

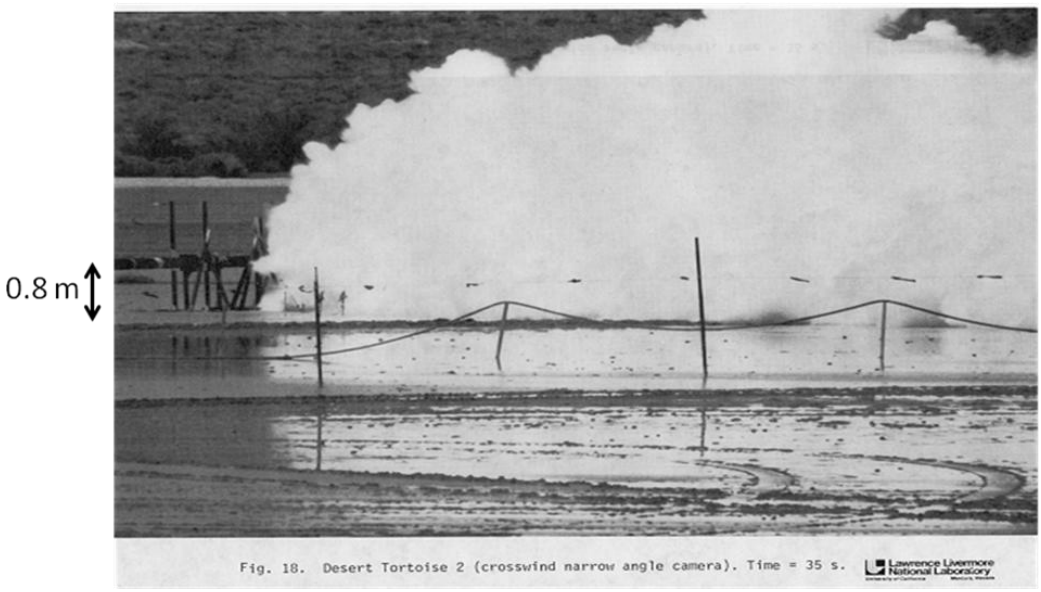

Figure 7 Side view of Trial 2 of the Desert Tortoise field experiment, a pressurized release of anhydrous ammonia, 35 s after the release. Photo from Goldwire *et al.* (1985). Experiment conducted at the Nevada Test Site, Nevada.

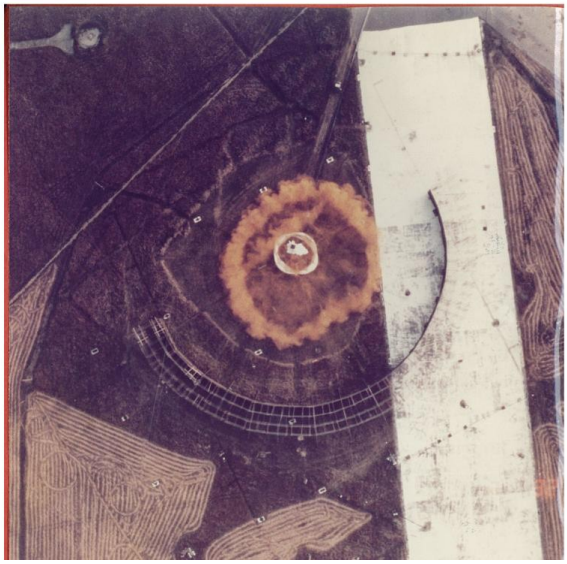

Figure 8 Top view of Trial 21 of the Thorney Island field experiment, a sudden collapse of a cylindrical dense cloud consisting of Freon-12 and nitrogen, 6 s after the release. Experiment conducted at Thorney Island, West Sussex, U.K. The distance from the center of the release to the semi-circular containment is 50 m. Photo from McQuaid and Roebuck (1985).

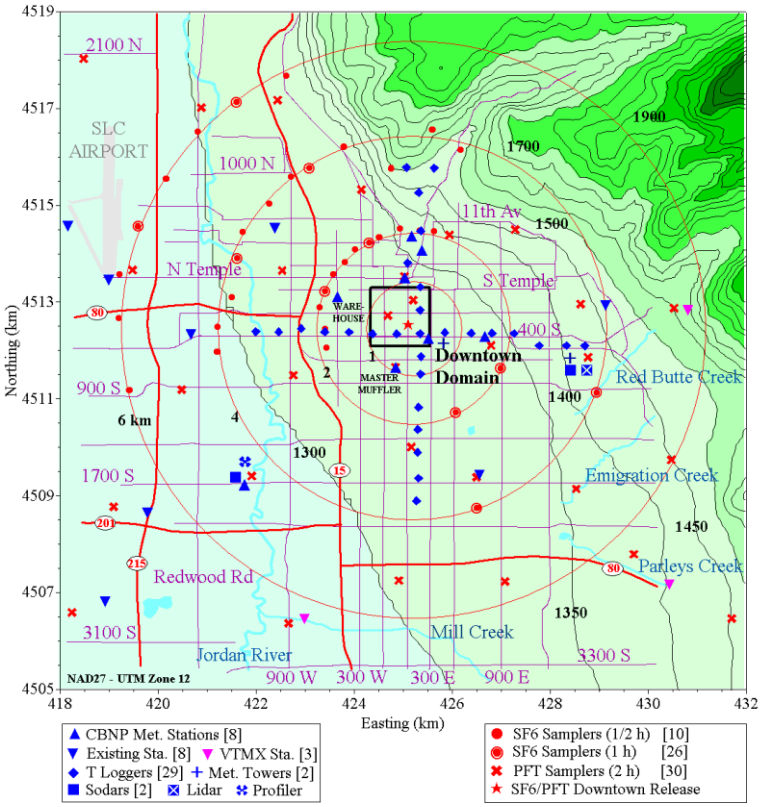

Figure 9 Sampler locations and terrain elevation of greater Salt Lake City, Utah, area for the Urban 2000 field experiment. Figure from Allwine *et al.* (2002).

Table 2 Summary of attributes for 35 of the data sets included in the MDA.

		Prairie Grass	DP26	OLAD	LROD	MADONA	Burro	Coyote	Desert Tortoise	Goldfish	Maplin Sands	Thorney Island	Hanford Kr85	Kit Fox	DSWA Phase I	MUST	Ventura	Pismo Beach	Cameron	Carpinteria	MVP	CAPTEX	ETEX	ACURATE	METREX	Kincaid	Bull Run	Indianapolis	Clifty Creek	Tracy	Martins Creek	Westvaco	Urban 2000	Joint Urban 2003	Los Angeles	Barrio Logan
Parameters	Sub-Categories																																			
Source Geometry	Point	x	x			x			x	x			x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Line			x	x																											x				
	Area						x	x			x			x																						
	Volume											x			x																					
Source Term	Instantaneous		x	x	x	x						x			x	x					x												x		
	Finite duration with constant (or slowly varying) rate	x				x	x	x	x	x	x		x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Finite duration with varying rate																																			
Source Elevation	Ground (0 to ~50 m)	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x							x	x	x	x
	Elevated (~50 m to atmospheric boundary layer)			x	x															x	x					x	x	x	x	x	x				
	High-altitude (beyond atmospheric boundary layer)																																			
Source Dynamical Effects	Neutrally buoyant	x	x	x	x	x							x		x	x	x	x	x	x	x	x	x	x	x							x	x	x	x
	Buoyant								x																	x	x	x	x	x	x					
	Dense						x	x	x	x	x	x		x																						
	Momentum (jets)								x	x																										
Source Location	Stationary	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Moving			x	x																															
Terrain	Flat (grass, crops, desert, forest, etc.)	x	x	x					x	x		x	x	x	x	x						x	x	x	x	x									
	Complex (mountains, valleys, etc.)		x	x		x																x	x	x			x		x	x	x	x				
	Coastal (land-water interface)																x	x	x	x	x															
	Overwater				x		x	x			x																									
	Urban															x									x			x					x	x	x	x
Time of Day	Day (neutral to unstable)	x	x	x	x	x	x	x	x	x	x		x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x
	Night (neutral to stable)	x	x			x							x	x	x	x			x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Transition			x		x						x									x	x	x	x	x	x	x	x	x	x	x				
Prevailing Weather	Steady (persistent)	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Frontal passage					x															x	x	x	x	x	x	x	x	x	x	x				
Meteorological Measurements	Surface (including towers)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Radiosondes (including tethersondes)		x	x	x	x										x					x	x	x	x	x	x	x	x	x	x					
	Remote sensing (profilers, sodars, etc.)		x	x		x										x					x					x	x	x							x
	Sonic anemometers (turbulence data)		x	x		x									x	x																			x
	Aircraft				x												x	x	x																
Sampler	Rows (includng rectangular arrays and lidar scans)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x						x	x	x		x			x	x	x	x
Distribution	Randomly spaced																					x	x	x	x			x		x	x				
	Aircraft or moving van				x																x														
Sampler	Near source (~ < 2 km)	x					x	x	x	x	x	x	x	x	x	x				x														x	x
Downwind Distance	Meso-gamma scale (~ 2 – 20 km)		x	x		x											x	x	x						x	x	x	x	x	x	x	x	x		
	Meso-beta scale (~ 20 – 200 km)				x																x															
	Meso-alpha scale (~ 200 – 2000 km)																					x	x	x												
Concentration Measurements	Time averages	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	High frequency time series (e.g., ~ 1 Hz)		x	x	x	x	x	x	x	x		x		x	x	x					x												x			
	Repetition of ensemble members					x									x	x																				
	Deposition																																			
Scale	Full scale field	x	x	x	x	x	x	x	x	x	x	x	x		x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Reduced scale field													x		x																					
	Laboratory																																			

Table 3 The MDA file for Desert Tortoise.

Desert Tortoise				.
Anhydrous Ammonia				.
NH3				. 3-char. abbreviation of chemical
4				: number of trials included in MDA
8				: time zone designation
DT1	DT2	DT3	DT4	: trial ID
8	8	9	9	: month
24	29	1	6	: day
83	83	83	83	: year
16	11	15	18	: hour
37	20	37	15	: minute
17.03	17.03	17.03	17.03	: mol. weight (g/mole)
239.7	239.7	239.7	239.7	: normal boiling point (K)
1.37e+06	1.37e+06	1.37e+06	1.37e+06	: latent heat of evaporation (J/kg)
2190.0	2190.0	2190.0	2190.0	: heat capacity - vapor (J/kg-K)
4490.0	4490.0	4490.0	4490.0	: heat capacity - liquid (J/kg-K)
682.8	682.8	682.8	682.8	: density of liquid (kg/m**3)
10.31499	10.31499	10.31499	10.31499	: coefficient A for vapor pressure equation
2132.52	2132.52	2132.52	2132.52	: coefficient B for vapor pressure equation
10.0	11.02	11.23	11.64	: exit pressure (atm)
294.7	293.3	295.3	297.3	: source temperature (K)
0.081	0.0945	0.0945	0.0945	: source diameter (m)
0.79	0.79	0.79	0.79	: source elevation (m)
HJ	HJ	HJ	HJ	: source type (IR,HJ,AS,EP)
C	C	C	C	: source phase (L,C,G)
-99.9	-99.9	-99.9	-99.9	: source containment diameter (m)
79.7	111.5	130.7	96.7	: spill/evaporation rate (kg/s)
126	255	166	381	: spill duration (s)
-99.9	-99.9	-99.9	-99.9	: total released (kg)
1.0e+06	1.0e+06	1.0e+06	1.0e+06	: initial concentration (ppm)
0.897	0.898	0.895	0.891	: ambient pressure (atm)
13.2	17.5	14.8	21.3	: relative humidity (%)
302.03	303.63	307.07	305.63	: ambient temperature #1-lower (K)
0.82	0.82	0.82	0.82	: measurement height for temperature #1 (m)
303.31	304.31	307.05	306.90	: ambient temperature #2-upper (K)
16.19	16.19	16.19	16.19	: measurement height for temperature #2 (m)
304.8	303.8	304.8	304.0	: soil temperature (K)
3	3	2	1	: soil moisture (1:dry,2:moist,3:water)
7.73	5.54	7.60	4.64	: wind speed (m/s)
3.36	3.36	3.36	3.36	: measurement height for wind speed (m)
7.4	5.8	7.4	4.5	: domain-avg wind speed (m/s)
1.2	0.7	1.0	-99.9	: domain-avg sigma-u (m/s)
5.7	7.5	8.3	5.0	: domain-avg sigma-theta (deg)
2.0	2.0	2.0	2.0	: measurement height for domain-avg wind data (m)
180.	180.	180.	180.	: averaging time for domain-avg data (s)
0.003	0.003	0.003	0.003	: roughness length z0 (m)
-99.9	-99.9	-99.9	-99.9	: friction velocity u-star (m/s)
-99.9	-99.9	-99.9	-99.9	: bowen ratio estimate
-99.9	-99.9	-99.9	-99.9	: inverse Monin-Obukhov length (1/m)
1.0	4.0	70.0	1.0	: cloud cover (%)
4	4	4	5	: Pasquill-Gifford stability class (A=1;D=4;F=6)
36.7	36.7	36.7	36.7	: latitude (deg)
116.0	116.0	116.0	116.0	: longitude (deg)
1.	1.	1.	1.	: averaging time for peak concentration (s)
80.	160.	120.	300.	: averaging time for averaged concentration (s)
100.	100.	100.	100.	: concentration of interest for modeling (ppm)
1.	1.	1.	1.	: suggested receptor height for modeling (m)
2	2	2	2	: number of distances downwind
100.	100.	100.	100.	: distance downwind
800.	800.	800.	800.	: distance downwind
-99.9	-99.9	-99.9	-99.9	: distance downwind (terminal record: -99.9)
63260	109580	97250	84260	: max. conc. (ppm) based on tpeak
10950	18590	15630	20910	: max. conc. (ppm) based on tpeak
49943	83203	76881	57300	: max. conc. (ppm) based on tavg
8843	10804	7087	16678	: max. conc. (ppm) based on tavg
11.83	14.72	15.24	15.67	: sigma-y (m) based on tavg
61.79	88.19	73.4	85.99	: sigma-y (m) based on tavg