DUSTTRAN: Assessing Atmospheric Dust Transport
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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. DUSTTRAN was developed to assist Department of Defense personnel in addressing particulate air quality issues at military facilities and to help manage dust-generating activities. DUSTTRAN 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 redesigned graphical user interface (GUI) screens leads a user through the process of specifying simulation parameters, including source location and strength. DUSTTRAN automatically handles data flow for tasks such as domain specification, input file setup, model execution, and processing and display of model output.

Basic DUSTTRAN Components
- Comprehensive dispersion modeling system fully integrated with ESRI’s ArcMap GIS software.
- Basic components include:
  - CALM95 meteorological model
  - CALPUFF and CALGRID EPA-regulatory dispersion models.
- Vehicle-generated dust dispersion model based on fuel studies of military vehicles and 48-42 emission factors.
- Wind-driven dust emissions model based on soil texture and vegetation.

DUSTTRAN Results vs. Field Observations
DUSTTRAN 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 DUSTTRAN 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:
  - OPF OR 296 HET trips, 24 Hummers, 33-5 trucks (87 km)
  - TF1: 96 HET trips, 50 Hummers, 50-5 trucks (125 km)
  - TF2: 96 HET trips, 50 Hummers, 50-5 trucks (23 km)
- Measurement strategies:
  - Sampling locations were selected on the basis of camp layout and vehicle movement patterns.
  - One HBT move-out from main cantonment to Dana Ana Range Camp on unsupplied supply roads.
- Measurements:
  - Range fire June 27-22, 2000
  - Buried 700 km² of shrub-dominated 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. DUSTTRAN simulations agree well with measured values.

Hour-Average Modeled PM10 Concentrations
- 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/m³) occur in the vicinity of S81.

Wind-Generated Dust: Hanford, WA
- Buried 700 km² of shrub-dominated 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. DUSTTRAN simulations agree well with measured values.

Hour-Average Modeled PM10 Concentrations
- DUSTTRAN predicted hour-average (1200-1300 PST) PM10 concentrations from wind-generated dust at Hanford.
- Road 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.

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

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 Realignments and Closures (BRAC) Commission recommendations will increase personnel and equipment assigned to Ft. Bliss, requiring additional land areas for off-road training.
- DUSTTRAN simulations were conducted to evaluate the potential for off-installation air-quality impacts from both existing and newly opened training areas and from unused supply routes.

Scenario Development: Vehicle-Generated Dust
- Ft. Bliss staff provided detailed GIS geo-referenced data layers, including on-road, off-road, training area boundaries, etc.
- A meteorological analysis was conducted; meteorological data from four representative weather periods were selected for 2006.
- Ft. Bliss and PMNS staff developed realistic move-out and combat training scenarios involving Heavy Brigade Combat Teams (HBCT) composed of 1121 military vehicles of various types.
- Potential contributions of military activities to the 24-hour average PM10 concentrations were determined.

Move-Out Scenario
- One HBCT move-out from main cantonment to Dana Ana Range Camp on unsupplied supply roads.
- Move-out begins at 0000 MST and is completed in 10 hours.
- Vehicle speeds conform to base regulations.

Combat Training Scenario
- Two full HBCTs and one HBCT battle 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 integrated into DUSTTRAN.
- High- and low-wind speed days were selected from historical meteorology to quantify expected range of wind-generated dust contributions to 24-hour average PM10 concentrations.

Low Wind Speed Case
- Ft. Bliss field studies conducted from mid-July to mid-August 2003.
- Under the same meteorological conditions, one HBCT move-out produces higher PM10 concentrations than combat training of multiple HBCTs.
- Impacts from move-outs are highly localized.
- Contributions to 24-hour average PM10 concentrations from military activities are much higher under high winds because lifted particles stay in the area of generation and are not readily dispersed.

High Wind Speed Case
- Under the same meteorological conditions, wind speeds increase by 10-20 mph, lifting particles much higher before dispersing.
- Wind and wind-generated dust concentrations vary inversely as wind speed increases—concentrations from wind-generated dust increase, whereas concentrations from vehicle-generated dust decrease.

Dust Findings
- Wind-generated dust contributions to 24-hour average PM10 concentrations can vary by an order of magnitude depending on wind speed.

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