

***Proposal for 2008-2009
Northwest Columbia Plateau PM₁₀ Project***

Objectives 3 and 4: Measurement and Modeling of PM₁₀

Title: *Development and Evaluation of a Regional Windblown Dust Modeling System*

Personnel: **Principal investigator: Serena Chung, WSU;
Co-principal investigator: Brian Lamb, WSU.**

Project Objectives

The overall goal for this work is to develop and evaluate a regional windblown dust modeling system for the Pacific Northwest. The specific objectives include:

- a) couple the Wind Erosion Prediction System (WEPS) dust submodule EROSION with the WRF/CMAQ air quality modeling system as a basis for a regional windblown dust model,
- b) evaluate the performance of WRF/WEPS/CMAQ for several historical dust storms and compare the performance with the previous modeling system,
- c) describe the results of the development and evaluation in a peer reviewed journal publication,
- d) evaluate selected land management practices in terms of the effects upon dust production and impact upon air quality using the new modeling system,
- e) describe the results for these land management effects in a peer reviewed publication, and
- f) incorporate the new dust modeling approach as part of the AIRPACT-3 air quality forecast system.

Recent Accomplishments

The major accomplishment in recent funding periods has been the development and compilation of detailed soil and land use databases on a gridded basis that are compatible with the use of the WEPS dust module in a regional modeling system. A journal paper describing these databases has been prepared and submitted for review.

Preliminary tests of using the previous dust emission algorithm with the new CMAQ modeling system were conducted, and preliminary work was initiated to investigate the best way to incorporate WEPS EROSION submodel into the WRF/CMAQ modeling system. These efforts provide a basis for the work proposed herein.

Planned Research

As indicated in the list of objectives, we will link the windblown dust module EROSION from the WEPS model with our existing regional air quality modeling system as implemented in the AIRPACT-3 automated daily forecast system. Currently, the AIRPACT-3 system uses meteorological forecasts from the University of Washington Mesoscale Meteorological model Version 5 (MM5). In the very near future, these meteorological forecasts will be generated using a new, state-of-the-art weather model called the Weather Research Forecast (WRF) model. We will thus begin using WRF as a routine part of the AIRPACT-3 forecast system. In AIRPACT-3, emissions from a wide range of sources, both anthropogenic and biogenic, are dynamically estimated on an hourly, gridded basis using existing EPA databases and an emissions processing tool called the Sparse Matrix Operating Kernel for Emissions (SMOKE). These emissions and the meteorological fields from WRF are input to the Community Multi-scale Air Quality (CMAQ) model. The CMAQ model explicitly accounts for terrain, landcover, gas and aerosol chemistry, particle dynamics, and wet and dry deposition to predict concentrations of a wide number of gas and aerosol phase pollutants including ozone and PM_{2.5}. The system is fully automated and runs daily to produce air quality forecasts for Idaho, Oregon, Washington, and surrounding areas. Results are provided to air quality managers and the public via a website: <http://www.lar.wsu.edu/airpact-3>.

We plan to link the dust module in WEPS to a stand alone version of the AIRPACT-3 system to take advantage of the automated processing that already exists for the system and as a step towards implementing a dust forecast as part of AIRPACT-3. Using the stand alone version will allow us to simulate past dust storms in a straightforward manner and in a way that is consistent with our current modeling system.

The key tasks in linking WEPS will be to identify the dust module data requirements and develop methods for supplying this information from the WRF meteorological fields and from the new soil and land use databases. Windblown dust will be treated in terms of inert coarse particulate matter (PMC) within the model. This will allow us to treat different source types or source areas separately in terms of different PMC traces and will give us additional information about which types of landcover or which areas within the domain are producing dust. For example, we can treat dry cropland, irrigated cropland, and CRP lands with individual tracers to keep track of the contributions of these land use types to the total PMC concentration.

After the WEPS dust module is linked and tested with the WRF/CMAQ system, we will apply it to several of the historical dust storms we have simulated previously (Sundram et al., 2004; Claiborn et al., 1998). In the previous simulations, the model system employed the MM5/CALGRID models and used a dust emission algorithm (EMIT) developed by Saxton et al (2000) based upon regional field and laboratory measurements for the CP₃ domain. The results for these previous simulations were quite mixed and generally required a significant calibration of the dust model to yield reasonable PM₁₀ concentrations compared to observed levels.

Results from the new modeling system for these historical events will be compared to observations and to the results from the previous modeling system. The work will be summarized in a manuscript for submission to a peer reviewed journal.

After evaluation of the WRF/WEPS/CMAQ system, we will conduct a series of sensitivity tests to investigate the effects of different farming practices upon dust production and the associated PM₁₀ ambient concentrations. The specification of these farming practices will be determined in consultation with other members of the CP₃ research group. Results from these sensitivity tests will be summarized in a paper for submission to a peer reviewed journal.

The last portion of this work will involve incorporation of the WEPS dust module into the operational AIRPACT-3 forecast system. This should be relatively straightforward since we will be using essentially very similar scripting of the programs for the historical tests as is used in AIRPACT-3. One consideration that will require additional thought and work is how to update landcover and soil moisture for the WEPS databases to account for seasonal changes. Soil moisture is available via the WRF modeling system and management practices are incorporated into the landcover database. We will seek to use these as part of the operational system.

The AIRPACT-3 system has been evaluated in a preliminary study and will undergo additional evaluations, in part through an automated validation system. These future evaluations will include examination of AIRPACT-3 performance for PMC during windblown dust periods.

References cited

- Claiborn, C., B.K. Lamb, A. Miller, J. Beseda, B. Clode, J. Vaughan, L. Kang, and C. Newvine. 1998. Regional measurements and modeling of windblown agricultural dust: The Columbia Plateau PM₁₀ Program. *J. Geophys. Res.* 103, 19753-19768.
- Saxton, K., D. Chandler, L. Stetler, B. Lamb, C. Claiborn, and B.H. Lee. 2000. Wind erosion and fugitive dust fluxes on agricultural lands in the Pacific Northwest, *Transactions of the ASAE* 43, 1-8.
- Sundram, I., C. Claiborn, T. Strand, B. Lamb, D. Chandler, and K. Saxton. 2004. Numerical modeling of regional windblown dust in the Pacific Northwest with improved meteorology and dust emission models. *J. Geophys. Res.* 109, D24208, doi:10.1029/2004JD004794, 2004.