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STRATEGIC ENVIRONMENTAL RESEARCH AND DEVELOPMENT PROGRAM (SERDP)
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Measurement and Modeling of Fugitive Dust from Off-road DoD Activities

(SISON-10-03: Fugitive Dust Emissions Due to Department of Defense Activities)

Abstract

Background: The U.S. Department of Defense (DoD) conducts military training and testing activities on approximately 30 million acres of land. These activities can create significant air quality challenges, including emissions of regulated particulate matter (i.e., PM_{10} and $PM_{2.5}$) and have the potential to impact the local and regional air quality. State/local regulatory agencies enforce the U.S. EPA-designated PM standards and can require reductions from sources which contribute significantly to PM concentrations in areas that exceed the National Ambient Air Quality Standards (NAAQS). Unfortunately, many military installations are located in, or near, existing or proposed air quality non-attainment areas. Accurately quantifying and assessing the particulate emission rates and near-source deposition, as a function of soil-specific, vehicle-specific, and activity-specific characteristics, is critical to understanding the impacts in the near-source area and the downrange area, especially at the installation fence-line.

Objective: The central goal of the proposed project is to utilize a combination of soil science, remote sensing, meteorological and traditional air quality sampling methods to accurately measure soil and surface characteristics, identify characteristics significant to fugitive PM emissions, develop emission factors based on those characteristics, test the validity of previously developed emission factors for vehicular traffic, investigate near-source particle transport and deposition, and measure and model fence-line concentrations from large area emission sources produced by military activities on DoD installations.

Summary of Process/Technology: The assembled collaborative research team consists of scientists from the USDA-ARS Engineering and Wind Erosion Research Unit (EWERU); Kansas State University, Biological and Agricultural Engineering Department (BAE); Utah State University, Department of Civil and Environmental Engineering (CEE); California State University, Chico, Departments of Physics and Geosciences (PG) and Space Dynamics Laboratory (SDL). These researchers will evaluate the $PM_{2.5}$ and PM_{10} emission and near-source deposition potentials for a variety of different vehicle type and soil/surface/vegetation combinations using remote sensing, traditional PM sampling, and soil science combined with dispersion and micrometeorological modeling.

The objectives will be achieved through a comprehensive set of tasks that are designed to obtain specific data required to: 1) adequately characterize changes in soil and surface conditions due to off-road military vehicle activities; 2) determine near-source deposition from generated emissions; 3) relate vehicle emission rates to vehicle and soil/surface properties; 4) monitor near-source plume development, dispersion and movement; and 5) measure incoming and outgoing PM at the installation fence-line.

Benefits: Limited field data are available on the impact of military activities on surface characteristics, fugitive emissions and fence-line concentrations of PM. Limited information is also available on the fate and transport of PM emissions from military training activities. This research will provide a critical step in understanding PM emissions from military activities and evaluating best management practices for mitigating fugitive dust emissions.

Transition Plan: Project results will be published in peer-reviewed publications. Results from the study will culminate in algorithms useful for assessing the susceptibility of soils and surface conditions to excessive fugitive dust and wind erosion emissions due to military training activities. Applications using research results will be presented at DoD workshops such as the Army Sustainable Range Program Workshop. We anticipate that improved PM-monitoring instrumentation will be developed that may be good candidates for ESTCP projects.

Technical Section

SERDP Relevance

Training activities at DoD facilities can present significant environmental challenges, including emissions of regulated atmospheric particulate matter (i.e., PM_{10} and $PM_{2.5}$). For example, a primary source of air quality degradation in terms of concentration and near-source visibility is the resultant airborne dust produced by military vehicles and related activities. Complicating matters is that many military installations are located in, or nearby, existing or proposed air quality non-attainment areas. These concerns elevate the importance of accurately assessing and minimizing air quality impacts to maintain compliance with local, state and federal air quality targets.

A typical base range environmental manager needs to assess the following: 1) immediate training impact on and recovery rates for plants and soils on training lands; 2) training impact on PM emissions (mainly PM_{10} and $PM_{2.5}$); 3) wind erosion potential from both disturbed and undisturbed training lands; 4) effect of wind erosion and fugitive dust emissions from military activities on the entire base, particularly PM_{10} and $PM_{2.5}$ concentrations at the base boundaries and personnel and family facilities; and 5) minimizing the detrimental effects of training activities on the environment.

Unfortunately, very little data are available for assessing the immediate impact of military training and testing activities upon the soil, surface and vegetation status. The destruction of vegetation and surface crusts as well as pulverizing soil aggregates on the soil surface by military activities is documented but not adequately characterized (Veranth et al., 2008). Likewise, recovery rates of such surfaces following training activities have not been well studied. Even though fugitive dust emissions from military vehicles have been studied and measured by previous SERDP funded projects (SI-1190, SI-1191, SI-1399, and SI-1400), they have not been adequately correlated to the soil, surface and vegetative conditions present at the time of activity, as is apparent by the lack of such data in reports and articles resulting from previous SERDP projects (Gillies et al., 2005; Gillies et al., 2007; Veranth et al., 2008). In addition, while the near-source transport and deposition of the generated PM has been investigated and quantified from unpaved roads by Veranth et al. (2008) and Gillies et al. (2005), there has not been an attempt to quantify deposition from military off-road travel. Further, near-source deposition has not been adequately quantified in commonly used atmospheric dispersion models. Thus, downwind fence-line PM concentrations are not easily predicted from military training activities. We propose to perform field measurement campaigns at Ft. Riley and at least two additional DoD installations, which will be identified in consulation with SERDP management personnel based upon our experimental needs and the installation's potential impact on nearby air quality issues. Candidate DoD installations include Ft. Irwin, 29 Palms, Camp Pendleton, Fort Carson, Fort Bliss, Fort Sill, Yuma Proving Grounds and Yakima Training Center.

The research proposed attempts to address all of the above listed deficiencies and has assembled a team of researchers with the background and special expertise to conduct specific experiments developed to meet the SERDP objectives. USDA-ARS Engineering and Wind Erosion Research Unit (EWERU) has decades of experimental research in wind erosion (Zingg and Chepil, 1950; Woodruff, 1971; Hagen and Woodruff, 1975; Hagen, 1984; Skidmore and Layton, 1988; Hagen, 1996; Mirzamostafa, 1998; Hagen and James, 1999; Wagner and Hagen, 2001; Hagen, 2001) and soil characterization experience (Chepil, 1950a, 1950b, 1951a, 1951b, 1951c 1958; Lyles, et al. 1970; Skidmore and Powers, 1982; Wagner and Ding, 1993, 1994; Wagner and Nelson, 1994) on agricultural lands. They have also developed the physically based Wind Erosion Prediction System (WEPS) model which estimates wind erosion soil loss and direction based upon the daily simulated changes to the surface, soil and vegetation state based upon climatic and management effects on the study site. The Space Dynamics Laboratory (SDL), Logan, Utah has developed a three-wavelength lidar (AgLite) to capture the concentration and dynamics of plumes (on a 10-meter scale) and, in concert with researchers from the Utah State University (USU) Department of Civil and Environmental Engineering, has demonstrated the ability to use the lidar to measure PM_1, $PM_{2.5}$, PM_{10} and TSP mass concentrations over areas up to 3 km^2 in a variety of agricultural settings (SDL, 2007; Bingham, et al. 2009; Marchant et al. 2009). SDL and USU personnel have also performed atmospheric dispersion modeling to calculate agricultural activity emission rates and factors using an inverse modeling approach (Martin et al., 2006; Martin et al., 2007). In addition, researchers from the Department of Biological and Agricultural Engineering (BAE) at Kansas State University have expertise in computational fluid dynamics (CFD) and inverse modeling approaches (Predicala and Maghirang, 2003; Brabec et al., 2005), and also have extensive experience in measuring fugitive emissions from large animal feeding operations (Guo et al., 2009; Razote et al., 2006, 2007a. 2007b, 2008).

Technical Objectives

The proposed project will be designed to specifically address the objectives in the Statement of Need (SoN). Specific tasks for each objective are as follows:

1. Improve understanding of fugitive dust emission potential from military activities.
    a. Characterize relevant temporal and intrinsic soil and surface properties, via laboratory wind tunnel tray studies, to measure total dust as well as PM_{10} emission potential on a range of disturbed and undisturbed military land soils.
    b. Collect soil and plant data from plot studies conducted on selected military sites before and after training activities and seasonally thereafter to determine both the impact of the activities on erodibility and the recovery times for the disturbed sites.
    c. Characterize and model individual military vehicle (tracked and wheeled) impacts on the changes in temporal surface and soil properties as functions of the intrinsic soil properties and specific physical attributes/parameters of the vehicles involved.
    d. Use data collected in tasks 1a, 1b, and 1c to develop algorithms and incorporate them into the WEPS model to predict potential fugitive dust emissions by wind erosion for a range of training land conditions.
2. Improve prediction of fugitive dust transport and emission fluxes.
    a. Measure diffusion and deposition for a range of soil dust particle sizes in the near-field scale (a few hundred meters) over a range of meteorological, soil, vegetation, and terrain conditions using a portable wind tunnel (4x4½ ft cross-section and 36 ft length) with a particle feeder to generate controlled emissions.
    b. Measure emission, diffusion and deposition in the near-field scale by particle size from selected military vehicle (both wheeled and tracked) traffic for a range of surface conditions and develop $PM_{2.5}$, PM_{10}, and TSP emission rates for each type of vehicle investigated.
    c. Combine data from tasks 2a and 2b to model the transport and fate of PM (PM_{10} and $PM_{2.5}$) using computational fluid dynamics (CFD) to develop algorithms for estimating emission fluxes resulting from military activities in the near-field scale.
    d. Evaluate and enhance short-range dispersion models for fugitive dust emissions from DoD activities.
3. Improve DoD's ability to achieve source compliance and ambient fence-line monitoring for fugitive dust emissions at their installations.
    a. Develop and test a prototype, eye-safe, wind and PM sensing lidar, WindPod, for real time wind vector and fugitive dust concentration measurement suitable for monitoring area and installation fence-line PM levels.
    b. Develop a portable, integrated stand-alone PM measurement emission prediction system consisting of the hardware (WindPod, several optical particle counters, computer, etc.) and software component called VAEPRS (Vehicle Aerosol Emission Prediction System) that will monitor and predict fugitive dust generated by vehicle activities. (The data collected in

objectives 1 and 2 will be used to develop the input model data set, and the data collected in task 3b will serve as calibration/verification for the VAEPRS model.)

c. In parallel to some experiments conducted in tasks 2a and 2b, fully characterize fugitive dust plumes from emission sources using multiple lidar systems at different locations and with different measurement ranges in order to track changes in plume shape, movement, and concentration with downwind distance. (This task is a full-scale demonstration of a WindPod-like lidar system.)

Technical Approach (Background, Methods and Milestones)

Task 1a: Characterize relevant temporal and intrinsic soil and surface properties, via laboratory wind tunnel tray studies, to measure total dust as well as PM_{10} emission potential on a range of disturbed and undisturbed military land soils.

Background: The dust emission potential of a bare soil varies temporally and is controlled by surface roughness, response of the immobile crust and aggregates to breakdown forces as well as the amount, size distribution and wetness of the mobile aggregates. Thus, standardized laboratory wind tunnel tray experiments, commonly applied in wind erosion studies (Hagen, 2001) will be conducted to determine the dust emission potential for a range of soils on military facilities.

Methods: Samples will be collected samples from selected sites at cooperating DoD installations to obtain the desired range of soils. We propose to construct plots at Ft. Riley, and additional DoD installations. Some of these sites will be selected based upon their suitability for the plot studies outlined later. Other subsequent field studies in this project will also be carried out on subsets of these sample data set locations. Test variables would include aggregate size distribution, dry stability of aggregates and crusts, surface roughness, friction velocity, and amount of sand abrader applied. These experiments would demonstrate the relative significance of the soil temporal variables we propose to measure in the plot studies. Hypothetical examples of wind tunnel results are illustrated in Appendix Fig. 1.

Milestones: The laboratory wind tunnel tray study would provide data tables showing the following:

a) Intrinsic properties of test soils: Total sand (50-2000 μm), very fine sand (50- 100 μm), course silt (10-50 μm), fine silt (2-10 μm), clay (< 2 μm), organic matter, calcium carbonate, cation exchange capacity and fraction of non-erodible material >2000 μm (rock fragments).

b) Temporal properties of test soils: Surface roughness, dry aggregate and crust stabilities, fraction crusted, crust thickness, and aggregate size distributions on mass basis including cut points at >2000 μm, 840 μm, 100 μm, 50 μm and 10 μm.

c) Emission results of test soils: Calculated atmospheric wind speed at 10 m, friction velocity, total dust, PM_{10} and $PM_{2.5}$ emission mass to stability by wind alone, total dust, PM_{10} and $PM_{2.5}$ emission with various levels of sand abrader.

Task 1b: Collect soil and plant data from plot studies conducted on selected military sites before and after training activities and seasonally thereafter to determine both the impact of the activities on erodibility and the recovery times for the disturbed sites.

Background: Soil and vegetation characteristics are altered when exposed to known physical forces and also respond to naturally occurring changes (events) in the environment (e.g., weather). This behavior is influenced by both the intrinsic and temporal properties of the soil, surface state and vegetation type, size and population density. To determine these responses, long term (multi-year) field plots are proposed on selected DoD sites where measurements are made immediately before and after specified military activities and periodically afterwards (i.e., after precipitation events >10 mm and wind erosion) to pick up the effects of natural weather factors and specific environmental events (e.g., precipitation, wind erosion, etc.). Measurements taken over time can determine the effects of long-term use, short-term use and how quickly, if ever, a trafficked site returns to its initial state.

Methods: Field plot locations on cooperating DoD installations will be selected based upon the soil and vegetation mix, frequency, level, type and time of season for military vehicle activities, climate, etc. These sites will be part of the wind tunnel tray study as well to provide continuity of the data sets and reduce duplication of measurement data. Field plots will be setup and samples will be collected to measure intrinsic soil properties and the initial temporal properties. Plots will be both undisturbed and disturbed by vehicle traffic. Additional measurements of temporal properties will be conducted seasonally throughout each year and after specific environmental events (precipitation, wind erosion, etc.).

Characterization data will include soil surface aggregate size distribution, dry aggregate stability and random roughness measurements. Crust characteristics such as stability, thickness and amount of loose erodible material on them, as well as the extent of biotic crusts (lichen) will also be recorded. In addition, vegetation characteristics such as type, extent of cover, mass, height and population of plants will be taken. Meteorological data will be collected at the sites, using cell phone transmission of met data. Some of these plots will need to be identified (marked) as off limits for future military activity for the duration of the study. Other plots may have additional subsequent planned activity (additional controlled and/or uncontrolled vehicle traffic, etc.), but measurements will need to be taken immediately before and after this activity takes place.

Milestones: Prediction algorithms of average dust emission potentials and their seasonal range for various soil types based on weather and disturbance (trafficking) levels. Emission data from the lab study will be coupled with measurements from the field plot studies to develop the prediction algorithms (Appendix Fig. 1).

Task 1c: Characterize and model individual military vehicle (tracked and wheeled) impacts (via individual vehicle impacts) on the changes in temporal surface and soil properties as functions of the intrinsic soil properties and specific physical attributes/parameters of the vehicles involved.

Background: Fugitive dust from military vehicle traffic at off-road sites may come from both initial emissions during vehicle passage and from wind erosion initiated on the disturbed surface. In general, wind erosion from significant areas of bare, disturbed soil will have the largest likelihood of causing fence-line PM violations for a military installation.

Methods: The degree and area of soil disturbance caused by various military vehicles will be measured by treating vehicle disturbances as a series of processes that cause aggregate breakdown, crust disruption, surface roughening or smoothing, soil compaction and, if present, changes in vegetation cover. This is similar to the proven approach taken in the Wind Erosion Prediction System (WEPS) with respect to tillage operations impact on the soil and surface state (Wagner and Ding, 1993; Wagner, 2000). Measured parameters describing these processes will be developed based on intrinsic and temporal soil conditions and vehicle speed, weight, wheel/track coverage and other pertinent physical characteristics. Single and multiple vehicle passes will be used on a series of soil types. Developing parameters for individual processes allows one to simulate the final soil conditions after passage by arbitrary, but known, combinations of vehicles or even untested vehicles for which vehicle characteristics are known.

Milestones: Algorithms will be developed that predict changes in temporal soil and surface conditions resulting from military vehicle traffic and will be similar to those developed for tillage and other implements in the WEPS model. These results can then be combined with those developed under tasks

1a and 1b to estimate emission potential from a wind erosion event or due to military activity based upon task 2b experiments. In addition, these algorithms can be used in other models to predict the changes in the temporal soil and surface conditions due to military vehicle traffic, which in turn can be applied to algorithms for predicting emissions from subsequent military trafficking activities on those sites.

Task 1d: Use data collected in tasks 1a, 1b, and 1c to develop algorithms and incorporate them into WEPS model to predict potential fugitive dust emissions by wind erosion for a range of training land conditions.

Background: WEPS is a physically based, daily time step wind erosion model that updates the surface conditions due to climatic effects and management specified operations. Although developed primarily for agricultural conditions, the process-based design allows a wide range of management operations, including military vehicle activities, to be simulated if appropriately parameterized. Thus, the surface and temporal soil property changes caused by military traffic can be simulated within the model, allowing WEPS to be employed as a tool for predicting wind erosion susceptibility following military training activities.

Methods: Code the soil disturbance algorithms developed from task 1c into the WEPS model so that it can simulate the physical processes unique to both tracked and wheeled military vehicles. Then, develop the vehicle specific data records from the field data collected in task 1c. Likewise, code the algorithms developed from the soil property data collected in tasks 1a and 1b so that the impact of military activities upon the military installation soils are correctly assessed.

Milestones: An improved WEPS model appropriately modified for military installations for use in estimating the probability of wind erosion events and their intensity, based upon local historical meteorological data.

Task 2a: Measure particulate transport and deposition for a range of soil dust particle sizes in the near-field scale (a few hundred meters) over a range of meteorological, soil, vegetation, and terrain conditions using a portable wind tunnel with a particle feeder to generate controlled emissions.

Background: Suspended particles are transported by the movement of air masses. The mass of some particles is large enough to overcome the vertical movement of the air, causing them to be deposited on a surface and removed from the atmosphere. Additionally, the near-source transport and deposition of fugitive dust plumes from both wind erosion and military vehicles are significantly affected by downwind surface and meteorological conditions. The amount of particle deposition with size has only been investigated from unpaved road surfaces at two locations under two meteorological conditions (Gillies et al., 2005; Veranth et al., 2008), and results of deposition studies of fugitive dust emissions from off-road areas were not available in literature.

Methods: A series of at least 3-5 transport and deposition studies will be carried out. Sites selected will include locations previously chosen for the field plot and laboratory wind tunnel studies (tasks 1a and 1b) for consistency in the data set and the desired range of soil and surface conditions. To better control experimental variables, a portable wind tunnel with a solid floor and particle feeder will be used to emit plumes with known quantities and size distributions of suspension-size soil particles. Because the emissions are known and controlled, a mass balance of the deposition and downwind transport for various particle sizes can then be measured using remote sensors and horizontal (x,y) and vertical (z) arrays of point samplers.

Tapered element oscillating microbalances (TEOMs) equipped with either PM_{10} or $PM_{2.5}$ size selective inlets and filter-based portable MiniVol PM samplers equipped to sample $PM_{2.5}$, PM_{10}, or TSP particulate fractions will provide PM mass concentration data downwind of the source, while optical particle counters (OPCs), aerodynamic particle sizer (APS) spectrometers, a scanning mobility particle sizer (SMPS) spectrometer, and time-averaged measurements of aerodynamic particle size distribution using cascade impactors will provide both optical and aerodynamic particle size distribution data with increasing distance from the source. Other particle concentration and deposition measuring instruments, along with meteorological tower measurements, will also be installed downwind of the portable tunnel. Similar, though less numerous, instrumentation will be used upwind to establish background conditions. We will also deploy a unique three-wavelength lidar (AgLite) to capture the size distribution, mass concentration, and dynamics of the tunnel-generated plumes (on a 10-meter scale) over time and we will examine how plume characteristics change with increasing distance from the source and how that relates to particle deposition. What is unique about the Aglite measurement system is that through the incorporation of an array of point sensors SDL will be able to calibrate the lidar and measure actual particle size distributions and mass concentrations throughout the lidar field of view instead of the more conventional application of relative particle density. This approach provides the ability to measure entire plumes, including concentration, at high temporal and spatial frequency, a technical gap identified at the Workshop on Research Needs for Assessment and Management of Non-Point Air Emissions from Department of Defense Activities (HydroGeoLogic, 2008). The concentration fields mapped by the lidar and point sensors and the calculated particle losses due to deposition can also be used to evaluate the predictive capabilities of dispersion models with respect to size distribution and mass concentration.

Test variables will include a range of atmospheric wind speeds and stabilities along with at least two selected particle size distributions emitted from the tunnel. Other test variables will include soil type and a range of downwind surface, vegetative and terrain conditions, which will influence near-source deposition rates. Samples will also be taken, if possible, from previously studied unpaved roads to compare/contrast with off-road samples. The surface characterization techniques will include aggregate size distribution, dry aggregate stability, and surface random roughness measurements. In addition, crust characteristics such as stability, thickness, and amount of loose erodible material on them as well as the extent of biotic crusts (lichen) can also be compared.

Milestones: Data required for developing algorithms for predicting dust deposition and determination of diffusion parameters in the near-field scale by particle size for a range of meteorological and surface conditions.

Task 2b: Measure particulate emission, transport and deposition in the near-field scale by particle size from selected military vehicle (both wheeled and tracked) traffic for a range of surface conditions.

Background: There is a tremendous range in off-road surface conditions that are subjected to military vehicle traffic during training operations. The majority of the PM emission rates and deposition values found in literature for military vehicles are derived from experiments conducted on unpaved roads (Gillies et al., 2005; Veranth et al., 2008). Additionally, one of the technical gaps identified at the Workshop on Research Needs for Assessment and Management of Non-Point Air Emissions from Department of Defense Activities was that algorithms for measurement-based emission factors need site and activity-specific measurable parameters (HydroGeoLogic, 2008).

Methods: We propose to carry out 2-3 intensive field sampling campaigns under different meteorological conditions, military activities, and surface conditions to measure and characterize PM emissions from the site. The field experiments will be conducted similar to those described in task 2a, but with the military vehicle being used as the PM generator (Appendix Fig. 2). Individual military vehicles will be exercised in both “controlled” and “typical” maneuvers. Both tracked and wheeled vehicles, varying in weight and type, will be evaluated under a range of speed, acceleration/deceleration, and turning radii conditions. Sites will be selected from those to be used in tasks 1a, 1b, and 2a for consistency in the data set and the desired range of soil and surface conditions, and sampling would occur immediately following the completion of studies using the wind tunnel as a plume generator.

Emission rates from each scenario will be calculated using several different methods. These vehicle-specific emission rates from each method can then be correlated with soil, surface, and vegetative conditions in order to develop algorithms that account for site and activity-specific conditions. One proposed method is the vertical profiling method. In this method, the upwind-downwind concentration profiles of PM will be measured. At the downwind boundary of the site, PM samplers will be arranged on a vertical structure to provide multi-point measurement of the plume. The sampler intakes will be arranged in a logarithmic configuration (e.g., 1, 2, 4, and 8 m above the ground). The vertical structure will be made up of open scaffolds to minimize blockage to wind flow through the sampling area. PM_{10} concentrations will be measured with continuous federal equivalent method TEOM PM_{10} monitors and also with time-averaged MiniVol PM_{10} samplers. TSP and $PM_{2.5}$ concentrations will be measured with time-averaged MiniVol TSP and $PM_{2.5}$ samplers and will be used to establish the $PM_{2.5}/PM_{10}$ and $PM_{2.5}$/TSP ratios. These ratios, combined with the measured fluxes for TSP or PM_{10}, will be used to infer the fluxes of $PM_{2.5}$ from the site. If warranted, during the intensive sampling campaigns, the TEOMs will be reconfigured to continuously measure the vertical concentration gradients of TSP and/or $PM_{2.5}$, which can then be used to calculate the emission fluxes of TSP and/or $PM_{2.5}$. The PM concentrations will also be measured at the upwind boundary of the site at a height of approximately 2-3 m. The PM_{10} concentrations upwind will be measured with a TEOM and MiniVol PM_{10} sampler. Collocated with the TEOM PM_{10} and MiniVol PM_{10} samplers upwind of the source will be MiniVol TSP and $PM_{2.5}$ samplers.

In addition, with upwind/downwind concentration data, we will be able to back-calculate emission fluxes by using atmospheric dispersion models (e.g., AERMOD – AMS/EPA Regulation Model) through the inverse modeling approach. Inverse modeling compares measured pollutant concentrations with concentrations modeled with an assumed emission rate (measured concentration over modeled concentration) to determine a scalar by which the assumed model-input emission rate is adjusted to yield the actual emission rate. Due to the many assumptions required, however, an emission flux estimate from dispersion models is expected to have an uncertainty no better than ±50% (NRC, 2003). By applying this method, we will be able to establish the error associated with the atmospheric dispersion model, in connection with the vertical profiling method.

The Aglite lidar system will also be used to determine vehicle-specific emission rates. As stated earlier, the array of point sensors (both mass-based PM samplers and OPCs) located upwind and downwind of the facility will be used to calibrate the lidar signal to yield particle size distribution and mass concentration data across the lidar field of view. By scanning vertically on the up and downwind sides of the operation, nearly perpendicular to the mean wind direction, and horizontally over the area of interest, the lidar can measure the PM entering and leaving the virtual control volume established by the scans. The emission rate can then be calculated by applying a simple mass balance to the total aerosol mass passing through the upwind and downwind control volume faces, taking into account the wind speed and direction at the time of each scan.

The effects of surface conditions and military activities will be evaluated. Results will also be compared with published emission factors.

Milestones: Direct PM emission prediction algorithms for off-road military vehicle operations as a function of soil and surface conditions, vehicle speed, and other selected vehicle characteristics (tracked/wheeled, weight, surface coverage, exhaust location, etc.) and possibly operational modes (accelerating/stopping/turning). Emission rates from each vehicle will be calculated using several different methods.

Task 2c: Combine data from tasks 2a and 2b to model the transport and fate of particulate matter (PM_{10} and $PM_{2.5}$) using computational fluid dynamics (CFD) to develop algorithms for estimating emission fluxes resulting from military activities in the near-field scale.

Background: Numerical simulation involving computational fluid dynamics (CFD) has become a key tool for a broad range of research and industrial applications, involving flow fields and transport of air contaminants. It involves numerical simulation of the air flow field and particle transport to provide information on the transport and fate (including deposition or removal) of particles. Recent and ongoing work at KSU has used CFD modeling in predicting the fate and transport of particles in ventilated spaces (e.g., Predicala and Maghirang, 2003; Brabec et al., 2005) and the capture and dispersion of particles associated with shelterbelts in the vicinity of large beef cattle feedlots. The proposed research will apply a similar approach to develop a more detailed analysis of the dynamics of air flow near the ground and its influence on PM concentrations. Such investigation should provide a better understanding of the effects of different surface roughness levels, vegetation type, size, and density on the dispersion, transport, and deposition of airborne PM produced through wind erosion and/or military activities.

Methods: A general-purpose CFD code, FLUENT, (Fluent, 2002) will be used in the proposed research to simulate the airflow field and the transport of particles that are generated by wind erosion and military activities. The numerical simulation with CFD will involve: (1) generating a computational grid by dividing the flow domain into discrete control volumes and specifying applicable governing equations and boundary conditions (pre-processing), (2) discretizing and integrating the governing equations using numerical techniques (solving), and (3) analyzing the output to obtain meaningful predicted values for the flow properties of interest (post-processing). A pre-processing software (GAMBIT 2.0, Fluent, Inc., Lebanon, NH) will be used to set up the physical geometry and generate the computational grid by subdividing the flow domain into control volumes. After initial solutions are obtained, the grid will be adapted by adding cells in regions of the domain with high gradients of flow properties (i.e., near inlets or boundaries) and increasing the grid size in regions with gradual change in flow parameters (i.e., far from boundaries).

Predicted results will be validated by comparing with experimental data from previously described controlled and vehicular emissions field tests (tasks 2a and 2b). The validated model will be used to examine the impact of surface conditions and meteorological conditions on the fate and transport of particles. In addition, it will be used to determine the potential of vegetative and manmade barriers in capturing PM emitted from the site.

Milestones: A validated numerical CFD model that predicts the fate and transport of particles in the near-field scale as a function of particle size and meteorological and surface conditions.

Task 2d: Evaluate and enhance short-range dispersion models for fugitive dust emissions from DoD activities.

Background: Determining the potential impact of fugitive PM emissions on areas downwind of DoD installations often requires a combination of monitoring and modeling of downwind PM concentrations. Models that can accurately simulate emission (i.e., suspension), transport (i.e., advection, diffusion/mixing), and removal (i.e., deposition) processes will provide the best tools for planning and projecting future scenarios. A wide variety of models are available for use to estimate the transport and dispersion of fugitive PM. The EPA has adopted AERMOD as the standard dispersion model for predicting downwind PM concentrations resulting from PM generating activities. In addition to AERMOD, other models that may potentially be used for estimating downwind and fence-line PM concentrations from DoD installations include ISCST3 and DUSTRAN. Limited research, however, has compared and validated the above models for DoD activities. Faulkner et al. (2008) also noted that differences between models may be significant, potentially by a factor of two or greater in the maximum modeled concentration, which is likely due to the different methods of determining the atmospheric dispersion parameters. Faulkner et al. (2008) found that ISCST3 model results were sensitive to changes in wind speed, temperature, solar radiation, surface roughness and mixing heights below 160 m and that AERMOD results were sensitive to changes in albedo, surface roughness, wind speed, temperature, and cloud cover. In addition, SDL's experience in running AERMOD has shown that the use of default input settings may cause great inaccuracy in predicted concentrations and that measured values are both more accurate and more desirable. Current work at KSU involves determining the applicability of AERMOD as a tool in back-calculating emission fluxes from cattle feedlots based on measured upwind/downwind concentrations and weather conditions.

Methods: The proposed research will examine the applicability of existing and candidate atmospheric dispersion models (e.g., AERMOD, ISCST3, DUSTRAN) in predicting the deposition and dispersion of fugitive PM and in predicting (or back-calculating) emission fluxes from DoD activities. The capabilities of the models will be compared for a wide range of scenarios and gaps in scientific contents will be identified. In addition, the models will be subjected to performance evaluation using a spectrum of field measurement observations in task 1c, covering an appropriate range of scenarios. The prediction algorithms for dust deposition and dispersion parameters developed in task 2c will be incorporated to enhance the accuracy and capabilities of the dispersion models.

Milestones: Enhanced short-range model to predict emission flux, dispersion, and deposition of fugitive PM from military operations will be developed. Successful development of these models would greatly assist in planning to achieve environmental compliance.

Task 3a: Develop and test a prototype, eye-safe, wind and aerosol sensing lidar, WindPod, for real time wind vector and fugitive dust concentration measurement suitable for monitoring installation fence-line PM levels.

Background: As part of ongoing efforts at the SDL, a small, stand-alone wind and aerosol sensing lidar called WindPod is being developed for deployment on small airplanes. WindPod is a combination of two technology concepts. The first is called EyePOD, which is a SDL airborne, jitter corrected, scanning mirror module designed for underwing mounting on aircraft. The second technology is Doppler Wind Lidar (DWL). Space Dynamics Laboratory is developing DWL as an eyesafe wind sensing technique that is used to measure the 3-D wind vector along the lidar's line of sight (Emmitt and O'Handley, 2003). In a separate investment and development effort, SDL is currently heavily committed to packaging a DWL into the EyePOD platform to create a new instrument called WindPod. Through careful analysis of the signal-to-noise ratio of the wind velocity spectrum it should be possible to also determine the average aerosol loading along that same line of sight, so that a single WindPod unit could measure both wind vector and aerosol loading. Appendix Figure 3 shows images of EyePOD.

Methods: Much of the WindPod instrument development is already underway through other SDL funded programs; therefore the basic instrument design has been determined. We propose to generate a separate WindPod instrument design specifically for deployment at DoD vehicle training facilities to be used for wind and aerosol monitoring. The wind and aerosol information received from this instrument will form a portion of the basic inputs for a real time aerosol emission prediction model. VAEPRS (VAEPRS will be discussed in next task 3b).

Milestones: A complete conceptual design for WindPod will include physical dimensions, key performance data and output data format.

Task 3b: Develop a portable, integrated stand-alone aerosol emission prediction system consisting of the hardware (WindPod, several OPCs, computer, etc.) and software component called VAEPRS (Vehicle Aerosol Emission Prediction System) that will monitor and predict fugitive dust generated by vehicle activities.

Background: We propose to merge the deliverables from the previous tasks to construct a stand alone aerosol emission prediction system with integrated hardware and software components. The acronym and name for this system is VAEPRS, which stands for Vehicle Aerosol Emission Prediction System. This system will be custom packaged to include a WindPod lidar that can be installed on a tower or mobile platform (like a humvee), several OPCs, and a computer with an embedded computer model for predicting downwind aerosol concentrations. The modeling software will be hardened so that a technician will be capable of running the VAEPRS suite with only modest training.

Presently, atmospheric lidar provides remarkable images and time-lapse animations. Observers have no difficulty seeing the wind-induced motion of aerosol structures in the resulting scan frames when they are animated. Similarly, observers can be quickly trained to identify aerosol plumes and atmospheric boundary layer depth. However, these tasks remain a subjective human process. Training a computer to do them objectively and automatically is the next step. Therefore, we propose a software development activity that will allow the derivation of quantitative products such as vector wind fields, streamlines, transport pathlines, aerosol plume boundaries and atmospheric boundary layer depth from the lidar imagery. This task is critical to achieving a highly reliable VAEPRS system.

The algorithms to automatically correlate time lapse images and extract vector wind fields and transport phenomena are currently in varying stages of technical readiness (Guerra 1999; Mayor and Eloranta, 2001). The project will complete the development of algorithms where necessary and transform them into software and reliable executable programs. For example, Mayor and Eloranta (2001) demonstrated how vector wind fields can be extracted from high performance elastic backscatter lidar data, but the software to do that is no longer available. Several methods to objectively determine the boundary layer height from lidar data have been documented and they must to be implemented and tested for use with WindPod.

Methods: Some of the key static inputs to the VAEPRS software will be the results of a soil survey of each training facility and the number and type of vehicles that will be involved in the training exercise (tasks 1 and 2). Some of the key real time inputs to VAEPRS will be local meteorological measurements (pressure, temperature, humidity), the aerosol and wind field information from WindPod, and measurements from two OPCs. All of the measurement hardware will be linked via wireless to the central VAEPRS computer so that the VAEPRS model can be continuously updated as the training operation progresses.

Milestones: The end product will be a system design that contains a hardware component consisting of a WindPod unit and two OPCs, and a software component called VAEPRS that will monitor and predict aerosols generated by vehicle activities.

Task 3c: Using multiple lidar systems, fully characterize fugitive dust from emission sources (selected military training activities), subsequent plume generation and near-source deposition due to downwind surface and terrain characteristics as well as monitor downwind visibility and installation fence-line PM_{10} and $PM_{2.5}$ levels.

Background: A comprehensive study will be undertaken to bridge the gap between soil properties and atmospheric transport modeling. The enabling technology to create this bridge is lidar. Our experience shows that a single lidar is usually not enough to capture the entire scope of dynamics. For aerosols and dust created by military vehicle activity we expect it will require three different lidar instruments, all operating simultaneously, to adequately capture the fast/slow timescale and short/long distance scale transport phenomena. In addition to these lidar measurements, we will perform a complete surface characterization, in situ particle sizing, and high frequency micrometeorological measurements. These will then be combined with existing and improved CFD modeling. This will allow us to compare measured and predicted levels of fugitive dust that propagates beyond the installation fence-line. Furthermore, because soil properties relevant to prolonged dust suspension are typically poorly characterized, there is a high uncertainty in the emission rates and predicted $PM_{2.5}$ and PM_{10} source contributions at downwind receptor test locations.

The important benefit from such a thorough study is that a strong experimental and theoretical link will be made between measured soil/surface properties and source/receptor models that can estimate the contribution of an activity to offsite $PM_{2.5}$, PM_{10} and TSP concentrations. This combination of measurement and theory will create an emissions model applicable to wheeled and tracked military vehicles which could eventually be applied across all DoD training facilities.

We employ proven in situ and remote sensing methods and integrate them into a reliable and deployable package to obtain dust suspension measurements for activities surfaces that are judged to cause the greatest potential for offsite impacts. Data acquisition, processing, and validation software are integrated with the measurement hardware to provide rapid and reliable integration of measurements from different continuous instruments and laboratory analyses. Relevant properties to be measured include—but are not limited to—particle size distributions at different heights and downwind locations, plume heights for different suspension causes, micrometeorological parameters that engender suspension, transport, and deposition, and chemical fingerprints in relevant size fractions. Acquired data will be used to develop and validate theoretical models that relate surface properties, activities, and meteorology to emission quantities and composition for relevant size fractions. The experiments will cover a sufficient range of variables to quantify confidence intervals when emission models are applied to less costly parameters measured at a large number of locations. The validated and documented database produced should be sufficient for use in testing source and receptor models that estimate off-site impacts of the dust emissions.

Methods: We will perform a whole-operation characterization of emissions due to vehicle operations. Concentrations and particle size distributions of aerosols will be measured a) upwind from vehicle operations, b) in the near vicinity of vehicle operation, and c) downwind from operations at the physical (or virtual) fence-line of a DoD facility. Due to the similarity in scope and logistical/monetary constraints, it is anticipated that this field experiment will be conducted in conjunction with the field experiments described in task 2b. A general diagram of the proposed study is shown in Appendix Fig. 4.

It cannot be over-emphasized that the level of detail required to address the aerosol issues facing DoD installations necessitates an extremely comprehensive survey of all available parameters. Such parameters include soil constitution, soil particle size distribution, soil stability, soil moisture, solar irradiance, area and micro meteorological conditions (e.g. pressure, temperature, humidity, wind). This effort will build upon tasks relevant to Objectives 1 and 2, insofar as EWERU will perform a complete soil characterization at the time of this campaign, and determine the emission potential for the facility under test. In addition, in situ measurements of aerosol concentration must be made across the entire operational area including an undisturbed upwind area where vehicle operations will not occur.

In situ sensors excel at providing measurements of specific quantities at a point in space. For example, a particle counter can provide the time history of aerosol particle concentration over a given particle size range per unit time for a single location. Unfortunately, it is not practical to install a sufficient number of point sensors to provide a complete picture of the spatial aerosol distribution. Therefore, atmospheric lidars will be used to provide two-dimensional images of optical aerosol scattering. It has been shown that the intensity of the aerosol backscattering measured by a lidar can be converted into the mass of suspended particulate material (Bingham, et al, 2009; Marchant, et al. 2009; Zavyalov et al., 2009). While the aerosol lidars do not provide all of the specific quantities as in situ sensors do, they excel at providing spatial information that is critical for the goals of this task. Furthermore, point sampling techniques can only generate accurate data near the Earth's surface and have been shown to inadequately represent more complex (and realistic) entrainment processes at elevations above ~10 m. (SDL, 2007). By using both point sensors and active remote sensors (lidars), a more comprehensive picture of aerosol character, transport, and dispersion can be obtained.

Also deployed at locations throughout the operations area will be over 40 different individual particulate and meteorological point samplers. Appendix Table 1 describes the available point samplers that can be used for this measurement. The point samplers are a critical component to this measurement because, as the only EPA approved method for measuring aerosol loading, the point samplers are used to calibrate the AgLite and REAL lidar return signals. Since the REAL system will also make simultaneous measurements of the same air volume as RusL, the REAL can be used to calibrate the RusL. In this way the proposed work will be able to quantitatively describe the aerosol emissions due to vehicle operations. Appendix Figure 5 shows the three lidar systems that will be used in this field operation. Appendix Figure 6 shows sample data from REAL and AgLite. Appendix Figure 7 shows PM_{10} and $PM_{2.5}$ concentrations in addition to the shape and size of the emission plume as measured by AgLite.

Milestones: A summary report that catalogs aerosol emission factor as a function of soil type and vehicle type and activity type. A critical conclusion from this report will be the identification of the few key observables that most strongly impact emission potential. This task feeds directly into task 3b.

Research Team

Dr. Larry Wagner is the PI of this project and will be responsible for coordination and execution of the entire project. Dr. Wagner is currently an Agricultural Engineer with 20 years experience at the USDA-ARS Engineering and Wind Erosion Research Unit. Dr. Wagner has researched the physical effects of tillage operations upon agricultural soils and their surfaces and vegetative cover with respect to wind erosion susceptibility and is the current leader of the WEPS modeling project.

Dr. John Tatarko is currently a Soil Scientist with 28 years experience at the Engineering and Wind Erosion Research Unit of the USDA-ARS and is also an Adjunct Professor in the Department of Agronomy at Kansas State University. His research interests include field and laboratory characterization of soil conditions affecting wind erosion, wind erosion simulation modeling, and weather driven and temporal changes in soil wind erodibility.

Dr. Mark Casada, P.E., is an Agricultural Engineer with USDA–ARS in Manhattan, Kansas. Prior to joining ARS he was an Assistant/Associate Professor for 10 years at the University of Idaho. He specializes in computer modeling of heat and mass transfer during grain drying and storage, having worked in CFD modeling, dust emissions from grain handling operations, and related grain storage and handling issues. He will work on CFD modeling of the transport and fate of particulate matter emitted from soils and on experimental emissions measurements.

Dr. Larry Hagen is a retired Agricultural Engineer formerly with USDA-ARS Wind Erosion Research Unit and is currently an official ARS collaborator. He has extensive (40+ years) experience in wind erosion mechanics, control practices and modeling. He will be providing advice and suggestions on both field plot design and setup of wind tunnel experiments. No SERDP funding is requested for these duties.

Dr. Ronaldo Maghirang is a professor in air quality engineering at the Department of Biological and Agricultural Engineering at Kansas State University. Current research includes measurement, modeling and control of air emissions from large area sources, including open beef cattle feedlots, and environmental and military applications of nanotechnology. Dr. Maghirang will provide leadership on CFD modeling of the fate and transport of particles and will also be involved in field measurement of particulate emissions.

Dr. James Steichen is a Professor of Biological and Agricultural Engineering and Associate Director of the National Institute for Land Management and Training at Kansas State University. He was PI of a SERDP project (SI-1339, completed in 2008) researching the impact of maneuver training on water quality and stream stability at Ft. Riley. He will spend 3 months on this project and will consult and may co-advise graduate and undergraduate students. He is familiar with military training land requirements and their relation to readiness.

Philip B. Woodford is the Fort Riley ITAM Coordinator. He will advise the research team and help coordinate activities at Army installations. He has over 30 years of experience with the military in engineering, environment, safety and natural resources. No SERDP funding is requested for these duties.

Dr. Michael D. Wojcik is currently the Branch Chief for Environmental Measurement at Space Dynamics Laboratory at Utah State University where his research interests are remote sensing of wind and aerosols as well as trace level detection of atmospheric gas species using molecular laser spectroscopy. Prior to working at Space Dynamics Laboratory Dr. Wojcik was a senior scientist at Pacific Northwest National Laboratory and worked to develop laser based chemical sensors, during which time he also served as an IPA at Dugway Proving Ground to provide expertise on chemical and biological warfare agent detection.

Dr. Randal S. Martin is an Associate Research Professor within the Department of Civil & Environmental Engineering at Utah State University in Logan, UT. Previous to his employment at USU, Dr. Martin was an Assistant/Associate Professor for eight years at New Mexico Institute of Mining & Technology in Socorro, NM. His current research interests center around characterization and measurement of fine particulate matter and agricultural contributions to air quality degradation. Dr. Martin has extensive experience in both ambient and source gas-phase pollutant and particulate measurement and characterization.

Dr. Shane Mayor is a research professor in the Departments of Physics and Geosciences at California State University, Chico. From 2003 to 2008, he served as scientist at the Earth Observing Laboratory at the National Center for Atmospheric Research, in Boulder, Colorado. Dr. Mayor conducted his PhD work, focusing on using volume image lidar (VIL) data to improve fine-scale numerical simulations of atmospheric boundary layer turbulence. Dr. Mayor then worked at NCAR through the Advanced Studies Program and the Atmospheric Technology Division to develop REAL, an eye-safe version of the VIL. Through a tech-transfer effort, commercial versions of REAL now operate for urban aerosol surveillance and at a military test range.

Dr. Tom Wilkerson, Ph.D. is a Senior Scientist at SDL and Research Professor (Physics Dept. and Center for Atmospheric and Space Science), Utah State University. He is also Professor Emeritus, Institute for Physical Science and Technology, Univ. of Maryland. He has over 50 years of experience in lasers, lidar remote sensing, advanced instrument development for laboratory and space experiments, and spectroscopy in support of astrophysical and atmospheric observations.

Kori D. Moore has performed air quality research work for seven years, with the last two at Space Dynamics Laboratory. Mr. Moore has been focused on agricultural impacts on air quality for nearly four years, including the quantification of fugitive dust emissions from tillage activities and confined feeding operations. He will charge 3 months per year to this proposed project for data collection, data analysis, and document preparation.

William J. Bradford is a Senior Environmental Engineer for Space Dynamics Laboratory at Utah State University. He has over 10 years of experience working in the research area of applied Environmental Engineering, including 2 years as an Environmental Engineer for the city of Logan, UT. His research expertise covers open channel flow hydraulic modeling; channel transport phenomena, aquatic habitat modeling, and most recently air quality and aerosol science.

Cooperative Development

The Space Dynamics Laboratory (SDL), a unit of the Utah State University Research Foundation, has a specific cooperative agreement (number 58-3625-4-121) with the United States Department of Agriculture, Agriculture Research Service (USDA-ARS), to measure the emissions and dispersion of gases and particulates from agricultural operations, thereby defining the operations that generate the emissions and identifying the practices that can help mitigate those emissions. The objective of the cooperative agreement is to work jointly to provide the data and analysis required to make increasingly large-scale agriculture production operations less objectionable. Specific objectives include the following: 1) develop new methods and improve existing methods of measuring emissions of particulate matter and gases from animal feeding operations, 2) develop and determine the effectiveness of management practices and control technologies to reduce emissions, and 3) develop tools to predict emissions and their dispersion across a range of animal production systems, management practices, and environmental conditions.

For the five years of the cooperative agreement, SDL and ARS have addressed these objectives as a multi-faceted program that includes a range of experimental and theoretical studies. The studies conducted are helping determine the particulate emission from livestock and cropping systems. SDL is also using their observations to refine existing dispersion models for more realistic conditions in agriculture. The years 2007 and 2008 have been very successful periods during which SDL has demonstrated their measurement techniques with the ARS.

The development of the WindPod is being funded jointly using SDL Internal Research and Development (IR&D) resources and USTAR (Utah Science and Technology and Research) funding directly from the State of Utah. The opportunity to accelerate this development and testing work for WindPod, through the outlined military site field studies, provides benefits for DoD by getting a system that could be used for monitoring particulate matter concentrations at their fence-lines without shouldering development costs of the hardware itself.

Transition Plan

Project results will be published in peer-reviewed publications generating at least 8 refereed manuscripts directly from tasks 1a, 1b, 1c & 1d, 2a & 2b, 2c, 2d, 3a, 3b and 3c respectively. Results from the study will culminate in algorithms useful for assessing the susceptibility of soils and surface conditions to excessive fugitive dust and wind erosion emissions due to military training activities. Applications using research results will be presented at DoD workshops such as the Army Sustainable Range Program Workshop.

Experiments from tasks 1a, 1b and 1c will obtain the necessary intrinsic and temporal soil properties as well as measured emission potential and seasonal variability from the test soils under a variety of weather and disturbance (trafficking) levels. The data relationships will be codified into algorithms which can be used to: a) relate the degradation of the soil and surface conditions due to military trafficking levels and b) relate the soil and surface recovery rates driven by pertinent weather events. These algorithms will be incorporated into the WEPS model for improved applicability to military conditions, but they can also be employed in other models as well.

The field studies (tasks 2a and 2b) are designed for determining near-source deposition rate data (by particle size) for a range of meteorological and downwind surface/vegetative conditions. This data will be used to develop improved algorithms for estimating near-source deposition from fugitive dust emission sources. These algorithms can either be used for determining better dispersion parameters for existing dispersion models or be incorporated directly into the models. Actual emission rates for specific military vehicles will also be determined from these studies (task 2b) and related directly to the soil and surface conditions present. This data will be parameterized and used directly in models such as WEPS and DUSTRAN. In addition, since this data will be parameterized based upon physical parameters of the military vehicles (weight, tires/tracks, etc.) and their operating conditions (speed, etc.), one can estimate additional emission rate data for untested vehicles based upon these measurable parameters.

A complete system will be designed and developed which includes hardware (WindPod) and software (VAEPRS) that will have the ability to monitor fence-line concentrations and predict fugitive dust generated by vehicle activities leaving the installation border downwind. We anticipate that this improved PM-monitoring instrumentation will also be a good candidate for ESTCP projects.

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Appendix: Proposed Schedule

Year 1:
Begin collecting samples for tasks 1a and 1b at Ft. Riley and begin processing data
Collect data for task 1c at Ft. Riley, some in conjunction with task 2b
Conduct tasks 2a and 2b at Ft. Riley
Begin task 3a

Year 2:
Continue collecting samples for task 1b from Ft. Riley
Collect samples for tasks 1a and 1b from at least two more installations and process data
Collect data for task 1c from at least two more installations, some in conjunction with task 2b
Conduct tasks 2a and 2b from at least two more installations
Collect data for task 3c, in conjunction with task 2b at one installation
Continue task 3a
Begin task 3b

Year 3:
Continue collecting samples for task 1b from previous installations
Complete task 1d
Complete tasks 2c and 2d
Complete tasks 3a and 3b
Dissemination of results

Timeline:

The project is scheduled to begin in March 2010 and last 3 years. The first year will be dedicated to developing the field site and collecting field data from Ft. Riley. Year two will focus on collecting additional field data from at least two additional DoD installations. Year three will be primarily dedicated towards data analysis, software development and publication of results and final report.

Time		
Year	**Month**	**Objective(s)**
2010	March	Project begins
	March	Select soil/surface sampling sites (tasks 1a and 1b) on Ft. Riley
	March	Select tasks 2a and 2b sites on Ft. Riley
	March	Setup weather station for task 1b site(s) at Ft. Riley
	March	Begin tasks 1a and 1b sampling at Ft. Riley
	June	Quarterly field sampling for task 1b at Ft. Riley
	June	Transport portable wind tunnel and AgLite lidar to Ft. Riley
	June	Begin collection of portable wind tunnel generated dust events
	June	Begin collection of military trafficking dust generation events
	July	Finish collection of dust generation (portable tunnel & trafficking) data
	September	Quarterly field sampling for task 1b at Ft. Riley
	December	Quarterly field sampling for task 1b at Ft. Riley
	March-December	Analyze laboratory data collected at Ft. Riley
	October	Attend SAB meeting
	November	Attend SERDP Symposium
	December	Submit annual report

2011	February	Site trip to determine locations for DoD sites 2 and 3
	February	Select soil/surface sampling sites (tasks 1a and 1b) on DoD sites 2 & 3
	February	Select tasks 2a and 2b sites for DoD sites 2 & 3
	March	Setup weather station for task 1b site(s) at DoD sites 2 & 3
	March	Begin tasks 1a and 1b sampling at DoD sites 2 & 3
	March	Quarterly field sampling for task 1b at Ft. Riley
	June	Quarterly field sampling for task 1b at Ft. Riley and DoD sites 2 & 3
	June	Transport portable wind tunnel and AgLite lidar to DoD site 2
	June	Begin collection of portable wind tunnel generated dust events
	June	Begin collection of military trafficking dust generation events
	July	Finish collection of dust generation (portable tunnel & trafficking) data
	July	Transport portable wind tunnel and AgLite lidar to DoD site 3
	August	Begin collection of portable wind tunnel generated dust events
	August	Begin collection of military trafficking dust generation events
	August	Begin collection of task 3c military trafficking dust generation data
	September	Finish collection of dust generation (portable tunnel & trafficking) data
	September	Quarterly field sampling for task 1b at Ft. Riley and DoD sites 2 & 3
	December	Quarterly field sampling for task 1b at Ft. Riley and DoD sites 2 & 3
	March-December	Analyze laboratory data collected at Ft. Riley and DoD sites 2 & 3
	November	Attend SERDP Symposium
	December	Submit annual report
2012	February	Begin
	March	Quarterly field sampling for task 1b at Ft. Riley and DoD sites 2 & 3
	June	Quarterly field sampling for task 1b at Ft. Riley and DoD sites 2 & 3
	September	Completion of field sampling for task 1b at all DoD sites
	November	
	November	Attend SERDP Symposium
	December	Submit annual and final reports

The following table provides a general project timeline by major project tasks.

Task	**FY10**	**FY11**	**FY12**
Collection of field data for task 1a	XX	XX	
Conduct lab tunnel tray study (task 1a)	XXXX	XXXX	
Collection of field data for task 1b	XX X X	XX X X X	X X X
Analyze soil data in lab (task 1b)	XXXXXXXX	XXXXXXXXXX	XXXXXXXX
Characterize vehicle effects on surfaces (task 1c)	XX	XX	X
Incorporate relationships into WEPS (task 1d)		X	X
Portable wind tunnel diffusion studies (task 2a)	XX	XXXX	
Military trafficking diffusion studies (task 2b)	XX	XXXXXX	
CFD analysis (task 2c)	XXXXX	XXXXXXXXXX	XXXX
Dispersion model eval. with new data (task 2d)		XXXXXXXXXX	XXXXXXXX
Develop WindPod hardware and specs (task 3a)	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXX
Develop WindPod software (task 3b)		XXXXXXXXXX	XXXXXXXX
Field study for WindPod development (task 3c)		XXXXXX	
Develop yearly and final reports	X	X	XXX

Appendix: List of Acronyms

3-D	three Dimensional
AERMOD	AMS/EPS Regulatory MODel
APS	Aerodynamic Particle Sizer spectrometer
AMS	American Meteorological Society
ARS	Agricultural Research Service
BAE	Biological and Agricultural Engineering Department, Kansas State University
BSNE	Big Spring Number Eight sediment sampler
CEE	Department of Civil and Environmental Engineering, Utah State University
CFD	Computation Fluid Dynamics
DoD	U.S. Department of Defense
DUSTRAN	DUST TRANsport
DWL	Doppler Wind Lidar
EPA	U.S. Environmental Protection Agency
ESTCP	Environmental Security Technology Certification Program
EWERU	Engineering and Wind Erosion Research Unit
FEM	Federal Equivalent Method
FTIR	Fourier Transform InfraRed spectrometer
GIS	Geospatial Information System
IPA	Intergovernmental Personnel Act
IR&D	Internal Research and Development
ISCST3	Industrial Source Complex Short Term, version 3.0
ITAM	Integrated Training Area Management
KSU	Kansas State University
lidar	LIght Detection And Ranging
NAAQS	National Ambient Air Quality Standards
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NRC	National Research Council
OPC	Optical Particle Counter
PFPA	Pentagon Force Protection Agency
PG	Department of Physics and Geosciences, California State University, Chico
PI	Principle Investigator
PM	Particulate Matter
PM_1	Particulate Matter with an aerodynamic diameter less than or equal to 1.0 µm
$PM_{2.5}$	Particulate Matter with an aerodynamic diameter less than or equal to 2.5 µm
PM_{10}	Particulate Matter with an aerodynamic diameter less than or equal to 10 µm
PM_{course}	Particulate Matter with aerodynamic diameters between 2.5 and 10 µm
REAL	Raman shifted Eyesafe Aerosol Lidar
SERDP	Strategic Environmental Research and Development Program
SDL	Space Dynamics Laboratory
SMPS	Scanning Mobility Particle Sizer
SNR	Signal to Noise Ratio
SoN	Statement of Need
TEOM	Tapered Element Oscillating Microbalances PM sampler
TSP	Total Suspended Particulate
USDA	U.S. Department of Agriculture
USTAR	Utah Science and Technology And Research
USU	Utah State University
VAEPRS	Vehicle Aerosol Emission Prediction System

VIL	Volume Imaging Lidar
VSACEM	Vertical Soil Aggregate Crushing Energy Meter
WEPS	Wind Erosion Prediction System

Abbreviations

B.S.	Bachelor of Science
Corp.	Corporation
Dept.	Department
Dr.	Doctor
etc.	Ectetera
Fig.	Figure
Ft.	Fort
ft	foot
Hz	Hertz
Inc.	Incorporated
km	kilometer, $1x10^3$ meter
kw	kilowatt, $1x10^3$ watt
m	meter
min	minute
mm	millimeter, $1x10^{-3}$ meter
Mr.	Mister
M.S.	Master of Science
Ph.D.	Doctor of Philosophy
Univ.	University
µm	micrometer, $1x10^{-6}$ meters
V	volt

State Abbreviations

CA	California
CO	Colorado
DC	District of Columbia
KS	Kansas
MN	Minnesota
NH	New Hampshire
NM	New Mexico0
UT	Utah

Appendix: Supporting Technical Data

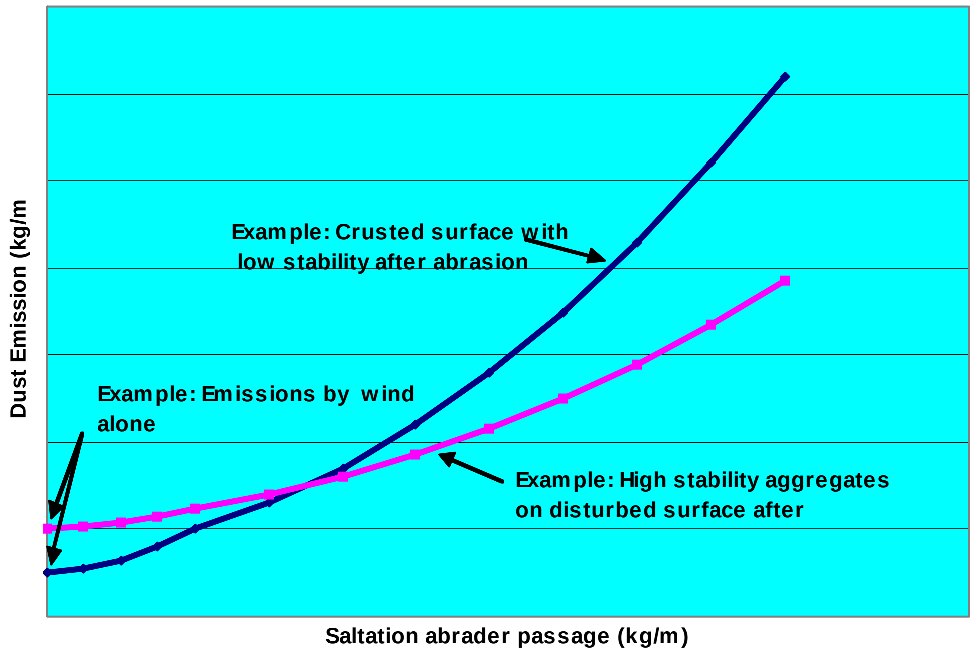

Figure 1: Hypothetical examples of lab wind tunnel test results on two differing soils.

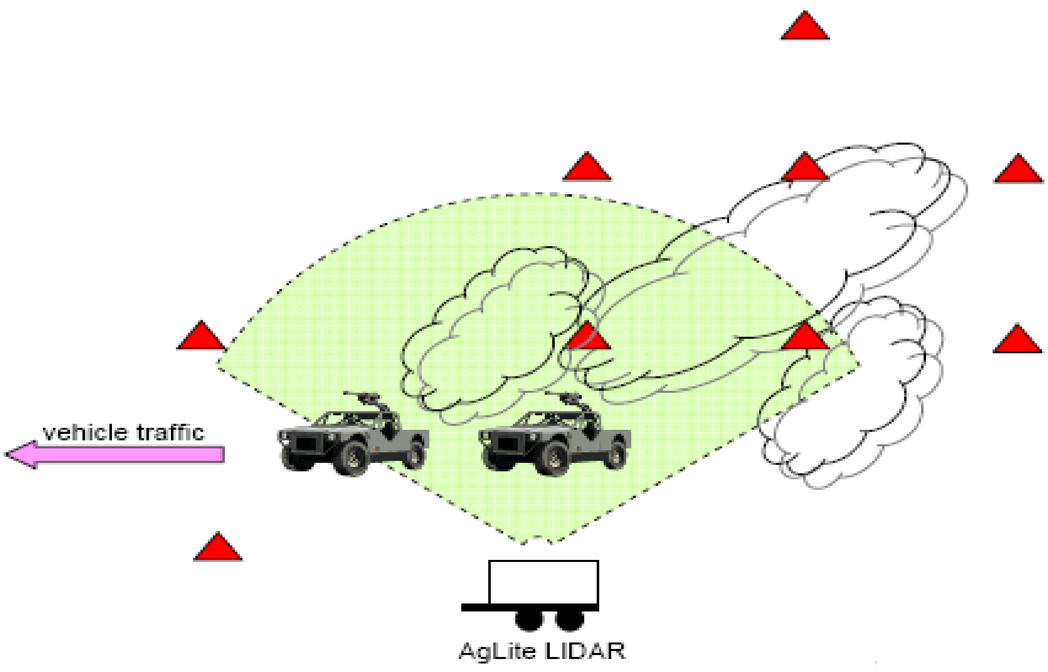

Figure 2. Possible configuration to measure the emission potential for vehicle traffic as a function of different soil types and traffic patterns. The red triangles represent the location of point sensors for ground truth and lidar calibration.

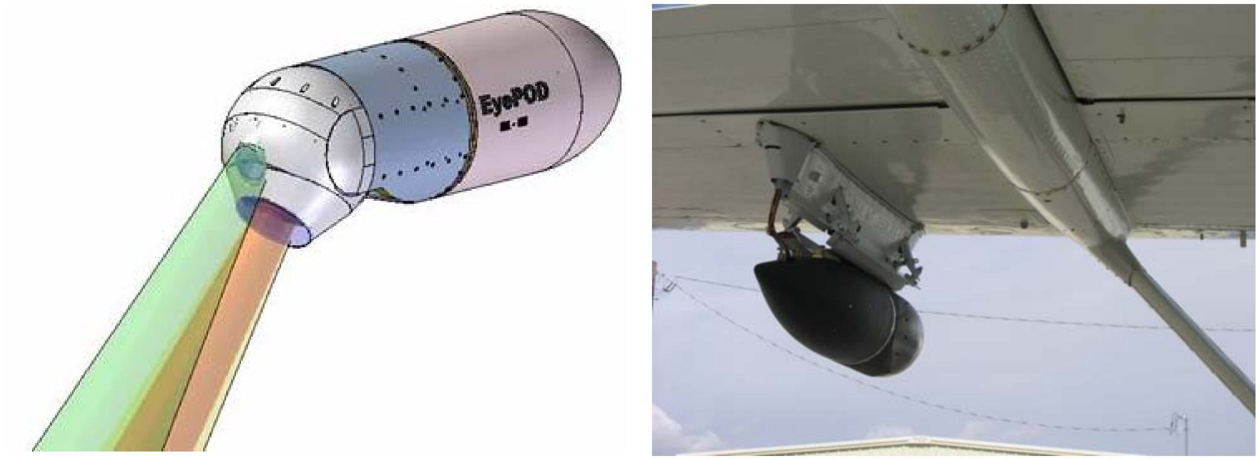

Figure 3. SDL's scanning airborne platform called EyePOD (left), EyePOD deployed underwing on an aircraft (right).

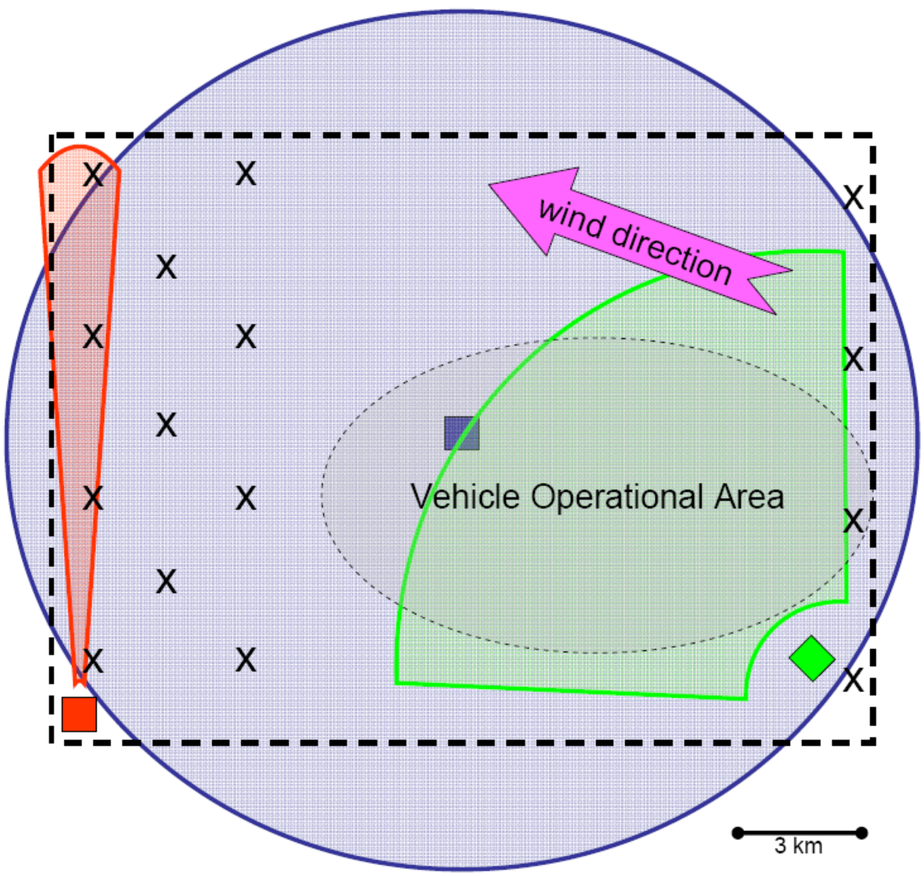

Figure 4. A conceptual design for a full facility characterization. The black dashed line represents the operational area, the large blue circle represents the field of regard for the REAL system, the red and green sectors represent the RusL and AgLite systems respectively. The colored squares indicate where each lidar is physically located. Xs mark locations for ground-based point sensors. The overall wind direction is indicated by the arrow. The distance scale is approximate.

Figure 5. left to right, AgLite, RusL, and REAL lidars. The REAL is unique in that it operates at 1.5 microns wavelength to provide high signal-to-noise ratio (SNR) elastic backscatter with eye-safety, and can typically "see" to ranges of 5 to 10 kilometers from a single pulse, REAL can scan 360º in azimuth and 0-45º in elevation. When scans from REAL are linked together this leads to time-lapse animations of the aerosol distribution. AgLite is a multi-wavelength, lidar with a range of 15 km, a range resolution of 10 meters and can scan over 280º of azimuth and 0–45º of elevation. AgLite was designed to measure the aerosol loading of the atmosphere in quantitative detail. When used in combination with just a few point sensors AgLite can determine the $PM_{2.5}$, PM_{10} and TSP mass loading over its entire field of regard. RUSL is a high-power lidar with a maximum range of 15 miles, a range resolution of ~10 m and the ability to scan over 360º of azimuth and 0–55º of elevation.

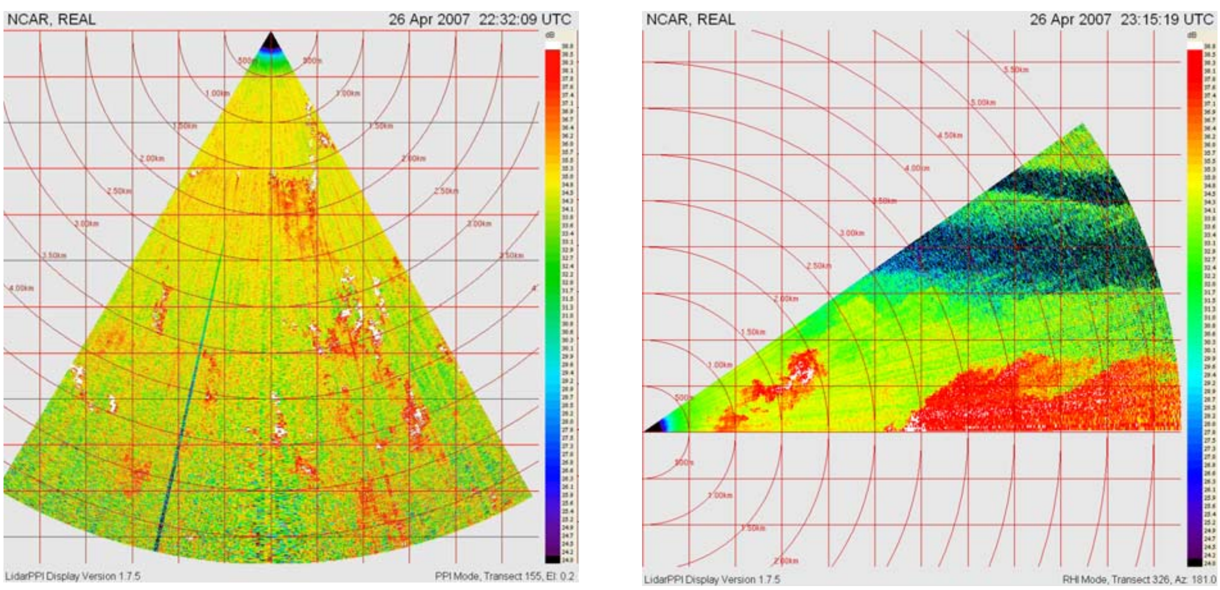

Figure 6: Sample REAL data, horizontal (left) and vertical (right) angular scans. Major divisions are at 500 m intervals. Plume features are clearly visible.

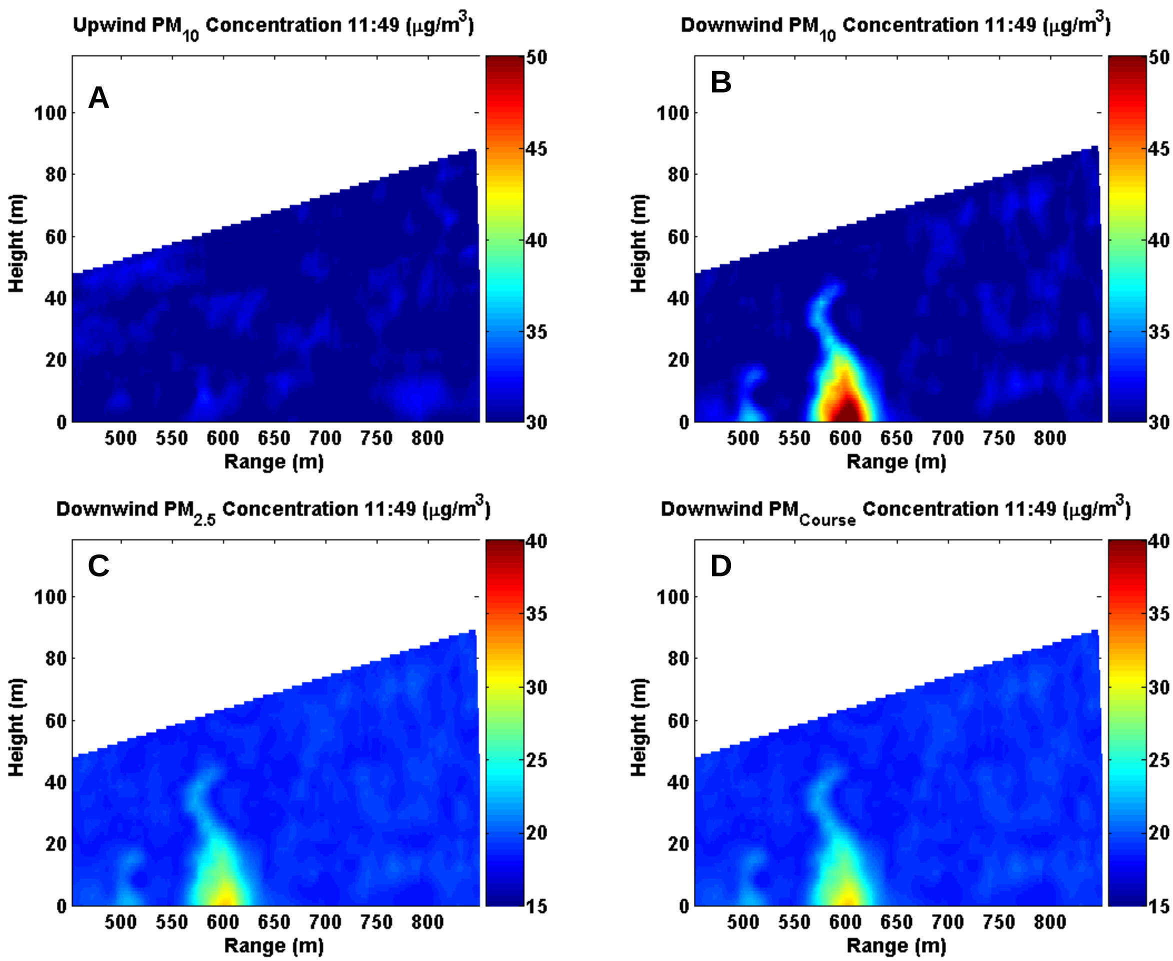

Figure 7. Sample AgLite data. Images of elevation scans representing particulate mass concentration fields of PM_{10}, $PM_{2.5}$; and PM_{course} (which is defined as PM_{10} - $PM_{2.5}$) from upwind (A) and downwind sides (B, C, and D) respectively. Plume features are clearly visible.

Appendix: List of Research Equipment

Table 1. Inventory of available SDL measurement instrumentation

Instrument	Quantity	What it provides
AgLite (lidar)	1	Real time PM, range to 20 km, confirmation of TSP fallout patterns
REAL (lidar) (Shane Mayor, Chico State)	1	Eye safe, fast frame rate, 360 deg view, wind feature visualization through dust plume shapes and movements
RusL (lidar)	1	Long range, downwind persistent plumes
Airmetrics MiniVol Portable Air Samplers	20	Mass concentrations for PM_1, $PM_{2.5}$, PM_{10}, or TSP, Mass Conversion Factor, chemical analysis of PM fractions
Met One Instruments Optical Particle Counters	12	Particle size distribution from 0.3 to >10 µm
Rupprecht and Patashnick Co. Inc Organic Carbon/Elemental Carbon Analyzer	1	Organic/inorganic carbon content of $PM_{2.5}$ or PM_{10}
Meteorology towers (15 m) equipped with 5 cup anemometers, 1 wind direction sensor, 1 temperature/humidity sensor and a data logger	2	Average met data, time stamped and automatically logged
Davis Weather Stations	3	Wind direction, wind speed, temperature, relative humidity, precipitation, insolation
HOBO Temperature Sensors and housings	10	Temperature, with on-board data logger
Aluminum towers	8 x 10 m 1 x 15 m	Mounting platforms for light-weight samplers
24 ft x12 ft enclosed trailer	1	The command post for field experiments, it has a heater/air conditioner, several computers, WiFi hub, and houses several of the aerosol measuring instruments.
California Measurements Quartz Crystal Microbalance Cascade Impactor	1	Real-time mass distribution in 10 stages from 0.05 to >10 µm aerodynamic diameter
Grimm Portable Aerosol Spectrometer	1	Size distribution of aerosol particles from 0.25 µm to 20 µm using 32 size bins, and collection of optically measured particles on a filter for mass or microscopic analysis
TSI Aerodynamic Particle Sizer	1	Size distribution of aerosol particles from 0.5 µm to 20 µm in aerodynamic diameter using 52 size bins
REMTECH Doppler Sodar	1	Three dimensional wind vector measurement from 50 m to 500 m in elevation in 5+ min averages
MDA Scientific FTIR Remote Sensor with telescope, retroreflectors (7), and	1	Open path FTIR spectrometer from 400-4000 cm^{-1}, scanning ability and multiple

scanning system		retroreflectors allow examination of multiple paths repeatedly
Gilian Gilibrator 2 Air Flow Calibration System	1	Used to check the flows of point samplers.
BIOS International Defender 520 Air Flow Calibration System	1	Used to check the flows of point samplers.

Table 2. Inventory of available KSU BAE Air Quality Laboratory measurement instrumentation

Equipment	Number of Units	Function
Tapered Element Oscillating Microbalance (Model 1400a, ThermoElectron) equipped with size-selective inlets for TSP, PM_{10}, and $PM_{2.5}$ – with climate-controlled outdoor enclosures	6	Real-time measurement of the mass concentrations of PM (TSP, PM_{10} or $PM_{2.5}$)
Aerodynamic Particle Sizer™ spectrometer (Model 3321, TSI Inc., Shoreview, MN) with dilution unit	1	Real-time measurement of the particle size distribution from 0.5 to 20 μm
Scanning Mobility Particle Sizer™ spectrometer (Series 3936, TSI Inc., Shoreview, MN)	1	Real-time measurement of the particle size distribution from about 10 nm to 1000 nm
Federal reference method (FRM) high-volume PM_{10} samplers	8	Time-averaged measurement of PM_{10} concentration
Mini-volume PM samplers equipped with size selective inlets for TSP, PM_{10}, and $PM_{2.5}$	12	Time-averaged measurement of PM concentrations (TSP, PM_{10} or $PM_{2.5}$)
Micro-orifice uniform deposit impactor (Model 100, MSP Corp., Shoreview, MN)	2	Time-averaged measurement of particle size distribution (0.056->18 μm)
Climet optical particle spectrometer with dilution unit	1	Real-time measurement of particle size distribution (0.3-15 μm)
Weather stations	2	Measurement of weather conditions
Instrument trailers	2	Transport and/or storage of instruments
Room-scale test chamber	1	Calibration and/or comparison of aerosol measuring instruments.

Table 3. Inventory of available USDA-ARS EWERU measurement instrumentation

Equipment	Number of Units	Function
Rotary Sieves (cuts of 44.45, 14.05, 16.35, 2.0, 0.84, 0.42 mm)	2	Measurement of soil aggregate size distribution
Vertical Soil Aggregate Crushing Energy Meter (VSACEM)	1	Measurement of soil aggregate and crust stability
Laser Distance Scanning System and Roughness Pin Meter	1 each	Measurement of soil surface roughness (oriented and random)

Portable Wind Tunnels with abrader material feeder	2	For generating selected wind speeds and applying desired abrader levels upon selected soil surfaces in the field
Outdoor Laboratory Wind Tunnel with abrader material feeder	1	For generating selected wind speeds and applying desired abrader levels upon selected soil surfaces in the lab
SWECO sieve system	1	For separating large quantities of suspension size material into selected sizes
10m meteorological towers with anemometers (@ selected heights, 10m, 2m, etc.)	2	Measurement of wind speed profiles
Meteorological station(s) with data acquisition system to measure wind direction, air temperature, relative humidity, solar radiation, and rainfall	2	Measurement of additional weather data required for WEPS
BSNE sediment catchers	>100 BSNE	Additional sediment flux measurements
Plant and residue measurement equipment, leaf area meter, sampling frame or steel tape	1 each	Measurement of plant material characteristics affecting wind flow and erosion
Soil characterization lab equipment including particle size distribution apparatus and sonic sieve systems	1 each	Measurement of additional soil characteristics affecting wind erosion
Loose material collection system	1	Characterization of soil crusts
Trailer mounted generator (15kW)	1	For providing power in the field
Honda portable generator (5kW)	1	For providing portable 110V power

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Education:

Ph.D	1984-88	Kansas State University, Manhattan, KS; Engineering
M.S.	1982-83	Kansas State University, Manhattan, KS; Agricultural Engineering
B.S.	1978-82	Kansas State University, Manhattan, KS; Agricultural Engineering

Experience:

1988-present	Agricultural Engineer, USDA-ARS, Manhattan, KS
1984-88	Grad. Teaching Asst., Kansas State Univ., Manhattan, KS
1982-88	Grad. Research Asst., Kansas State Univ., Manhattan, KS
1982	Designer, Caterpillar Tractor Company, Peoria, IL

Committees:

American Society of Agricultural and Biological Engineers
- 1990-present Member, SW-223 Erosion Control Research Committee
- 2001-2007 Member, M-141 Paper Awards Committee (chair 2007)

Soil and Water Conservation Society
- 1996-2000 Secretary/Treasurer, Manhattan Chapter

Kansas Crop Residue Alliance
- 1992-2006 Member, Board of Advisors

Kansas Technical Committee (NRCS)
- 2008-present Member

Other
- 2000-2001 Member, Organizing committee for international symposium, "*Soil Erosion Research for the 21st Century*" ASAE (Jan. 2-4, 2001)
- 1992-present Member, Graduate Faculty at Kansas State University, Manhattan, KS.

Accomplishments (1999-present):

Dr. Wagner serves as an Agricultural Engineer in the Engineering and Wind Erosion Research Unit, GMPRC, Manhattan, KS. The interdisciplinary research mission addresses all aspects of wind erosion, including: identification and quantification of physical processes; development of simulation prediction models; development and evaluation of control practices; and evaluating off-site impacts of soil erosion by wind. This research contributes to the ARS National Program Areas #203 (Air Quality) and #202 (Soil Resource Management). Within the research unit, the incumbent is part of a team conducting research on wind erosion processes, prediction, and control. Dr. Wagner leads a national multi-unit, multi-disciplinary core team (since Sep. 1999) assigned to develop, test, and deliver a new Wind Erosion Prediction System (WEPS). He provides special expertise on soil/residue/tillage interactions and leadership in both science and interface modeling issues as well as responsibility for the MANAGEMENT submodel component of WEPS.

Selected Relevant Publications:

Wagner, L.E., Ambe, N.M., and Barnes, P. *Tillage-induced effects on temporal soil properties.* ASAE Paper No. 91-2018, St. Joseph, MI. 21 pp. 1991.

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University of the Philippines at Los Baños, Philippines, M.S., 1986.
Pennsylvania State University, University Park, PA, Ph.D. in Agricultural Engineering, 1992.

Appointments
Professor, Department of Biological and Agricultural Engineering, Kansas State University, Manhattan, KS, 2004 - present.
Special Assistant to the Dean, College of Engineering, Kansas State University, Manhattan, KS, 2006 – 2007.
Associate Professor, Department of Biological and Agricultural Engineering, Kansas State University, Manhattan, KS, 1999 - 2004.
Visiting Scientist, Veterinary Programs in Agriculture and Department of Agricultural Engineering, University of Illinois at Urbana-Champaign, Urbana, IL, Fall 2000 (while on sabbatical from Kansas State University), and Summer 2002.
Assistant Professor, Department of Biological and Agricultural Engineering, Kansas State University, Manhattan, KS, 1994 – 1999.

Synergistic Activities
Division Program Chair, Structures and Environment Division, American Society of Agricultural and Biological Engineers (ASABE), 2005-08.
Associate Editor, Transactions of the ASABE and Applied Engineering in Agriculture, 2000-2009.
Program Chair, Third International Conference on Air Pollution from Agricultural Operations, October 2003, Raleigh, NC.
As Special Assistant to the Dean of Engineering, provided leadership on the activities of the Office of Student Services, Office of Recruitment & Leadership Development, Women in Engineering & Science Program (WESP), Multicultural Engineering Program (MEP), and Engineering Computing Services in the College of Engineering, Kansas State University.

Honors and Awards
Making a Difference Awards (3 awards in 2007 and 2 awards in 2008), Women in Engineering & Science Program (WESP), Kansas State University.
Outstanding Advisor Awards (2007-08 - Biological & Agricultural Engineering; 2007-08 and 2006-07 - Agricultural Technology Management), Department of Biological and Agricultural Engineering, Kansas State University.
Outstanding Paper Awards (3: Superior Paper – 2006; Honorable Mention Paper – 2004, 2007), American Society of Agricultural and Biological Engineers (ASABE).
2005 Engineering Research Excellence Award, College of Engineering, Kansas State University.
2002 Outstanding Professor, Advisor and Mentor Award, Mortar Board Senior Honor Society, Kansas State University.
2000 James L. Hollis Memorial Award for Excellence in Undergraduate Teaching, College of

Engineering, Kansas State University.
2000 Young Member Engineer of the Year, Mid-Central Section of the ASAE (for Nebraska, Kansas, Iowa, Missouri).

Recent Publications

Almuhanna, E., R.G. Maghirang, J.P. Murphy, and L.E. Erickson. 2009. Electrostatically-assisted particulate wet scrubber for controlling dust in livestock buildings. *Applied Engineering in Agriculture* (accepted).
Pjesky, S.C. and R.G. Maghirang. 2009. Relative chargeability of nanostructured and conventional particles by tribocharging. *Particulate Science & Technology* (in press).
Guo, L., R.G. Maghirang, E.B. Razote, J. Tallada, J.P. Harner, and W. Hargrove. 2009. Field comparison of PM_{10} samplers. *Applied Engineering in Agriculture* (accepted).
Maghirang, R.G. and E.B. Razote. 2009. Smoke dissipation with solid particles and charged water sprays. *Fire Safety Journal* (in press).
Yang, X., C. Cao, L. Erickson, K. Hohn, R.G. Maghirang, and K.J. Klabunde. 2008. Synthesis of visible-light-active TiO_2-based photocatalysts by carbon and nitrogen doping. *Journal of Catalysis* 260:128-133.
Boac, J.M., M.E. Casada, and R.G. Maghirang. 2008. Feed pellet and corn durability and breakage during repeated elevator handling. *Applied Engineering in Agriculture* 24(5):637-643.
Almuhanna, E., R.G. Maghirang, J.P. Murphy, and L. Erickson. 2008. Effectiveness of electrostatically-charged water spray in reducing dust concentration in enclosed spaces. *Transactions of the ASABE* 51(1):279-286.
Yadav, R., R.G. Maghirang, L.E. Erickson, B. Kakumanu, and S.G. Castro. 2008. Laboratory evaluation of the effectiveness of nanostructured and conventional particles in clearing smoke in confined spaces. *Fire Safety Journal* 43(1):36-41.
Zhang, N., Z.C. Zheng, and R.G. Maghirang. 2008. Numerical simulation of smoke dissipation with dispersed nanoparticle aggregates. *International Journal for Numerical Methods in Engineering* 74:601-618.
Mulukutla, R., P. Malchesky, R.G. Maghirang, J.S. Klabunde, K.J. Klabunde, and O. Koper. 2007. Metal oxide nanoparticles for smoke clearing and fire suppression. U.S. Patent No. 7,276,640.
Yang, X., C. Cao, K. Hohn, L. Erickson, R.G. Maghirang, D. Hamal, and K.J. Klabunde. 2007. Highly visible-light active C-, V-doped TiO_2 for oxidation of acetaldehyde. *Journal of Catalysis* 252:296-302. **[Selected as one of Top 25 Hottest Articles].**
Ingles, M.E.A., M.E. Casada, R.G. Maghirang, T.J. Herrman, and J.P. Harner III. 2006. Effects of grain-receiving configuration on grain commingling in a country elevator. *Applied Engineering in Agriculture* 22(5):713-721.
Razote, E.B., R.G. Maghirang, B.Z. Predicala, J.P. Murphy, B.W. Auvermann, J.P. Harner, and W.L. Hargrove. 2006. Laboratory evaluation of the dust emission potential of cattle feedlot surfaces. *Transactions of the ASABE* 49(4):1117-1124. **[Received 2007 ASABE Honorable Mention Paper Award].**
Brabec, D.L., R.G. Maghirang, M.E. Casada, and E.L. Haque. 2005. Characterization and modeling of a high-pressure water fogging system for grain dust control. *Transactions of the ASAE* 48(1):331-339. **[Received 2006 ASABE Superior Paper Award].**
Razote, E., R.G. Maghirang, L. Seitz, and I. Jeon. 2004. Characterization of volatile organic compounds on airborne dust in a swine finishing barn. *Transactions of the ASAE* 47(4):1231-1238.
Miller, G.Y., R.G. Maghirang, G.L. Riskowski, A.J. Heber, M.J. Robert, and M.E.T. Muyot. 2004. Influences on air quality and odor from mechanically ventilated swine finishing buildings in Illinois. *Journal of Food, Agriculture & Environment* 2(2):353-360.
Brabec, D.L., R.G. Maghirang, and M.E. Casada. 2004. Effectiveness of high-pressure, water fogging system in controlling dust emissions at grain receiving. *Transactions of the ASAE* 47(2):505-511.
Billate, R.D., R.G. Maghirang, and M.E. Casada. 2004. Measurement of particulate matter emissions

from corn receiving operations with simulated hopper-bottom trucks. *Transactions of the ASAE* 47(2):521-529.

Predicala, B.Z. and R.G. Maghirang. 2004. Measurement of particulate matter emission rates from mechanically ventilated swine barns. *Transactions of the ASAE* 47(2):557-565.

Predicala, B.Z. and R.G. Maghirang. 2003. Numerical simulation of particulate matter emissions from mechanically ventilated swine barns. *Transactions of the ASAE* 46(6):1685-1694. **[Received 2004 ASAE Honorable Mention Paper Award].**

Ingles, M.E., M.E. Casada, and R.G. Maghirang. 2003. Handling effects on commingling and residual grain in an elevator. *Transactions of the ASAE* 46(6):1625-1631.

Jerez, S.B. and R.G. Maghirang. 2003. Effectiveness of local supply ventilation in improving worker zone air quality in swine confinement buildings – a pilot study. *ASHRAE Transactions* 109 (Part 2):822-828.

Predicala, B.Z. and R.G. Maghirang. 2003. Field comparison of inhalable and total dust samplers for assessing airborne dust in swine confinement barns. *Applied Occupational and Environmental Hygiene Journal* 18:694-701.

Current Grants and Contracts

Principal Investigator, "Characterization and measurement of air emissions from large open cattle feedlot," USDA CSREES NRI, with S. Trabue, L. McConnell, J. Prueger, C. Hapeman, W. Schmidt, K. Ro, J. Harner, and W. Hargrove. April 2009 – March 2012. $399,981.

Principal Investigator, "Air quality: Reducing emissions from cattle feedlots and dairies," USDA CSREES (subcontract through Texas Agricultural Experiment Station), with W. Hargrove, J. Harner, and J. Pickrell. September 2008 – August 2009. $142,000.

Principal Investigator, "Impacts of water sprinkler systems on air quality at cattle feedlots," USDA CSREES NRI, with S. Trabue, L. McConnell, J.P. Harner III, W.L. Hargrove, and F. Mercurio. January 2007 – December 2009. $499,378.

Principal Investigator, "Improved handling of grain in commercial elevators," USDA ARS. July 2005 – June 2010. $63,800.

Principal Investigator, "Air quality: odor, dust and gaseous emissions from concentrated animal feeding operations in the Southern Great Plains," USDA CSREES (subcontract through the Texas Agricultural Experiment Station), with W. Hargrove, J.P. Murphy, J. Harner, and J. Pickrell. May 2002 – March 2009. $640,699.

Principal Investigator, "Improved sensing system for grain measurement and storage," USDA ARS, September 1, 2007 – August 31, 2010. $26,300.

Co-Principal Investigator, "Center for Nanostructured Materials for Indoor Air Quality," KSU Targeted Excellence Program, with S. Eckels, C. Sorensen, K. Klabunde, L. Erickson, D. Zollman, A. Chakrabarti, Z. Zheng, J. Pickrell, and G. Marchin. July 2007 – June 2010. $625,000.

Co-Principal Investigator, "Urban operations laboratory," US DoD (subcontract through M2 Technologies, Inc.), with L. Erickson, L. Glasgow, M. Hosni, K. Klabunde, Z. Zheng, S. Eckels, and others. August 2002 – March 2009. $8,173,000 (Amount for our research in BAE: $836,600).

Collaborator, "Air quality extension and education: enhanced learning opportunities for addressing air quality issues in animal agriculture," USDA CSREES NRI, with R. Stowell, D. Schulte, R. Koelsch, and others. February 1, 2007 – January 31, 2010. $498,562.

Michael D. Wojcik

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North Logan, UT 84341

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435.797.4109

Citizenship
Born 08 February 1974, Springfield, MA, United States

Security Clearance
DOD TS clearance granted November 2008
DOE Q clearance granted February 2006 (presently inactive)

Education
1992-1996, Rensselaer Polytechnic Institute, Troy, NY. B.S. Chemistry.
1996-2001, University of Idaho, Moscow, ID. PhD. Chemical Physics
2001-2003, JILA-NIST, University of Colorado, Boulder, CO. Post-doctoral Research Associate

Work History
2007-present, Space Dynamics Laboratory, Utah State University, North Logan, UT
Branch Chief and Senior Scientist for environmental measurements and modeling group.

2003-2007, Pacific Northwest National Laboratory, Richland, WA.
Senior Research Scientist, Chemical and Biological Sciences Group

May 2007-November 2007, Dugway Proving Ground, Dugway, UT.
Project Scientist, Chemical Test Division, 6-month IPA while working for PNNL

Teaching Experience
1998-1999, University of Idaho, Moscow, ID. Teaching Assistant for Physical Chemistry Laboratory.
1996-1998, University of Idaho, Moscow, ID. Teaching Assistant for General Chemistry.
1995-1996, Shaker High School, Latham, NY. Student teaching experience, General Chemistry, A.P. Chemistry, Earth Science.
1995, Doyle Middle School, Troy, NY. Student teaching experience, General Science.

Selected Peer Reviewed Publications
"A directly-dissociative stepwise reaction mechanism for gas phase peroxyacetic acid." BK Keller, MD Wojcik, TR Fletcher. Journal of Photochemistry and Photobiology A: Chemistry. Vol. 195, pp. 10-22, 2008

"External cavity quantum cascade laser for quartz tuning fork photoacoustic spectroscopy of broad absorption features." MC Phillips, TL Myers, MD Wojcik, BD Cannon. Optics Letters, Vol. 32 (9) pp. 1177-1179, 2007

"Gas Phase Photoacoustic Spectroscopy in the Mid-Wave Infrared Using Quartz Tuning Forks and Amplitude Modulated Quantum Cascade Lasers." MD Wojcik, MC Phillips, and BD Cannon, Applied Physics B, Vol. 85 (2-3), pp. 307-313, 2006

"Direct evidence for nonadiabatic dynamics in atom plus polyatom reactions: Crossed-jet laser studies of $F+D_2O \rightarrow DF+OD$" M. Ziemkiewicz, Michael D. Wojcik, D.J. Nesbitt Journal of Chemical Physics, Vol. 123 (22) 224307, 2005

"Using Lambda Doublet Ratios to Understand Collision Geometry in Direct Bimolecular Reactions" Michael D. Wojcik, T. Rick Fletcher. Journal of Chemical Physics, Vol. 117, pp. 1507-1510, 2002

"The Role of Translationally Excited Species in Atmospheric Reactions" T. Rick Fletcher, Michael D. Wojcik. Physics and Chemistry of the Earth, Part C Vol. 26/7, pp. 487¬493, 2001

Selected Invited Talks

"Laser Photoacoustic Spectroscopy of Chemical Weapons Using Quantum Cascade Lasers and Quartz Tuning Forks", 234th Anuual Meeting of the American Chemical Society. Boston, MA. 2007

"Laser Photoacoustic Spectroscopy of Chemical Weapons Using Quantum Cascade Lasers and Quartz Tuning Forks", Washington State University. Pullman, WA. 2005

"Quantum Cascade Laser Development Efforts for Implementation into Chemical and Remote Sensing Systems", Michael D. Wojcik, Tanya L. Myers, Matthew S. Taubman, Bret D. Cannon, Bryan Broocks, Trinesha Mosely. SPIE – Optically Based Biological and Chemical Sensing for Defence, London, UK. 2004

"Toward a Quantum Cascade Laser Photoacoustic Sensor: QC-LPAS", Michael D. Wojcik, Tanya L. Myers, Matthew S. Taubman, Bret D. Cannon, SPIE – Photonics West, San Jose, CA. 2005

Professional Organizations

SPIE. American Chemical Society, Air & Waste Management Association, Psi Alpha Upsilon,

Dr. Shane D. Mayor
Department of Geosciences and Department of Physics
California State University, Chico, CA 95929
Office: Holt Hall, Room 148, 530-898-6337, Cell: 720-938-1144
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Research Interests

Boundary layer meteorology. Development and application of atmospheric lidar systems. Aerosols and their impact on climate change, air quality, and national security.

Current Employment

Adjunct and Research professor in the Departments of Geosciences and Physics at California State University, Chico. Operate and maintain the Raman-shifted Eye-safe Aerosol Lidar (REAL). Conduct research in lidar, aerosols, and boundary layer meteorology.

Past Employment

2003—2008	Scientist, National Center for Atmospheric Research (NCAR)
2001—2003	NCAR Advanced Studies Program Postdoctoral Fellow
1996—2001	Graduate Student, University of Wisconsin Lidar Program
1994—1996	Associate Scientist, National Center for Atmospheric Research
1990—1993	Programmer/Analyst, Lidar Applications Group at NASA Langley
1989	Undergraduate student assistant, Research Aviation Facility, NCAR
1987—1988	Undergraduate student assistant, Control Data Corporation

Education

2001 Ph.D. in Atmospheric and Oceanic Sciences, University of Wisconsin–Madison. Dissertation: Volume Imaging Lidar Observations and Large-Eddy Simulations of Convective Internal Boundary Layers. Advisor : Dr. Edwin Eloranta

1995 M.S. in Meteorology, Saint Louis University. NCAR Cooperative Thesis: Evaluation of the NCAR Doppler Lidar and Applications to Measuring Boundary Layer Structure. Advisor : Dr. Donald Lenschow

1990 B.S. in Meteorology, Millersville University of Pennsylvania Professional

Memberships

American Meteorological Society (AMS)
American Geophysical Union (AGU)
Optical Society of America (OSA)
Society of Photo-Optical Instrumentation Engineers (SPIE)
The Institute of Electrical and Electronics Engineers (IEEE)

Professional Activities

Member of *Committee on Effectiveness of National Biosurveillance Systems: BioWatch and the Public Health System*. Institute of Medicine and National Research Council of the National Academies. July 2008—October 2009.

Co-host and co-chair of the 24th International Laser Radar Conference. 23-27 June 2008, Boulder, Colorado. Over 300 participants.

Chair of session on "Radar/Lidar Networks and Integration with other Instruments" at the Symposium on Recent Developments in Atmospheric Applications of Radar and Lidar. 88th Annual Meeting of the American Meteorological Society, New Orleans, 23 January 2008.

Member of the National Academies' *Committee on Testing and Evaluation of Biological Stand-Off Detection Systems* (2007). Coauthor of report: ISBN 13:978-0-309-11443-1 and 10:0-309-11443-8

Co-chair of session on "Boundary Layer and Mesoscale Studies" at the 7th International Symposium on Tropospheric Profiling. June 2006, Boulder, Colorado.

Co-chair of the American Meteorological Society's 2nd Symposium on Lidar Atmospheric Applications. January 2005, San Diego.

Member of American Meteorological Society's Committee on Laser Atmospheric Studies from 2003-2006.

American Meteorological Society Board Certified Consulting Meteorologist since 1999.

US Patents Pending

10/804,863	High Pulse-Energy, Eye-safe Lidar System, Mayor and Spuler. Filed 19 March 2004
11/291,505	Receiver for Eye-safe Lidar Systems, Spuler and Mayor. Filed 1 December 2005
11/459,267	Depolarization Measurement Capability on REAL, Mayor and Spuler. Filed 21 July 2006
11/459,269	Aerosol Backscatter Calibration Capability on REAL, Spuler and Mayor. Filed 21 July 2006

Partial list of peer-reviewed journal articles

De Wekker, S. F. J. and S. D. Mayor, 2009: Observations of atmospheric structure and dynamics in the Owens Valley of California with a ground-based, eye-safe, scanning aerosol lidar. Accepted to *J. Appl. Meteor. Clim.*

Mayor, S. D., P. Benda, C. Murata and R. J. Danzig, 2008: Lidars: A key component of urban biodefense. *Biosecur Bioterror*, **6**, 45-56, DOI: 10.1089/bsp.2007.0053.

Mayor, S. D., S. M. Spuler, B. M. Morley, E. Loew, 2007: Polarization lidar at 1.54-microns and observations of plumes from aerosol generators. *Opt. Eng.*, **46**, 096201, DOI: 10.1117/12.781902.

Spuler, S. M. and S. D.Mayor, 2007: Raman shifter optimized for lidar at 1.5-micron wavelength. *Appl. Optics*, **46**, 2990-2995.

Warner, T., P. Benda, S. Swerdlin, J. Knievel, E. Argenta, B. Aronian, B. Balsley, J. Bowers, R. Carter, P. A. Clark, K. Clawson, J. Copeland, A. Crook, R. Frehlich, M. L. Jensen, Y. Liu, S. Mayor, Y. Meillier, B. Morley, R. Sharman, S. Spuler, D. Storwold, J. Sun, J. Weil, M. Xu, A. Yates, and Y. Zhang, 2007: The Pentagon Shield Field Program Toward Critical Infrastructure Protection. *Bull. Amer. Met. Soc.*, **88**, 167-176. (DOI:10.1175/BAMS-88-2-167)

Lothon, M., D. H. Lenschow, and S. D. Mayor, 2006: Coherence and scale of vertical velocity in the convective boundary layer from a Doppler lidar, *Bound. Layer Meteor.*, **119**, DOI: 10.1007/s10546-006-9077-1.

Spuler, S. M. and S. D. Mayor, 2005: Scanning Eye-safe Elastic Backscatter Lidar at 1.54 microns, *J. Atmos. Ocean. Technol.*, **22**, 696-703.

Mayor, S. D., and S. M. Spuler, 2004: Raman-shifted Eye-safe Aerosol Lidar, *Appl. Optics*, **43**, 3915-3924.

Mayor, S. D., G. J. Tripoli, and E. W. Eloranta, 2003: Evaluating large-eddy simulations using volume imaging lidar data. *Mon. Wea. Rev.*, **131**, 1428-1453.

Mayor, S. D., P. R. Spalart, and G. J. Tripoli, 2002: Application of a perturbation recycling technique in a large-eddy simulation of a mesoscale convective internal boundary layer. *J. Atmos. Sci.*, **59**, 2385-2395.

Mayor, S.D. and E.W. Eloranta, 2001: Two-dimensional vector wind fields from volume imaging lidar data, *J. Appl. Meteor.*, **40**, 1331-1346.

Senff, C. J., R. M. Hardesty, R. J. Alvarez, S. D. Mayor, 1998: Airborne lidar characterization of power plant plumes during the 1995 Southern Oxidants Study, *J. Geophys. Res.*, **103**, 31173-31189.

Banta, R. M., C. J. Senff, A. B.White, M. Trainer, R. T. McNider, R. J. Valente, S. D. Mayor, R. J. Alvarez, R. M. Hardesty, D. Parrish, F. C. Fehsenfeld, 1998: Daytime buildup and nighttime transport of urban ozone in the boundary layer during a stagnation episode, *J. Geophys. Res.*, **103**, 22519-22544.

Sullivan, P. P., C.-H. Moeng, B. Stevens, D. H. Lenschow, and S. D. Mayor, 1998: Structure of the entrainment zone capping the convective atmospheric boundary layer, *J. Atmos. Sci.*, **55**, 3042-3064.

Cohn, S. A., S. D. Mayor, C. J. Grund, T. Weckwerth, C. Senff, 1998: The Lidars in Flat Terrain (LIFT) Experiment, *Bull. Amer. Meteor. Soc.*, **79**, 1329-1343.

Mayor, S. D., D. H. Lenschow, R. L. Schwiesow, J. Mann, C. L. Frush, and M. K. Simon, 1997: Validation of 10.6-micron CO2 NCAR Doppler lidar radial velocity measurements and comparison with a 915-MHz profiler, *J. Atmos. Ocean. Technol.*, **14**, 1110-1126.

Higdon, N. S., E. V. Browell, P. Ponsardin, B. E. Grossmann, C. F. Butler, T. H. Chyba, M. N. Mayo, R. J. Allen, A. W. Heuser, W. B. Grant, S. Ismail, S. D. Mayor and A. Carter, 1994: Airborne differential absorption lidar system for measurement of atmospheric water vapor and aerosols, *Appl. Optics*, **33**, 6422-6438.

Schwiesow, R. L., S. D. Mayor, V. M. Glover and D. H. Lenschow, 1990: Intersection of a sloping aerosol layer observed by airborne lidar with a cloud-capped marine boundary-layer, *J. Appl. Meteor.*, **29**, 1111-1119.

DR. JOHN TATARKO

Soil Scientist
USDA-ARS Engineering &Wind Erosion Research Unit
1515 College Avenue
Manhattan, KS 66502

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FAX: (785) 537-5507
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EDUCATION

1976 B.S. Agriculture, Stephen F. Austin State University, Nacogdoches, TX
1980 M.S. Soil Science, Texas Tech University, Lubbock, TX
1991 Ph.D. Soil Science, Kansas State University, Manhattan, KS

EMPLOYMENT HISTORY

2001 - present Soil Scientist, USDA-ARS Engineering & Wind Erosion Research Unit, Manhattan, KS

2003 - present Adjunct Faculty, Department of Agronomy, Kansas State University, Manhattan, KS

1998 - 2003 Research Assistant Professor, USDA-ARS Wind Erosion Research Unit and Kansas State University, Manhattan, KS

1998 - 2000 Instructor, Agronomy 635 – Soil Conservation and Management, Kansas State University, Manhattan, KS

1991 - 1998 Research Associate, USDA-ARS Wind Erosion Research Unit and Kansas State University, Manhattan, KS

1981 - 1991 Research Assistant, USDA-ARS Wind Erosion Research Unit (WERU), Manhattan, KS

PROFESSIONAL ORGANIZATION MEMBERSHIPS

Soil Science Society of America, International Erosion Control Association, Soil Conservation Society of America, American Society of Agronomy, Gamma Sigma Delta.

SIGNIFICANT HONORS AND AWARDS

USDA Certificates of Merit for superior performance, 2002, 2003, 2005, 2006 & 2008 and outstanding performance, 2004 & 2007.

USDA Certificate of Special Recognition and cash award in appreciation for contributions to the Weather Submodel, Main Program, and Training Manuals for the Wind Erosion Prediction System, April, 2005.

American Society of Agronomy, 2004 Educational Materials Awards Program, Certificate of Excellence in the Audio Video category for "Soil Erosion by Wind and its Control".

American Society of Agronomy, 2001 Educational Materials Awards Program, Certificate of Excellence in the Internet Web Sites category for "Kid's Field Day: A virtual site for kids to learn about agronomy".

USDA Certificate of Appreciation and cash award for outstanding contributions in planning, organizing, and conducting "Wind Erosion: An International Symposium/Workshop", June 1997.

SELECTED PEER-REVIEWED PUBLICATIONS

Tatarko, J. and N.A. Stefonick. 2007. Wind erodibility of biosolids - amended soils: A Status Report. Water Environment Federation. 12(5):12-15.

van Donk, S. J., L.E. Wagner, E.L. Skidmore, and J. Tatarko. 2005. Comparison of the Weibull model with a wind speed distributions for stochastic wind generation. Trans. of the ASAE. v48(2), pages 503-510.

Lui, L.Y., E.L. Skidmore, E. Hasi, L. Wagner, and J. Tatarko. 2005. Dune sand transport as influenced by wind directions, speed and frequencies in the Ordos Plateau, China. Geomorphology. 67:283-297.

Coen, G.M., J. Tatarko, T.C. Martin, K.R. Cannon, T.W. Goddard, and N.J. Sweetland. 2003. A method for using of WEPS to map wind erosion risk assessment of Albert soils. Environmental Modelling and Software. Vol. 19, No. 2, pp 185-189.

Tatarko, J. and L.E. Wagner. 2002. Using WEPS with measured data. In: Lee, J.A. and Zobeck, T.M. (eds), Proceedings of ICAR 5/ GCTE-SEN Joint Conference, International Center for Arid and Semiarid Land Studies (ICASALS), Texas Tech University, Lubbock, ICASALS Publication 02-2, pp. 282-284.

Tatarko, J., L.E. Wagner, and C.A. Boyce. 2001. Effects of overwinter processes on stability of dry soil aggregates. *In:* J.C. Ascough II and D.C. Flanagan, (eds.), Soil Erosion Research for the 21st Century - An International Symposium, ASAE, pp 459-462. ASAE, St. Joseph, MI.

Tatarko, J. 2001. Soil aggregation and wind erosion: processes and measurements. Annals of Arid Zone 40(3): 303-322.

SIGNIFICANT INVITED PRESENTATIONS

Walker, D.G., J. Tatarko, and D. Stenlund. 2008. Theory in practice: Wind erosion prediction system (WEPS). International Erosion Control Association Annual Meetings. 2006, Anaheim, CA; 2007, Reno, NV; & 2008, Orlando, FL.

Tatarko, J. 2007. Wind Erosion: Processes, control, and simulation. Invited Seminar to the faculty of The Center for Atmospheric Science of the National Autonomous University of Mexico. 29 March, 2007. Mexico City, Mexico.

Invited lecturer to the Department of Agronomy Soil Conservation and Management class at Kansas State University. Deliver lecture on topics of wind erosion damage, processes, and control and provide a tour of the wind erosion laboratory facilities. (2001–2008).

Invited lecturer to the Department of Biological & Agricultural Engineering class, Natural Resources Engineering at Kansas State University. Deliver a lecture on topics of wind erosion damage, processes, and control and provide a tour of the wind tunnel laboratory facilities. (2000 – 2009).

Invited to conduct a two-day WEPS training workshop for Canadian agricultural scientists of Agriculture and Agri-Foods Canada in Lethbridge, Alberta. (2000).

Invited to present a lecture titled "Wind Erosion: Processes and Control" to the Natural Resources and Environmental Science Capstone Course at Kansas State University. (2003).

Mark Casada

Lead Scientist and Agricultural Engineer – USDA-ARS, GMPRC, EWERU, 1515 College Ave. Manhattan, Kansas 66502; phone: 785-776-2758; fax: 785-537-5550; email: mark.casada@ars.usda.gov

Education

Ph.D., Biological and Agricultural Engineering (minor: Mechanical Engineering), North Carolina State University, Raleigh,1990

M.S., Agricultural Engineering, University of Kentucky, Lexington, 1985

B.S., Mechanical Engineering, University of Kentucky, Lexington, 1981

Professional Experience

1999–present, **Lead Scientist and Agricultural Engineer.** USDA–ARS, Grain Marketing and Production Research Center, Manhattan, KS. Lead scientist responsible for grain handling and storage research. Focusing on research on reducing dust emissions from grain handling operations, modeling temperature and moisture changes in stored grain, improved aeration control strategies, heat as a sanitation pre-treatment to control insects in on-farm grain bins, and identity preserved grain handling.

1999–present, **Adjunct Professor.** Kansas State University, Biological and Agricultural Engineering Department. Member of graduate faculty.

1990–1999, **Associate/Assistant Professor.** University of Idaho, Biological and Agricultural Engineering Department. Taught and conducted research on grain drying and storage, modeling of transport phenomena in crop storage and food engineering, and potato transportation. Member of graduate faculty.

1989–1990, **Research Assistant**, Biological and Agricultural Engineering Department, North Carolina State University. Studied the effect of livestock and poultry waste on global warming due to the greenhouse effect from increasing levels of atmospheric methane.

Major Committees

American Society of Agricultural Engineers (ASAE):

FPE-04, Publications Group, Chair, 2008 to present

FPE-702, Crop and Feed Processing and Storage committee, Chair, 2003–2005

FPE-704, Special Crops Processing, Chair, 1990–1991

American Society for Engineering Education (ASEE):

Biological and Agricultural Engineering. Division, Chair, 1999–2000;

Biological and Agricultural Engineering. Division, Proceedings Editor, 1998–1999

IWQC-II, International Wheat Quality Conference:

Advances in Processing Technology Technical Committee, Chair, 2000–2001

College Committees (University of Idaho):

Engineering Curriculum Committee, 1995-1999
Engineering College Strategic Planning Group, 1994, 1995

Major Committees (continued)

Department Committees (University of Idaho, Biological & Agricultural Engineering Department):
ABET 2000 Chair, 1998–1999
Curriculum Committee Chair, 1995–1999

Other Professional:
Industry Advisory Board, Biological Systems Engineering Department, Washington State University. 1998-1999
ASABE-FPEI Associate Editor (*Transactions of the ASABE*; *Applied Engineering in Agriculture*). 1997–present
NC-213 Multistate Research Project, "The U.S. Quality Grains Research Consortium," Chair, 2001–2002, 2009 to present

Theses Supervised

University of Idaho:

Alghannam, A. 1995. Safe rewetting of grain in the pacific northwest. M.S. Thesis.
Albaloushi, N.S. 1998. Tray drying of potato slices. M.S. Thesis.
Zhu, H. 2000. Control of soft rot during transportation of fresh potatoes. Ph.D. Dissertation.
Albaloushi, N.S. 2004. Heat and mass transfer during French frying. Ph.D. Dissertation.

Kansas State University (Co-Major Professor):

Billate, R. 2003. Dust emission and air entrainment during grain unloading. M.S. Thesis.
Ingles, M.E. 2005. Identity preservation of grain in elevators. Ph.D. Dissertation.
Tilley, D.R. 2007. Heat treatment for disinfestation of empty grain storage bins. M.S. Thesis
Boac, J.M. Expert system for identity preservation of grain. Ph.D. Dissertation (In Progress)
Tilley, D.R. Evaluation and economic modeling of incidence and spread of insects from bucket elevator leg boots. Ph.D. Dissertation. (In progress)

Honors and Awards

Member, Sigma Xi, Alpha Epsilon, Member, Pi Tau Sigma

ASABE Manuscript Reviewer Award, 2007. Outstanding reviewer for FPEI division of ASABE

ASABE Superior Paper Award, 2006, "Characterization and modeling of a high-pressure fogging system for grain dust control. *Transactions of the ASAE*. 48(1): 331-339. (top 2.5% of papers)

ASAE Paper Award 1995, "Model for heat and moisture transfer in arbitrarily shaped two-dimensional porous media" *Transactions of the ASAE.* 37(6):1927-1938. (top 5% of papers)

Recent Publications

Boac, J.M., R.G. Maghirang, and **M.E. Casada**. 200X. Effect of repeated handling on particle size distribution of grain dust emissions. In Press: *Transactions of the ASABE*.

Boac, J. M., **M.E. Casada**, and R.G. Maghirang. 2008. Feed pellet and corn durability and breakage during repeated elevator handling. *Applied Engineering in Agriculture* 24(5): 637-643.

Casada, M.E., M.S. Ram, and P.W. Flinn. 2008. Thermal design of shipping containers for beneficial insects. *Applied Engineering in Agriculture* 24(1): 63-70.

Casada, M.E., and P. R. Armstrong. 2008. Evaluation of fringing field capacitive sensor for wheat moisture measurements. ASAE Paper No. 085207.

McIntosh, R.B., and **M.E. Casada**. 2008. Fringing field capacitance sensor for measuring the moisture content of agricultural commodities. *IEEE Sensors Journal* 8(3): 240-247.

Tilley, D.R., **M.E. Casada**, and F.H Arthur. 2007. Heat treatment for disinfestation of empty grain storage bins. *Journal of Stored Product Research* 43(3): 221-228.

Tilley, D.R., M.R. Langemeier, **M.E. Casada**, and F.H. Arthur. 2007. Cost and risk analysis of heat and chemical treatments. *Journal of Economic Entomology* 100(2): 604-612.

Akdogan, H., and **M.E. Casada.** 2006 Climatic humidity effects on controlled summer aeration in the hard red winter wheat belt. *Transactions of the ASABE* 49(4): 1077-1087.

Ingles, M.E., **M.E. Casada**, R.G. Maghirang, T.J Herrman, and J.P. Harner III. 2006. Effects of grain receiving configuration on commingling in a country elevator. *Applied Engineering in Agriculture* 22(5): 713-721.

Akdogan, H., **M. Casada**, A. Dowdy, and B. Subramanyam. 2005. A novel approach for analyzing grain facility heat treatment data. *Journal of Stored Product Research* 41(2): 175-185.

Arthur, F.H., and **M.E. Casada**, 2005. Evaluation of temperature management strategies to control insects in stored wheat. *Applied Engineering in Agriculture* 21(6): 1027-1038.

Brabec, D.L., R.G. Maghirang, and **M.E. Casada**. 2005. Characterization and modeling of a high-pressure fogging system for grain dust control. *Transactions of the ASAE* 48(1): 331-339.

Billate, R.D., R.G. Maghirang, and **M.E. Casada**. 2004. Measurement of particulate emissions from corn receiving operations with simulated hopper bottom trucks. *Transactions of the ASAE* 47(2): 521−529.

Brabec, D.L., R.G. Maghirang, and **M.E. Casada**. 2004. Effectiveness of a high-pressure, water-fogging system in controlling dust emissions at grain receiving. *Transactions of the ASAE* 47(2): 505−511.

Current Grant Support

2009-2011, *Incidence and Spread of Insects from Bucket Elevator Leg Boots*. PI. Andersons Research Grant Program, Team Competition. ($146,000)

DR. RANDAL S. MARTIN

Associate Research Professor, Environmental Engineering
Department of Civil & Environmental Engineering
4110 Old Main Hill
Utah State University
Logan, UT 84322-411

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FAX: (435) 797-3663
E-mail:rmartin@engineering.usu.edu

EDUCATION

MONTANA TECH, Butte, Montana, B.S., Environmental Engineering, 1982
WASHINGTON STATE UNIVERSITY, Pullman, Washington, M.S., Environmental Engineering, 1989
Thesis: *Measurement of Isoprene and Subsequent Oxidation Products in an Eastern Deciduous Forest*
WASHINGTON STATE UNIVERSITY, Pullman, Washington, Ph.D., Civil Engineering, 1992
Dissertation: *Concentration and Flux Measurements of Biogenic Hydrocarbons from Forest Ecosystems*

EMPLOYMENT HISTORY

2000-present	Utah State University, Department of Civil & Environmental Engineering Logan, Utah, Associate Professor
1992-2000	New Mexico Institute of Mining and Technology, Department of Environmental Engineering, Socorro, New Mexico, Assistant/Associate Professor
1987-1992	Washington State University Pullman, Washington, Research Assistant I & II
1982-1987	Southern Research Institute Birmingham, Alabama, Assistant/Associate Environmental Engineer

AFFILIATIONS

Air and Waste Management Association
- Chair, Higher Education Division (2003-2007)
- Vice-Chair, Higher Education Division (2001-2003; 2007- present)
- Chair, Scholarship Awards Committee (1996-2001)
- Chair, Student Affairs Committee (2000-2002)

American Geophysical Union
- Editorial Board, Earth-In Space Journal (1995-2000)

American Society of Agricultural & Biological Engineers
Association of Environmental Engineering and Science Professors
American Chemical Society
Engineers Without Borders

RECENT & RELEVENT PUBLICATIONS AND PRESENTATIONS

Bingham, G.E., C.C. Marchant, V.V. Zavyalov, D.J. Ahlstrom, K.D. Moore, D.S. Jones, T.D. Wilkerson, L.E. Hipps, R.S. Martin, P.J. Silva, and J.L Hatfield (2009), Lidar based emissions measurements at the whole facility scale: Method and error analysis, J. Applied Remote Sensing, accepted for publication.

Marchant, C.C., T.D. Wilkerson, G.E. Bingham, V.V. Zavyalov, J.M. Anderson, C.B. Wright, S.S. Conelsen, R.S. Martin, P.J.Silva, and J.L. Hatfield (2009), Aglite lidar: A portable lidar system for investigating aerosol and wind motions at or around agricultural production facilities, J. Applied Remote Sensing, accepted for publication.

V.V. Zavyalov, C.C. Marchant, G.E. Bingham, T.D. Wilkerson, J.L. Hatfield, R.S. Martin, P.J. Silva, K.D. Moore, J. Swasey, D.J. Ahlstrom, and T.L. Jones (2009), Aglite lidar: Calibration and retrievals of well characterized aerosols from agfricultural operations using a three-wavelength elastic lidar, J. Applied Remote Sensing, in final (2nd) review..

Villanueva-Fierro, I., C.J. Popp, R.W. Dixon, R.S. Martin, J.S. Gaffney, N.A. Marley, and J.M. Harris (2008), Ground Level chemical Analysis of Air Transported from the 1998 Mexican-Central American Fires to the Southwestern USA, accepted for publication Jan. 2009, *Revista Internacional de Contaminacion Ambiental*, 1, Vol. 25.

Martin, R.S. (2008), Agricultural Ammonia & $PM_{2.5}$: A Case Study of Cache valleu, UT/ID, invited presentation, 2008 Air Toxics Summit: What's Up in the West: Coming of Age in Air Toxics, USEPA, Regions 10 & 8, Boise, ID, Aug. 4-7, 2008.

Martin, R.S., P.J. Silva, K. Moore, M. Erupe, and V.S. Doshi (2008), Particle Composition and Size Distributions in and around a Deep Pit Swine Operation, *J. Atmos. Chemistry*, 59(2), 135-150, Feb. 2008.

Watterson, T.L., J. Sorenson, R. Martin, R.A. Coulombe, Jr. (2007), Effects of PM2.5 Collected from Cache Valley, UT on Genes Associated with the Inflammatory Response in Human Lung Cells, *J. Tox. & Environ. Health*, 70, 1732-1744, Sept. 2007.

Hipps, L., J.H. Prueger, J. Hatfield, G.E. Bingham, E. Eichinger, T.D. Wilkerson, V.V. Zavyalov, R. Martin, and P. Silva (2006), Integrating Lidar and Atmospheric Boundary Layer Measurements to Determine Fluxes and Dynamics of Particulate Emissions from an Agricultural Facility, Proceedings, Workshop on Air Quality: State of the Science. Bolger Conference Center, Potomac, Maryland, June 5-8, 2006: 752-755.

Bingham, G.E., J. Hatfield, J.H. Prueger, T.D. Wilkerson, V.V. Zavyalov, R.L. Pfeiffer, L. Hipps, R. Martin, P. Silva, and W. Eichinger, (2006), An Integrated Approach to Measuring Emissions from Confined Animal Feeding Operations at the Whole Facility Scale. Proceedings, Workshop on Air Quality: State of the Science, Bolger Conference Center, Potomac, Maryland, June 5-8, 2006: 88-89.

Hipps, L., J.H. Prueger, J. Hatfield, G.E. Bingham, E. Eichinger, T.D. Wilkerson, V.V. Zavyalov, R. Martin, and P. Silva (2006), Integrating Lidar and Atmospheric Boundary Layer Measurements to Determine Fluxes and Dynamics of Particulate Emissions from an Agricultural Facility, Proceedings, Workshop on Air Quality: State of the Science, Bolger Conference Center, Potomac, Maryland, June 5-8, 2006: 752-755.

Zavyalov, V.V., G.E. Bingham, T.D. Wilkerson, J. Swasey, C. Marchant, C. Rogers, R. Martin, P. Silva, and V. Doshi (2006), Characterization of Particulate Emission from Animal Feeding Operations with Three-wavelength Lidar Using Simultaneous In-situ Point Measurements as Calibration Reference Sources, Proceedings, Workshop on Air Quality: State of the Science, Bolger Conference Center, Potomac, Maryland, June 5-8, 2006: 1263-1273.

Martin, R. (INVITED) (2006), Dairy-related emissions of ammonia and particulate matter and their influence on air quality in northern Utah's and southern Idaho's Cache Valley, Proceedings, Western Dairy Air Quality Symposium, Las Vegas, Nevada, March 21-22, 2006: 59-60.

Malek, E, T. Davis, R.S. Martin, and P.Silva (2006), Meteorological and Environmental Aspects of the Worst National Air Pollution (15 January 2004) in Logan, Cache Valley, Utah, U.S.A., J. Atmos. Res., 79(2), 108-122.

Villanueva, I., C.J. Popp, R.S. Martin (2004), Biogenic Emissions and ambient Concentrations of Hydrocarbons, Organic Acids, and Carbonyl Compounds from Ponderosa Pines and Cottonwood Trees at Rural and Forested Sites in Central New Mexico", Atmos. Env., 38(2), 249-260.

Martin, R.S., C. Popp, S. Huang, and R. Arimoto (2002), Groundlevel Measurements of Atmospheric Trace Species During and Subsequent to the 2000 Cero Grande (Los Alamos, NM) Fire, Paper No. 2002-46, Presented at the October 2002 meeting of the Rocky Mountain Section of the American Chemical Society, Albuquerque, NM.

Martin, R.S., R. Hunsaker, and C. Popp (2002), Ambient Air Criteria Pollutant Concentrations and Behavior at Canyonlands and Grand Canyon National Parks, Paper No. 2002-50, Presented at the October 2002 meeting of the Rocky Mountain Section of the American Chemical Society, Albuquerque, NM.

Popp, C.J., R.S. Martin, O. Wingenter, S. Huang, and B. Sive (2002), Haze Formation in the Southwestern United States, Paper No. 2002-49, Presented at the October 2002 meeting of the Rocky Mountain Section of the American Chemical Society, Albuquerque, NM.

Huang, S., R.S. Martin, C.J. Popp, and S. Schery (2002) Alpha-Particle Radioactivity in Aerosols During the 2000 Cerro Grande/Los Alamos Fire, Paper No. 2002-47, Presented at the October 2002 meeting of the Rocky Mountain Section of the American Chemical Society, Albuquerque, NM.

Popp, C.J., R.S. Martin, S. Huang, R. Arimoto (2000), Atmospheric Effects of Large Fires: Spring 2000 Cerro Grande, NM (Los Alamos) Fire, Paper AB52-06, presented at the Fall 2000 meeting of the American Geophysical Union, San Francisco, CA, Dec. 15-19, 2000.

Aimone-Martin, C.T. and R.S. Martin (2000), Effects of Temperature and Humidity on Airblast Sound Pressure Levels, *J. of Explosives Eng.*, 17(2), 34-40.

Martin, R.S., I. Villanueva, J. Zhang, and C.J. Popp (1999), Nonmethane hydrocarbon, monocarboxylic acid, and low molecular weight aldehyde and ketone emissions from vegetation in central New Mexico, *Environ. Sci. Technol.*, 33, 2186-2192.

Frost, G.J., M. Trainer, G. Allwine, M.P. Buhr, J.G. Calvert, C.A. Cantrell, F.C. Fehsenfeld, P.D. Goldan, J. Herwehe, G. Hübler, W.C. Kuster, R. Martin, R.T. Mcmillen, S.A. Montzka, R.B. Norton, D.D. Parrish, B.A. Ridley, R.E. Shetter, J.G. Walega, B.A. Watkins, H.H. Westberg, E.J. Williams (1998), Photochemical ozone production in the rural southeastern United States during the 1990 Rural Oxidants in the Southern Environment (ROSE) program, *J. Geophys. Res. - Atmos*., **103**(D17), 22491-22508.

Gaffney, J.S., N.A. Marley, R.S. Martin, R.W. Dixon, L.G. Reyes, and C.J. Popp (1997), Potential air quality effects of ethanol-gasoline blend fuel usage: A field study in Albuquerque, New Mexico, *Environ. Sci. Technol.*, 31, 3053-3061

KORI D. MOORE

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Space Dynamics Laboratory
1695 North Research Park Way
North Logan, UT 84341

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EDUCATION

M.S./B.S.	Civil and Environmental Engineering (Concurrent Program) UTAH STATE UNIVERSITY, Logan, UT	2007
M.S. Thesis	Derivation of Agricultural Gas-Phase Ammonia Emissions and Application to the Cache Valley	
B.S. Design Projects	▪ Senior Thesis: Feasibility Study of Constructing a Spawning and Rearing Channel on the Virgin River for Woundfin Minnow Population Restoration ▪ Air Quality Management: Feasibility Study of Implementing a Vehicle Inspection and Maintenance Program in Cache County, UT	

EMPLOYMENT HISTORY

2007 - Present	Space Dynamics Laboratory North Logan,UT *Environmental Engineer I*
2005 - 2007	Utah Water Research Laboratory Utah State University Logan, UT *Research Assistant*
2003 – 2005, Summers	Summer Undergraduate Research Experience, Global Change Education Program 2004, 2005 Aerodyne Research, Inc. Billerica, MA 2003 Pacific Northwest National Laboratory Richland, WA *SURE Fellow*
2002 - 2005	Utah Water Research Laboratory Utah State University Logan,UT *Research Technician*

AFFILIATIONS

Air and Waste Management Association
American Society of Agricultural and Biological Engineers
American Association of Aerosol Researchers

RECENT AND RELEVANT PUBLICATIONS AND PRESENTATIONS

Bingham, G.E., C.C. Marchant, V.V. Zavyalov, D.J. Ahlstrom, K.D. Moore, D.S. Jones, T.D. Wilkerson, L.E. Hipps, R.S. Martin, P.J. Silva, and J.L Hatfield (2009), Lidar based emissions measurements at the whole facility scale: Method and error analysis, J. Applied Remote Sensing, accepted for publication.

V.V. Zavyalov, C.C. Marchant, G.E. Bingham, T.D. Wilkerson, J.L. Hatfield, R.S. Martin, P.J. Silva, K.D. Moore, J. Swasey, D.J. Ahlstrom, and T.L. Jones (2009), Aglite lidar: Calibration and retrievals of well characterized aerosols from agfricultural operations using a three-wavelength elastic lidar, J. Applied Remote Sensing, in final (2nd) review.

Wojcik, M.D., G.E. Bingham, C.C. Marchant, V.V. Zavyalov, D.J. Ahlstrom, K.D. Moore, T.D. Wilkerson, L.E. Hipps, R.S. Martin, J.L. Hatfield, and J.H. Prueger. 2008. "Lidar Based Particulate Flux Measurements" Proceedings of the IEEE, IGARSS, Boston, MA: pp. IV, 263-266.

Going, C., G. Bingham, N. Pougatchev, E. Day, K. Moore, R. Martin, and E. Reese. 2008. "Multi Path FTIR Agriculture Air Pollution Measurement System," Paper Number 08, 2008 ASABE Annual International Meeting, Providence, Rhode Island, June 29-July 2, 2008.

Martin, R.S., P.J. Silva, K. Moore, M. Erupe, and V.S. Doshi. 2008. Particle Composition and Size Distributions in and around a Deep Pit Swine Operation, *J. Atmos. Chemistry*, 59(2), 135-150.

G.E. Bingham, R.S. Martin, V.V. Zavyalov, T.D. Wilkerson, C.C. Marchant, K. Moore, D. Jones, P. Silva, C. Going, J. Bowman, and N. Pougatchev. 2007. "Agricultural Pollutant Emissions Determined via Standard Emission Rate Estimation Methods and Lidar Techniques," presented at AAAR 2007 Annual Meeting, Reno, NV, September 2007.

Bingham, G.E., T. Wilkerson, V. Zavyalov, J. Bowman, C. Marchant, K. Moore, R. Martin, P. Silva, L. Hipps, and J. Hatfield. 2007. "Integrated Whole Facility Aerosol Fluxes," Western Dairy Air Quality Symposium, Las Vegas, NV, April 26, 2007.

Martin, R.S., V.S. Doshi, and K. Moore. 2006. Determination of particulate (PM_{10} and $PM_{2.5}$) and gas-phase ammonia (NH_3) emissions from a deep-pit swine operation using arrayed field measurements and inverse Gaussian plume modeling, pp. 890-894, in: Viney, P.A. *et al*. (Ed.), Proceedings: Workshop on Agricultural Air Quality: State of the Science. Dept. of Communication Services, North Carolina State University, Raleigh, NC.

Silva, P., R.S. Martin, V.S. Doshi, K. Moore, and M. Erupe. 2006. Variations in particle composition and size distributions in and around a deep pit swine operation, pp. 584-585, in: Viney, P.A. *et al*. (Ed.), Proceedings: Workshop on Agricultural Air Quality: State of the Science. Dept. of Communication Services, North Carolina State University, Raleigh, NC.

JAMES M. STEICHEN, Associate Director, National Institute for Land Management and Training, and Professor of Biological and Agricultural Engineering, Kansas State University

Degrees:	Ph.D., Agricultural Engineering	Oklahoma State University, 1974
	BS, Agricultural Engineering	Oklahoma State University, 1970

PROFESSIONAL: Licensed Professional Engineer—Kansas # 10,037
Certified Professional in Erosion and Sediment Control—CPESC # 1750

AREAS OF SPECIALIZATION: Hydrology, water quality, military training lands management, soil erosion control, ecological engineering.

EXPERIENCE:
Associate Director, National Institute for Land Management and Training, Kansas State University, 1996-
Professor, Kansas State University, 1988-
Associate Professor, Kansas State University, 1980-1988
Assistant Professor, Kansas State University, 1978-1980
Assistant Professor, University of Missouri-Columbia, Extension Soil and Water Specialist, 1974-78
Maintainability Engineer, Army Materiel Command, Texarkana, Texas, 1970-1971
Professional Summer Employment:
U.S. Geological Survey, Lawrence, Kansas, 1988-1991
Kansas Department of Health & Environment, 1991

CURRENT DUTIES:
Administrative—Associate Director, National Institute for Land Management and Training, Kansas State University, Manhattan, Kansas, January, 1996 to present
Teaching—Professor, Department of Biological and Agricultural Engineering, Kansas State University, Manhattan, Kansas, 1988 to present
Courses taught (current and previous): ATM 661—Water and Waste in the Environment (On-campus & Internet), ATM 451—Water Resources and Hydrology (Internet course), BAE 551—Hydrology, BAE 530—Natural Resources Engineering, BAE 533—Applied Hydrology, BAE 815—Graduate Seminar, ATM 653—Water Management and Irrigation Systems, ATM 654—Irrigation Systems Lab, BAE 690—Non-Point Pollution Engineering, ATM 558—Soil Erosion & Sediment Pollution Control, ATM 160—Engineered Systems and Technology in Agriculture. Team taught DEN 582—NRES Environmental Project.
Research—Member of the Graduate Faculty.

CURRENT AND PREVIOUSLY COMPLETED PROJECT REFERENCES

- Principal Investigator for "Assessing the Impact of Maneuver Training on NPS Pollution and Water Quality" funded by the Strategic Environmental Research and Development Program (SERDP) of the Department of Defense. ($1,337,512) (2003 – 2008) Project SI-1339.
- Co-Principal Investigator for "Continuous, Wireless Monitoring of Sediment Flux at Multiple Low-Water Stream Crossings on Tank Trails." DOD ESTCP Project. Co-PI, $229,655 1st year, Project started in 2008. This project resulted from work in the previous SERDP project.
- Principal Investigator for "Vehicle Impact Tracking Study" funded by U.S. Army Construction Engineering Research Laboratories, Champaign, IL. ($204,966) (2000 - 2001)
- Principal Investigator for various "Integrated Training Area Management (ITAM) Program Support" contracts funded by U.S. Army Environmental Center. Aberdeen Proving Ground, MD. (Approximately $3.5 million since 2000)

SELECTED PUBLICATIONS:

Kalita, P.K., G.J. Kluitenberg, P.L. Barnes, A.P. Schwab, J.K. Koelliker, J.M. Steichen, D. Black, M.J. Borah, and D.L. Oard. 1998. A monolith weighing lysimeter system for characterizing fate and transport of agricultural chemicals in soils. Applied Engineering in Agriculture 14(5):485-491.

Sample, Larry J., James Steichen, and John R. Kelley, Jr. 1998. Water quality impacts from low water fords on military training lands. *Journal of the American Water Resources Association.* 34(4):939-949.

Stoll, Quentin, Zhang, Naiqian, Hutchinson, Stacy, and Steichen, James. 2003. Methods for measuring suspended-sediment concentration in streams, Paper Number: 033147, 2003 ASAE Annual International Meeting, ASAE, St. Joseph, MI.

Steichen, James. 2003. A strategy for military training lands to comply with TMDL requirements. Published Abstract, SERDP/ESTCP Partners in Environmental Technology Symposium.

Doyle, Geoffrey L., Charles W. Rice, Dallas E. Peterson, and James Steichen. 2004. Biologically defined soil organic matter pools as affected by rotation and tillage. Environmental Management 33:S528-S538.

Watanabe, Hirozumi, Nathan L. Watermeier, James M. Steichen, Phillip Barnes, Thai K. Phong. 2006. Impacts of tillage and application method on atrazine and alachlor losses from upland fields. Accepted for publication. Weed Biology and Management.

Malinga, Gilbert, James Steichen, Timothy Keane, Stacy L. Hutchinson, and Philip B. Woodford. 2007. Assessing Impact of Low Water Fords on Stream Stability, Fort Riley, Kansas. *In Proc. 2007 International ASABE Annual Meeting,* CD-ROM. ASABE Paper No. 073079. St. Joseph, Mich.: ASABE.

Malinga, Gilbert, James Steichen, Timothy Keane, and Philip B. Woodford. 2007. Design, Site Selection and Construction of Low Water Fords at Fort Riley, Kansas. *2007 Army Sustainable Range Workshop*, Hampton, VA.

Malinga, Gilbert, James Steichen, Timothy Keane, Stacy L. Hutchinson, and Philip B. Woodford. 2007. Low Water Fords: Site Selection, Design and Construction. 2007. American Ecological Engineering Society Annual Meeting. Manhattan, KS.

Steichen, E. Marie, Alok Bhandari, James Steichen, and Larry E. Erickson. 2007. Educating Students for Participation as Members of Multidisciplinary Teams. In *Innovations 2008.* International Network for Engineering Education and Research, Arlington, VA. Book chapter, accepted for publication.

Zhang, Yali, Naiqian Zhang, Gerhard M. Grimm, Carl Johnson, Darrell Oard, and James Steichen. 2007. Long-term Field Test of an Optical Sediment-Concentration Sensor at Low-Water Stream Crossings. ASABE Paper No. 072137. St. Joseph, Mich.: ASABE.

SYNERGISTIC ACTIVITIES:

From about 1997 – 2003 the National Institute for Land Management and Training (NILMT) implemented demonstration projects and provided support services for the U.S. Army Integrated Training Area Management (ITAM) Program. The purpose of ITAM is to support military training by assuring the sustainable use of military training lands and ranges. NILMT worked with Army and National Guard installations in several states to provide assistance in managing their training lands, implementing innovative land rehabilitation projects, developing LCTA programs, range design, and creating comprehensive GIS-based land management systems. From 1997 – 2003 NILMT implemented demonstration projects and provided support services for the ITAM Program. The SERDP-funded "Assessing the Impact of Maneuver Training on NPS Pollution and Water Quality" research project at Ft. Riley evaluated the effectiveness of native grass filter strips in improving water quality, evaluated the impact of hardened stream crossings on stream stability, developed a real-time in-stream sediment concentration sensor, and developed GIS tools for making land management decisions by Army officials. The 2006 ITAM Workshop held at K-State and Ft. Riley was attended by over 500 people. The field day was a major technology transfer activity for demonstrating SERDP research results for Army professionals.

WILLIAM J. BRADFORD

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Space Dynamics Laboratory
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CITIZENSHIP:

Born 18 February 1969, Logan, Utah, United States

EDUCATION:

Utah State University, Logan, Utah
June 1997, B.S. – Environmental Engineering
GPA - 3.427 (4.0 = A)

EMPLOYMENT HISTORY:

2007 – Present	Space Dynamics Laboratory North Logan, UT *Civil Engineer II*
2005 - 2007	City of Logan Logan, UT *Environmental Engineer*
1999 – 2005	Utah Water Research Laboratory Logan, UT *Research Associate*
1998 – 1999	Idaho Association of Soil Conservation Districts St. Anthony, ID *Water Quality Resource Conservationist*
1996 – 1998	Utah Water Research Laboratory Logan, UT *Research Technician*

LICENSES:

Utah Commercial Drivers License
Class A
Expires February 2013

Appendix A1 – Master Cost Spreadsheet

Master budget (EWERU lead)		Year 1		Year 2		Year 3		GRAND TOTAL	
						Proposal Number: 10 S103-032			
Labor (*1)	**Rate**	Units	Total	Units	Total	Units	Total	Units	Total
Larry Wagner - PI for entire project	$50.00	700	$0	700	$0	700	$0	2,100	$0
John Tatarko	$45.00	520	$0	520	$0	520	$0	1,560	$0
Mark Casada	$45.00	520	$0	520	$0	520	$0	1,560	$0
ARS Post-Doc	$30.00	2,080	$62,400	2,080	$64,272	2,080	$66,200	6,240	$192,872
Student labor (4 half time& 1 full time individuals)	$9.75	6,240	$60,840	6,240	$62,665	6,240	$64,545	18,720	$188,050
TOTAL LABOR			**$123,240**		**$126,937**		**$130,745**		**$380,923**
Indirect Charge #1 @ 35% (Post-Doc)	35.00%		$21,840		$22,495		$23,170		$67,505
Indirect Charge #1 @ 7.65% (students)	7.65%		$4,654		$4,794		$4,938		$14,386
Indirect Charges (total)			**$26,494**		**$27,289**		**$28,108**		**$81,891**
Subcontractor: (all contracts greater than $10,000)									
KSU (Biological and Agricultural Engineering Dept.)			$297,327		$300,686		$282,797		$880,810
Space Dynamics Laboratory			$288,120		$333,524		$132,788		$754,432
Chico State University			$0		$365,224		$110,461		$475,685
Total Subcontractor			**$585,447**		**$999,434**		**$526,046**		**$2,110,927**
Travel:									
Wagner - SERDP Symposium			$2,000		$2,000		$2,000		**$6,000**
Wagner - ASABE or related meeting			$2,000		$2,000		$2,000		**$6,000**
Post-doc ASABE or related meeting			$2,000		$2,000		$2,000		**$6,000**
Tatarko - SSSA Conference			$2,000		$2,000		$2,000		**$6,000**
Casada - ASABE or related meeting			$2,000		$2,000		$2,000		**$6,000**
Wagner plus one student for site survey travel			$2,000		$2,000				**$4,000**
Wagner - Per Diem/lodging for field experiments					$9,720				**$9,720**
Post-Doc - Per Diem/lodging for field experiments					$9,720				**$9,720**
3 Students - Per Diem/lodging for field experiments					$29,160				**$29,160**
Tatarko - Per Diem/lodging for field experiments					$9,720				**$9,720**
Casada - Per Diem/lodging for field experiments					$9,720				**$9,720**
Per Diem/lodging for plot sampling									
MS and student (2 individuals) 10 days per trip (3 per year)			$10,800		$10,800		$10,800		
Transport of tunnel to experimental sites ($1/mile) (3500 miles)					$3,500				**$3,500**
Field vehicles to experimental sites (Ford truck) $0.55/mile (3500 miles)					$1,925				**$1,925**
Field vehicles to experimental sites (Ford van) $0.55/mile (3500 miles)					$1,925				**$1,925**
Field vehicles to experimental sites (truck pulling 30ft trailer) $0.55/mile (3500 miles)					$1,925				**$1,925**
Field vehicle travel to plot sites ($0.55/mile*3 trips/yr) (3500 miles)			$5,775		$5,775		$5,775		**$17,325**
Lease 2nd 5th wheel dually vehicle for 30ft trailer (estimate)					$6,500				**$6,500**
Total Travel			**$28,575**		**$112,390**		**$26,575**		**$167,540**
Other Direct Costs:									
DusTrak DRX or similar samplers 5@$5,000ea			$25,000						**$25,000**
High end workstation for Post-doc/data processing			$6,500						**$6,500**
SWECO Sieve			$5,000						**$5,000**
Materials, Supplies and Consumables									**$0**
Soil Sampling Tubs (500 @ $10ea)			$5,000						**$5,000**
Soil Sampling plastic containers with lids (500 @ $7.50ea)			$3,750						**$3,750**
Arizona Test Dust (reference grades)			$5,000		$5,000				**$10,000**
Fuel for portable tunnel ($5/gal*5gal/hr*4hr/day) * 30 and 40 days			$3,000		$4,000				**$7,000**
Fuel for portable generators ($5/gal*5gal/hr*12hr/day) * 30 and 40 days			$9,000		$12,000				**$21,000**
Publication Costs					$1,000		$2,000		**$3,000**
Other									**$0**
Total Other Direct Costs			**$62,250**		**$22,000**		**$2,000**		**$86,250**
Subtotal Cost			**$826,006**		**$1,288,050**		**$713,474**		**$2,827,531**
Indirect Charge #2 @11.11% (*3) (excluding major equip.)	11.11%		$87,714		$143,102		$79,267		**$310,084**
Total Cost Excluding Fee			**$913,720**		**$1,431,153**		**$792,741**		**$3,137,614**
Fixed Fee @ X% (if applicable) - Excluding Equipment (*4)									
TOTAL PRICE			**$913,720**		**$1,431,153**		**$792,741**		**$3,137,614**

Appendix A1 – KSU Subcontract Cost Spreadsheet

								Proposal Number: 10 S103-032	
KSU subcontract with EWERU		Year 1		Year 2		Year 3		GRAND TOTAL	
Labor (*1)	**Montlhy Rate**	Month	Total	Month	Total	Month	Total	Month	Total
Lead Technical Individual - R. Maghirang	$12,191	2.00	$24,382	2.00	$25,113	2.00	$25,867	6.00	$75,362
Other Significant Technical Individual - J. Steichen	$9,751	0.75	$7,313	0.75	$7,533	0.75	$7,759	0.75	$22,605
Post-doctoral research associate	$3,750	12.00	$45,000	12.00	$46,350	12.00	$47,741	12.00	$139,091
Graduate research assistant	$2,083	12.00	$25,000	12.00	$25,750	12.00	$26,522	12.00	$77,272
Graduate research assistant	$2,083	12.00	$25,000	12.00	$25,750	12.00	$26,522	12.00	$77,272
Undergraduate research assistant			$5,000		$5,150		$5,305		$15,455
TOTAL LABOR			**$131,695**		**$135,646**		**$139,715**		$407,056
Fringe Benefits			**$27,296**		**$28,114**		**$28,958**		**$84,368**
Subcontractor: (all contracts greater than $10,000)									
Organization Name (Subcontractor 1)									
Total Subcontractor			**$0**		**$0**		**$0**		**$0**
Travel:									
Domestic Travel			$10,000		$10,000		$10,000		**$30,000**
Foreign Travel			$0		$0		$0		**$0**
Total Travel			**$10,000**		**$10,000**		**$10,000**		**$30,000**
Other Direct Costs:									
Major Equipment									**$0**
Materials, Supplies and Consumables			$12,000		$12,000				**$24,000**
Publication Costs					$2,000		$2,000		**$4,000**
Other			$22,500		$18,000		$13,000		**$53,500**
Total Other Direct Costs			**$34,500**		**$32,000**		**$15,000**		**$81,500**
Subtotal Cost			**$203,491**		**$205,761**		**$193,673**		**$602,925**
Indirect Charge #2 @ 48% (*3)			$93,836		$94,925		$89,124		**$277,885**
Total Cost Excluding Fee			**$297,327**		**$300,686**		**$282,797**		**$880,810**
Fixed Fee @ X% (if applicable) - Excluding Equipment (*4)									
TOTAL PRICE			**$297,327**		**$300,686**		**$282,797**		**$880,810**

Appendix A1 – SDL Subcontract Cost Spreadsheet

SDL subcontract with EWERU		Year 1		Year 2		Proposal Number: 10 S103-032 Year 3		GRAND TOTAL	
Labor (*1)	**Rate**	Units	Total	Units	Total	Units	Total	Units	Total
Lead Technical Individual - Dr. Mike Wojcik	$48.23	420	$20,257	500	$25,130	120	$6,284	1,040	$51,671
Civil Engineeer - Kori Moore	$26.10	570	$14,877	637	$17,326	100	$2,834	1,307	$35,037
Civil Engineeer - William Bradford	$24.52	570	$13,976	637	$16,275	100	$2,662	1,307	$32,914
Technical Writer	$32.74	44	$1,441	44	$1,501	44	$1,564	132	$4,506
Cost Analyst/Program Coordinator	$36.52	44	$1,607	44	$1,674	44	$1,745	132	$5,026
Graduate Students	$16.17	659	$10,651	659	$11,099	659	$11,564	1,976	$33,313
TOTAL LABOR			**$62,808**		**$73,006**		**$26,653**		**$162,467**
Indirect Charge #1 @ ~115% (*2) for SDL employees									
Indirect Charge #1 @ ~33% (*2) for graduate student labor									
Indirect Charges (total)			**$74,091**		**$87,208**		**$25,470**		**$186,769**
Subcontractor: (all contracts greater than $10,000)									
Utah State University - Dr. Randy Martin			$38,122		$44,002		$36,126		$118,251
									$0
Total Subcontractor			**$38,122**		**$44,002**		**$36,126**		**$118,251**
Travel:									
Domestic Travel			$41,954		$41,954		$3,000		**$86,909**
Foreign Travel			$0		$0		$0		**$0**
Total Travel			**$41,954**		**$41,954**		**$3,000**		**$86,909**
Other Direct Costs:									
Major Equipment									**$0**
Materials, Supplies and Consumables			$7,000		11000		$2,000		**$20,000**
Publication Costs									**$0**
Other			$12,755		$16,832		$9,874		**$39,461**
Total Other Direct Costs			**$19,755**		**$27,832**		**$11,874**		**$59,461**
Subtotal Cost			**$236,731**		**$274,002**		**$103,123**		**$613,856**
Indirect Charge #2 @ 12.8% (*3)	12.8%		$30,547		$35,412		$17,156		**$83,115**
Total Cost Excluding Fee			**$267,278**		**$309,413**		**$120,279**		**$696,970**
Fixed Fee @ 7.8% (if applicable) - Excluding Equipment (*4)	7.8%		$20,842		$24,111		$12,509	$	57,462
TOTAL PRICE			**$288,120**		**$333,524**		**$132,788**		**$754,432**

Appendix A1 – USU Sub-Subcontract Cost Spreadsheet

						Proposal Number: 10 S103-032			
USU sub-subcontract with SDL		Year 1		Year 2		Year 3		GRAND TOTAL	
Labor (*1)	**Rate**	Units	Total	Units	Total	Units	Total	Units	Total
Lead Technical Individual - Dr. Randy Martin	$8,670.00	1.5	$13,004	2.0	$17,860	1.0	$9,197	5	$40,061
Undergraduate Student	$500.00	10	$5,000	10	$5,150	11	$5,355	31	$15,505
TOTAL LABOR			**$18,004**		**$23,010**		**$14,552**		**$55,566**
Indirect Charge #1 @ X% (*2)			**$5,992**		**$6,254**		**$6,515**		**$18,761**
Subcontractor: (all contracts greater than $10,000)									
Organization Name (Subcontractor 1)									$0
Total Subcontractor			**$0**		**$0**		**$0**		**$0**
Travel:									
Domestic Travel			$0		$0		$0		**$0**
Foreign Travel			$0		$0		$0		**$0**
Total Travel			**$0**		**$0**		**$0**		**$0**
Other Direct Costs:									
Major Equipment									**$0**
Materials, Supplies and Consumables			$1,390		$1,582		$1,469		**$4,441**
Publication Costs									**$0**
Other			$2,000		$2,060		$2,122		**$6,182**
Total Other Direct Costs			**$3,390**		**$3,642**		**$3,591**		**$10,623**
Subtotal Cost			**$27,386**		**$32,906**		**$24,658**		**$84,950**
Indirect Charge #2 @ X% (*3)			$10,736		$11,096		$11,469		**$33,301**
Total Cost Excluding Fee			**$38,122**		**$44,002**		**$36,126**		**$118,251**
Fixed Fee @ X% (if applicable) - Excluding Equipment (*4)			$0		$0		$0		$0
TOTAL PRICE			**$38,122**		**$44,002**		**$36,126**		**$118,251**

Appendix A1 – Chico State Subcontract Cost Spreadsheet

						Proposal Number: 10 S103-032			
Chico St. subcontract with EWERU		**Year 1**		**Year 2**		**Year 3**		**GRAND TOTAL**	
Labor (*1)	**Rate**	Units	Total	Units	Total	Units	Total	Units	Total
Shane Mayor (manage and conduct field deployment)	44.23		$0	520	23,000		0		$23,000
Shane Mayor (manage software development)	44.23		$0	347	15,348	347	15,808		$31,156
Post-doctoral associate			$0		40,000		41,200		$81,200
Two students to pack/unpack lidar in Chico	12.00		$0	160	1,920		0		$1,920
Two students to pack/unpack lidar at field site	12.00		$0	160	1,920		0		$1,920
Two students to help operate lidar for four weeks	12.00		$0	448	5,376		0		$5,376
TOTAL LABOR			**$0**		**87,563**		**57,008**		$144,572
Fringe Benefits (Mayor @ 30%/33%)	0.30		**$0**		**11,504**		**5,217**		$16,721
Fringe Benefits (Post-Doc @ 42%)	0.42		**$0**		**16,800**		**17,304**		$34,104
Fringe Benefits (Post-Doc @ 10%)	0.10		**$0**		**922**		**0**		$922
Indirect Charge #1 @ X% (*2)			**$0**		**29,226**		**22,521**		$51,747
Subcontractor: (all contracts greater than $10,000)									
NCAR/EOL labor subcontract					20,825				$20,825
Total Subcontractor			**$0**		**20,825**		**0**		**$20,825**
Travel:									
Domestic Travel			$0		0		0		**$0**
Mayor - site survey travel					2,000				
Mayor - travel & lodging for field experiment					10,840				
Spuler - travel & lodging to optimize REAL after returned to Chico					2,380				
Morley - travel & lodging to optimize REAL after returned to Chico					2,380				
Students - travel & lodging for field experiment					21680				
Spuler and Morley - travel & lodging for field experiment					10,260				
Foreign Travel			$0		0		0		**$0**
Total Travel			**$0**		**49,540**		**0**		**$49,540**
Other Direct Costs:									
Major Equipment (Workstation for post-doc/vector winds)					6,500				**$6,500**
Materials, Supplies and Consumables									
General OE (ie. Phones, postage etc)					500		515		**$1,015**
Software for workstation					1,000				**$1,000**
Cleaning supplies					1,000				**$1,000**
Forklift rental (United Rentals)					2,000				**$2,000**
Methane and Argon gas and fuel tank rental					600				**$600**
Fuel 7762 gal $5.50/gallon					42,691				**$42,691**
Flash lamps (20 lamps @$250 ea)					1,500				**$1,500**
Hard disks (6 @ $250)					1,500				**$1,500**
Shipping of lidar (round trip)					12,000				**$12,000**
Contractual									
125KVA Diesel Generator (rental) (incl delivery, txs, ins)					6,500				**$6,500**
Publication Costs									
Other									
Post-doc relocation costs					2,500				**$2,500**
Post-doc advertising for position					1,000				**$1,000**
Total Other Direct Costs			**$0**		**79,291**		**515**		**$79,806**
Subtotal Cost			**$0**		**266,445**		**80,044**		**$346,489**
Indirect Charge #2 @ X% (*3)	38.00%		$0		98,779		30,417		**$129,196**
Total Cost Excluding Fee			**$0**		**365,224**		**110,461**		**$475,685**
Fixed Fee @ X% (if applicable) - Excluding Equipment (*4)									
TOTAL PRICE			**$0**		**$365,224**		**$110,461**		**$475,685**

Appendix A1 – NCAR Sub-Subcontract Cost Spreadsheet

						Proposal Number: 10 S103-032			
NCAR sub-subcontract with Chico St.			**Year 1**		**Year 2**		**Year 3**		**GRAND TOTAL**
Labor (*1)	**Rate**	Units	Total	Units	Total	Units	Total	Units	Total
Lead Technical Individual - Spuler	$96,650			2.00%	$1,933			0	$1,933
Associate Scientist - Morley	$84,225			8.00%	$6,738			0	$6,738
TOTAL LABOR			**$0**		**$8,671**		**$0**		**$8,671**
	53.5%				**$1,034**				
	53.5%				**$3,605**				
Indirect Charge #1 @ 53.5% (*2)					**$4,639**				**$4,639**
Subcontractor: (all contracts greater than $10,000)									
									$0
Total Subcontractor			**$0**		**$0**		**$0**		**$0**
Travel:									
Domestic Travel			$0		$0		$0		**$0**
Foreign Travel			$0		$0		$0		**$0**
Total Travel			**$0**		**$0**		**$0**		**$0**
Other Direct Costs:									
Major Equipment									**$0**
Materials, Supplies and Consumables									
Publication Costs									**$0**
Other									
Total Other Direct Costs			**$0**		**$0**		**$0**		**$0**
Subtotal Cost			**$0**		**$13,310**		**$0**		**$13,310**
Indirect Charge #2 @ 51.9% (*3)	51.9%		$0		$6,908		$0		**$6,908**
Total Cost Excluding Fee			**$0**		**$20,218**		**$0**		**$20,218**
Fixed Fee @ X% (if applicable) - Excluding Equipment (*4)			$0		$0		$0		$0
TOTAL PRICE			**$0**		**$20,218**		**$0**		**$20,218**

Appendix A2 – Cost by Task Spreadsheet

Cost Proposal By Tasks **Proposal Number: 10 S103-032**

Task	Year 1 ($K)	Year 2 ($K)	Year 3 ($K)	Total ($K)
Task 1a - Characterize relevant temporal and intrinsic soil and surface properties, via laboratory wind tunnel tray studies, to measure total dust as well as PM10 emission potential on military land soils	$106	$85	$86	$276
Task 1b - Collect soil and plant data from plot studies to determine impact of military activities on erodibility and the recovery times	$45	$54	$40	$139
Task 1c - Characterize and model individual military vehicle impacts on temporal surface and soil properties as functions of intrinsic soil properties and vehicle attributes/parameters	$60	$68	$40	$167
Task 1d - Develop algorithms and incorporate them into WEPS to predict potential fugitive dust emissions by wind erosion	$15	$15	$15	$45
Task 2a - Measure diffusion and deposition for a range of soil dust particle sizes in the near-field scale	$241	$297	$118	$656
Task 2b - Measure emission, diffusion and deposition in the near-field scale by particle size	$263	$215	$104	$583
Task 2c - Model the transport and fate of particulate matter using computational fluid dynamics	$77	$99	$72	$248
Task 2d - Evaluate and enhance short-range dispersion models for fugitive dust emissions from DoD activities	$77	$115	$103	$296
Task 3a - Develop and test a prototype, eye-safe, wind and PMsensing lidar, WindPod	$29	$6	$59	$95
Taks 3b - Develop a portable, integrated stand-alone PM measurement emission prediction system consisting of WindPod and software component called VAEPRS	$0	$24	$44	$68
Task 3c - Fully characterize fugitive dust plumes from emission sources using multiple lidar systems to track changes in plume shape, movement, and concentration with downwind distance	$0	$454	$111	$565
Total	$914	$1,431	$793	$3,138

Provide dollar amounts associated with each task for every year of the project