

# DUSTRAN: Assessing Atmospheric Dust Transport

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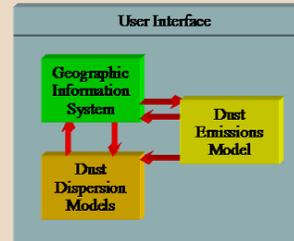
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## Background

Activities at military training and testing ranges can be sources of dust into air sheds governed by air quality regulations. DUSTRAN was developed to assist Department of Defense personnel in addressing particulate air quality issues at military facilities and to help manage dust-generating activities. DUSTRAN is a comprehensive atmospheric dispersion and deposition modeling system. It currently consists of emission models for vehicle- and wind-generated dust, a diagnostic meteorological model, and two EPA-regulatory dispersion models that are integrated seamlessly into Geographical Information System (GIS) software. A series of intuitively designed graphical user interface (GUI) screens leads a user through the process of specifying simulation parameters, including source locations and strengths. DUSTRAN automatically handles data flow for tasks such as domain specification, input file setup, model execution, and processing and display of model output.

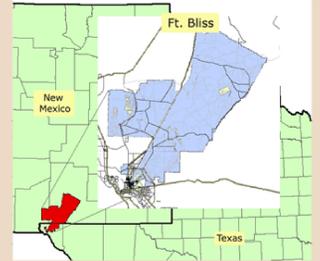
## Basic DUSTRAN Components

- Comprehensive dispersion modeling system fully integrated with ESRI's ArcMap GIS software.
- Basic components include:
  - CALMET meteorological model,
  - CALPUFF and CALGRID EPA-regulatory dispersion models,
  - Vehicular-generated dust emissions model based on field studies of military vehicles and AP-42 emission factors, and
  - Wind-blown dust emissions model based on soil texture and vegetation.



## Dust Plume Modeling at Ft. Bliss

- Ft. Bliss is a multi-mission, 1.12 million acre installation stretching over parts of Texas and New Mexico.
- Base Realignment and Closure (BRAC) Commission recommendations will increase personnel and equipment assigned to Ft. Bliss, requiring additional land areas for off-road training.
- DUSTRAN simulations were conducted to evaluate the potential for off-installation air-quality impacts from both existing and newly opened training areas and from unpaved supply routes.



## DUSTRAN Results vs. Field Observations

DUSTRAN concentration estimates compare very well with field observations of both vehicle- and wind-generated dust emissions. Field measurements from two case studies—Ft. Irwin, CA and Hanford, WA—are compared to DUSTRAN model results below.

### Vehicle-Generated Dust: Ft. Irwin, CA

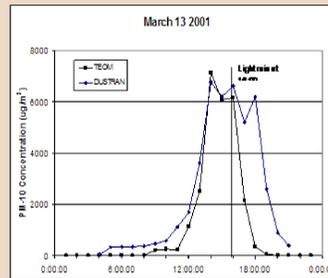
- July 14, 2001 0500–1500 PST vehicle move-out from cantonment prior to training operation.
- Military vehicle types include:
  - OPFOR: 298 HET trips, 24 Humvees, 33 5-ton trucks (67 km)
  - TF1: 96 HET trips, 50 Humvees, 50 5-ton trucks (12.5 km)
  - TF2: 96 HET trips, 50 Humvees, 50 5-ton trucks (23 km)

Measurement Location	Observed <sup>(a)</sup>	Modeled	Modeled (within 4 km)
Soda Mt.	1	1	1
Eastgate	3	1	1
EB2	3	1	2
Cemetery	4	3	4
EB1	5	1	2
SB2	10	3	10
SB1	105	90	150

(a) Minus upwind concentration of 12 µg/m<sup>3</sup>.

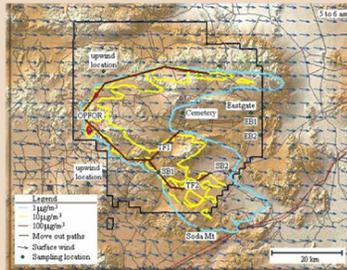
### Wind-Generated Dust: Hanford, WA

- Range fire June 27–July 2, 2000.
- Burned 700 km<sup>2</sup> of shrub-steppe habitat on Department of Energy Hanford site.
- Monitoring of PM10 initiated February 2001 because of increased wind erosion.
- Observations on March 13, 2001 indicate increasing PM10 concentrations occurring after 1200 PST. DUSTRAN simulations agree well with measured values.



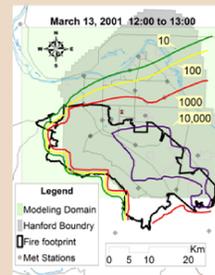
### Hour-Average Modeled PM10 Concentrations

- DUSTRAN predicted hour-average (0500–0600 PST) PM10 concentrations from military vehicle move-out training at Ft. Irwin on July 14, 2001.
- Nine measurement locations, three move-out paths (OPFOR, TF1 and TF2), and predicted PM10 concentration contours are shown.
- Highest observed and predicted concentrations (≈ 100 µg/m<sup>3</sup>) occur in the vicinity of SB1.



### Hour-Average Modeled PM10 Concentrations

- DUSTRAN predicted hour-average (1200–1300 PST) PM10 concentrations from wind-generated dust at Hanford on March 13, 2001.
- Fire footprint is shown as solid-black contour; predicted PM10 concentrations are shown as colored contours.
- Peak concentrations occur in the vicinity of the fire footprint due to lack of vegetation as well as the disturbed soil surface.



## Scenario Development: Vehicle-Generated Dust

- Ft. Bliss staff provided detailed GIS geo-reference data layers (e.g., roads, tank trails, training area boundaries, etc.) which were incorporated into DUSTRAN.
- A meteorological analysis was conducted; meteorological data from four representative weather periods were selected from 2005.
- Ft. Bliss and PNNL staff developed realistic move-out and combat training scenarios involving Heavy Brigade Combat Teams (HCBT) composed of 1112 military vehicles of various types.
- Potential contributions of military activities to the 24-hour average PM10 concentrations were determined.

### Move-Out Scenario

- One HCBT move-out from main cantonment to Dona Ana Range Camp on unpaved supply roads.
- Move-out begins at 0600 MST and is completed in 10 hours.
- Vehicle speeds conform to base regulations.



### Combat Training Scenario

- Two full HCBTs and one HCBT battalion train simultaneously in 3 different ranges.
- Combat training begins at 0700 MST and lasts 10 hours.
- Vehicle speeds and travel distances adhere to military training guidelines.



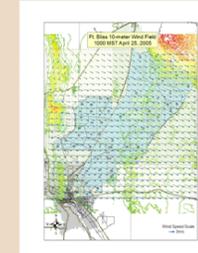
## Scenario Development: Wind-Generated Dust

- Ft. Bliss staff provided detailed GIS soils and vegetation data layers that were incorporated into DUSTRAN.
- High- and low-wind speed days were selected from archived meteorology to quantify expected range of wind-generated dust contributions to 24-hour average PM10 concentrations.

### Low Wind Speed Case



### High Wind Speed Case



## Summary

- DUSTRAN is a comprehensive dispersion modeling system giving practical answers to questions involving PM10 and PM2.5 regulatory issues, risk identification and mitigation measures.
- DUSTRAN can also be used to address other air quality dispersion modeling issues and emergency response situations.
- DUSTRAN is composed of scientifically-based emission modules and EPA-regulatory models integrated into an easy-to-use GIS interface.
- DUSTRAN operates on a Windows-based personal computer within a few minutes for several hours of simulated time. The system is for public distribution.

## Ft. Bliss Findings

- Under the same meteorological conditions, one HCBT move-out produces higher PM10 concentrations than combat training of multiple HCBTs.
- Impacts from move-outs are highly localized.
- Contributions to 24-hour average PM10 concentrations from military activities are higher under light winds because lofted particles stay in the area of generation and are not readily dispersed.
- Wind-generated dust contributions to 24-hour average PM10 concentrations can vary by an order of magnitude depending on wind speed.
- Wind- and vehicle-generated dust concentrations vary inversely as wind speed increases—concentrations from wind-generated dust increase, whereas concentrations from vehicle-generated dust decrease.

## Acknowledgements

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